
Innovation Funding Incentive





Network companies need to facilitate the move to a low carbon economy while maintaining safe, secure and reliable energy supplies at long-term value for money to consumers. Gas and electricity networks will need to be smarter to integrate more renewable and intermittent sources and to encourage customers to manage their demand. To achieve this, network companies will need to innovate at an unprecedented rate.”

Quote taken from the RIIO T1 Decision Business Plan available on the Ofgem website.

Contents

By Chapter

01 Introduction from Nick Winser	01	08 Innovation Profile	10
02 Our Business	02	09 Knowledge Transfer	12
03 Awards and Recognition	03	10 Focus on Electricity Innovation	13
04 Investment in Innovation	04	11 Focus on Gas Innovation	18
05 The Innovation Transmission Team	06	12 Finance Overview and Benefits of the Portfolio	21
06 RIIO Arrangements	07	13 Looking Forward	22
07 Technology Readiness Level	09	14 Keep in Touch	24



“Innovation is central to our strategy at National Grid. Extensive feedback from customers and stakeholders through the RIIO process has confirmed this is important to them as well. We will continue to push the boundaries of innovation in our sector to ensure we keep delivering the service expected from us.”

Nick Winser, Executive Director, National Grid UK

Highlights

Electricity Transmission IFI Investment

£6,656,000

+1.25%

Gas Transmission IFI Investment

£3,232,000

+16%

Total Number of Projects

152

+18%

Electricity Transmission NIA Budget

£10,928,000

+52%

Gas Transmission NIA Budget

£4,386,000

+34%

Welcome to this 2012/13 report covering the sixth year of National Grid's research and development programme funded by the Transmission Innovation Funding Incentive (IFI).

2012/13 has been a great year for R&D within National Grid. We have started to work on a whole range of new ideas and projects, as well as continuing to develop those from previous years with a longer time to implementation. This programme is designed to ensure that we stay at the forefront of technology in our sector and deliver the economic and efficient service customers expect from us. During the year we have refreshed our company vision and line of sight framework. A core part of this framework is our strategy; a definition of what and how we will achieve our vision. Our commitment to innovation within this remains unchanged.

Innovation has a crucial role in enabling us and the wider energy industry to meet the challenges of delivering low carbon energy safely and reliably. Building on our historical successes of driving new ideas we have been able to build an innovation strategy that leverages both internal and external expertise. The initiatives we have delivered under the Innovation Funding Incentive provide considerable value now, and will continue to do so as these new technologies are installed on our networks.

This last year was an important one for National Grid as we accepted the RIIO proposals. This comes into effect in the 2013/14 financial year with innovation a fundamental part of it. For National Grid this means an increase in the already large portfolio of projects along with encouraging us to broaden our thinking into other areas of the business. For example, we are now strongly encouraged to find new ways to deliver the same

network outputs at a lower capital cost. As a result we will be investigating what commercial innovation looks like and has to offer. Innovation under RIIO can also include process improvements such as more effective supply chain management and streamlined work planning. This broadening remit supports us in driving innovation in to every area of our business, and enables the staff, stakeholders and customers of National Grid to benefit.

Over the next 8 years, we anticipate substantial investment in our networks. In Gas Transmission we need to harness innovation to fulfill our statutory environmental obligations and operate a more flexible network. This will support the different operational characteristics of gas fired generation plant providing the necessary back-up for intermittent sources of renewable generation as the electricity sector decarbonises. In Electricity Transmission we need to understand the impact this decarbonisation will have on network operations to ensure we deliver the same secure and reliable service. As well as playing our part in the decarbonisation of the energy sector, we have had some exciting developments in reducing the direct impacts that our assets have on the environment, both in our Gas and Electricity businesses.

With our continued challenges, it is vital that we minimise cost increases and become more efficient in what we do. We will stimulate innovation throughout our businesses and support the development of technologies and ways of working to build, maintain and operate the networks of the future.

National Grid is one of the largest investor-owned energy companies in the world. We own and manage the grids that connect people to the energy they need, from whatever the source. In Britain and the north-eastern states of the US, we run systems that deliver gas and electricity to millions of people, businesses and communities.

UK Transmission

Description

Electricity Transmission

We own and operate the electricity transmission system in England and Wales. Our networks comprise approximately 7,200 kilometres (4,470 miles) of overhead line, 1,400 kilometres (870 miles) of underground cable and 329 substations. We are also the national electricity transmission system operator, responsible for both the England and Wales transmission systems and the two high voltage transmission networks in Scotland, which we do not own.

Gas Transmission

We own and operate the gas national transmission system in Great Britain. The network comprises approximately 7,660 kilometres (4,760 miles) of high pressure pipe and 23 compressor stations.

US Regulated

Description

We own and operate electricity distribution networks in upstate New York, Massachusetts and Rhode Island serving approximately 3.4 million electricity consumers. We also maintain and operate the electricity transmission and distribution system on Long Island owned by the Long Island Power Authority. We own and operate an electricity transmission system of approximately

14,000 kilometres (8,800 miles) spanning upstate New York, Massachusetts, Rhode Island, New Hampshire and Vermont. Our US gas distribution networks serve around 3.5 million consumers across the northeastern US, located in upstate New York, New York City, Long Island, Massachusetts and Rhode Island.

UK Gas Distribution

Description

We own and operate four of the eight regional gas distribution networks in Great Britain. Our networks comprise approximately 131,000 kilometres (82,000 miles) of gas distribution pipeline and we transport gas from the gas national transmission system to around 10.9 million consumers on behalf of 26 gas shippers.

We manage the national gas emergency number (0800 111 999). This service, along with the enquiries lines, appliance repair helpline and meter enquiry service, handled more than 2,480,000 calls during 2012/13.

Other Activities

Description

Our other activities in the UK include National Grid Metering, National Grid Property, our LNG importation facility at the Isle of Grain, BritNed and Xoserve. In the US, they include LNG storage and road transportation, and transmission pipelines.

Awards & Recognition

“**Innovation is hugely important for National Grid, so it’s vital that we keep ourselves at the forefront of good practices and an obvious way to do this is to learn from others. The award helps to encourage others to openly share their solutions to challenges across the power and energy sector.**”

David Wright, Director of Electricity Transmission Asset Management – on presenting the Power and Energy accolade



LineScout Team



Composite Cross Arms Team



Innovation Transmission Team with awards

National Grid’s approach to innovation has been rewarded by the Institution of Engineering and Technology at their annual innovation awards ceremony.

Over 500 of the country’s top engineers from across all sectors attended the event, which was hosted by Olympic swimmer Mark Foster. For the first time, two National Grid sponsored entries for innovation won – highlighting the work being done to develop our innovation programme, working closely with industry experts and sharing best practice and ideas with other companies.

The Asset Management category was won by Hydro-Quebec, who outshone other entries for the development of LineScout – a high-voltage overhead-line robotic inspection and repair platform, which essentially is a robot that can inspect and make repairs on live transmission electricity conductors, even going over obstacles when necessary.

Hydro-Quebec has worked closely with National Grid to test this technology in the UK, with essential work being carried out prior to the Olympics using the LineScout. This has led to National Grid making arrangements to purchase two LineScouts for use by our own employees on our overhead lines from next year.

The ‘Power and Energy award’, sponsored by National Grid, was won by Arago Technology in collaboration with electricity transmission companies and the University of Manchester for the development of an insulating cross arm. This can be retro-fitted to existing overhead lines, allowing operators to increase transmission capacity by up to 150 per cent – in some circumstances this can avoid the need for new overhead line routes.

“Innovation will be vital for energy network companies as we meet future challenges. There are significant benefits from partnership and collaboration in the innovation we do with Linescout being a prime example. As we move forward enhancing our partnerships will be key.”

Paul Auckland, RIIO Strategy and Innovation Manager (Electricity)

With the challenges of the next 8 years, we welcome the new regulatory changes for the Network Innovation Allowance (following on from the Innovation Funding Incentive), as well as the brand new Network Innovation Competition. This will allow us to continue to deliver innovative solutions such as the key innovation achievements that we have progressed in the current price control period. We welcome the increase in funding from OFGEM, acknowledging the challenges that we face. To date, knowledge, technology and modelling have been implemented throughout the Asset Management businesses, adding to developments in many areas.

These include, but are not limited to:

Novel Conductor Trial

Alternative High Temperature Low Sag conductor developed by 3M is being trialled on an overhead line route. This could assist in managing constraint costs.

Strategic Asset Management

The strategic asset management (SAM) programme is being continually developed to provide a simple yet clever system to extend the lives of our assets by improved condition monitoring.

Enhanced Network Modelling

Many of the R&D projects provide increased learning of our networks using modelling to understand the implications of introducing new technology or network developments. This provides us with confidence in the resilience and security of our networks.

Maximising Capacity

Strategic reinforcement and increased ratings are being addressing across boundary constraints which will lead to active management of constraint costs.

Combined Geophysics Tool

New approaches to subsurface (geophysical) surveying have been trialled successfully, which will reduce the cost and impact on pipeline construction projects caused by unforeseen or avoidable sub-surface ground conditions.

Third Party Work Surveillance from Pipeline Marker Posts

Marker posts adapted to house camera monitoring systems have been successfully trialled. The system will provide an option to monitor third party civil works near pipelines.

Paint systems for Above Ground Installations

Large scale, long term field trials of single coat paint systems designed to extend the life of existing coatings have been successfully completed.



“Innovation isn’t just a specific output or a clever idea – it’s the desire we create across our company to find new and different ways of doing what we do more efficiently and effectively.”

*Neil Pullen, Director,
Gas Transmission Asset
Management*

“ National Grid’s job is to connect people to the energy they use, safely. We are at the heart of one of the greatest challenges facing our society – delivering clean energy to support our world long into the future. We work with all our stakeholders to promote the development and implementation of sustainable, innovative and affordable energy solutions.

We are proud that our work and our people underpin the prosperity and wellbeing of our customers, communities and investors.”

Chairman and Chief Executive’s welcome from the National Grid plc Performance Summary 2012/13

People are key to improving the service that we provide to customers. Without the critical thinking that is present within National Grid, we would not be able to produce the innovations that are detailed in the later sections of this report. There are many different opinions of what innovation is and what it means to us. The key to our high performing, virtual team of approximately 26,000 people is that we can all see the end goal of delivering a more efficient, more effective service to customers. This gives us a framework to work within, and express our innovative creativity effectively.

Behind this report, the innovation portfolio and multiple other R&D activities within and external to National Grid, sit the Innovation Transmission team. Our team helps stimulate, nurture and facilitate projects with people both inside and outside of the company.

Crucial to the role of our Innovation Transmission team are the employees of National Grid and our external R&D colleagues, who hold innovation at the centre of their careers and help the company to develop new processes, develop and trial new technologies, and are proud of their contribution to the innovation culture. We would like to thank everyone who contributes to the Innovation that happens in National Grid, even if their work is not featured in this regulatory report. Your work is appreciated and does not go unnoticed.

We build continually on what we have already learned within the business areas through research and innovation projects. This means that our projects do not fail, they just produce an aspect of learning that we had not considered before, and therefore they are of value. Projects continue to build on these foundations. It is this approach that gives you, the customer, a continually better service from us.

We hope that you will enjoy reading this report and we welcome feedback.

Thank you,

Jenny Cooper and the Innovation Transmission Team

“ Innovation to me is about a passion to do things better through increased knowledge, improved products and effective processes. Innovation depends on people and their willingness and enthusiasm to think differently. Innovation is at the heart of change and growth.”

Jenny Cooper, NIA Manager, National Grid

“ To me innovation is an abstract concept with many facets: it can mean taking a critical objective look at what we do and asking ourselves whether we are fundamentally clear why we are doing it at all, and why this is the best way to do it.”

David Oram, NIC Manager, National Grid

IFI to NIA:

Delivering the IFI portfolio for the last 6 years has been both challenging and rewarding. The project engineers who have initiated, managed, delivered and implemented the projects have seen great successes as well as great frustrations, as is expected within innovation. The number of people engaged with innovation grows annually as does the number of partners and suppliers. In 2012/13, we had over 40 collaborative project partners. The extended innovation community, developed through IFI, provides a great basis for the Innovation Stimulus under RIIO-T1.

The Network Innovation Allowance (NIA) allows us to expand our innovation support, from just asset focused, to any innovation with impact on the networks including commercial and operations innovation. We continue to rely on our colleagues to propose innovation that will impact their work area and is in line with our innovation strategy to drive innovation for customer benefit. We also encourage any external suppliers to introduce us to other potential innovation with impact on our networks. The future can never be predicted in innovation and I certainly look forward to the range and creativity of NIA projects over the next 8 years.


Jenny Cooper, NIA Manager, National Grid

Network Innovation Competition:

In 2013 the first annual Network Innovation Competitions, one for gas networks and one for electricity transmission networks, open for proposals for innovative demonstration and development projects. The focus of both competitions is to support innovations that will help accelerate the decarbonisation of the GB energy sector with maximum value to our customers.

The competition recognises the value of collaboration between Network Licensees as well as industrial, academic and other partners. This year National Grid transmission have put forward three proposals and supporting other transmission licensees with another two.

David Oram, NIC Manager, National Grid



“Innovation for me is about getting where you want to get to, but by a different route and in substantially less time. It is about breaking the rules of conventional wisdom”

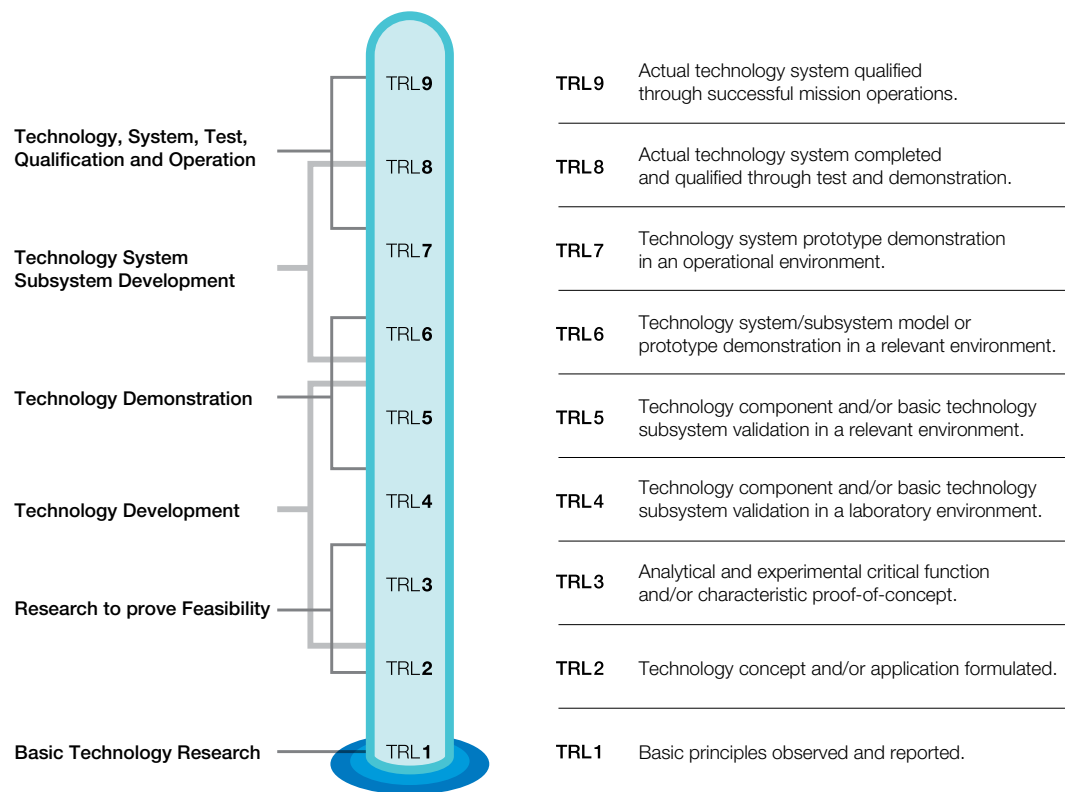
*David Wright, Director,
Electricity Transmission Asset Management*

Technology Readiness Level

“ Innovation represents experimenting with new ideas and constantly evolving to develop and create new and exciting ways of working.

Innovation also challenges and pushes you out of your comfort zone in order to continually strive and achieve better results.”

Stakeholder Comment, June 2013



The Technology Readiness Level (TRL) indicates how close a technology is to becoming both technically and commercially viable and can be seen in the description above. The bottom level on the TRL, Level 1 relates to research with no obvious purpose more commonly known as “Blue Sky Research”, Level 9 on the TRL scale indicates products/information readily available with no development required

Technology Readiness Level is a key part of understanding the risk associated with a project. National Grid creates a balanced portfolio of projects ranging from TRL level 2 – 8. This range ensures that National Grid balances both tactical and strategic projects within its portfolio but

also ensures that innovation funding is used for innovation activities and not purchasing existing solutions, where possible National Grid seeks to minimise the risk associated with lower level TRL projects by entering into collaborative agreements, utilising funding from additional sources.

With the introduction of the Network Innovation Competition (NIC) in next year’s regulatory framework, National Grid is aiming to take forward innovative technologies through to full scale demonstration projects focussed on delivering value to National Grid’s customers and assisting the transition to a low carbon economy.

“ We are rightly investing focus on potential game changing innovations that have the potential to deliver for customers. But we are also determined to seek out the many small innovations that when implemented help us become more effective in everything we do.”

Steve Holiday, CEO, National Grid

The way we look at our innovation portfolio is changing. Rather than focussing on the innovation of specific asset types, we are now profiling our portfolio based on key themes. These themes have been developed with our stakeholders and other businesses within the energy value chain to deliver excellent levels of safety, reliability, security, customer service and environmental performance. By focusing on these themes we can connect our innovation portfolio directly to our RIIO commitments to deliver safe, efficient and reliable energy networks to the consumer.

The following pages display our innovation portfolio, broken down into each key theme. This allows us to see in some detail how the innovation funding is being allocated to meet our objectives.

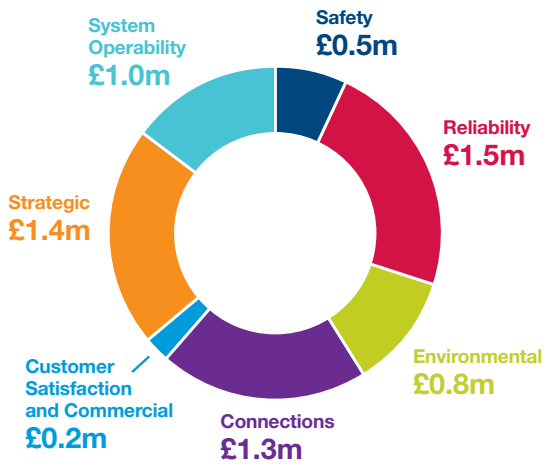
Of the themes, we spent the largest proportion of the Electricity Transmission budget on 'Reliability'. Reliability projects are those associated with ensuring that the network is resilient and the security of supply is continually high.

'Connections' projects accounted for a sizeable proportion of the electricity spend. The number of these projects has increased and will do so under the RIIO period, as we look to facilitate the transition to the low carbon economy. Renewable generation can have significant effects on the transmission system, and a large portion of these projects are trying to understand what phenomenon will be caused by changing generation conditions.

The largest proportion of our Gas Transmission spend this year, was on reliability projects. These projects focus on asset management issues such as compressor availability, flexible networks and gas quality.

The profile also shows us how we can expand our innovation spending moving forward into RIIO. Currently customer satisfaction and commercial innovation accounts for only 2.6% of our innovation spend. This is because the IFI scheme had an asset focus, and there are relatively few potential projects with an overlap between areas such as commercial innovation and asset based research and development. There are also sub-themes that we have outlined in RIIO where we have little or no spend at present. These include Ancillary Services, Information Provision and Information Security. We expect, under RIIO, these areas to expand as we fund broader innovation across National Grid.

Electricity Profile £6.7m



Strategic

Our strategic research ensures we are collaborating with Universities and other utilities and industrial groups to investigate next generation technologies in long term research. We continue to ensure that we make the best use of the latest technologies and develop new materials.

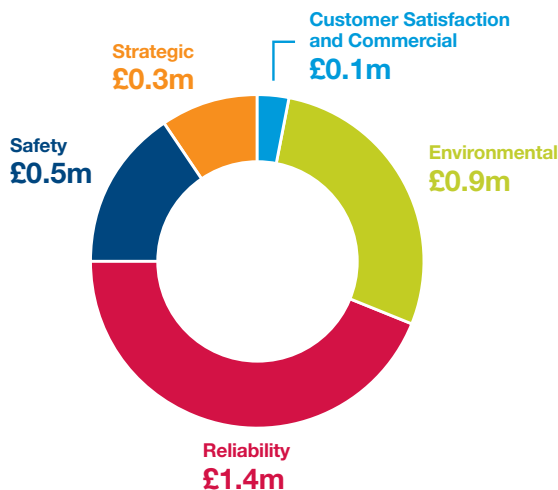
Connections

We are developing techniques to maximise System Access. This means reducing constraints due to maintenance and increasing the speed and flexibility of our maintenance schemes. By creating a smarter transmission philosophy we can ensure our networks are capable of connecting large volumes of renewable generation and active distribution networks. And building on the success of connect and manage, we are developing methods to manage the system in more efficient ways, thus facilitating connections of new generation.

Reliability

We are optimising asset management by reducing maintenance times, minimising the need for human intervention, optimising asset life and creating a step change in real-time data on asset performance. We are developing new tools for knowledge retention and training while addressing the issue of Information security. We continue to innovate in our network protection and control systems to cope with operating an increasingly complex transmission network.

Gas Profile £3.2m



Safety

We are developing new tools, techniques and processes to protect our staff, contractors and the general public. We're researching new ways of protecting our assets from third party interference. 68% of our gas safety spend went to infrastructure research. This research enables us to maximise the efficiency of our use of assets, without compromising their integrity.

Reliability

We are looking to manage the Gas quality to appropriate levels, improve compressor availability, and improve the design of any new build options. This includes new processes pre-building, and also asset improvements and ageing of current assets to give a more flexible, more efficient and quieter network, in accordance with our customers' needs and the change in energy supply. We are investigating new pipeline materials together with improving knowledge on metal fatigue and corrosion.

Environmental

We seek to minimise our impact on the landscape and reduce our carbon footprint. We are working to reduce the volumes of gas vented during operational procedures. Further, our environmental innovation projects aim to facilitate the transition to a lower carbon energy mix for the United Kingdom. Researching new and existing transmission technologies means that we can utilise existing assets to their maximum potential.

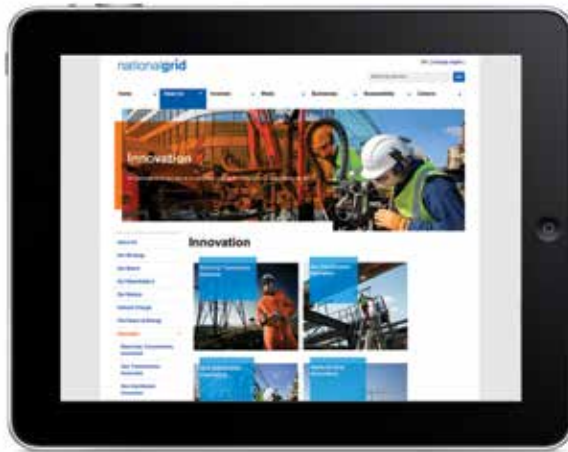
Engagement

The last year of the extended TPCR price control has highlighted the need for change as we enter the RIIO period. We will be smarter about how we innovate, and look for more areas to collaborate on projects and share our learning with other network licensees. Our portfolio from 2012/13 had over 40 collaborative partners, as well as external project suppliers who help us to deliver these projects.

With an increased focus on innovation within National Grid, the Innovation Transmission team have supported a number of key conferences to highlight our current innovation work. The Transmission and Distribution innovation teams joined National Grid's senior leadership (UK and US) conference that took place in Birmingham this year. The display we provided prompted

significant interest and many discussions about implementation of innovation within the company and the wider industry.

Innovation was a focus at National Grid's Annual General meeting, opening the innovation projects up to a wider range of stakeholders and interested parties. We also have very strong engagement on innovation with organisations such as the Energy Research Partnership, ENTSOE, EPSRC, UK universities, Customers, our equipment suppliers, the Scottish Transmission Operators and others. National Grid will be present at the distribution companies' Low Carbon Network Fund Conference to assist in the dissemination of information, sharing knowledge across the whole value chain.



1. nationalgrid.com/innovation

Externally, we have launched our new website – www.nationalgrid.com/innovation

The aim of this website is to enable everyone to have quick and easy access to the innovation work that National Grid is doing. This area will house our innovation forms, as well as project updates.

Please use the website for up-to-date project information, and new projects in the National Grid portfolio.



2. Asset Management Matters

Internal communications to all staff have increased over the last year. Recently, we have had an innovation month, where the innovative work we have done was brought into the buildings and displayed to our office-based employees.

The Innovation Transmission team have worked with National Grid's communication team to establish an ongoing summary page on innovation in every issue of Asset Management Matters. The articles showcase three current innovation projects setting them in context within the business and highlighting the potential impact.

Focus on Electricity Innovation – EPRI Transmission and Substations

Focus : Strategic | Substations
 TRL : Varied
 Project Title : EPRI Substations



Transformer Life Management Improvements

EPRI (Electric Power Research Institute) appreciates National Grid's active support across its advisory and sector councils.

At a project level National Grid advisors guide and shape the direction of the research, of National Grid's seat on EPRI's Research Advisory Council (RAC) Arshad Mansoor (Senior Vice President Research & Development) said, "it's essential for EPRI that our members steer and prioritise our research. National Grid's RAC involvement brings an international perspective which strengthens our collaborative portfolio".

National Grid's active participation in EPRI's Transmission and Substation programme allows access to a wide variety of projects whilst benefiting from leveraged funding of approximately 14 times. The portfolio covers applied research to technology demonstrations and the examples below show how EPRI is working closely with National Grid to develop and demonstrate solutions.

Transformer Life Management Improvements

Understanding end-of-life processes, condition assessment methods and possibilities for life extension is essential to optimising replacement expenditure and maintaining system reliability. EPRI is working closely with National Grid to develop



Sulphur Hexafluoride Leak Management

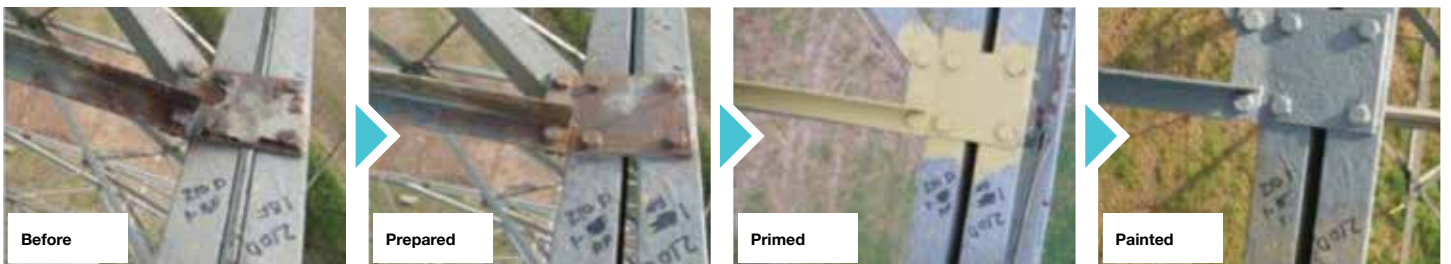
novel techniques which provide unique information on transformer condition and algorithms to develop actionable information from this and other data. "Validating the output and underlying algorithms/ methodology of these tools is vital" said Bhavin Desai (EPRI Programme Manager), "we're working with National Grid and other utilities around the world to test EPRI software analysis results against observations from utility transformer forensic studies and tests on paper samples collected through end of life strip downs".

Sulphur Hexafluoride Leak Management

Managing sulphur hexafluoride (SF6) leaks is an environmental imperative and an operational priority. Working together with EPRI and the University of Liverpool, National Grid has been trialling a novel leak capture technology at a gas insulated substation. Rich Lordan (EPRI Senior Technical Executive) said "the access granted by National Grid to conduct these trials has been outstanding", commenting on the initial results he added "the first field trials results are very positive and we will be working closely with National Grid to carry out further testing".

Focus on Electricity Innovation – In-Situ Remediation of OHL Tower

Focus : Reliability | Overhead lines (OHL)
 TRL : 8
 Project Title : In-Situ Remediation of OHL Tower Steelwork



In-Situ Remediation of OHL Tower Steelwork is currently being trialled on the electricity transmission system. Initial tests have shown that this concept could be available for roll out after R&D testing.

The development of an alternative to having to replace tower steelwork came when 2 different processes merged knowledge. This resulted in an R&D project looking at how we can best extend the operational lifetime of an OHL tower.

The Tower Steelwork Strategy Group (TSSG) was formed with a purpose of progressing towards the production of a strategy and a guidance document for the treatment of corroded tower steelwork. The objective of this was that the tower should achieve its anticipated asset life since original construction. This group was formed as a result of the escalating costs associated with complying with current legislation. These costs were primarily those caused by the high volume of steelwork replacement and the difficulties in obtaining sufficient outage lengths on certain circuits to facilitate the work. This was a time consuming and difficult co-ordination and data processing task.

National Grid had started a review of tower painting during 2008 with the intention and objective of improving the overall performance of tower painting. The members of the working group set up to run this R&D scheme included representatives from R J Stokes paint manufacturers, the three tower painting companies (CLC, Fountains and PDC) and Capcis (a materials consultancy and specialist testing company).

The working group produced a technical specification using a 'four coats' proposal. The system consists of preparing each area of steelwork using hand held power tools then painting with primer and then the R J Stokes single coat system top coat. This leaves the tower ready to be painted conventionally, so the affected areas eventually receive mechanical preparation followed by primer, single coat system, primer then topcoat.

The technical specification was rigorously tested. The methodology was initially trialled on the ZDA Cottam West Burton route on towers ZDA 210-227. The trial was positive with the necessity to replace large quantities of grade 4 steelwork being avoided.

Further trials were carried out on the ZE Cellarhead-Daines-Macclefield circuits. The methodology has been refined and improved to meet requirements. The recovery of the steelwork resulted in 188.5 tonnes of steelwork not having to be replaced on that project.

Focus on Electricity Innovation – Liveline Working

Focus	: Connections Overhead Lines (OHL)
TRL	: Varied
Project Title	: Live Line Working Equipment



Modified Helicopter



Electrically Insulating Rope



Live Working Basket

Live Line working equipment has been developed within National Grid with numerous different external suppliers since August 2009. This year has seen some major progress, with flight trials having been completed.

Since 2009, Maintenance Delivery Electricity (MDE) have been revisiting the prospect of LiveLine working. This was originally used back in the 1960s, but was stopped due to being non-economically viable and increasing risk unnecessarily. In the current technological era, and with energy prices being substantially higher than ever before, this project was set up to re-address those key issues.

Safety is crucial for National Grid, and obviously was a big factor when being 'plugged in' to 400,000 volts.

There have been huge concerns over the safety of working live, which the LiveLine project team have overcome and dealt with. The Health and Safety Executive (HSE) were deliberately involved throughout the lifetime of the project, and we are pleased to say that this has now been signed off.

Another driver for re-visiting the Liveline work was the increasing cost of energy. The infrastructure at National Grid is subject to regular maintenance and, when required, replacement of assets.

The work has to be done under conditions where there is no power being transmitted through the assets themselves. This has a knock on effect to different parts of National Grid, and we have to reconfigure the system to allow access to our overhead lines for maintenance. This is known as an 'outage'. As with everything, there is a cost associated with this outage, and it has now become so great, and the need to utilize the increased flexibility of the network has also increased drastically due to the green agenda that we have decided to look at working live from an economical viewpoint. It would be naïve and irresponsible of us to create an outage and increase energy costs when we hadn't visited other options first.

This project focused mainly on development of a safe system that was not only mechanically strong enough to hold the basket and staff under a helicopter, but was also electrically insulating. This was a challenge for the team as there were different international standards to match with the aviation authority standards, and also match with National Grid standards. This resulted in a complete new system needing to be developed which has undergone the first set of flight trials successfully.

Focus on Electricity Innovation – Composite Cross Arms

Focus	: Environment Overhead Lines (OHL)
TRL	: 8
Project Title	: Composite Cross Arms Study



Comparison of towers



Ice build up on crossarm

Development of a new cross arm that is a facilitator to up rating 275kV to 400kV OHL towers.

Composite Cross arms were developed with a specific task in mind, to enable National Grid to up rate existing 275kV towers to 400kV. This could be possible due to the mechanical strength of the cross arm, but also due to the electrical insulating capabilities that composite materials provide.

Progress remains to be made on undertaking a full line study to examine the challenges that would exist in upgrading an overhead line from 275kV to 400kV operation. Analysis has shown that the challenges associated with mechanical reinforcement would reduce with the use of Aluminium Conductor Composite Reinforced conductors (ACCC) as opposed to All Aluminium Alloy Conductors (AAAC). In addition, the 30% load relief for broken wire situations would be achieved by the use of a small (few cm) link between an insulating cross-arm and the conductor. It remains likely that selective tower reinforcement would have to take place to upgrade an entire line.

Analysis has also been carried out with support from Balfour Beatty on the reduction in size that can be delivered by a new build line making use of insulating cross-arms. Calculations show that a 400kV tower would be reduced in height by over 30% with a 275kV tower being reduced by over 25%. This would greatly improve the visual impact of overhead line towers while also reducing costs

of build. This is therefore a promising opportunity to examine with National Grid moving forward and is the subject of the NIC bid submitted by SSE and will be the subject of an NIA project over the next 9 months.

In May, the two insulating cross-arms that have been installed at the St Fergus test site completed a full year of operation at 231kV (the phase to earth voltage of the 400kV system). The St Fergus test site is hosted by Scottish Hydro Electric Transmission Ltd and is in a near coastal location on the east coast of Scotland. Two insulating cross-arms are fitted at the site on a bespoke tower and are energized using a 231kV test transformer. Instrumentation monitors the current flowing in each member of the insulating cross-arm and further sensors monitor the weather and a number of other parameters with all data being stored locally and transmitted instantaneously to a live monitoring system.

Apart from two brief outages resulting from issues on the 11kV overhead line feeding the site, the trial has run continuously over the past twelve months with the cross-arms performing well in all weather conditions including the snow that fell at the site earlier this winter. The site continues to operate and gives the project team confidence in the robustness of the cross-arm design while providing valuable data. Operations will continue at the St Fergus test site in the immediate future with the project looking to relocate the test to a new location in 2014.



“Innovation is the pursuit and application of solutions that address/meet new or existing requirements, and nascent business needs. This is accomplished through more effective products, processes, services, technologies, and ideas that are implemented and readily available within the business for our customers.”

Misha Bruce, Innovation Engineering Coordinator, National Grid Gas Transmission

Focus on Gas Innovation – Measurement of LNG Rich Transmission Pipeline Gas using On-Line Gas Chromatographs

Focus : Reliability | Optimising Asset Management
TRL : 7
Project Title : Liquefied Natural Gas (LNG) gas property measurement



LNG Terminal at Grain



Workers installing pipeline

Potential to inspect buried pipelines from above ground to locate metal loss and stress features.

The efficient and safe operation of the gas National Transmission System (NTS) necessitates accurate gas quality measurement to satisfy the statutory, fiscal and energy balancing requirements. As such, the NTS utilises a widespread network of on-line process gas chromatographs (OGCs) to provide real time composition and hence physical property data across the system. The testing and validation of these instruments has been predicated on a likely range of natural gas compositions based on knowledge of typical UK continental shelf (UKCS) gases. As part of the normal operation of OGCs, the instruments also perform a daily calibration using a certified gas.

The increasing use of imported Liquefied Natural Gas (LNG) to satisfy UK gas demands means that gas compositions in different parts of the network can be significantly different from historic values. This is particularly prevalent in the measurement of carbon dioxide and the higher hydrocarbon (butane, pentane and hexane) components which are likely to be significantly lower or present in quantities below the instruments' detection level. Typically both representative calibration gases and validation gases contain significant levels of higher hydrocarbons and carbon dioxide.

Of particular interest is whether the current OGC equipment is well adapted to measuring gases which are rich in LNG. It was considered appropriate to assess the performance of typical OGCs to ensure that there is no unacceptable error in the determination of energy and other gas properties.

The current programme was confined to evaluation of the effect of an LNG gas on the measurement response of two conventional OGCs. Both OGCs employed thermal conductivity detectors but differed in their respective handling of the sample gas during analysis. The two usual gas sampling handling procedures during analysis are back flush or forward elution (single pass through). A typical gas chromatograph of each sample handling type installed on the NTS was tested. All OGCs were tested using three typical LNG gases taken from the main UK LNG import facilities and a reference UKCS gas. Each OGC measurement of the LNG test gases was compared to a detailed gas analysis determined by dedicated accredited laboratory-based equipment.

For LNG rich gas the heavier hydrocarbons (butanes, pentanes, hexanes) are likely to fall below the detection limits but nevertheless it was expected that each OGC type would give measurement errors. Both analyser types gave acceptably small calorific value (CV) measurement errors with the representative LNG samples tested. The results from this programme provide strong experimental evidence to suggest that large scale penetration of LNG gas across the NTS will not compromise CV determination and thus will not contribute to any measurement uncertainties.

Focus on Gas Innovation – Variable Envelope Compressors

Focus : Safety | Infrastructure
 TRL : 5
 Project Title : Variable Envelope Compressors



Compressor



Compressor Drive Shaft

A fleet of 68 pipeline compressors on the National Transmission System (NTS) drive the gas supply from injection points to all parts of the gas network. This research and feasibility programme is investigating technical and commercial methods for varying the performance envelope of centrifugal compressors. Variable envelope technology will allow efficient and stable compressor operation in Great Britain's increasingly variable flow patterns of gas supply and demand.

Pipeline compressors have two main components; a drive unit and a compressor unit. Each compressor is designed to operate efficiently within limits known as the envelope of operation. Gas compressor units predominantly feature single stage, centrifugal compressors that do not include technology to vary the operation other than by speed control.

The design of each compressor on the network is based on the performance requirements that were determined by network analysis at the time of installation. However, National Transmission System (NTS) gas flow patterns have experienced unprecedented changes in recent years. North Sea gas sources mainly connected in Scotland are contributing less to Great Britain's supply, while the Liquid Natural Gas (LNG) sources that import in South Wales and the South East of England are contributing more.

These changes are leading to a high degree of daily volatility in gas flow requirements and the trend is expected to continue. Future gas supply and demand variations are also expected as requirements change in response to where our gas comes from, what we use our gas for and where we use it, and in correlation with Great Britain decarbonising the energy sector.

All of these changes have led to a number of compressors on the National Transmission System (NTS) being required to operate in inefficient regions of their design envelope, for increasing amounts of time. Running a compressor around the limits of its envelope results in a highly unstable or inefficient operation which could result in:

- An increase in fuel utilisation
- Reduced Machine Life due to vibration
- Increased risk of equipment breakdown

In response to the increasingly variable flow pattern of Great Britain's gas supply and demand, National Grid is investigating methods for varying the operating envelope of centrifugal compressors.

The development and demonstration of a variable envelope solution that can be retrospectively installed on one of our compressors is one of our NIC proposals for 2013.



Finance Overview and Benefits of the Portfolio

Electricity IFI

Description	
IFI Allowance	£7.168m
Number of Active Projects	107
External Expenditure	£5.235m
Internal Expenditure	£1.421m
Total Expenditure	£6.656m
Anticipated NIA Allowance (For 2013/14)	£10.928m

Gas IFI

Description	
IFI Allowance	£3.278m
Number of Active Projects	45
External Expenditure	£2.865m
Internal Expenditure	£0.366m
Total Expenditure	£3.232m
Anticipated IFI Allowance (For 2013/14)	£4.386m

This section of the report gives the financial information associated with the 2012/13 National Grid Transmission IFI funded portfolio as agreed in the Innovation Good Practice Guide for Energy Networks (G85).

In year 6 there have been 152 live reportable projects moving through the innovation portfolio ranging from proof of concept through to demonstration projects. The total investment for 2012/13 was £9.887m utilising 94.65% of the IFI allowance. R&D outputs form a key part of National Grid's asset management activities by finding solutions to technical problems, managing risk and helping drive efficiencies.

Benefits are assessed on an individual basis and reported on in the detailed section of the report; the IFI portfolio delivers a balanced program of work which provides an overall positive Net Present Value (NPV). When calculating a project NPV, the costs attributed to the benefits are:

Direct costs – e.g. Costs saved through a reduced planned capital expenditure or targeted maintenance.

Avoided costs- e.g. Through deferred investment, reduced failures and establishing true condition of equipment potentially improved ratings.

The IFI program also delivers a range of non financial benefits. While these produce negative NPV's (via the methodology provided in the G85 document) they are still key to providing benefit to customers. The inclusion of these elements helps to create a more accurate picture of the true benefit that the innovation program provides. These include but are not limited to:

- Safety
- Environmental
- Network Performance
- External risk
- Knowledge transfer

The overall NPV for the current Electricity Transmission portfolio is £34m. The overall NPV for the current Gas Transmission portfolio is valued at £10m.

“ Innovation means always looking for better ways of doing things so that we can provide better service to our customers and not just defaulting to the way we have always done things – whether it is new technology, changing our processes, or coming up with new innovative commercial contracts and approaches.”

*Mike Calviou, Director, Transmission Network Service,
National Grid*

Three Core Pillars

Our innovation strategy continues to be built upon three core pillars:

Building upon the experience and lessons learnt from the IFI scheme, feedback from our stakeholders and from other third-party organisations, we will leverage our three pillar approach to maximise the benefits to the end consumer. In recognition of the fact that innovation is broader than just technological R&D, the Innovation Transmission team will encourage, coordinate and govern the wider innovation process.

We use innovation to drive improvement in our business processes and technology application, delivering value to customers and consumers through cost reduction, expedient delivery, improving efficiency, reducing environmental impact, maintaining reliability and improving safety. The challenges we must overcome to facilitate the decarbonisation of the energy sector and satisfy the climate change targets can only be met through developments and innovation in both what we do and how we do it.

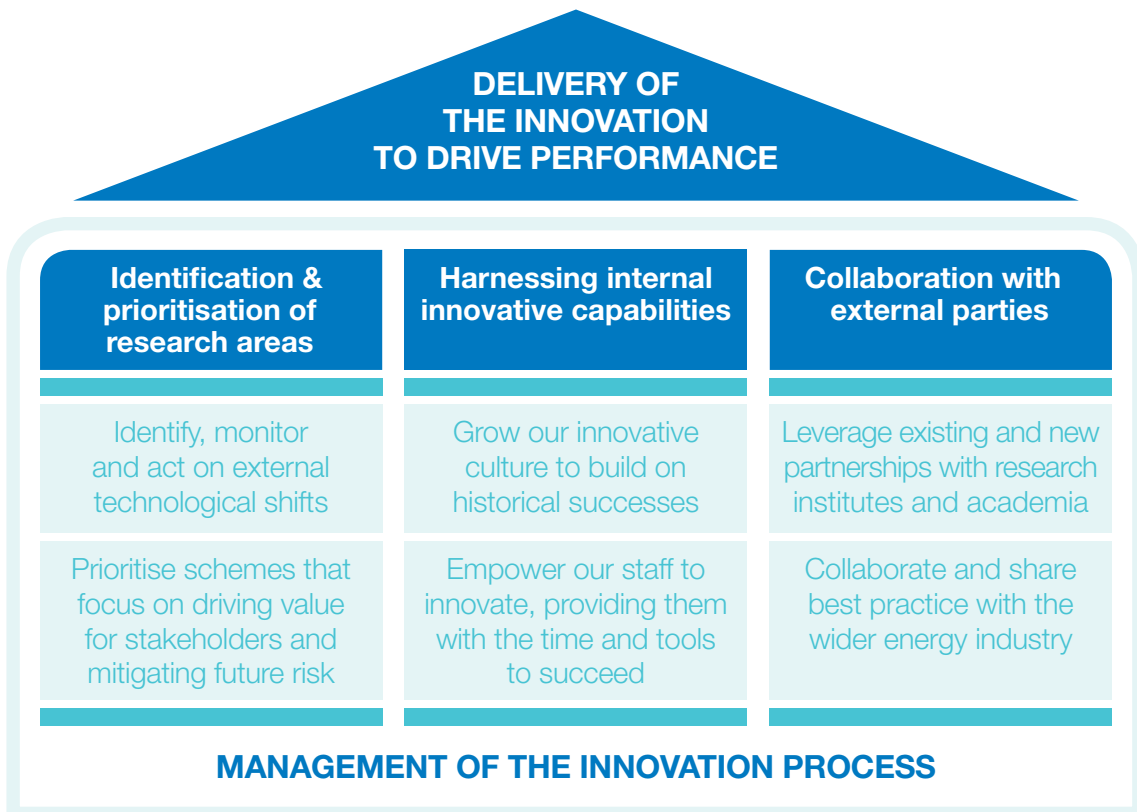
Over the next decade, we forecast substantial investment in our networks; innovation will be key to establishing efficient, effective and economic solutions to the upcoming challenges and delivery of desired stakeholder outputs.

In Gas Transmission, through harnessing innovation, we can ensure National Grid fulfils and outperforms our statutory environmental obligations, operate a more flexible network and continue to facilitate connection to the NTS of our customers. All of these areas will support the flexible operation of gas fired generation plant that has potential to provide the necessary reserve for wind generation which is predicted to increase significantly as the electricity sector decarbonises.

In Electricity Transmission, innovation is key to understanding the condition of our assets, ensuring they are able to operate in a more flexible manner, which will facilitate connection of our customers. We will continue to looking for ways to reduce the direct environmental impact of our own network.

Innovation in all its forms has huge potential to drive our business and enhance delivery. Without new approaches and technology, a low-carbon future for the UK's economy is much less certain.

We are committed to being an innovative leader in energy management and this commitment is supported by our stakeholders.



Keep in Touch

We hope you enjoyed this introduction to the 2012/13 IFI annual report. If you have any feedback, or would like to approach us with a potential new project that you have, please contact us by:

Email:

.box.InnovationTransmission@nationalgrid.com

Or write to us at:

Innovation Transmission Team, National Grid House,
Warwick Technology Park, Gallows Hill, Warwick,
United Kingdom, CV34 6DA

See our website:

www.nationalgrid.com/innovation





National Grid plc

1-3 Strand, London WC2N 5EH, United Kingdom

Registered in England and Wales No. 4031152

www.nationalgrid.com