Our approach to
Innovation
Strategy and delivery

March 2014

UK Power Networks
Delivering your electricity

ukpowernetworks.co.uk

Customer value and **efficiency** drive our innovation

Welcome to UK Power Networks' Innovation Strategy document. We have established a leadership role in respect of innovation over the current period and we are fully committed to maintain this leadership position in RIIO-ED1. This document sets out why we innovate, in what areas, and the outcomes which customers will see delivered during the RIIO-ED1 price control period.

The RIIO-ED1 review of our business plans comes at a critical time in the UK energy sector. Electricity is the hidden lifeblood vital to any economic recovery, and UK Power Networks' role in this is clear as we continue to serve regions responsible for 41 per cent of the UK's gross value added (GVA), a measure of economic activity. Separately, both the last government and the current coalition government have set binding targets in law for the UK to reduce its contribution to carbon emissions, and UK Power Networks knows that it will play a leading role in enabling this low carbon transition. Furthermore, the sector must deliver value to its customers and stakeholders, both in terms of innovation activities themselves and embedding the fruits of innovation into core business activities.

To this effect, we have committed ourselves to £141 million of savings in capital investment in our RIIO-ED1 business plan submission based on our innovation portfolio creating the required capacity in different ways. Our innovation strategy also enables us to meet the efficiency challenges that we have set ourselves, for example by replacing assets reaching end-of-life with equipment which is more cost-efficient or which offers more capabilities for the same price.

We believe that innovation will be crucial to delivering the low carbon economy in a financially sustainable way, as innovation provides us the flexibility to respond better, faster or more cost-efficiently to the potentially changing requirements of our future customers. This Innovation Strategy demonstrates that we are exploring levers at all stages in the value chain: from trialling financial incentives for customers able to suppress or shift their electricity demand, through increasing flexibility within the existing network, to ensuring that we build smarter or more capable networks when there is no alternative but to build new network.

This is very much a document for all our stakeholders, all of whom will have a valuable perception of our appetite for change and attitude towards innovation, based on your existing day-to-day interactions with UK Power Networks. Others amongst you will be in a position to comment on the detail within this innovation strategy, whether it is sufficient and addressing the right challenges, and will have insights into the way in which we should manage innovation and change. Innovation and the low carbon transition have also been explicitly discussed with a select group of stakeholders early in the business plan preparation, informing our work, and a first draft of this document was shared with R&D experts for their feedback.

Regardless of your background, I trust that this strategy provides you with the link between the challenges facing the UK, the challenges facing UK Power Networks as an electricity Distribution Network Operator (DNO), and our innovative responses for the benefit of our customers.

Basil Scarsella
Chief Executive Officer

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1 We are delivering **benefits** to our **customers**

Key messages

We have built **£141 million of savings to our customers from technology innovation** and Smart Grids into our business plan submission.

This represents a **net payback of all our work to date since 2005** and all the work we currently have committed under the Low Carbon Network Fund.

Before the technology savings were applied, the business plan had already **benefited from the continual improvement** activities in the business in data models and costs efficiency.

A number of **new products** now exist for use on our network as the result of UK Power Networks **working with partners**.

Customers must be confident that our continual improvement and network innovation activities are delivering the level of service, network reliability and stable bills that they expect. This short summary set outs the financial benefits to our customers.

Both UK Power Networks and our regulator Ofgem recognise that innovation has a different risk/reward balance compared to the rest of our activities. This is the basis for funding mechanisms such as the Innovation Funding Incentive (IFI), Low Carbon Network Fund (LCNF), Network Innovation Allowance (NIA) and Network Innovation Competition (NIC), which share up-front costs with customers. These up-front costs are expected to be re-couped either within a short time period, or to be re-couped through savings built into our business plan for the next period. This section also gives a clear picture of where our current investments under these funding mechanisms are being made, in terms of topics and in terms of outputs for customers, and give some practical examples in the form of case studies.

1.1 Key solutions delivering benefits in the business plan

Our business plan sets out the amount of capital expenditure that UK Power Networks needs to invest to maintain or replace our existing electrical assets, and to build capacity on the network. Separately it sets out our forecast for the uptake of new generation and demand connections, and which will be funded or part-funded by the connecting customer at the time of connection.

Our past and present innovation performance has allowed us to achieve a significant reduction in the capital expenditure we require:

- Our work within the Low Carbon London project has given us the confidence to replace 14 traditional reinforcement schemes in our business plan with interim solutions which we expect to fulfil through Demand Side Response (DSR). We expect DSR to play a role in managing complex construction timelines within a further 6 reinforcement schemes. This will provide a saving of £43 million compared with the original planned schemes and will minimise disruption to customers
- We have reduced our capital allowances on overhead line upgrades by £8.6 million, in anticipation that we will find simpler upgrade options identified through the use of Light Detection and Ranging (LIDAR) surveys
- Our trials of a number of transformer monitoring solutions for primary and grid transformers over the previous years, and previous work carried out to model thermal cycling of transformers, has given us the confidence to reduce our capital allowances on transformer upgrades by £15 million. We expect to meet the gap by managing existing transformers using a combination of advanced monitoring, modelling of their thermal effects, and potentially pre-cooling of the transformer ahead of system peaks or additional Demand-Side Response contracts to relieve load on the transformer in the event of a fault event. The trials of transformer monitoring equipment attracted funding under the Innovation Funding Incentive (IFI)
- We are not requesting sufficient capital expenditure to carry out all the replacement of low-voltage (LV) cable which is predicted by our models to need replacing due to the uptake in electric vehicles, micro-generation and heat pumps. This results in both a financial saving to our customers and in reduced disruption due to fewer excavations on the street. We are confident that there are a variety of technologies being worked on by ourselves and other DNOs which can help to manage voltage issues at either the distribution substation or at the customer's premises, or indeed at a mid-point along the length of the feeder; and opportunities to control load or automatically re-configure the low-voltage network to resolve some loading issues. Alongside existing processes we already follow when investigating high or low voltage issues, we are committing to manage a potential stretch of up to £35 million compared to our models' forecasts

- Our ability to consider refurbishment rather than replacement of equipment, yet maintaining network reliability, has reduced our capital expenditure forecast over the RIIO-ED1 period by £39.3 million. This has its roots in our skilled engineers, but who in turn are informed by and develop our innovation programmes such as the Strategic Technology Programme, a joint research programme in which the GB and Irish DNOs participate. We continue to explore issues within the Strategic Technology Programme such as the performance of insulating oils, failure modes of transformers, and deterioration of insulating media such as Sulfur hexafluoride (SF6), and pride ourselves on knowing our assets as well if not better than their original manufacturer. Whilst UK Power Networks has never run a replace-only policy, and refurbishment has always been part of our solutions, we have increased the focus on this approach to deliver this level of savings
- We have reduced our capital allowance for replacement of switchgear by £9 million on the basis that we expect that we can manage the condition of the switchgear using real-time partial discharge monitoring. Real-time monitoring gives a picture of the developing nature of faults, and which complements the spot-checks which are carried out across all switchgear on a regular inspection cycle

As stated earlier, this is only part of the complete picture, the other part of the picture being the tens of thousands of new connection requests which we fulfil annually, and an increasing proportion of which are for renewable generation projects. In the context of supporting new generation and demand connections:

- We have issued new 'interruptible' offers to a number of renewable generation developers as part of our Flexible Plug and Play (FPP) LCNF Tier 2 project. If taken up, these could potentially save significant sums for the developers and reduce their time to break even, amounting to a total reduction of £12.4 million across the six offers issued to date. These offers represent a fully worked-up template for future contracts, and with application to both generation and demand connections
- We have trialled Active Network Management (ANM) technology as part of both our Low Carbon London and Flexible Plug and Play projects, and which is the vital technology enabler behind interruptible contracts and some Demand Side Response contracts. We have increasing confidence as we see the technology operating over a variety of communications backhauls and interfacing using the latest IT standards and protocols

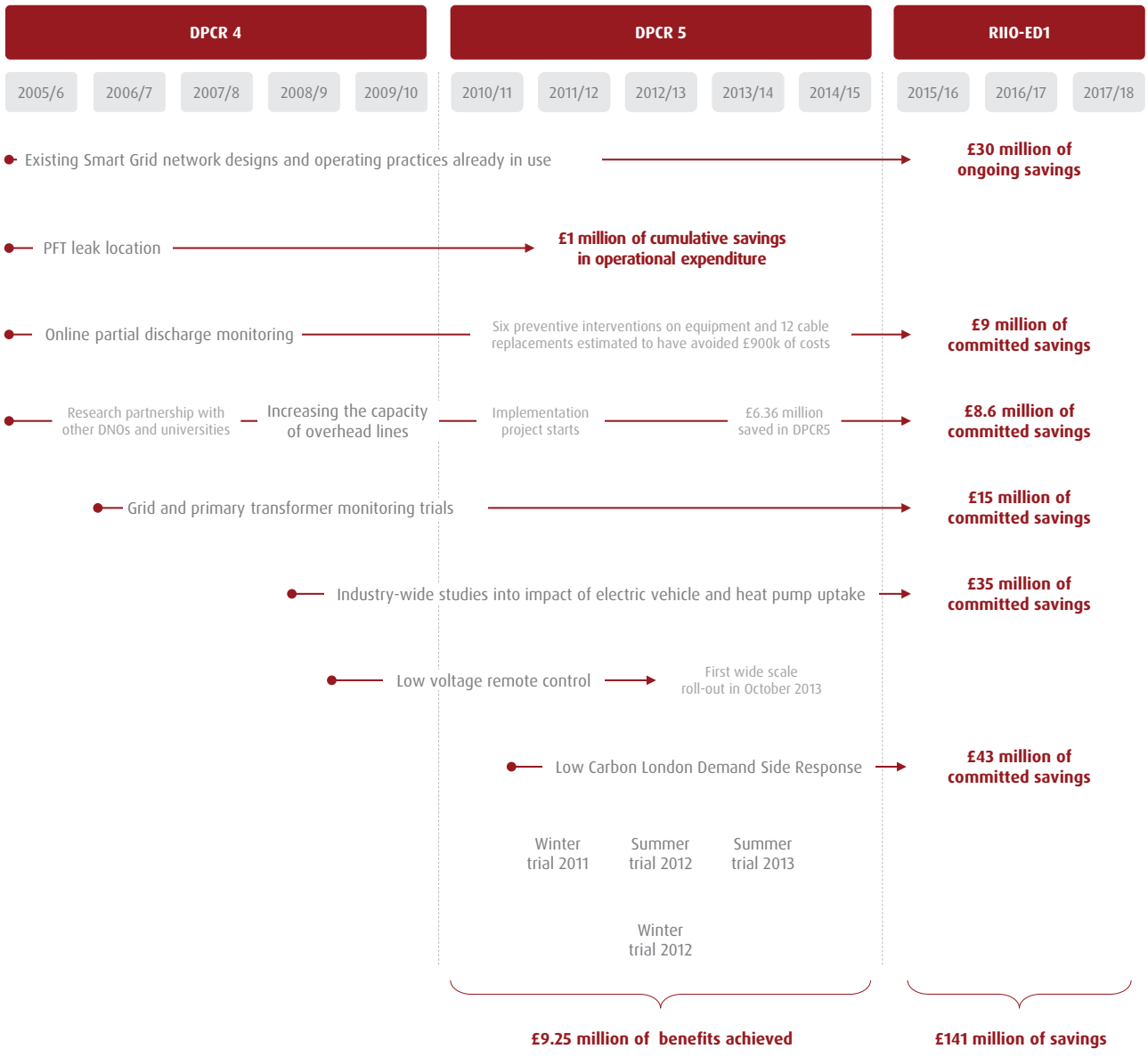
1.2 We have an excellent return on investment for innovation

Figure 1 introduces a number of highlights from our portfolio over the previous years, a number of which are expanded as case studies on the next few pages. The diagram also demonstrates the return on investment. Specifically, during the DPCR4 price control period we received £14.8 million of customer contributions and by the end of DPCR5 we have delivered or committed benefits of £9.25 million from these projects.

This rate of return is accelerating, and over the entire DPCR4 and DPCR5 periods, we will have received around £92 million of customer contributions, and are making £141 million of savings in the RIIO-ED1 business plan. These savings are as much as 25 per cent in the case of our plans to avoid LV cable reinforcement by using Smart Grid solutions, and 15 per cent in the case of Demand Side Response. These savings are fully documented in our Innovation Annex, which also contains a more detailed description of our Smart Grid strategy.

In addition to these technical innovations, we are reducing the time it takes us to deliver work for our customers in both connections and general enquiries. We have extended the range of communication channels that we use to interact with customers, to include web, voice, SMS, social media. We have reduced our environmental impact from street-works with more than 97 per cent of waste soil now recycled, and we have carried out trials with utilising waste heat from some of our larger transformers. More information is provided in Chapter 7 of this document, 'Continuously improving the business'.

Figure 1: Return on investment from our innovation portfolio



1.3 We have increased our innovation intensity across our themes to deliver more benefits

Figure 2 below shows how this increase in benefits has come about, from an increased intensity of activities, and how the innovation portfolio is spread throughout our innovation themes which are explained later in the document.

Our overall spending on innovation has increased from £4.5 million in 2010/11 to just over £15 million in 2012/13. We continue to have a core part of our portfolio which relates to our functions of running the network reliably and efficiently, maximising the use of assets and their lifetime, and improving our ability to respond to faults.

This core appears as the bottom part of each pillar in Figure 2, under the themes 'Managing asset risk and improving fault performance', 'Understand the condition of our assets' and 'Understand current and future performance of the HV and LV network'. An example of this is our work on overhead line capacity, through which UK Power Networks has been able to remove £8.6 million of capital expenditure from its plan, or roughly £1 million for every year of the next price control.

A valuable outcome from our consultation with R&D experts on the first draft of this document was the endorsement that we maintain this core part of our portfolio. Over the coming months we will be looking to strengthen the 2014/15 portfolio in this area to a similar level of spend as took place in 2012/13 and as forecast in 2013/14.

The top part of each pillar represents the majority of the increase in expenditure, and has been driven by the increased challenges presented by the Low Carbon transition and uptake of distributed generation (DG), micro-generation at household level such as photovoltaics, and the expected uptake in heat pumps and electric vehicles in coming years. In particular, our work under the theme 'Leverage industrial and commercial demand response and dispatchable generation' greatly increased over the last two years, and has given us the confidence to include savings related to Demand-Side Response into out our plan.

Figure 3 also shows the contribution of the portfolio shown in the figure above, but in terms of their contribution to the six primary output categories within Ofgem's RIIO framework: safety, environmental impact, customer satisfaction, connections, social obligations and reliability and availability. We have supplemented these with two internal additional outputs relating to cost efficiency: namely 'Capital Efficiency' and 'Operational Efficiency' and the over-arching challenge of driving sustainable networks which can support low-carbon demand and generation in mind. Whilst not primary outputs in their own right, these are essential behaviours which Ofgem expects to see from all of the regulated network operators. Over this time frame innovation investment has been driven by factors ranging from social obligations to the low carbon agenda.

Figure 2: Growth in UK Power Networks' innovation portfolio, and annual average allocation of resources across innovation themes

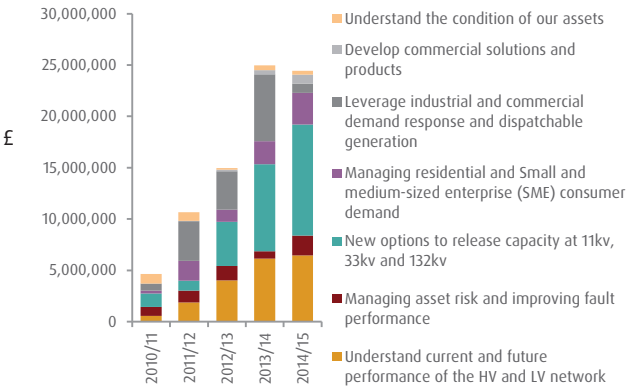
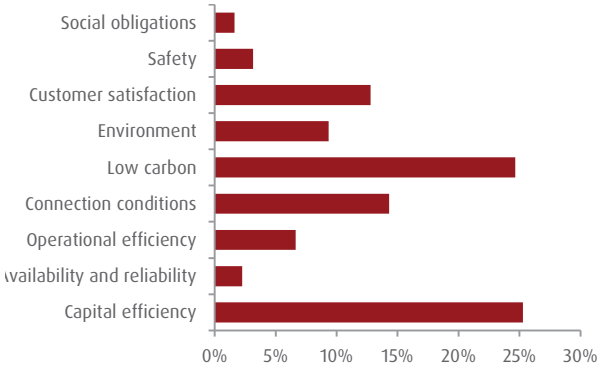


Figure 3: UK Power Networks' innovation portfolio by driver over the period 2010/11 to 2013/14



1.4 Our innovation is delivering real products and real value

The following case studies have been chosen to demonstrate the impact that our innovation is having on quality of supply, on the day-to-day operational expenditure involved in maintaining the network, on our major capital investment spend and finally in taking up new commercial solutions such as DSR – and 'interruptible' connections for distributed generation.

Quality of supply – LV remote control

UK Power Networks has made significant improvements in its quality of Quality of Supply performance over 2010 to 2013. This was the result of improved network fault management procedures and investment in increasing the amount of remote control on the High Voltage (HV) feeders. However the performance of the Low Voltage (LV) network, particularly in UK Power Networks' urban areas, continues to be an issue.

With the above in mind, an IFI project to investigate innovative approaches to further improving the management of the LV network was initiated, and resulted in the successful development of a new solid-state switching technology.

Retrofit circuit breakers for installation in place of LV fuses in substations, and switches for installation in place of links in under-ground link boxes will enable remote management and monitoring of the LV network.

Successful trials of the technology developed have led to the Smart Urban LV Network LCNF Tier 1 project, in which the technology is to be demonstrated in a large scale trial. The project is also expected to inform future deployment strategies by establishing under which circumstances the benefits from installing a more costly LV switching technology outweigh a purely reactive approach to faults requiring visits to site.

LV Remote Control and Automation Toolbox

The products developed provide UK Power Networks with a set of innovative LV management tools which can be strategically deployed to improve network performance and enable active management of the LV network.

Benefits expected to be realised during RIIO-ED1 period from the deployment of the technology

- **Improved quality of supply** – integration with the SCADA system will enable automation to be implemented
- **Increased safety** – circuit Breakers cannot reclose onto a fault and devices utilise arc-less switching
- **Improved LV network visibility** – this will be provided by the load monitoring capabilities of the device and is expected to lead to enhanced network planning
- **Active network management** – the ability to dynamically reconfigure the network will facilitate the integration of distributed generation and Electrical Vehicles by enabling peaks of load to be shifted if neighbouring feeders have spare capacity, and will help prevent fuse operations caused by overloading

Prototype Circuit Breakers Installed to a distribution board in an IFI trial

Retrofit switches being installed to a Link Box

Circuit Breakers installed in place of standard LV fuses – enable remote re-closure after LV fault. It can be installed as part of an integrated LV management system, or deployed as part of a standalone LV fault management system (targeted installations on transient faults/ repeat fuse operations).

Link Box Switches, provide the ability to remotely reconfigure the LV network, and isolate faulted sections of network. Can be strategically installed to key points in the network or densely rolled out to LV network areas.

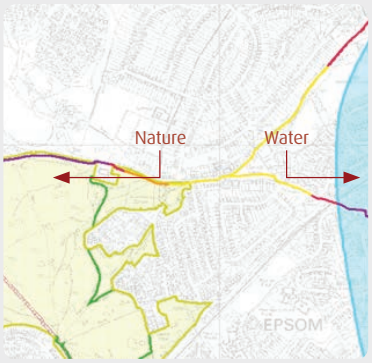
Improved management of fluid filled cables

UK Power Networks currently operates 2,500km of Fluid Filled Cables (FFC) with an approximate capacity of 27 million litres. The majority of these cables were installed in the 1960s in the fast growing conurbations such as London. Whilst there is a long term strategy to decommission these cables (108.1km during RIIO-ED1), this ageing population of cable has to be to be carefully managed as it is susceptible to leaks.

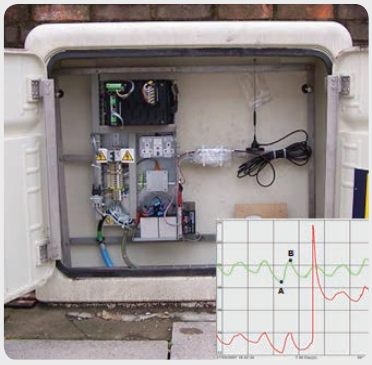
Several initiatives (summarised below) have enabled an overall improvement in the way UK Power Networks manages fluid filled cables, in allowing circuits to be assessed and prioritised against a range of environmental and condition risk factors such as fluid pumping history, risk associated with the environment, cable condition, number of connected customers and physical access constraints.

Improvements in our business processes

Environmental sensitivity maps



Remote cable pressure monitoring



Pumping figures recorded directly into asset register

Perfluorocarbon Tracer Leak (PFT) Leak location

The successful development of the PFT leak location technology funded under the IFI has enabled UK Power Networks to improve its overall FFC management process, and start delivering tangible benefits.

Achievements

- Faster and more accurate leak location (<2 million) when a circuit is tagged
- Significant reduction in the cost of leak location
- Successful Business As Usual transfer
- This technique is now being used to locate leaks in gas cables

Benefits achieved since business deployment

- A large number of circuits have been tagged with PFT leak location technology across all UK Power Networks' regions
- 104 successful locations and repairs achieved with an overall success rate of >85 per cent
- Leak rate has been reduced significantly since 2009 and financial savings delivered to date are in excess of £1 million; when compared to the traditional technique of freezing the cable to localise the fault, and other commercially available methods

Increasing the capacity of Overhead Lines (OHLs)

UK Power Networks has been involved in several innovation projects relating to Overhead Lines (OHLs) over DPCR4 (2005 to 2010) and DPCR5 (2010 to 2015). Most of these have been collaborative projects that have been carried out in conjunction with some or all of the other DNOs.

An implementation project was launched in 2011 to implement new techniques, update our processes, and provide useful guides to disseminate the learning to our staff.

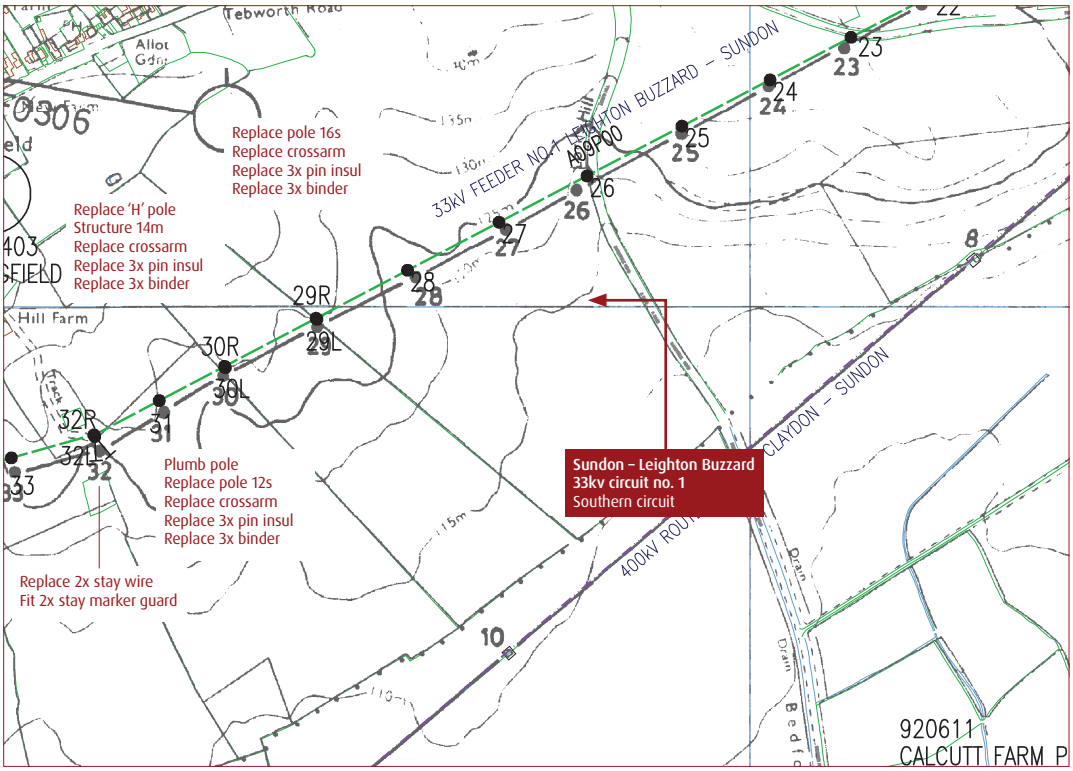
In order to maximise capacity with existing lines and structures, Light Detection And Ranging (LiDAR) scanning can be used to prove existing clearances and to determine mitigating actions required (if any) were a line capacity to be increased. As more current flows through an overhead conductor the temperature increases, causing it to 'sag' as the metal expands thereby reducing ground clearances.

On the trial routes (Pelham/Wymondley 132kV, Sundon/Leighton Buzzard 33kV) this technology also identified existing clearance violations (when the line would be operating at maximum temperature) that had been missed in our regular patrols. These were immediately actioned for resolution.

This technology determined that with relatively few mitigating actions, capacity could be increased on the two routes investigated, which has enabled a £6.36 million scheme to re-conductor a route to be deferred from 2014/15 until the conductor condition requires its replacement.

Temperature monitoring is also being installed to ensure that the maximum operating temperature is not exceeded, in order to prevent damage to the conductor. This will only occur under two co-incident faults or a single fault during a maintenance outage – assuming that this is under peak load conditions.

This approach is being rolled out across the schemes proposed for re-conductoring in RIIO-ED1 to determine whether any of this work can be deferred. This includes the use of LiDAR and temperature monitoring of OHLs as a means of assessing condition problems.



Demand Side Response brought from trial to adoption through the Low Carbon London project

Drivers of Demand Side Response (DSR) development

In London, factors such as high load and customer density; higher than typical cost of conventional reinforcement; and higher levels of interconnection make it the perfect test case for implementation and assessment of Demand Side Response (DSR) programmes. For all these reasons, UK Power Networks has made DSR a core part of the Low Carbon London Programme trials from the very start of the LCNF Tier 2 awarded funding.

Low carbon London DSR

DSR services can take any number of forms and functions, from autonomous dispatch of back-up generation units and which temporarily serve the local demand in the building in which they are installed, to commercially contracted demand reductions called upon manually by network control engineers and carried out by the facilities manager on the customer site. Residential, SME and I&C customers all provide unique opportunities as well as unique requirements in order to develop mutually beneficial DSR arrangements. UK Power Networks set out in Low Carbon London to understand through demonstration a full range of these opportunities. These trials have included:

- Contracting with demand aggregators supplying a portfolio of I&C DSR 'building turn-down' and responsive generation services
- Using Active Network Management systems to monitor and control the output of generators embedded in the distribution network
- Deploying smart meters and time varying electricity tariffs to test the responsiveness of residential and SME demand
- Exploring the opportunities for and effectiveness of electric vehicles providing DSR services – including commercial and technical solutions

Whilst all of these trials are still on-going, and the project looks forward to obtaining and analysing the results, the first area of DSR to begin trial has been the aggregated I&C DSR. Already this has also become the DSR opportunity first demonstrating positive, DNO benefits and which has given us the confidence to build £43 million of savings into our plan based on DSR.

The project conducted these trials by contracting DSR in a series of phases covering summer and winter peak demand seasons. These contracts required the demand aggregator to provide a set quantity of demand (MW) when called upon and to make that demand available for dispatch throughout the defined trial phase.

The trial phases completed to date – including Winter 2011/2012, Summer 2012 and Winter 2012/2013 – have been successful in enrolling DSR services:

- Across four primary substations in LPN
- 15.8 MW cumulative DSR made available through seven sites
- 115 MW of potential DSR available from c.90 prospective participants
- Including DSR delivered through standby generation output as well as building turn down
- Up to maximum of 109.1 MWh of responsive demand utilised per trial phase

A nearly 80 per cent successful response rate – it is worth noting that only one site was responsible for all of the non-compliant events.

Flexible Plug and Play – enabling cheaper and faster connections

Unviable projects with expensive connections

The trial area of the Flexible Plug and Play (FPP) project within the EPN distribution network has experienced increased development of generation projects and connection requests. This has resulted in network constraints due to thermal, voltage and power flow limits being exceeded. For this reason, each customer that requests to connect in a constrained part of the network is offered a the minimum cost option that connects them on a firm basis to a further part of the network, sometimes exceeding 10km of a new line. By implementing innovative solutions such as dynamic line rating and active network management, UK Power Networks is now able to offer customers with more affordable connections that will connect them to their closest point of connection on an interruptible basis.

> “UK Power Networks has been involved in several innovation projects relating to Overhead Lines (OHLs) over DPCR4 (2005 to 2010) and DPCR5 (2010 to 2015). Most of these have been collaborative projects that have been carried out in conjunction with some or all of the other DNOs. An implementation project was launched in 2011 to implement new techniques, update our processes, and provide useful guides to disseminate the learning to our staff.”

2 We have set up our **innovation** process for **successful delivery**

Key messages

We ensure our innovation portfolio **is balanced to maximise our success**.

We have **robust governance** round our network innovation projects.

Our **Future Networks team is responsible** for coordinating and governing all network related innovation

We **understand the inherent risks** of innovation and try to minimise the impact.

We have **a dedicated process to embed successful innovation** as Business as Usual.

We have committed ourselves to deliver savings to our customers in ED1 by using innovation. To meet this commitment, we have to manage our innovation portfolio carefully to ensure successful delivery. Due to its very nature, not all innovation projects will deliver and we accept that. That is the reason it is so important that we set up a balanced total innovation portfolio so that we can deliver the required outcomes and manage our projects. We have a dedicated team, our Future Networks team, to coordinate and govern this process.

2.1 Governance at the portfolio level

The Future Networks team is responsible for setting and maintaining our innovation portfolio. They drive innovation together with the business by:

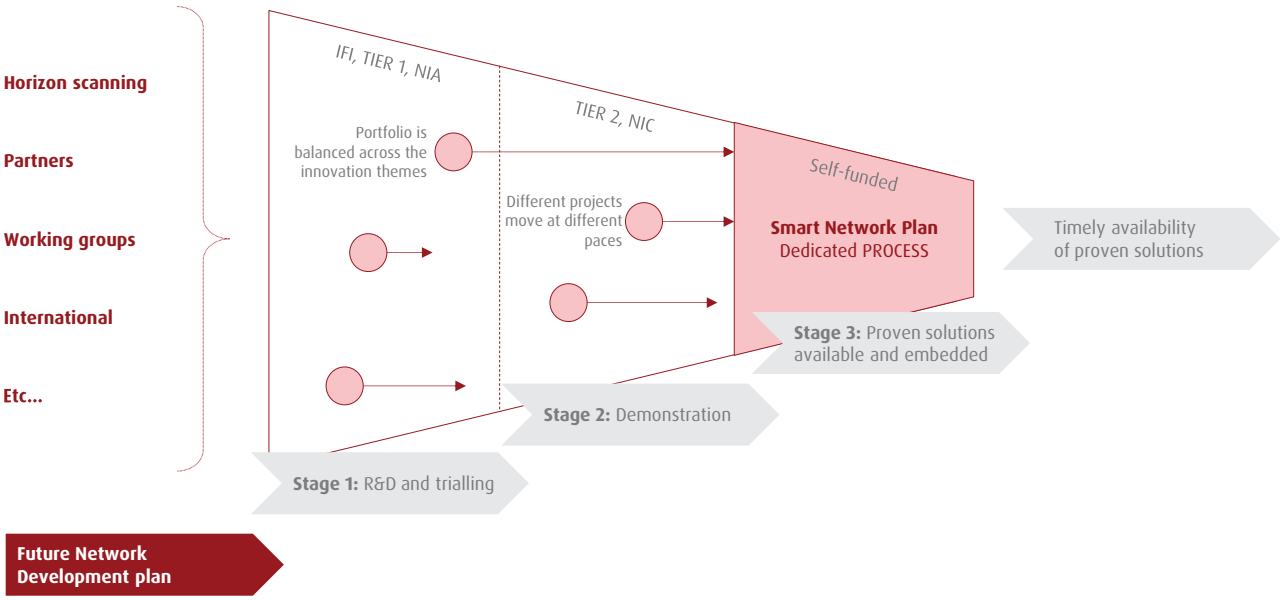
- Seeking and absorbing issues and ideas from the business
- Keeping abreast of technology developments and bring an 'external' challenge to the business
- Informal and formal reviews of the Future Network Development Plan and innovation strategy
- Actively developing and scoping new projects
- Running projects and carrying out some aspects of the research itself
- Driving projects through to implementation

We ensure our innovation portfolio is balanced to maximise our success. The Future Networks team is responsible for maintaining balance within the overall portfolio of innovation projects. In setting our portfolio, we balance:

- Projects addressing short, medium and long term issues from across our innovation themes
- Projects which are addressing technical and commercial aspects
- Projects in different stages of development, from initial ideas through to innovation being embedded by the Smart Network Plan and critical to our £141 million of committed savings
- High risk and low risk projects
- Projects being funded collaboratively and those which are contracted directly to UK Power Networks
- External partners and suppliers, so that the portfolio is neither too diverse in its relationships nor too dependent on a few critical relationships

Figure 4 illustrates how we set and balance our portfolio. In particular, at the earlier stages of R&D and trialling, we would expect to see a balance across themes and readiness. Necessarily as we place larger 'bets' on technologies in large-scale projects funded by the Low Carbon Network Fund Tier 2 or the Network Innovation Competition, the focus moves less from achieving a balance of money spent across themes, to ensuring that the project is still relevant, is performing well, and meets its original business case. Projects will move at different paces and the main check that we apply is that they are still on track to deliver the technology or solution by the time at which it is required.

Figure 4: Our approach to managing our innovation portfolio



Funding network innovation is likely to come from two sources: part-funded support from Ofgem or a third party funding agency, or self-funded investment. As technologies get closer to being proven and embedded back in business-as-usual they increasingly become self-funding from within our business plan like other continual improvement activities.

In Chapter 8 of this document we provide the deliverables which customers can expect from our innovation programme over RIIO-ED1 and also provide an assessment of how dependent those deliverables will be on the external policy environment and economic environment. We expect the Innovation Stimulus to be particularly useful in managing this uncertainty and allowing us to defer decisions until more data is available, and to manage cases in which the roll-out may be self-funding, but over a period which spans price control periods.

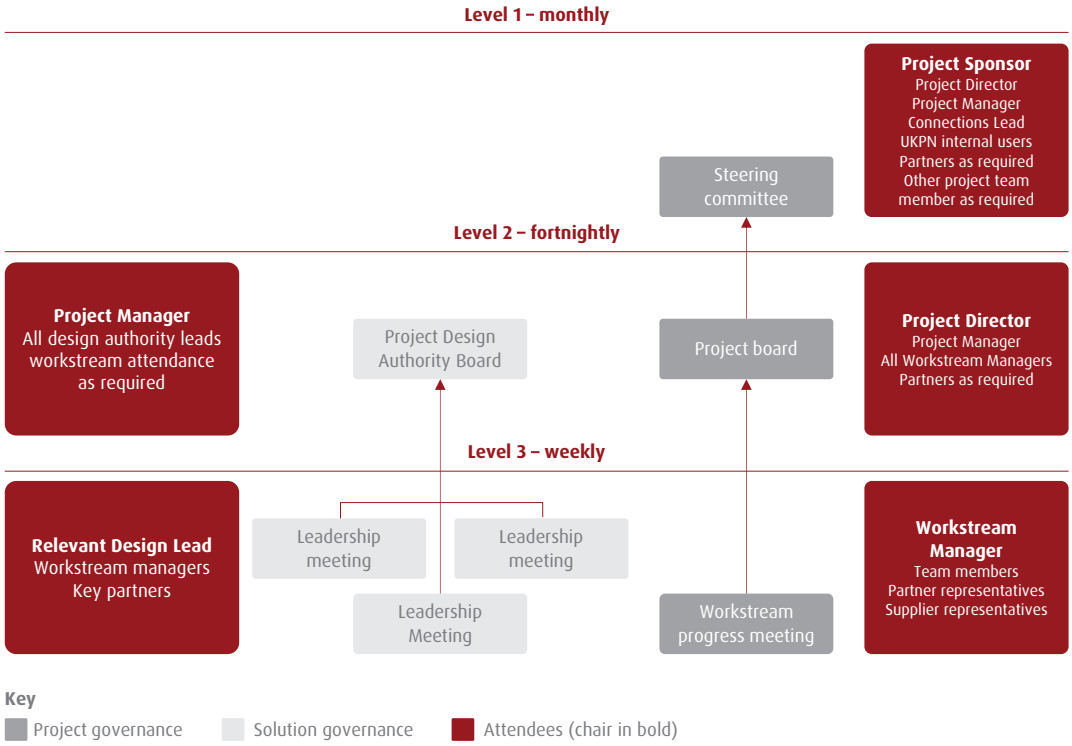
2.2 Governance at the project level

Our innovation projects are subject to our established project governance framework. Successful innovation projects are then rolled out as Business as Usual under the governance framework of the Smart Network Plan, which is covered in Chapter 11.

We established our innovation project governance framework for the LCNF projects that we are currently delivering. Each project applies the framework in a manner that is appropriate for the scale of the project. For each project we define a project organisation structure with defined roles and responsibilities, typically including project sponsor, project director if required (for larger projects), project manager, project management office, design authority, workstream managers if required (for larger projects) and project resources.

The governance structure for larger innovation projects typically covers three hierarchical levels and has two different streams, solution governance and project governance. This model facilitates a robust focus on identifying and developing the most effective solution, matched with an effective structure for delivering the solution to the project's time and cost constraints. The governance model is supported by, and aligned with, simple but effective reporting and project control mechanisms to enable quick and informed decisions to be made in a controlled manner. For each of the governance groups shown in the diagram below there are clear terms of reference, detailing the type of decisions the boards will make, who will attend, what the outputs of that meeting should be, the interaction with other governance groups and the levels of delegated authority that each board is to be given. This ensures that the business case is continuously reviewed at the appropriate level, all risks and issues are properly identified, reviewed and challenged, and effective decision making is delivered.

Figure 5: Project governance structure



2.3 Managing risks associated with innovation

Whilst governance at the project level is in place to manage the specific risks and issues arising within individual projects, there are a number of generic risks associated with our network innovation programme. These generic risks need to be addressed structurally by the way in which UK Power Networks organises its innovation activities.

These generic risks are identified in Figure 5 alongside the structural solutions that we have put in place to mitigate these. We recognise that innovation is an inherently risky endeavour. There is also a continuing challenge in knowledge management from the wide portfolio of projects being run; we need to ensure a strong approach to capturing and acting on lessons learned within the portfolio, and that we can continuously improve the extent to which innovation is embedded into our company culture and accountabilities.

Using our Low Carbon Network Fund projects to ensure future interoperability

The Flexible Plug and Play project is concerned with the implementation of a communications and IT infrastructure platform upon which various applications and technologies can be trialled. The deployment of these applications and technologies will enable the increased connection and operation of renewable generation across an area of 700 km^2 between Cambridge and Peterborough. The 'Plug and Play' term emphasises the use of open standards and interoperability in the communications, IT infrastructure, devices and any applications to be installed.

Figure 6: Generic risks associated with our network innovation programme

Risk	Description	Mitigations
Innovation programme backs the wrong technologies	The challenges we have outlined typically have multiple solutions. Amongst these solutions, a number are likely not to succeed in the long term as the best approaches are adopted. Backing only one approach therefore has a risk associated with it.	Leverage the wider portfolio of projects across the DNOs and research community. Allow our portfolio to explore alternate approaches wherever possible.
Low carbon transition timeline is not in line with current forecasts resulting in innovation being delivered prematurely or too late	The low carbon transition will largely be delivered through market mechanisms, implying a fluid environment as the market determines the best approaches. As such, investigating issues such as Electric Vehicle charging need to be timed to deliver in time for, but not too far in advance of, major uptake.	6-monthly review of our activities and need-by dates for technologies, based on latest GB forecasts and indicators of activity in the markets (such as the list price for Plug-in Hybrid Electric Vehicles).
Insufficient attention to lessons learnt	Project management best practice requires that lessons are documented and made use of during future projects. Failure to do this can lead to time delays, additional cost or even failure of future projects.	1:1 interviews with project team and external peer review by consultants used for the first time in 2012.
Knowledge Management and business adoption	Findings are not sufficiently communicated and new techniques are not adopted by the business.	The Smart Network Plan described in chapter 11 represents our methodology for adoption into the business. We are working collaboratively with the ENA and Smart Grid GB on knowledge capture but recognise that there is more to do.
Staff handovers	Many of our innovation projects and trials last for a number of years and therefore encounter staff handovers during the project.	High quality project inception documents and progress reports, which act as handover documentation.
Customer and technology uptake	Many DNO innovation projects rely on customers using technology or reacting to offers and being willing for us to observe the results. If insufficient customers are recruited, the learning is not robust.	Financial incentives are provided to reach adequate trial participation, and to date our experience has been that these incentives are reasonable and economic to offer.
Customer misunderstanding	There is potential for our interaction with customers to create a misunderstanding of UK Power Networks' role, or the role or functions of other parties and initiatives in the energy market.	Customer engagement plans are drafted and approved by the regulator Ofgem before contacting customers directly.

Risk	Description	Mitigations
Delay in commissioning equipment	Our innovation programme is deploying larger volumes of equipment (such as LV circuit breakers) or significant capital items (such as Fault Current Limiters).	Specialists added to the core team during 2012. Delivery through our existing Capital Programme and small works teams. Our delivery during 2013 has provided significant proof of senior commitment across the company.
Equipment failures limit learning	Whilst there are occasions in which equipment failures provide a valuable indicator of reliability of new equipment, its immediate impact is to limit the results which can be collected and analysed.	All equipment must first pass the company's standard design approval and which appraises health and safety, lifecycle management, outages and protection issues.
Interoperability of new technologies	Many new smart grid technologies rapidly appear on the market or are still under development. Without robust standards and protocols, interoperability (the ability of these devices to talk to each other) can become a serious issue. The same can happen between new releases of the same type of technology, ensuring that version 2 of the same device works properly with previously installed version 1.	Through strict product specifications and dedicated trials, we test and aim to ensure interoperability of our solutions. In addition, we actively push for open standards, so we will not be locked in with a single supplier in the future. We are doing this most visibly in our Flexible Plug and Play (FPP) project.

Part one
Our innovation strategy

3 Our innovation strategy

Key messages

Why? UK Power Networks has committed to both network and commercial innovation targets in order to deliver stakeholder value and continuous improvement benefits.

Where? We have a proactive innovation approach so opportunities may be identified from any part of the organisation and by any source.

How? UK Power Networks seeks to be consistent and apply eligibility criteria to our R&D projects.

Risks? We place importance on risk assessment, mitigating actions and incorporating flexibility at all stages of our projects.

Who? The Future Networks team and other innovation leaders in the business work closely with selected technical and commercial expertise providers to reach successful results.

Next steps? A systematic approach has been developed for integrating innovation into Business as Usual and is being embedded into our company policies and procedures.

UK Power Networks is a Distribution Network Operator (DNO). Distribution companies operate and maintain the electricity networks. Throughout the UK, there are fourteen DNOs, each responsible for different areas of the country. If you live in London, the South East or East of England, regardless of who your supplier is (who you pay your electricity bill to), it is our cables and other network equipment that bring power to your home or business every day.

We continuously try to do our work better, cheaper or faster, and innovation is one of our means to achieve this. In addition, our sector is gearing up to deliver the low carbon economy, and which will have a significant impact on the way in which we run out networks.

Whilst this document is written for all of our stakeholders, Ofgem has helpfully set out its expectations. At the beginning of the document we provided evidence of how our work during the current and previous price control periods are showing financial returns for customers. In Part 1 of the main document, we describe the guiding principles and key elements of our Innovation Strategy and the challenges that we face as a business. We introduce the way in which we have created themes and roadmaps which allow us to prioritise technologies and solutions. We also outline our approach to finding innovative ideas. In Part 2 of the main document we provide a list of deliverables in Chapter 8, evidence of how we work with stakeholders and partners in Chapters 9 and 10, and and the processes by which we integrate results back into the day-to-day business in Chapter 11. We discussed a draft of this document with a panel of R&D specialists, and commit to updating our innovation strategy every two years.

3.1 What is innovation?

Innovation has many different definitions and interpretations depending of the context in which it is used. UK Power Networks views innovation as introducing something new to our business processes or distribution network so we can provide a better, cheaper or quicker service than before. Innovation does not always have to be ground-breaking; many improvements are achieved by smaller step-by-step improvements.

In UK Power Networks we often think of innovation as either:

- Incremental innovation – continuous evaluation to achieve gradual improvements of our business efficiency, for example by using small remote controlled helicopters to carry out overhead line inspections
- Disruptive or transformational innovation – redefining the way we run our business or network, embodied in our Low Carbon Network Fund (LCNF) projects to trial Smart Grid technologies

3.2 Why do we innovate?

In UK Power Networks **we innovate to identify opportunities for developing new or more efficient services, processes or solutions.** This rationale for innovation contains two vital elements which are at the heart of our approach to innovation:

- Value to our stakeholders – if we cannot identify how a proposed innovation will deliver value to our stakeholders then we do not proceed with it. We are clear of our duties to serve customers; support the economic recovery; and facilitate the government's carbon reduction targets. Our innovations deliver across all of these goals
- Continuous improvement – we are committed to deliver continuous improvement of our services, processes and solutions. This commitment covers the entirety of UK Power Networks, including customer relations, new connections, management of our substation assets, the remote workforce, health, safety and sustainability, our construction programme and back office functions, rather than being focused only on specific areas

We have made a conscious decision to be leading in innovation and decided against the option of being a 'fast follower', relying on our right of access to the work being carried out by other Distribution Network Operators (DNOs) and then implementing the lessons learned on our own network. We believe that much of the learning and knowledge transfer takes place as a result of experiences in-project and are not fully conveyed by end-of-project summaries. This position is also key to our vision to be an attractive business to work for, since it allows our staff to be exposed first hand to new developments in their fields and to understand and respond to the implications of policy decisions made by government or Ofgem.

3.3 Where do we get innovation ideas from?

Our commitment to continuous improvement across UK Power Networks means that **innovation opportunities may be identified from any part of the organisation or from our stakeholders**. We will continue to actively encourage and promote this approach, as the best innovation ideas often come from those that can see where new value can be delivered and can identify how it can be realised most efficiently.

We accept the inherently risky nature of innovation and are committed to identifying opportunities to develop the distribution network itself, incorporating any potential failures into our lessons learned for continuous improvement.

Our Future Networks team coordinates and delivers our portfolio of network innovation projects, including the Innovation Funding Incentive (IFI) and LCNF projects, and will be responsible for our portfolio of Network Innovation Allowance (NIA) and Network Innovation Competition (NIC) projects from the start of the RIIO-ED1 period. RIIO-ED1 is the first electricity distribution price control to identify innovation as a key input and reflect Ofgem's new RIIO (Revenue = Incentives + Innovation + Outputs) model.

In order to ensure that our innovation portfolio is balanced and delivers value both to UK Power Networks and to the industry at large, our Future Networks team also ensures that we are active in both contributing to and learning from network innovation in the wider industry through participation with universities, in institutions including the Institution of Engineering and Technology (IET) and the International Conference on Electricity Distribution (CIRED), in associations such as the Energy Networks Association (ENA), and attending industry events such as the annual LCNF conference.

Our Future Networks team is part of our Strategy and Regulation directorate and will therefore also be responsible for identifying, agreeing and monitoring our strategic direction on the key network innovation topics that we expect to evolve throughout RIIO-ED1 and beyond. As an example, the team takes the lead in crystallising the definition of a Distributed System Operator (DSO) concept for UK Power Networks and ensuring that our innovation project portfolio is fully aligned with the company's vision.

3.4 How do we innovate?

We undertake innovation by a variety of approaches that are tailored to achieving effective outcomes and value for money. Our innovation projects draw on internal and external resources so that we take advantage of best advice and experience, we adopt the best techniques, and we build new in-house knowledge for the future. This leads us to work with large and small manufacturers, academia, specialist advisers, community organisations and other stakeholder representatives.

In order to deliver innovation of the scale that we believe is required, we access funding from a variety of sources over and above our own financial support. We will naturally seek to optimise our use of available income from the IFI, LCNF, NIA, NIC or third party funding agencies. As we identify new innovation ideas, they are scoped out to the extent that is required in order to understand the associated costs, benefits and risks. We then evaluate if the potential project will deliver appropriate new value on a self-funding basis and decide whether or not to proceed. Where the benefits are not immediately quantifiable or available, but could be substantial, we will seek to deliver the project using the other available innovation funding mechanisms.

There will also be circumstances **where we identify technology development activities which we regard as worthwhile but may not be eligible for funding; in these scenarios we will determine on a case-by-case basis if the potential value is sufficiently high for us to self-fund**. An example of this was the Green Rhino filtration bag (see case study in Chapter 7), which was developed with a manufacturer and offers a means to remove water from an excavation, by ensuring that any contaminants are held in the bag and disposed of whilst the remaining water is released.

We actively engage in the ENA Research and Development (R&D) working group and we collaborate with them in specific projects. Participating in collaborative projects is a good way of delivering value for money for customers sharing information and results across our industry.

We have established a Future Networks department to act as a single point of accountability for innovation activities which affect the network Any of our innovation activities which are not immediately self-funding from within our existing allowances are rigorously assessed by our Future Networks team before commencing.

Those innovation activities or projects that are selected for delivery are actively monitored to clearly identify the business case for innovation throughout their delivery lifecycle. This will help us ensure that the expected value to be delivered remains on target, and enables us to monitor its realisation after delivery. This is formalised in a set of 'stage gates' including an after-the-event post investment appraisal, in line with project management best practice.

We maintain a balanced portfolio The Future Networks team is responsible for maintaining balance within the overall portfolio of innovation projects. Our balanced portfolio contains a mix of:

- Projects addressing short, medium and long term issues from across our innovation themes
- Projects which are addressing technical and commercial aspects
- Projects in different stages of development, from initial ideas through to innovation being embedded by the Smart Network Plan and critical to our £141 million of committed savings
- High risk and low risk projects
- Projects being funded collaboratively and those which are contracted directly to UK Power Networks
- External partners and suppliers, so that the portfolio is neither too diverse in its relationships nor too dependent on a few critical relationships

3.5 How do we address risks and uncertainty?

We recognise that the outcomes from innovation projects inevitably carry a degree of uncertainty and the ever evolving UK power sector adds further complexity to the task. We are also conscious that our funding mechanisms are funded from our customers. **To respond to these challenges, our innovation strategy places importance on managing risks and incorporating flexibility at all stages**. Specifically, the risks around the low carbon energy transition and how fast low carbon technologies will effectively be incorporated into customer's daily consumption behaviours are the most important to actively assess.

We ensure that our portfolio of innovation projects has appropriate management oversight throughout the delivery lifecycle, and many of these projects will progress and deliver as expected. For those innovation projects that are flagged up as failing to deliver the required value, we make a clear decision on what needs to change in order to get us back on track and ultimately whether or not to continue. **All innovation activities and projects are subject to this governance, which includes regular assessment of risks and the business case for innovation,** thus ensuring that we will take into account and adjust our portfolio in the light of the changing environment we expect to experience during the RIIO-ED1 period and beyond.

Part of the development of network innovation project proposals includes risk assessment and the identification of mitigating provisions. Our governance framework for innovation projects also ensures that we continuously assess and monitor our innovation work with respect to health and safety, thus ensuring that such risks are actively assessed and addressed in a manner commensurate with our commitment to health, safety and sustainability.

Flexibility is a key approach to managing uncertainty and this is incorporated into the solution designs delivered by our network innovation projects, through techniques such as modular or scalable solutions, and the use of open standards and interface protocols. This ensures that solutions have longevity and are not left behind if technology changes direction.

3.6 How do stakeholders feature in our innovation strategy?

Stakeholders are an integral driver and enabler for our innovation activities. **We work hard to understand the needs of stakeholders, both as part of our day to day business and through formal stakeholder events and interactions as outlined in our overall business plan.**

Stakeholders are included at a number of stages in the lifecycle of our projects, from generating new ideas through to working with us to implement changes in processes and policy once techniques are proven.

The business plan we are submitting to Ofgem as part of RIIO-ED1 is the product of the most extensive stakeholder engagement process ever undertaken by the organisation. We have examined concerns raised by stakeholders through forums other engagement tools such as the website and telephone surveys.

As a result:

- Our innovation strategy seeks to reflect the business plan that has been amended following direct feedback
- We have used the feedback to strengthen our strategy and ensure transparency of our planned activities
- As part of being transparent, where we are not able to incorporate specific feedback we strive to provide the rationale for our decisions

As an example, we were challenged at one of our stakeholder panel sessions on the way we developed estimates for the uptake in electric home-heating using new low-carbon technologies (i.e. ground-source and air-source heat pumps). In particular, a number of stakeholders stated that they saw less government policy support and less commercial activity in this area, than, for example, in electric vehicle charging infrastructure. As such, they questioned whether our forecasts would come about unless the policy support and commercial activity materialised.

This highlights the need for us to seek technical and commercial solutions which solve common problems, rather than solutions which are unique to a specific technology such as heat pumps. Fortunately, electric vehicles and heat pumps do cause some similar network management issues and therefore attract some common solutions. UK Power Networks should therefore be careful in committing large amounts of innovation funding to problems which are unique to heat pumps, until the external policy support is seen to be strengthening. Another conclusion is that we should do more collaborative work with the other DNOs where the problems are unique to heat pumps, in order to reduce the overall cost of the research work to consumers.

A key part of our engagement forums has been to discuss the low carbon transition and ask open questions about whether stakeholders are willing to see the role of UK Power Networks change, and whether they agree with our approach of having a strong in-house innovation team. This culminated in a review of the first draft of this document and feedback session with a panel of recognised R&D and industry experts..

3.7 How do we support continual improvement activities?

We have a number of innovation sponsors across our business at senior manager or technical expert level and who work closely with our Future Networks department. Specifically these sponsors are seeking improvements in the following areas:

- Health and safety
- Responding to faults
- Seeking new construction methods to reduce time and cost
- Driving technical specification of the electrical plants that we purchase
- Improving customer service

Each of these sponsors involve key players across the business as required to deliver continual improvements, ranging from part-time involvement from a few colleagues through to full-time project teams. Our expenditure on continual improvement in our existing business processes in the last financial year, 2012, amounted to £5.8 million. Our expenditure on safety improvement programmes and maintaining and developing safety and environmental compliance policy amounted to £7.1 million in financial year 2012. These activities were self-funding from within our existing allowances.

3.8 How do we make innovations business as usual?

Our innovation projects will only be successful if we embed the new knowledge into our 'Business as Usual' (BaU) practices to improve the way we work and serve our customers.

The integration of innovation sponsors at a senior level within the directorates in the company is an important part of this process. Their senior roles allow them to be fully aware of the working practices and day-to-day challenges; therefore, they are best placed to drive the company through change.

We have developed a systematic approach that is being integrated into our company policies and procedures. This includes management oversight through project sponsorship and tracking mechanisms to ensure closed-loop governance. These governance mechanisms ensure that network innovation project outputs are consistently embedded into BaU solutions and become part of our toolkit for planning and operational activities at all stages in the asset life cycle.

An important requirement at this stage area is to adapt the knowledge and skills to deliver the outcomes of demonstration projects and make solutions suitable for deployment at scale. To assist the transition to BaU of our network innovation we have developed and implemented an approach we call the Smart Network Plan (SNP). The SNP is a comprehensive transitioning plan and governance process which gives confidence that the outputs of network innovation projects are migrated smoothly into BaU solution options that can be adopted at scale throughout the RIIO-ED1 period and beyond.

In the next chapters we provide further detail on the challenges we are facing and how these will be met by our network and business innovation approach.

3.9 How will customers benefit as a result of our innovation?

We have built £141 million of reinforcement savings from technology innovation into our business plan submission and which are the fruit of existing Smart Grid network designs and processes, activities carried out using the funding incentives available during the DPCR5 price control (2010 to 2015), and committed savings delivered from our RIIO-ED1 innovation portfolio.

This represents a net payback of all our work to date since 2005 and all the work we currently have committed under the Low Carbon Network Fund. The final chapter of the document provides case studies of examples in which our innovation projects are making an impact on the way that we work, and the way that we design and run the network.

It is important to note that some of these savings during ED1 are realised by deferring investments to a later point in time (e.g. during ED2) by using smart solutions; it's also relevant that those deferrals are part of our way to manage the uncertainty around the low carbon economy. The ability to postpone an expensive investment decision by making a much smaller investment is of high value in a world of many uncertainties (e.g. we are not certain when the mass roll-out of electric vehicles or heat pumps will take place). Innovation allows us the flexibility to 'buy time' so we do not overinvest early on at the expense of our customers.

3.10 How will we track future benefits from innovation?

To be sure we delivering value for money to our customers and wider stakeholders, we need to continuously demonstrate benefits of our efforts We will apply common best practice processes consistently identify, track and manage benefits across our portfolio. Key metrics for benefit tracking include our ability to:

- Provide improved service, but at similar cost, such as reduced time-to-connect, faster fault restoration or disruption to customers
- Reduce existing planned schemes with lower cost alternatives by extending the service life or capacity of assets
- Avoid future reinforcement and therefore future costs
- Provide greater understanding of risk, on which investment decisions can be made
- Increase safety, both for employees as the public
- Reduce environmental impact, including emissions of greenhouse gases

4 Our **commitment** to continuous **improvement**

Key messages

As a business, we have **two key business cycles** to ensure the existing network delivers the expected performance, and to invest in the capacity of the network.

We are **continually improving** within each of these cycles, and in **every element of each cycle**.

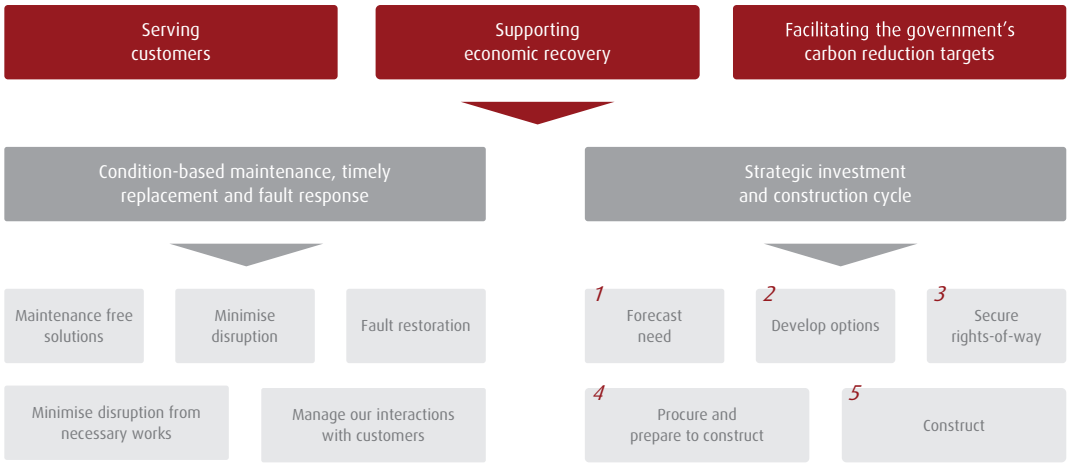
As well as our continual improvement activities, we run a separate programme of research, development and trials **to develop new methods of network design and operation**.

We **refresh our innovation portfolio** by continually looking for new opportunities, stimulated by a specific business need or by technological advancements.

Innovation is core to the success of UK Power Networks. We drive business innovation to improve our customer satisfaction, be more cost efficient and optimise our investment to keep customers' bills down. The diagram below sets out UK Power Networks' broad approach to innovation.

At the highest level our stakeholders have three expectations: that we serve our customers; that we support the economic recovery; and that we facilitate the government's carbon reduction targets. An additional and over-riding pre-requisite is that we achieve this safely, for both our employees and the general public.

Figure 7: How UK Power Networks supports its approach



UK Power Networks achieves these strategic goals through adopting innovative approaches within its **two key business cycles:**

1. Ensuring the existing network delivers the expected performance through maintenance of equipment, timely replacement and fault response – ensuring reliable supplies to customers, by seeking to specify maintenance free solutions wherever appropriate; planning maintenance and replacement based on the condition of individual pieces of plant, to avoid faults; and restoring service following the faults which do occur, minimising the disruption from necessary works and ensuring that customers are kept informed
2. Investing in the capacity of the network by strategic planning and construction which is comprised of five steps – forecasting the need for additional capacity; developing options including non-conventional or 'smart' options; securing rights-of-way, which can be significant especially in our congested urban areas; procuring and preparing to construct and which can often involve constructing subsidiary or supporting schemes in order to provide transfer capacity during the full construction works; and finally construction

Continuous innovation takes place across all levels of the business as set out above, including decision making, cost efficiency, innovation in street-works and in the field, customer service and communication channels, managing customer demand and health and safety.

Alongside our continual improvement activities we also run a programme of supporting research, development and network trials, such as our work on Low Voltage (LV) remote control, our work to increase the capacity of overhead lines, and Demand Side Response (DSR) to maintain network security during construction works. A number of these are highlighted in case studies in the final section of this document.

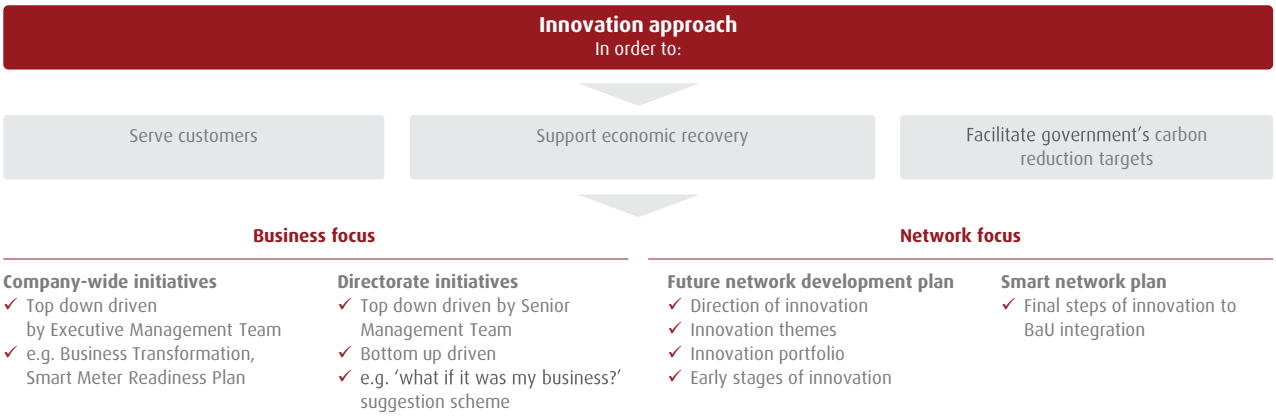
Demand side response

Demand Side Response is a deliberate change in demand for electrical power by a network user at a given point in time and for an agreed period of time. This may be either a shift in demand from one time period to another, or a permanent change of electrical power. Changes may be put into effect by either managing electrical load or by the self-supply of electrical load from local generation sources.

4.1 Structuring our continuous business improvement and network innovation

We structure our activities supporting these **two key business** cycles into two distinct areas: continuous business improvement and network innovation. Our innovation strategy reflects this distinction and both focus areas will be discussed in the following chapters (network challenges and our response in Chapters 5 and 6, and the way that we deliver continuous business improvement in Chapter 7).

Figure 8: UK Power Networks' approach to innovation



As discussed in Chapter 7, our continual improvement activities are often led by the innovation leads in the individual directorates within our organisation, all of whom are in senior management or recognised expert positions within the company. Occasionally, a company-wide change is sought and a company-wide change project is established and which reports directly to our Executive Management team. An excellent example of this are the preparations for residential smart meters, spanning the information we will receive about the condition of our equipment next to the meter in our customers' homes, the increased customer expectations around fault response, and the insight into loading on our network. These will impact our connections, investment planning, field force and customer service teams, warranting a company-wide approach.

Our network innovation is guided by our internal network innovation strategy, the 'Future Network Development Plan', and is complemented by a dedicated approach to implementing network innovation back into the business known as the Smart Network Plan. We recognise that what is delivered within an innovation project needs to be able to be replicated many times over, often against strict deadlines, and with a working knowledge rather than detailed insight when it is adopted into our 'Business as Usual' (BaU) practices. The Smart Network Plan is discussed in further detail in Chapter 11.

From Olympics innovation to Olympics legacy

UK Power Networks built the new state-of-the-art electrical network, and kept the power running, for the London 2012 Olympics Games venues and London Transport hubs. This was a significant new project and resulted in substantial learning which we are now embedding in our business. For example, we have developed a matrix to compare future Major Public Events against the network preparations that were made for the Olympics. The matrix includes five priority levels that can be used to classify such an event, with examples of events ranging from the London Marathon to a Royal Wedding. The priority level of the event determines the senior management involvement. More importantly, the matrix describes which network activities are likely to be required for the event, the full list of which contains 32 activities that were undertaken for the Olympics.

Our network innovation is particularly important in facilitating the government's carbon reduction targets. As a result of our network innovation, we can commit that:

We will be ready by having leading indicators in place to anticipate customer and stakeholder requirements, which will be informed by and tested with these parties. We will develop processes to increase visibility of our network, including adopting smart technologies where it is in the customers' interest. Finally, we will have the agility to proactively respond to external changes in the uptake of Low Carbon technologies and demand.

We will be fast and flexible by offering simple accessible 'smarter' solutions and innovative, competitive connection offers and meeting customers' expectations of time and cost. Where possible, we will use smart solutions to release latent capacity so that we can best meet the needs of a growing customer base.

We will take the long-term best view by deploying smart technical and commercial solutions where there is a whole-life positive investment case compared with conventional network investment and proven through trials and real experience of procurement; but will not be afraid to invest in traditional reinforcement where more appropriate. Wherever possible, we will seek to keep our options open when investing, given the great uncertainty that exists in the sector, especially around new technologies.

We will build our capabilities by being innovative in developing standardised smart solutions that are able to accommodate new technologies in a simple and effective way. This is particularly relevant for Information and Communications Technology (ICT) which has shorter life than most of our electrical assets, but where technology can advance far more quickly.

We will pro-actively manage the network by promoting innovative solutions that keep the option open of moving to a more active network management regime as and when new demand increases. For example, better network management will involve distributed generation (DG) and the dispatching of Demand Side Response where necessary to alleviate pinch points on the network.

4.2 Keeping our innovation strategy up to date

We see our Innovation Strategy as a live document, expressing our high level approach to innovation at a point in time, and recognising that we are in an uncertain environment. As such, our Innovation Strategy describes how we will address risks and uncertainty in the projects that are selected for delivery, both as innovation projects and in transferring the outcomes of innovation projects into business as usual. We also understand the need to keep the Innovation Strategy itself up to date throughout the RIIO-ED1 period and beyond, especially given that it looks ahead well into the future.

While we will keep our Innovation Strategy under constant informal review, we also plan to undertake a full formal review on a biennial cycle. During this review we will start with the Innovation Strategy itself and determine if there are any fundamental changes that need to be made in the light of experience since the last review. We will then cascade this down through our innovation related documents, including our Smart Network Plan and Future Network Development Plan. Updated versions of all innovation documents will be promoted and shared throughout UK Power Networks, and public documents will be published on our website.

A review and update of our Innovation Strategy may also be triggered outside of the biennial cycle by specific events. These could include:

- A major new technology breakthrough
- A substantive change to innovation funding arrangements
- Significant new learning from other projects delivered by other DNOs

In each case this will trigger a full formal review of the Innovation Strategy.

5 The **challenges** which **UK Power Networks** is facing

Key messages

Our focus on R&D in recent years has become more intense because not only will we face **new challenges** from changing global climates but **existing pressures** will increase as a result of the low carbon transition.

UK Power Networks is committed to ensuring these operating difficulties **will not negatively impact our customers**.

We have day-to-day challenges like any business, but DNOs now face **unprecedented challenges which require extensive innovation** in order to address them at the least long term cost. We face unique challenges due to the nature of our networks. Our recent investments in innovation have demonstrated our understanding of these challenges and our commitment to address them, and we are committed to continue this.

As a business UK Power Networks faces day-to-day challenges, some of which are common to the other electricity DNOs and indeed common to other utilities, and others are specific to our network or our customers. The following five challenges are detailed in this section, followed by consideration of what would happen if UK Power Networks did not invest in innovation:

- The climate and energy landscape
- The economic situation
- Changing customers' expectations
- Ageing assets
- The need for Smart Grids

5.1 Climate and energy landscape

The UK, in common with other EU countries, has binding obligations towards CO_2 emissions, energy efficiency and renewable energy. Electricity will bear the brunt of delivering the 'renewables' target with more than 30 per cent of electricity (117TWh pa) generated from renewable energy sources by 2020, and increasing electrification of heat and transport will mean increased electrical demand.

For distribution networks, this also means a paradigm shift from the current passive regime where power flows in one direction down-stream from centralised power stations to consumers and where consumer demand was very predictable. Currently, intermittent forms of generation and the wider use of distributed energy resources will mean less predictable, up-stream and down-stream power flows, while major new applications for electricity (in particular electric vehicles and heat pumps) may eventually result in up to 50 per cent greater consumption of electricity than today[1].

5.2 Economic situation

The economic downturn over the past few years has been reflected in limited growth, which has led to fiscal pressure on the public, government and companies. This pressure is particularly evident in the regulated sector. There exists a need to do 'more with less' in order to keep consumer bills manageable while still promoting innovation when delivering services and this is a very real challenge for UK Power Networks.

5.3 Changing customer expectations

There is an increasing expectation from our Industrial and Commercial (I&C) customers that our staff are multi-skilled and our interactions with them are seamless. They expect to be able to talk through and understand our engineering limitations and, in turn, to share their commercial constraints with UK Power Networks and expect us to work with them in maximising value and speed of their connections. Customer experiences with other sectors outside of electricity distribution have raised consumer expectations in this sector, and we need to meet these expectations.

5.4 Ageing assets

A number of our asset populations are, on the face of it, candidates for renewal at points within the RIIO-ED1 or RIIO-ED2 price control periods. As a buried asset, the cable population at 33kV and 132kV has limited opportunities for inspections, has served many decades and is a critical asset. A significant fraction of our grid and primary transformers were commissioned in a short timeframe from 1962 to 1965 and are being carefully monitored to understand how their refurbishment and/or eventual replacement may fall and be scheduled. Similarly, a large number of wood poles will have reached 70 years asset life in the RIIO-ED2 period. Our challenge is to find the cost-efficient, innovative balance between managing these neither as individual assets, nor en-masse, but as selective programmes of upgrades and replacements targeting those at a similar level of deterioration to ensure best value for customers.

1. 'Benefits of advanced Smart Metering for demand response based control of distribution networks', Imperial College London, April 2010, page 24, available from www.energynetworks.org.

5.5 The need for Smart Grids

If extensive reinforcement of distribution networks is to be deferred, which in turn would lead to price increases for consumers as well as significant disruption due to street-works and risk of damage to UK economic competitiveness, then smarter means of accommodating distributed energy resources combined with smarter management and control of electricity demand will be essential.

This gives rise to the concept of 'smart grids' which will facilitate new technologies and commercial products to enable a much wider penetration of DG from renewable or low carbon sources, and a major increase in electricity consumption from the electrification of heat and transport. According to the European Technology Platform for Smart Grids, smart grid can be defined as:

> "An electricity power system which can significantly integrate the actions of all users connected to it – generators, consumers, and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies."

In the case of UK Power Networks, smart grid principles will need to be applied to everything from very dense underground urban networks through to overhead rural networks.

The smart grid itself raises challenges as well as opportunities. For example:

- Our reliance on ICT will increase, and thus our reliance on ICT professionals will increase
- Our field staff will be working on a network that is more active and autonomous than today, delivering improved quality of service but requiring new safe systems of work
- Our interaction with our customers will increase dramatically with the use of smart meters and Demand Side Response (DSR). We need to have the customer service and data management capabilities to handle this as well as the network operational capabilities
- Our planning processes will need to factor in smart solution options, and potentially rapid changes in network requirements as a result of increasing renewable generation connections and dynamic demand profiles as a result of electric vehicles and heat pumps
- The opportunity to use more cost-efficient commercial off-the-shelf (COTS) ICT equipment may increase, meaning we can provide more to customers for less

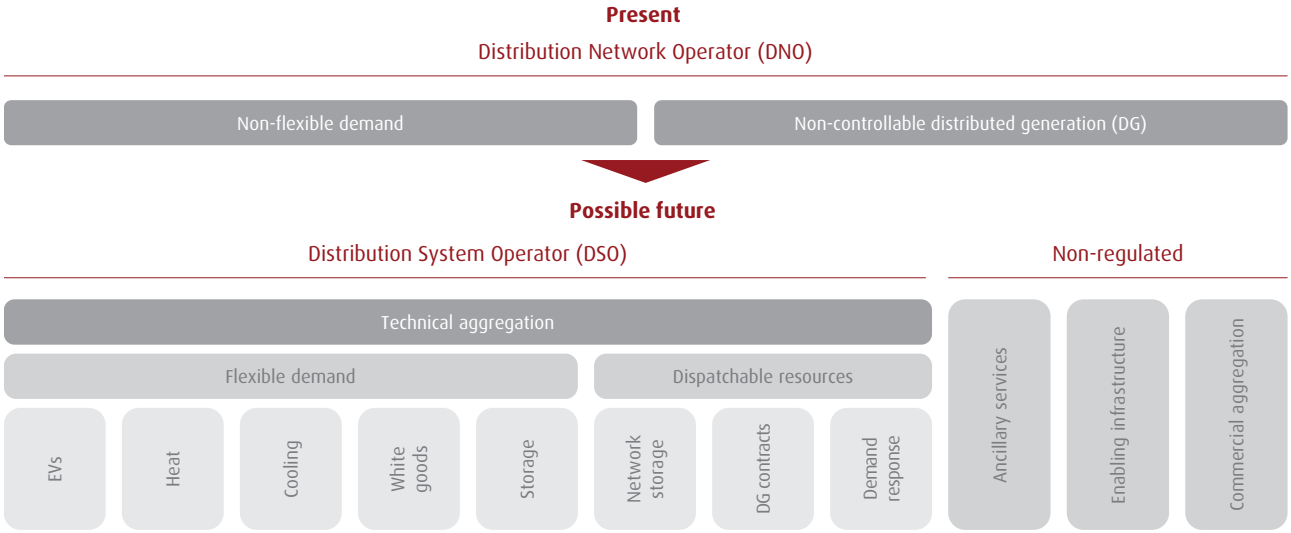
We strongly believe that the challenges we have set out above amount to a radical change from the current business, and to a future in which DNOs become 'Distribution System Operators (DSOs)'. This change is being strongly debated by government and the industry. It is clear that the DSO future defines a direction of travel for the DNOs which will take many years to navigate and with a great deal of uncertainty regarding timing, technologies and customer behaviour. The move from the present DNO to the possible future DSO, which innovation will play a key role in, is illustrated on the following page.

Figure 9: UK Power Networks' draft approach for the potential transition to a DSO

Distribution system operator

A Distribution Network Operator (DNO) continues to build in response to growth in maximum or peak demand. A DNO does not have the ability or desire to influence demand and generation, and tends to introduce flexibility only to the extent that it supports existing regulatory priorities (such as to reduce supply interruptions and the risk of catastrophic asset failure).

By contrast, a Distribution System Operator (DSO) has access to a portfolio of responsive demand, storage and controllable generation assets that can be used to actively contribute to both distribution network and wider system operation. A DSO builds and operates a flexible network with the ability to control load flows on its network. The combination of a highly flexible network and access to demand and generation response allows the DSO to contribute to the increasing challenge of encouraging demand to follow generation.



5.6 What would happen if UK Power Networks did not invest in innovation?

In the absence of UK Power Networks undertaking innovation as set out in this document, the challenges described in this section would result in increased cost to customers as a result of reactive (and often expensive) works to build capacity at short notice. In particular:

- The UK would continue on a path of relatively high-emissions and would find it more difficult to meet binding low carbon targets such as through the development of wind farms in EPN, which the government, and ultimately the public, would be accountable for
- London may be at risk of losing its status as a world-leading city without necessary investment in innovative network infrastructure
- Greater disruption for customers due to street-works and other interruptions would be likely
- The UK would be behind the rest of the world in smart grid innovations which would have an effect on our economy and innovative position
- The following section details how we are responding to the challenges facing us to ensure that the adverse outcomes set out above do not materialise

6 Our **response** to the **challenges**

Key messages

We structure our network innovation projects into **seven capability themes**.

These **themes describe the actions** that need to be carried out to meet the challenges facing the company.

Each of the theme areas is further developed with a **vision statement**.

The vision statements are then developed into a **roadmap of required capabilities**.

This allows us to **prioritise the technologies** and solutions which we need to investigate knowing that they directly link back to the challenges we face and the capabilities we need to establish.

We visualise our technologies and commercial solutions and the priority order in which we should develop them as **'innovation trays'**.

Our approach to network innovation is well thought-through, and shows just how **integral a part of our business it is for the long term**.

The challenges we face require us to be better at what we already do, and to innovate in the way in which we design, build, maintain and operate the network. UK Power Networks has been refreshing its network innovation strategy throughout 2011 and 2012 to deal with these challenges. We are clear that neither a fully traditional approach in the face of such challenges nor a 'build it and they will come' approach to smart grids is appropriate.

In the first case, UK Power Networks is likely to be faced with significant reactive work in the event of a faster-than-expected low-carbon uptake, which will end up could potentially end up costing customers more.

In the latter case, we feel that this may not be efficient use of customers' money – investing in assets which are under-utilised in the early years of life, and in particular ICT assets which are currently evolving rapidly and have much shorter useable life and support lifecycles, is not efficient.

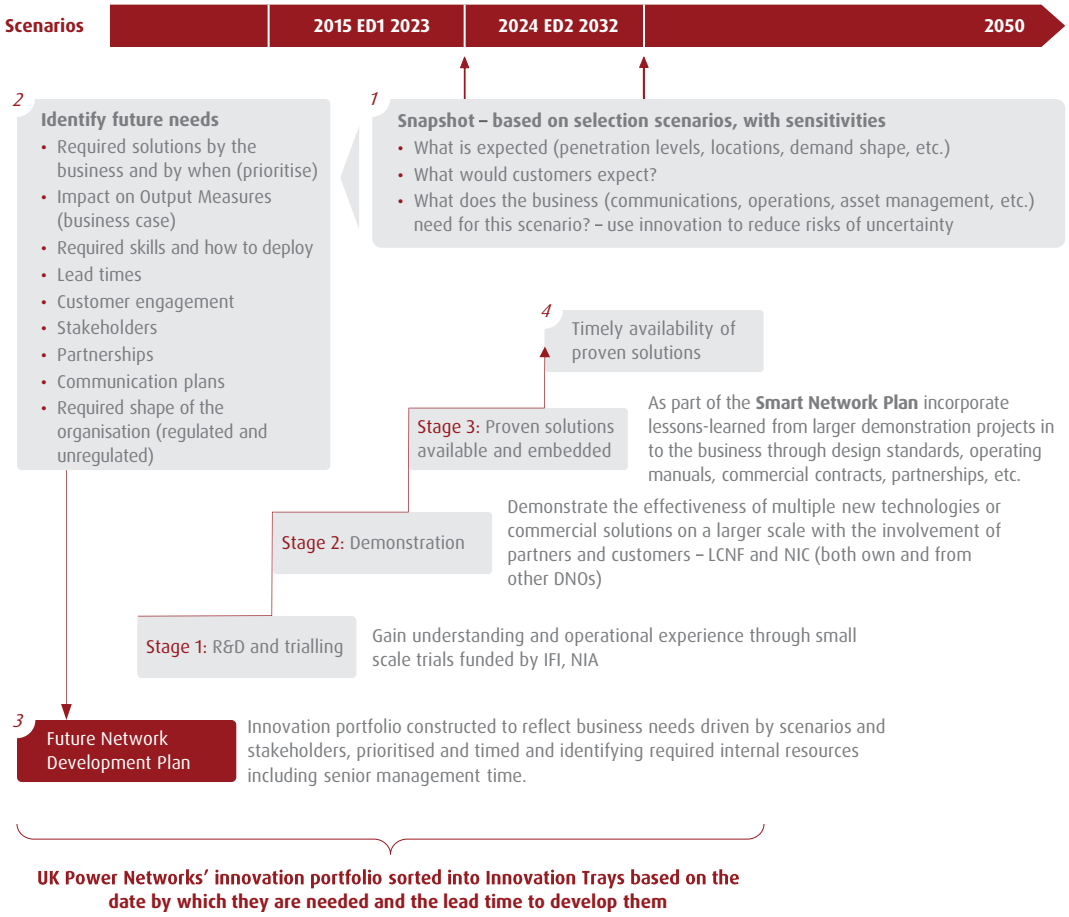
In this section we set out how we will respond to the challenges in a way that retains flexibility and delivers best value to customers.

6.1 Looking at the challenges to identify solutions needed

We have defined a process that is summarised in Figure 10, which consists of four numbered steps, shown in the diagram:

1. UK Power Networks' internal network innovation strategy, known as the 'Future Network Development Plan', determines how innovative network solutions are organised into themes and how these themes translate into deliverables via a series of stages
2. We use our network planning forecasting tools to understand the level of penetration of new low carbon technologies and underlying generic demand growth. These forecasts are run under different scenarios, varying from very high to very low uptake. We analyse these futures, how our networks would be used and what customers would expect. We do this at several moments ('snapshots')
3. With the knowledge of what could happen on our network and what customers would expect at these snapshots, we identify the future needs of the network, ranging from technology, to services, and to our own skills, and what the lead time would be to develop them
4. Depending on when the solutions or changes are required and the lead time to develop them, we initiate a staged approach from R&D and trialling (e.g. using the Innovation Funding Incentive (IFI) or Network Innovation Allowance (NIA) regulatory allowances) to demonstration (e.g. using First Tier and Second Tier of the LCNF or the Network Innovation Competition (NIC)) towards migrating the solution in to the business. This staged approach will ensure that we fully understand the solution before it is widely implemented and reduced the financial risk by first investing in smaller studies before starting larger, more expensive demonstrations
5. Following this process, the solutions will be available and proven by the time they are needed

Figure 10: Development of UK Power Networks' Future Network Development Plan



We also structure our research, development and network trials into a number of cross-cutting themes.

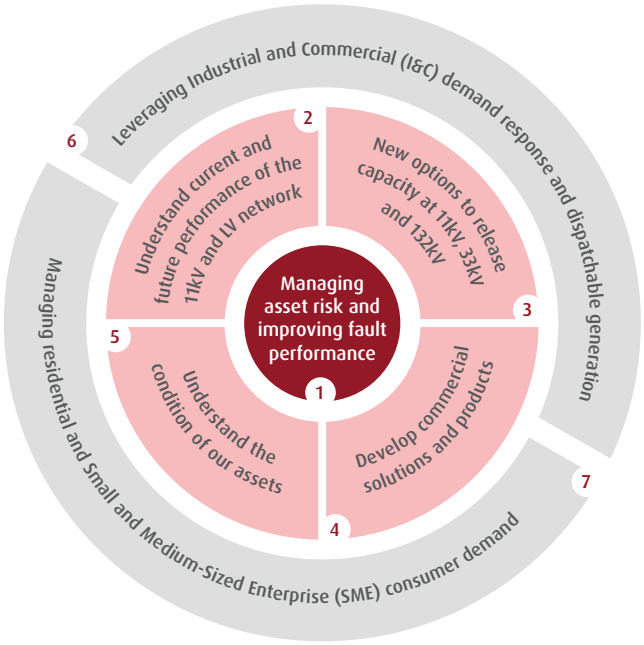
Our intention in organising our activities in this way has been to create a wider vision within the company around particular issues and how we might respond. The themes serve to ensure that we are giving sufficient balance to both technical and commercial solutions to the same challenge. Within each theme we have developed a roadmap of the capabilities that the organisation needs to develop to respond to the challenges identified in the previous section.

Throughout this section we will demonstrate the way in which the themes determine the prioritisation of innovation activities required so that future capabilities can be delivered in a timely manner. These activities are organised into chronological 'innovation trays', also discussed in Chapter 11.

6.2 Introduction to the capability themes areas

The Figure below shows the seven themes into which we organise our innovation activities. These themes describe the actions that need to be carried out to deliver innovations in a cost effective and timely manner.

Figure 11: UK Power Networks' innovation themes



The five themes at the centre of the diagram (labelled 1 to 5) are critical success factors in the service that we offer to current and potential customers. The two themes shown in the outer ring (labelled 6 and 7) describe a more interactive relationship with our customers, whether directly or through energy suppliers, aggregators and other market entities.

1. Managing asset risk and improving fault performance

At the centre of the diagram is the most basic innovation theme. This will correspond to all activities or innovation which we need to carry out in order to fulfil our central function of serving existing customers and managing risks to our electrical assets. Examples of innovation that falls into this category are investigations into improved fault restoration techniques (discussed on Chapter 12) and methods which have the potential to improve reliability of customer supply.

2. Understand current and future performance of the 11kV and LV network

The change in demand and the introduction of micro-generation will bring new pressures to the parts of our network which are currently least visible to us in real-time. This includes changes to the Low Voltage (LV) network and 11kV (or in some cases 6.6kV) feeders and the load cycle on our assets. It is important to understand, for example, their ability to dissipate heat and thereby cool down between peaks of high load. Understanding of the loading on the network is essential to the service improvements that we are seeking to make in time-to-connect and cost of connection.

3. New options to release capacity at 11kV, 33kV and 132kV

This theme is strongly targeted to facilitate the low carbon economy. We are currently exploring the particular cases in which a commercial solution such as DSR may provide a way to avoid reinforcing the network. We are aware that the driver for these solutions is the greatly increased demand peaks which we might see as a result of the low carbon uptake. There are immediate applications for Demand Side Response, such as managing the load transfers that are required to support a wider 132kV reinforcement scheme; but our research intensity is based on the wider challenges arising as a result of the low carbon economy. Similarly, we are exploring the use of dynamic line rating technologies as a means of releasing network capacity.

4. Develop commercial solutions and products

The alternatives that are explored throughout our innovation strategy are analysed in order to be implemented and therefore contracted. Therefore, in line with identifying the new options to release capacity at 11kV, 33kV and 132kV with our existing assets, it is critical to understand the commercial implications of the new technologies. This implies having a specific innovation theme related to developing commercial solutions and products to support the technological solutions.

5. Understand the condition of our assets

Just as understanding the current and future performance of the 11kV and LV network, it is important for UK Power Networks to understand the condition of our assets. This will be essential to meet the efficiency savings that we have set for ourselves on our existing inspection and maintenance expenditure and asset replacement expenditure.

6. Leveraging I&C Demand Side Response and dispatchable generation

The theme 'Leveraging I&C Demand Side Response and dispatchable generation' expresses a series of actions which UK Power Networks needs to take and capabilities which it needs to develop, in order to capitalise on the opportunities offered by Industrial and Commercial (I&C) demand and generation. Historically, the distribution network has been a passive network with a one-way power-flow towards end customers. This model will continue to change into a two-way network through the widespread adoption of DG, back-up generation, and Combined Heat and Power (CHP) schemes. A significant number of our I&C customers firmly view the distribution network as a two-way network in which they can make use of latent back-up generation capacity in the system reserve market. This capability could equally be deployed by the DNO to support the network in critical periods. Our outlook, customer interactions and back-office systems need to adapt to this and capitalise on it.

7. Managing residential and Small and Medium Size Enterprise (SME) consumer demand

The theme 'Managing residential and SME consumer demand' recognises the unprecedented opportunity represented by the roll-out of half-hourly Smart Meters to every residential and SME premises. Currently a proportion of the population have their electric home heating controlled or timed by Radio Tele-Switch (RTS) technology. Smart meters will provide the opportunity to expand this small set of directly controlled customers and to introduce tariff-based incentives or additional offers which are more visible and immediate to the consumer.

6.3 Visions statements and capability roadmaps – an example

Each of the theme areas mentioned in Section 6.2 is further developed with a vision statement, an example of which is shown on the following page for the theme area 'Leveraging industrial and commercial (I&C) DSR and dispatchable DG' (see Figure 12). The vision statement also demonstrates the way in which the Future Network Development Plan links a theme area and the customer priorities it supports, through to the catalogue of potential technologies. In order to give a clearer picture of how each of the visions has been developed into a roadmap of required capabilities for UK Power Networks, the roadmap associated with this theme is also shown in Figure 13.

Figure 12: Example vision statement for the theme 'Leveraging industrial and commercial (I&C) DSR and dispatchable DG'

Leveraging Industrial and Commercial (I&C) DSR and dispatchable DG

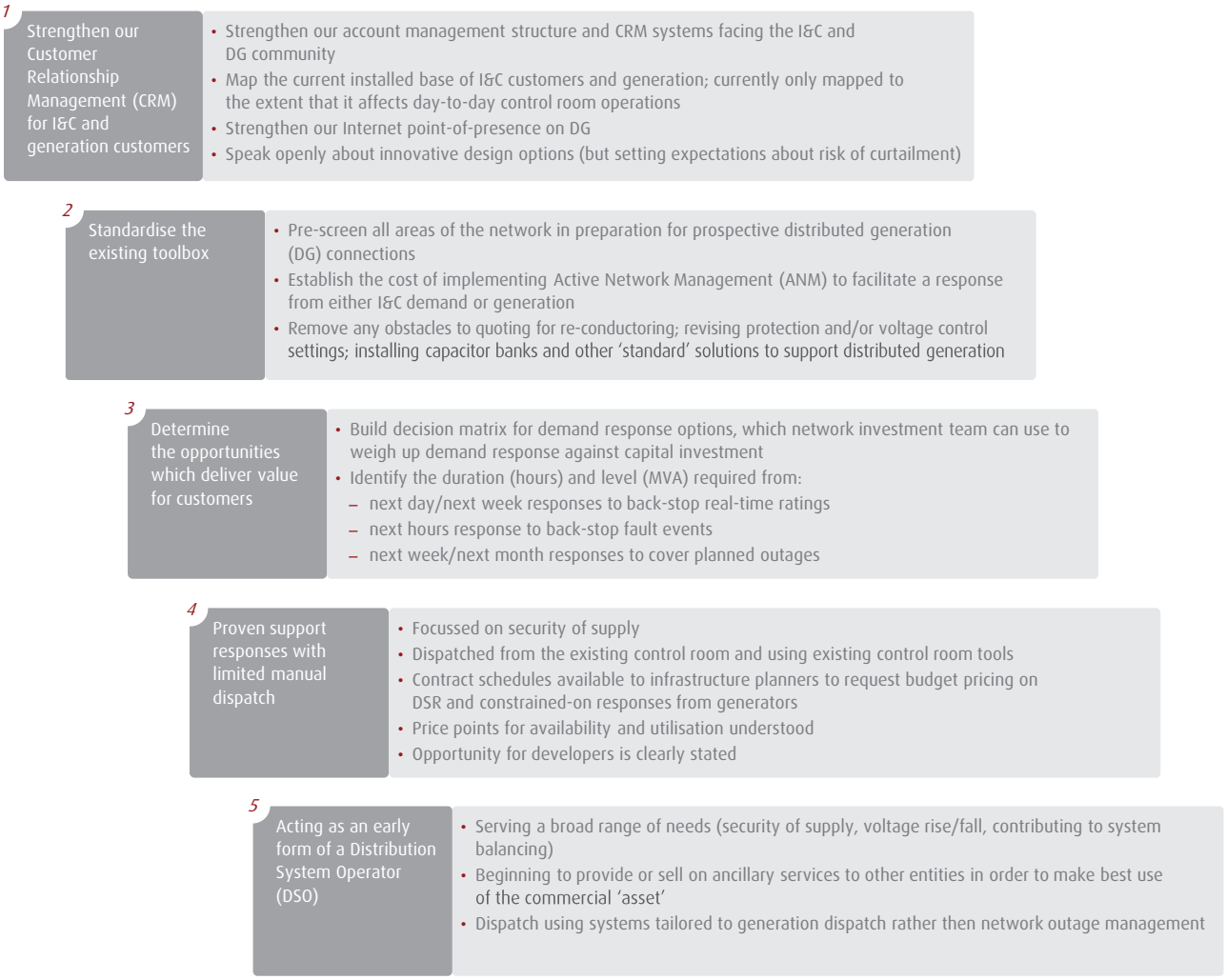
If extensive reinforcement of distribution networks is to be deferred, then smarter means of accommodating distributed energy resources combined with smarter management and control of electricity demand will be essential. UK Power Networks has the additional pressure of space constraints in London, making it even more important to find alternatives to reinforcing the network. I&C demand, particularly for space heating and cooling, may represent a significant lever.

UK Power Networks will position itself to capture this opportunity through either bilateral relationships with individual I&C customers or through contracts with an aggregator supplying a portfolio of responsive I&C demand. Similarly, generation connected to our network will begin to be rewarded for its flexibility in non-fault conditions, ranging from the trivial ('switch off') to the highly controllable (able to commit to production in certain periods and at a given power factor). Whilst this will require UK Power Networks to develop new skills in 'dispatching' generation and load response, a core foundation is to do the basics right. We actively facilitate the connections process explaining the cost implications of different options by making our data accessible to developers, pre-screening and
pre-analysing areas of the network, setting expectations and articulating potential design options. Progress is actively measured through customer satisfaction surveys and focus groups.

Draws on the following Smart Grid Products/Functions defined by the Smart Grid Forum

DSR	Generator Providing Network Support
Real Time Thermal Rating	Active Network Management – Dynamic Network Reconfiguration
Enhanced Automatic Voltage Control	Advanced control systems
Communications	

Figure 13: Example roadmap for the theme 'Leveraging industrial and commercial (I&C) DSR and dispatchable DG'



Example roadmap for the theme 'Leveraging I&C DSR and dispatchable DG'

As outlined in Figure 13, the first stage in the roadmap of strengthening our customer relationship management is being tackled through a number of continual improvement activities within the business. This will introduce a clearer, more responsive service to existing major connections customers, as well as help to recognise any customers that should be elevated into a formally managed account because of their opportunity to support UK Power Networks in managing its network constraints.

The second stage in the roadmap, of standardising the toolbox, begins to rely on innovative network solutions explored through research and development and trials, but continues to contain elements of continuous improvement. Specifically for leveraging I&C DSR and dispatchable DG:

- We have commenced a piece of work aimed at harmonising our voltage control policy and ensuring that it provides support for issues raised by generation connections
- The Low Carbon London project is building an understanding of the reliability of Demand Side Response from I&C customers, and the take-up rate amongst the I&C community
- The Flexible Plug and Play project is working with a small number of generation customers in trial area of 700km^2 between Peterborough, Wisbech and March in the East of England to understand their appetite and ability to accept an interruptible connection, which would be faster and cheaper compared to a non-interruptible connection

Incorporating results and exploring other technologies

The Low Carbon London and Flexible Plug and Play projects, and those of the other DNOs, will provide some of the learning that will be required in order to reach a state in 2015 to 2017 when we expect to be using Demand Side Response and support from individual generators as part of our regular network management plans, and which is shown in the list of deliverables that we expect from our RIIO-ED1 innovation programme in the next section.

In anticipation of reaching this position, we have replaced 14 traditional reinforcement schemes in our business plan with interim solutions which we expect to fulfil through Demand Side Response from I&C customers. We expect Demand Side Response to play a role in managing complex construction timelines within a further six schemes.

Separately, we have been involved previously in piloting techniques for auto-mapping our network for capacity for DG, and automatic quoting. However, we recognise that we have more work to do in making data available to generation customers to allow them to self-assess the viability of their investments.

A significant amount of work remains to be done, however, and will require additional innovation and additional analysis into areas such as commercial arrangements, back-office IT and control systems, telecommunications and electrical plant. Thus, our work in this area must continue throughout RIIO-ED1 under the Network Innovation Allowance and the Network Innovation Competition.

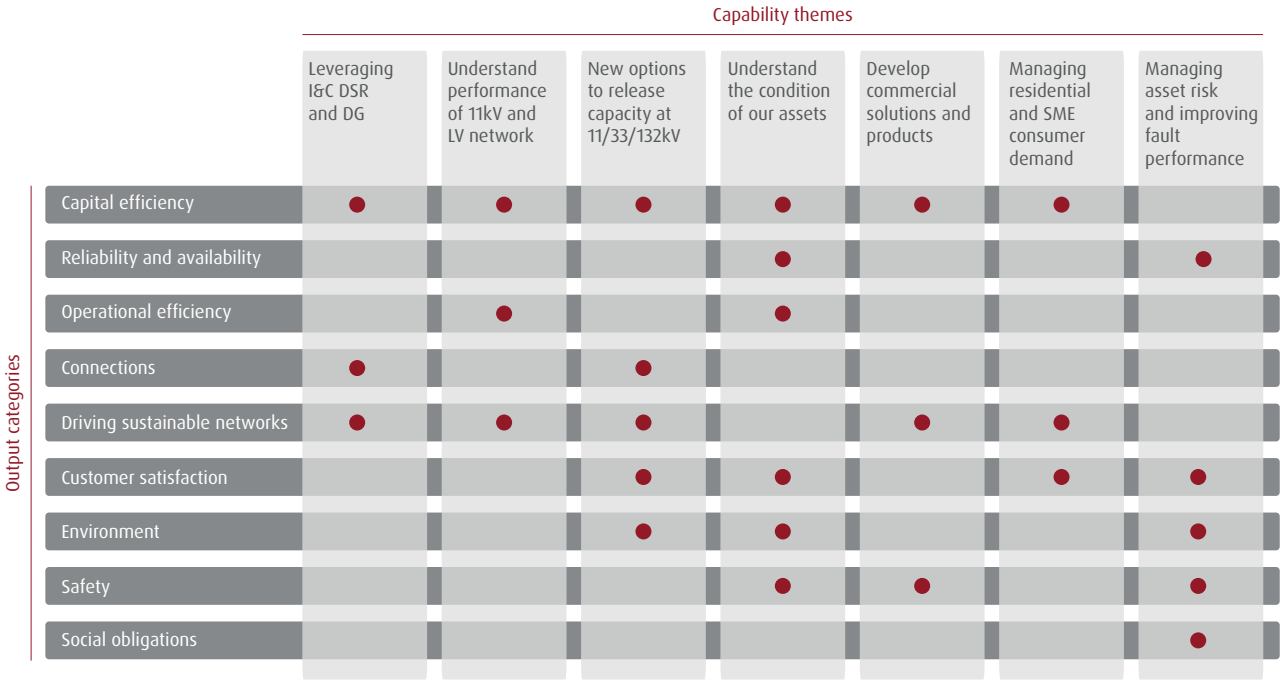
In particular, we envisage projects which explore:

- The interaction with I&C customers who have a regional or UK-wide reach, and who would naturally look to contract with a single entity (such as the system operator National Grid, an aggregator, or an alliance of DNOs) as opposed to individual DNOs
- Standardising Active Network Management (ANM) technology and equipment, establishing standards and competitive procurement routes similar to traditional DNO plants
- The means of reducing the cost of backhaul communications infrastructure, enabling technologies such as ANM to be more accessible for those who are seeking connections. There is a risk that communications and ANM platforms introduce an alternative type of 'first-comer' problem, in which the first connectee is expected to pay for the communications infrastructure in a similar way to which the first-comer has been expected to pay for the reinforcement of the electrical infrastructure
- Testing and integration of dispatch systems and/or advanced control systems
- The use of Demand Side Response and generation response to manage a variety of constraints above and beyond the thermal rating of an existing substation
- Providing price signals which encourage the development of flexible standby generation plants or flexible CHP plants which can assist the DNO and/or the system operator

6.4 Contribution of the capability themes to our RIIO-ED1 primary outputs

Finally we have aligned our capability themes with the six primary output categories within Ofgem's RIIO framework: safety, environmental impact, customer satisfaction, connections, social obligations and reliability and availability. Figure 14 shows how our seven capability themes align with these outputs. Furthermore, the six RIIO primary outputs have been supplemented with two internal additional outputs relating to cost efficiency: namely 'Capital Efficiency' and 'Operational Efficiency'. This cross reference has been made with the over-arching challenge of driving sustainable networks which can support low-carbon demand and generation in mind. Whilst not primary outputs in their own right, these are essential behaviours which Ofgem expects to see from all of the regulated network operators. As shown in Figure 14, the themes are cross-cutting and serve a number of customer priorities.

Figure 14: Alignment of UK Power Networks' innovation themes with Ofgem's RIIO-ED1 framework



By structuring our network innovation in this way, we can be sure that we can create momentum around key capabilities that we need to develop, whilst being sure that we are solidly founded on the outputs shown in the diagram and which are most critical to customers. The next chapter will discuss how we deliver continual improvements in existing processes in order to meet these same outputs.

7 Continuously **improving** the **business**

Key messages

A number of **innovation leaders** are in place across the company.

The innovation leaders have the seniority to act as effective sponsors for **individuals pursuing their own improvement ideas**, and to create **dedicated project teams**.

Continual improvement activities **touch every single part of our business** and take place across our sites.

We are improving our decision making and cost efficiency, reducing our disruption due to faults and excavations, and improving the variety and timeliness of customer contact.

We expect the **Smart Meter roll-out** across GB will enable us to make further improvements in these areas.

Continual improvement activities at UK Power Networks formerly took place through a centralised Project Management Office and Design Authority. A decision was made to change this and spread innovation throughout the business so that it became a part of everyday activity, as opposed to being undertaken in isolation. Innovation is on each of our Executive Management Teams' minds and is not the sole accountability of a single Executive Manager. One way in which this approach has manifested itself is through the number of sites where innovation is taking place. As of today, UK Power Networks has 18 sites where staff are contributing to innovation and improvement projects[2]. Each part of the business is best placed to drive their own improvement through nominated innovation leaders seeking improvements, and which are typically self-funding within our existing business plan. However, if the innovation is related to new technical or commercial solutions, or is not self-funding, it is centrally coordinated and governed by the Future Networks team. As a result of this approach, the company is able to better embed continuous improvements in everyday activity.

7.1 Sourcing new innovation ideas

Across UK Power Networks' directorates, improvement ideas are sourced both internally and externally. Internal methods of sourcing innovation come from our employees themselves and include:

- The 'If It Were My Business' scheme implemented within the company, where employees suggest their ideas and then champion them through to fruition. No dedicated resource exists to take these ideas and run with them, hence the ideas must be self-funding, with the idea being that the employee will own the idea and will benefit from splitting the savings made with UK Power Networks
- Suggestion boxes: these are located throughout UK Power Networks' sites and are used to source further innovative ideas for improvement from employees

External methods of sourcing innovation include:

- Learning from other networks and operators: looking at what others are doing e.g. LineScout, which crawls along an overhead line to inspect for faults, as used by National Grid. Industry collaboration also takes the form of working groups and forums such as the ENA and the Green Construction Board
- Stakeholders: particularly via the Critical Friends' stakeholder panel sessions, which provide the opportunity for customers, developers, local government and any other interested party to challenge our thinking
- Trade journals: seeing what is being done in wider industry circles. For example, the idea to use unmanned aerial vehicles discussed later in the chapter was pursued after seeing the technology being used on towers in another sector

Innovations taken from these sources are presented in this section under the following headings: decision making; cost efficiency; health, safety and environment; street-works and activities in the field; customer service and communication channels; and using the smart meter roll-out to improve our service.

7.2 Decision making

In order to achieve long-term best value for our customers, decision making needs to be founded on good quality data and based on outputs from proven models.

Innovation to promote good quality data for decision making

An integral part of improving business performance is having good data on which to base decisions. As such we have embarked on a journey to improve the standard of our asset information and our information management practices, which began in 2011 with a full review of our business critical data items.

2. The 18 sites are Bengeworth Road (London), Bidder Street (London), Majesty House (Braintree), Bury St Edmunds, Darenth House (Dartford) (Regus), Energy House (Crawley), Fore Hamlet, Maidstone, Matthews Yard (Crawley), Newington House (London), Potters Bar, Saxon House (Crawley), Skylines, Smallfield Grid Site, St Neots, Stephenson Way (Crawley) and Trowse.

London 2012 Games have a lasting legacy for us

With the whole world focussed on the UK for the London 2012 Olympic and Paralympic Games, excellent network resilience was of vital importance. We worked hard with our key stakeholders, using both novel and traditional methods, to plan and test our operational and business readiness and resilience. Many of the lessons learned from this challenge we now use to improve UK Power Networks' performance.

The lessons included greater testing through 'what if' scenarios, and the importance of clarity of purpose (a common view of 'what success looked like') across the entire company and third parties. Lessons learned were also documented in the areas of management of health and safety, good project management discipline, internal communications and staff, stakeholder engagement, team development.

These lessons-learned have now been disseminated and embedded into business operations to achieve sustainable performance improvements.

To measure and promote the quality of the data feeding into our models we have developed a Completeness, Accuracy and Timing scoring methodology. This methodology drives future data improvements by articulating the business' expectations of data completeness, quality and timeliness, and by fostering a culture where high quality information is recognised as paramount. Only with high quality data can the most cost-effective investment decisions be made.

Innovation in decision-making modelling

In order to help us better interpret the rich asset loading and health data that we collect, we have worked in partnership with industry experts to further enhance the modelling capability on which our Capital Expenditure is based.

Together with Imperial College London, we have developed a new Load Related Expenditure Model that provides enhanced long-term forecasting of the money we need to invest to increase capacity in the network, to supplement our established bottom-up planning techniques. This new tool enables the rapid assessment of a range of network development scenarios, various uptake scenarios of low carbon technologies such as electric vehicles, heat pumps, commercial air conditioning, the various forms of Distributed Generation (DG), smart appliances and energy efficiency measures.

The Asset Risk and Prioritisation (ARP) model is another example of modelling innovation. The ARP models use a combination of information relating to an asset's age, environment, duty and specific condition and performance information to help us determine when an asset requires intervention (replacement, refurbishment, retrofit or other appropriate action) and how to prioritise the order of such interventions to ensure value for money.

7.3 Cost efficiency

Cost efficiency is essential to the business, and improvements in cost efficiency are a central part of our plans for RIIO-ED1.

A new performance management framework

For cost efficiency we have implemented a new performance management framework. This framework improves accountability for the delivery of targets by ensuring that these targets are allocated appropriately throughout the business at an individual level and that delivery of targets is linked to the company bonus structure.

The unit cost project

Our unit cost project supports better performance management and improves the accuracy of cost forecasting. By ensuring the cost of network related expenditure is clearly visible and actively tracked we have been able to see where there are areas to bring unit costs down.

The use of the Green Rhino when pumping street-works

'Green Rhino' technology is being deployed by UK Power Networks on street-works to benefit the company, our customers, and the environment. Before the introduction of the Green Rhino it was accepted practice to pump water out of a street-works hole and discharge to a grass verge, if available, or down the street if not. If the water was heavily contaminated with oil and/or sediment, the company would have to arrange for a tanker to pump out the water and take it off site for disposal at a cost of approximately £1,000. UK Power Networks worked closely with Capture Green to develop the Green Rhino, an oil and sediment filter, for use when dewatering small excavations prior to undertaking work. The Green Rhino prevents the need to tanker away lightly contaminated water and also ensures any water that is pumped is clean. A Green Rhino bag costs £150 and is re-usable, with the technology subsequently having been adopted by other DNOs and in the gas, water and telecommunications sectors.

7.4 Health, safety and environment

Innovation continues to play a key role in managing health and safety both internally within UK Power Networks and for members of the public, and in managing our environmental footprint. Some of our recent examples are:

We are increasing safety by developing Unmanned Aircraft Vehicles for line inspections

We are exploring the use of Unmanned Aircraft Vehicles (UAVs). These small helicopters of 80cm in diameter are equipped with a camera and other sensors if needed. They are small, battery powered, low noise and environmentally friendly and will pass by relatively quickly to minimise any disturbance.

The use of the UAVs will minimise the need for Working at Height when condition assessments are required of towers or poles. The UAVs can inspect towers, poles or lines when they are live, therefore reducing the need for extensive load transfers and switching operations.

Line patrols after storms are inherently dangerous due to falling objects and obstructions along roads and pathways so the ability to overfly the route and take photos will greatly reduce the need for personnel to be exposed to the additional risks of foot patrols.

The trials are focussing on the usability for trained users and the quality of visuals which are obtained from the helicopter.

We reduce our environmental impact when excavating street-works

UK Power Networks continues to be environmentally friendly by recycling spoil excavated during street-works and using recycled material where possible for back fill. In 2006 the government re-classified materials excavated from street works activities from inert to reactive, making it a hazardous material. UK Power Networks was quick to act by considering what could be done to reduce the amount of excavated material sent to landfill. This resulted in the sponsorship of a PhD project with Surrey University. The first part of the project aimed to reduce the amount of material sent to landfill, and reduce the amount of virgin material used. Quickly changes were implemented to recycle excavated materials. We are now in a position where less than 3 per cent of excavated spoil now goes to landfill from a starting point of 74 per cent. The project cost £125,000 but by 2010/11 estimated to have saved £17.5 million, had we continued at 2006/07 levels of landfill use.

We have carried out trials with utilising waste heat

London has some of the largest commercial buildings in the country, requiring large amounts of electricity to heat and cool them. As an innovative example of how we can be more energy efficient by using waste heat, we developed a water cooled heat exchanger for our substation at Bankside on the Thames, adjacent to the Tate Modern. Substation transformers generate heat that is lost to the environment. The heat exchanger allows the waste heat to assist the space heating at the Tate. The benefits for us are that less energy will need to be expended within cooler fans at the substation, and lower maintenance and replacement cost will be incurred. The overall carbon footprint of the site and assets will be reduced.

7.5 Innovation in street-works and in the field

UK Power Networks operates in a challenging environment including the most densely inhabited area of the UK and with a high level of regulations across 29 different local authorities. As such, innovation in street-works and in the field, such as through the use of the latest technology, offers an important way in which we demonstrate continuous business improvement.

To meet the challenge of reducing our impact while undertaking street-works we are:

- Investing in a new IT application to track and oversee cable excavations. This will simplify our processes and ensure we manage our work to avoid fixed penalty notices, overstay charges and the impact of lane rental charges
- Investing in a new customer service street-works information system. This is on our website to improve information flow to our customers. There will also be a smartphone application to support this service
- Implementing a new policy on site information signs that will provide better information for the travelling public. This will inform them of what is happening at our works
- Working with local authorities and other utilities (particularly in London) to understand how we can collaborate on works and reduce our impact on traffic congestion

7.6 Customer service and communication channels

We are radically overhauling our approach so that we manage the customer experience from the point of initial contact through to confirming customer satisfaction, making contact with customers at key points within their journey.

Customer service innovation

We are reducing the time it takes us to deliver work for our customers in both connections and general enquiries. Our innovation in customer service will improve our approach so that we can deliver service on the day the customer chooses. We are redefining our approach to provide a single point of contact, with ownership for our customer's request. This will mean that when customers call our staff will have the relevant information from previous contacts.

These improvements aim to answer enquiries quickly and clearly. When issues do escalate into complaints, the customer service improvement programme has already resulted in a reduction in the time taken to resolve them.

Innovative customer communication channels

With respect to customer service we have looked to extend the range of communication channels that we use to interact with customers. An example of this is that we now use Twitter to keep customers updated during power cuts. The increasing use of smartphones makes this an effective tool for communicating with customers, and has been received positively.

7.7 Using the smart meter roll-out to improve our service

During the upcoming national programme for the roll-out of smart meters, starting in Autumn 2015, up to 8 million meters will be replaced in our three network areas. For the first time, domestic customers, energy suppliers and network companies will have detailed information on individual consumption. Not only will this enable customers to monitor and manage their usage more effectively, but also the roll-out will create opportunities for network companies to improve our service and efficiency.

UK Power Networks understands the full potential of the smart meter data and is taking a proactive approach to the use of this data to improve current ways of working across customer service, fault handling, network planning and income management.

Some of the benefits we are investigating are:

- Improved customer service – features such as 'last gasp' (automated customer outage notification) and increased fault visibility (location and potential cause) allow for a more proactive response to faults and customer engagement. Customers may receive better information about recovery time, via SMS or phone calls for single customers or via digital and social media for larger groups of customers (e.g. in storm conditions)
- Improved security of supply performance – the increase fault visibility will allow us to reduce the interruption time through improved response to LV faults, storm response and other fault conditions
- Improved safety – the smart meter will alarm the DNO in high/low voltage alarms, leading to more informed problem identification and improved scheduling of actions. Furthermore the roll-out will necessitate the inspection of all meters and fuses on the network to assure customer safety
- Planning of our network – the data will provide enhanced network information which will improve accuracy and efficiency of network investment needs and options

It is expected that the smart meter rollout will reach critical mass in the RIIO-ED1 period, when the majority of these benefits can be realised – although some benefits such as customer outage notification will be realised earlier.

iPad and 'GeoSub' app for London field staff

Recently we have started to trial the use of iPads and a 'GeoSub' app for London field staff. The aim is to reduce the number of Customer Minutes Lost (CMLs) by helping engineers to quickly navigate around the city's 16,000 substations and pulling up detailed drawings of each upon arrival. This innovation will be applied throughout the company's operations should it prove cost-effective.

Trialling the deployment of a small team of super-users to investigate 'really difficult' faults

We are currently establishing a team of three specialised low voltage (LV) fault technicians in the LPN area. Their aim will be to assist the existing fault repair teams and will focus on the more complicated faults, freeing up the other teams for the more common faults. This will reduce the overall time needed to restore supplies to customers.

For these technicians to be effective they have a vehicle that is equipped with both simple and sophisticated fault location and conditioning equipment.


Electricity on call
www.ukpowernetworks.co.uk

Part two
Our innovation delivery

8 Delivering network **innovation**

Key messages

We have **identified a list of key deliverables** that stakeholders can expect from our RIIO ED1 innovation programme.

We believe that these are **relevant and well-justified**, having been derived from an exhaustive catalogue of technologies, their readiness and applicability to our networks.

We will not pursue these deliverables at all costs, specifically checking that they continue to be relevant, and that **they still achieve what we set out to achieve**.

We have **robust governance** round our network innovation projects.

We have discussed our proposed deliverables with stakeholders and one R&D specialist commented **'The proposed technology mix feels right from an engineer's point of view'**.

The previous section of this document described the way in which we deliver continual improvements in the business. In this chapter we draw the earlier discussion of the challenges and themes in network innovation which we are seeking to fund through the Network Innovation Allowance (NIA) or Network Innovation Competition (NIC) and integrate into a focussed set of deliverables.

The remaining chapters give the assurance that once we have chosen the right topic to work on, we will integrate the views of stakeholders to get an appropriate, accepted solution; that we will do it with the right skill-set and at competitive rates; and that we will ensure that high quality results are implemented back into the business.

8.1 Our ED1 Deliverables

The list of deliverables presented in Figure 15 consolidates the way in which we organise our innovation programme into themes and roadmaps, discussed in Chapter 6. The list is based on the exhaustive list of technologies and solutions in our Future Network Development Plan, and which has qualitative assessments against it of their readiness and applicability under different scenarios, which he have then combined with stakeholder review. Separately we have used quantitative data in the form of results from our Load Related Expenditure (LRE) model developed by Imperial College and the Transform model of Smart Grid costs and benefits developed under the direction of the Smart Grid Forum.

The deliverables are listed in the form of solutions in the Transform model on Figure 15. We deliberately provide no further detail other than to split the period into 'beginning' (2015 to 2017), 'middle' (2018 to 2020) and 'end' (2021 to 2023), given the long time frames involved in these predictions. These are estimated dates of when these technologies could go live. The table also describes how we will identify success for each of these deliverables, measured in terms of real benefits to customers. Finally, each solution is scored for its 'resilience', based on our assessment of its applicability to our network in each of the scenarios of low-carbon uptake defined by the Department for Energy and Climate Change (DECC). A high score indicates that the solution is vital in our view under any of DECC's scenarios, and a low score indicates that the solution may be specific and only required if one of the scenarios comes to pass.

In several cases, technology solutions make multiple appearances. We have colour-coded the entries in the table to emphasise this aspect. For example, 'Generation constraint management – HV connected' and 'Generation network support – HV' contribute to the early deliverable of enhanced system security, the later deliverable of providing upstream system balancing services, and the yet later deliverable of improving system losses. These represent several different levels of optimisation using the same technology, with the priority being given first to system security. Only as a second priority would we explore possibilities to share the assets in order to better utilise it by providing it to the GB system operator; this refers to both a Demand Side customer or generation contract.

Figure 15: Capabilities to be delivered as part of our innovation solutions

RIIO-ED1 deliverable	Success measure	Go Live	Using the following tools defined by the Smart Grid Forum	Resilience to economic and low carbon scenarios 15 = highly resilient, 0 = highly sensitive	
Enhanced control systems resilience	Reliability and availability	2015-17	Ensured security of critical systems Ensured protection of customer data	11	●
Enhanced system security through procured ancillary services	Reliability and availability, capex efficiency	2015-17	Generation constraint management – HV connected HV connected Electrical Energy Storage (EES) – large	10 3	● ●
Increased plant and line utilisation	Enabling connections; reliability and availability, capex and opex efficiency	2015-17	Advanced control systems Real-time Thermal Ratings (RTTR) for EHV Overhead Lines RTTR for EHV/HV transformers RTTR for EHV Underground Cable Dynamic Network Reconfiguration – EHV	10	●
Facilitating higher levels of DG penetration	Enabling connections	2018-20	Dynamic Network Reconfiguration – EHV Generation constraint management – EHV connected HV Non-superconducting fault current limiters	10	●
Improved network visualisation	QoS, capex and opex efficiency	2018-20	Design tools Advanced control systems HV Circuit Monitoring (along feeder)	10	●
Increased supply resilience	Reliability and availability	2018-20	Dynamic Network Reconfiguration – HV Dynamic Network Reconfiguration – EHV	10	●
Power outage management	Reliability and availability	2018-20	Smart Metering infrastructure – DNO to DCC 2 way A+D	15	●
Voltage quality management	Capex efficiency, enabling connections	2018-20	HV Circuit Monitoring (along feeder)	11	●
Enhanced network flexibility and interoperability	Capex and opex efficiency	2021-23	Comms FABRIC Advanced control systems HV/LV Transformer Monitoring	8 8 10	● ● ●
Enhanced system integrity	Reliability and availability, capex and opex efficiency	2021-23	HV Circuit Monitoring (along feeder) w/ State Estimation Smart Metering infrastructure – DCC to DNO 1 way HV Circuit Monitoring (along feeder)	8 11 11	● ● ●
Improved load and loss load factor	Enabling connections; capex efficiency	2021-23	Generator network support – HV connected Generation constraint management – EHV connected DNO to residential HV connected EES – large	6 10 5 3	● ● ● ●
Losses optimisation	Capex and opex efficiency	2021-23	DNO to HV commercial DSR DNO to residential Dynamic Network Reconfiguration – LV	7 5 8	● ● ●
Provision of upstream system balancing services	Opex efficiency	2021-23	Generation constraint management – HV connected Generation constraint management – HV connected HV connected EES – large	10 10 3	● ● ●
Smart management of Distributed Energy Resources	Enabling connections, capex and opex efficiency	2021-23	Enhanced Active Voltage Control (AVC) – LV circuit voltage regulators Enhanced AVC – HV/LV Transformer Voltage Control Smart Metering infrastructure – DCC to DNO 1 way HV Circuit Monitoring (along feeder)	3 6 11 11	● ● ● ●
Smart management of Electric Vehicles (EVs) and heat pumps	Enabling connections, capex and opex efficiency	2021-23	DSR – Products to remotely control loads at consumer premises DNO to residential DNO-controlled EV charging – LV domestic connected	6	●
System voltage optimisation	Capex efficiency	2021-23	Static Synchronous Compensator (STATCOM) – EHV	6	●

8.2 Maintaining flexibility

The list of deliverables on the previous page represents our current best view based on the challenges on the business and the readiness of solutions, and is derived from the Future Network Development Plan.

Various sources of information help us to maintain a view of whether these deliverables are still appropriate and appropriately timed. Specifically:

- Government incentives can change and low-carbon uptake can accelerate or stay steady
- Customers appetite for the uptake of low carbon technology can change from our current best view e.g. it can be accelerated by government incentives or a technology/commercial break-through or decelerated by prolonged poor economic conditions
- Manufacturers may demonstrate progress through the Technology Readiness Levels (TRLs) or indeed slower progress than we might have expected
- The results from both our trials and other DNOs' trials inform and either strengthen or weaken the cost-benefit case for individual solutions

Our Future Network Development Plan is designed to make flexible decisions, by ensuring that each type of update flows through to the deliverables list and so that the impact can be tracked. The plan depicts the applicability of each solution to each of the low-carbon uptake scenarios (as was colour-coded in Figure 15), allowing us to flex our innovation portfolio in response to the changes from our best view scenario.

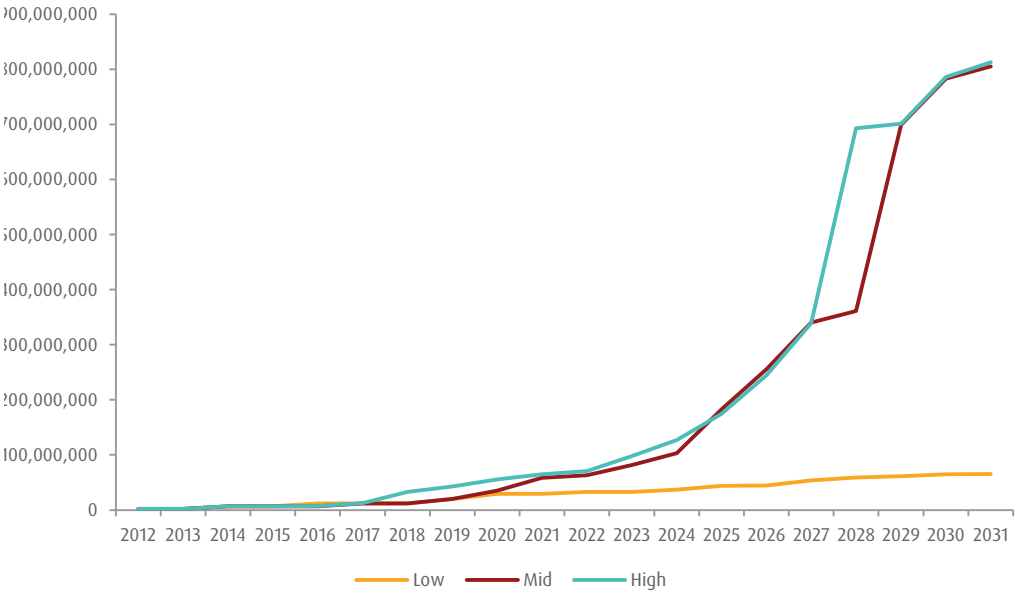
The implications of this are that we might decide that a technology is becoming increasingly niche and will only have a cost-benefit case if a particular low-carbon technology takes off, in which case we may decide to de-prioritise our activities, relying more on manufacturing and overseas R&D activities to bring the solution to market. Another example would be where we are seeing a technology coming to the market much later than expected, in which case we may reduce our efforts on it in the short term. Conversely, we continue to recognise gaps in our innovation portfolio and where we need to start trials of technology at short notice.

8.3 Rolling out the smart enablers

A particular area in which we will seek to maintain flexibility is in migrating our ICT systems in order to support 'Smart Grids'. We are conscious that the Transform model of Smart Grid Forum is currently forecasting a wide range of investment which may be required in this area. As an example, the Figure below shows the forecast expenditure which may be required by the GB DNOs on 'last mile' communications infrastructure.

Figure 16: Example of estimated investment required to support Smart Grids across the GB in a number of DECC's low carbon uptake scenarios

Communications (last mile) investment profile

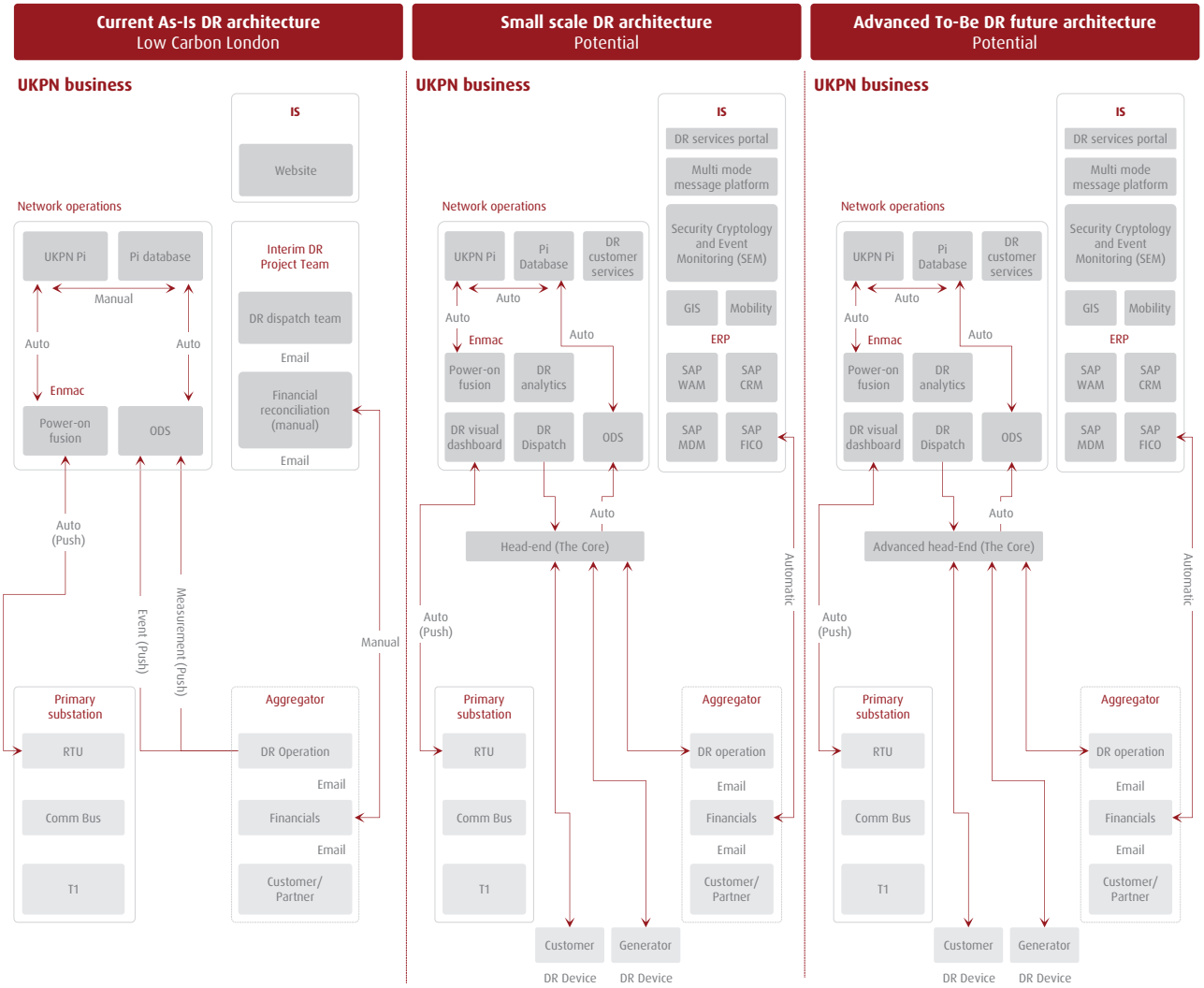


Clearly there is an extremely wide variation which does not justify investment at this stage, until we are more certain of the future. Our approach is a combination of maintaining and updating this scenario planning view, and separately ensuring that we have an internal picture of how the requirements of ICT may realistically evolve.

An example is shown below in which we illustrate the ICT architecture associated with our Industrial and Commercial (I&C) Demand Side Response trials within Low Carbon London; how this may evolve as it becomes a mainstream but small-scale solution; and how an eventual enduring solution might look.

The enduring solution is typically where the most investment is required, and the business case to transition to this enduring solution will always be made on the basis that the initial architecture supporting the initial mainstream but small-scale roll-out is becoming unwieldy, will become difficult to maintain and is not fit-for-purpose in the long run. However, by at least knowing what an enduring solution would look like from an early stage, we can stay flexible in planning for it and deciding on the innovation and trials which are worth investing in early RIIO-ED1.

Figure 17: Example of the way in which the corporate IT architecture may evolve to support Demand Side Response



Key

ODS Operational Data Source **GIS** Geographic Information System **MDM** Meter Data Management
CRM Customer Relationship Management **ERP** Enterprise Resource Planning

Accelerating and decelerating of our innovation efforts will impact the amounts of money, staff and the timing we would commit to trials within our innovation programme and we make sure that we, together with our partners, are geared up to deliver the programme.

In conclusion, this chapter has given an insight into the work that we will fund with a Network Innovation Allowance or through the Network Innovation Competition, and the capabilities that will be built on the basis of our work to date and the R&D work to be carried out during RIIO-ED1.The next chapter will provide assurance that it will be carried out in co-operation with stakeholders.

> “Our Future Network Development Plan is designed to make flexible decisions, by ensuring that each type of update flows through to the deliverables list and so that the impact can be tracked. The plan depicts the applicability of each solution to each of the low-carbon uptake scenarios, allowing us to flex our innovation portfolio in response to the changes from our best view scenario.”

9 Working **together** with **stakeholders** and **customers**

Key messages

The views of our stakeholders are an important **input** in informing our innovation activities.

We have active engagement with our stakeholders to make sure that our work **delivers outcomes that benefit them**.

We involve our stakeholders in our everyday business to give us insight and real **practical experience** of business pressures on the 'customer' side.

Our approach has been to establish a **two-way dialogue** with our customers.

We have **consulted stakeholders and key experts** on our Innovation Strategy before submission of our RIIO-ED1 business plan.

If you have any questions or comments, or would like to contact us, please email: stakeholder.engagement@ukpowernetworks.co.uk.

We actively engage with our customers and stakeholders to understand their view points on innovation before starting major innovation projects. Our consultative style includes getting feedback on our ideas as well as seeking the opinions on the key issues and challenges we have identified in our business. This way of working is above and beyond the industry standard consultation process.

We have worked with our stakeholders to develop our innovation strategy; their involvement ensures our approach will provide our customers with value for money as we develop our network to ensure it meets future needs and demands within a low carbon economy. Engagement with our stakeholders helps us clarify what is needed; we learn how to prioritise our options and stakeholder feedback helps us to understand what is achievable.

9.1 Who are our customers and stakeholders?

Our stakeholders range from our eight million end-customers to whom we deliver electricity; local authorities charged with planning and implementing the government's low carbon policies; our suppliers and delivery partners; renewable energy developers, electricity suppliers, our fellow DNOs, National Grid; trade associations and customer interest groups.

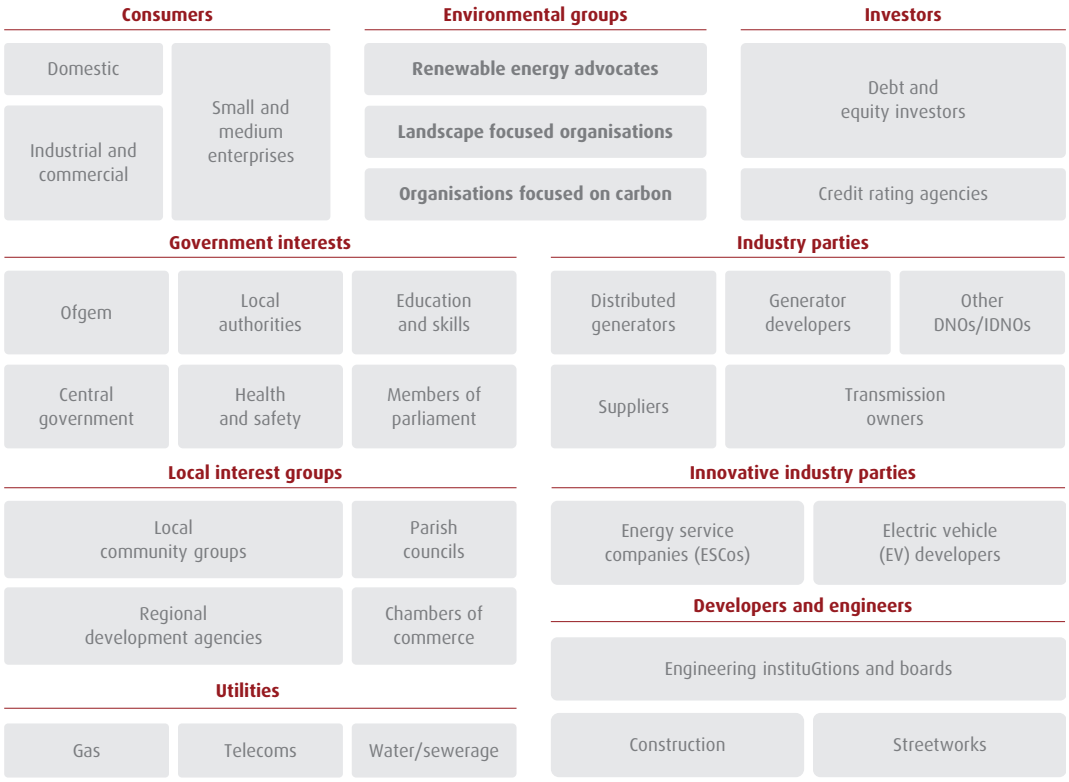
All stakeholders are involved in different ways to help us develop and implement our innovation projects whether as trial participants, project partners or as members of our panels or sounding boards, and as we make the transition to a low carbon future, our eight million end-customers continue to be our priority as we continue to ensure they receive secure, affordable and environmentally-sustainable electricity.

9.2 How do our stakeholders influence our strategy?

We aspire to be a leading company in the transition to the low carbon economy. We recognise that this can only be achieved if our objectives are aligned with the interests of all relevant stakeholders. Stakeholder engagement is therefore a fundamental part of our business.

To ensure stakeholder feedback is fully captured and acted upon, we have designed our 'Critical Friends' stakeholder engagement panels. These panels focus on key topics and which have included the government's low carbon economy targets and the impact of low carbon technologies. For this purpose, we have worked with representatives from all stakeholder groups cited shown in the figure overleaf to help shape our strategy.

Figure 18: UK Power Networks' primary stakeholders



The Critical Friends panel is a useful venue to obtain direct opinions from our stakeholders. For example, at a previous Critical Friends event, a local authority representative asked if UK Power Networks has considered being part of a local energy company. Specifically he said:

> "For me this new world doesn't have a 'big 6' – instead for each local area there is an energy generating company that has decentralised energy production and you are the energy distributor. Local residents have more say and control over energy prices as it is produced locally, potentially you will save on reinforcement costs, you have more control over the Smart Grid and because you cover the South East, you would be able to maximise technological innovations and possibly lever in procurement savings. Its winding the clock back a bit as this is how it all started but given where we need to get to this seems like the best solution."

This observation highlights for us that our stakeholders are also acknowledging that the way DNOs operate must change and that customers are at the heart of the low carbon transition. The discussions also revealed that local authorities are often on the front-line of implementing the low carbon agenda, both through the actions they take to secure energy efficiency measures for their residents and, increasingly, in areas such as communal switching of suppliers; and by setting conditions on local development to ensure that it contributes to new low carbon infrastructure.

Another example of this direct feedback was a comment made by a housing developer, when he explained that he now has challenges that involve future low carbon technologies. Specifically, he mentioned:

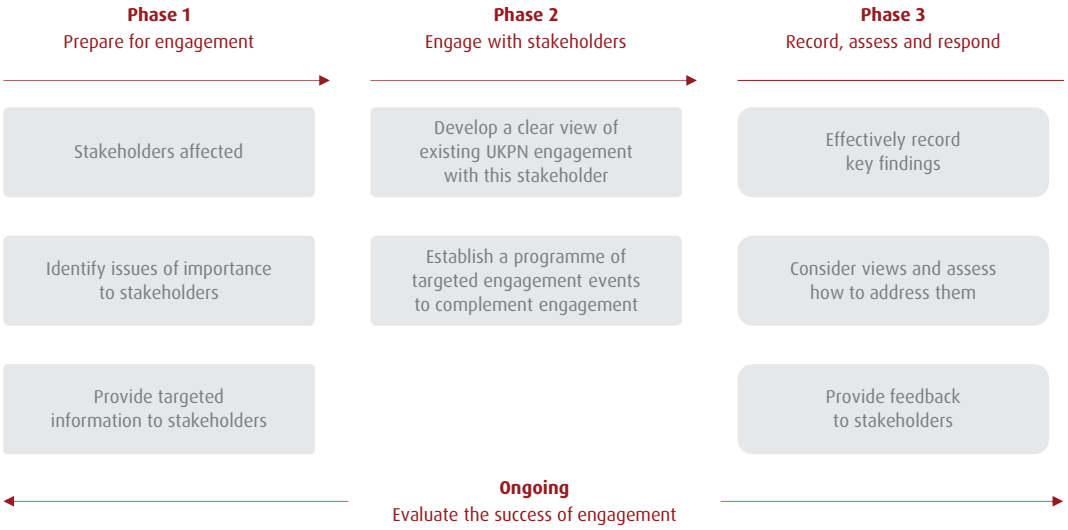
> “I have to install electric vehicle charging points as a condition of my planning permission for the flats that we’re building.”

As a result of the above feedback and further discussions with the individuals, UK Power Networks was able to develop a project concept for an innovation project. The concept was under consideration for our 2013 LCNF (Tier 2) submissions, and may be pursued in a future funding round or through the Innovation Funding Incentive.

9.3 Our approach to on-going stakeholder engagement

Figure 19 illustrates our approach to stakeholder engagement within innovation projects. Using the customer list described previously, Tier 2 projects like Low Carbon London, Smarter Network Storage and Flexible Plug and Play have devised detailed stakeholder engagement plans, identifying specific stakeholders for each project, the type and frequency of engagement.

Figure 19: Approach to ongoing stakeholder engagement



We have a thorough catalogue of smart grid technologies and commercial arrangements within our internal Future Network Development Plan. However, we realise that we cannot undertake innovation effectively and expect to roll out these technologies on the network without buy-in from stakeholders, especially our customers.

An important element of maximising the stakeholder engagement we carry out as part of our innovation planning and deployment is to ensure that we identify the most appropriate stakeholders to consult and at what stage to engage with them. Some stakeholders may be key at the very early stages of defining the best ways to tackle an issue or challenge and their input is vital in helping us to refine our ideas and assumptions. Others may be taking part in the trials we run or may be essential in the dissemination of the learning from the projects. All customers impacted directly or indirectly by our innovation projects are always identified as a critical stakeholder group and we ensure that they are at least aware of any risks and consequences that might affect them, regardless of their interest in outcome of any innovation project.

Below are a number of examples of stakeholder engagement that we have carried out at different stages of the lifecycle within innovation projects:

Idea generation

Our long-standing involvement in the ENA R&D working group, and our more recent membership of the Energy Innovation Centre is intended to make ourselves available to suppliers with good ideas, whatever their size or previous sales into the energy sector. We recognise that good ideas taken forward by the Distribution Network Operators help both our customers and the economy and the Energy Innovation Centre provides a good opportunity through their programme of outreach to potential R&D providers.

Survey-based research

Our innovation project 'International DSM survey' funded via the Innovation Funding Incentive during 2010 investigated the opportunities that might exist for distribution networks in using active customer engagement to introduce Demand Side Response. The project contracted KEMA (now DNV KEMA) to carry out a survey of industrial and commercial (I&C) customers. This survey allowed us to hear direct feedback about the appetite to be involved in Demand Side Response. Sample customer trends were analysed in order to understand the extent to which on-site demand can be mitigated during peak periods. A further investigation was carried out to analyse the mix of services (essential and otherwise) employed within each of the premises and how mitigation strategies would work with each of the services. The project was further informed by an international investigation of demand side options, where the most prominent (and likely to be the most appropriate) options were considered in the survey.

Documenting the current state of the art

We share data with other DNOs, anonymously where required, in order to understand differences in our approaches to designing our networks and our interpretation of standards, in order to identify better methods. This technique has been used particularly by the Strategic Technology Programme, a long-standing programme of innovation which is subscribed to by all DNOs.

Involvement at the design stage

The Flexible Plug and Play (FPP) project is trialling a number of innovative technical and commercial solutions to enable faster and cheaper connections of DG to the distribution network. Stakeholder engagement is at the heart of this project to better understand the issues and barriers of connecting DG to parts of the networks where there is a high concentration of connections. The aim of this engagement is to better understand the needs, concerns and viewpoints of DG developers, other DNOs, renewable generation developer trade associations, local government, and regulatory and policy-making bodies in the context of the FPP project, and their current activities in this area. Some of the most important findings related to DG developers' views were on 'curtailment', which involves the DNO signalling when there is no remaining network capacity and the generator turns down its output until the constraint is alleviated. Generator curtailment was perceived as offering substantial opportunities, which could be implemented as part of Active Network Management schemes to optimise the export of multiple generation developers onto the distribution network in the face of known network constraints. These findings have been absorbed into the project and on-going engagement also ensures that the customer/DG developer can influence and input into the innovative technical solutions and commercial framework being developed by the project. Our third flagship project awarded from the LCNF Tier 2, Smarter Network Storage, focuses on the benefits of electrical storage, and is currently engaged in a similar consultation with stakeholders around business models for storage.

Giving customers who may be affected a voice

Within the Smarter Network Storage project, UK Power Networks will install a 6 MW/10 MWh electrical storage device within the project area. Ahead of the mandatory council-led resident engagement activities, we consulted with local residents to fully understand any concerns.

Recruiting trial participants

Within our Low Carbon London project, we developed and implemented detailed consumer engagement plans for our Smart Meter and Electric Vehicle trials. The plans identified some overall principles for customer engagement, together with the proposed approach for the six separate customer groups, including vulnerable customers or those on the Priority Services Register. The project retains the flexibility to adapt these plans as we receive feedback from our customer and partners, or from other stakeholders. We are following a similar approach in our project funded by the LCNF Tier 1 to monitor a sample of customers' solar panels. The success of the Feed in Tariff (FiT) resulted in rapid growth in the number of domestic 'micro generation' installations with the vast majority of them being Photovoltaic (PV) solar panels. The project has developed a detailed customer engagement plan to carry out this activity, paying special attention to any potential vulnerable customers.

Discussing industry change

Within the Low Carbon London project, UK Power Networks is working with the transmission system operator (TSO) National Grid and other DNOs to examine the interactions between the DNOs' studies into Demand Side Response and National Grid's procurement of reserve services. This provides a forum in which we openly discuss areas in which DNOs and TSO have competing or overlapping requirements and which are best met by expanding the overall base of participants involved in reserve services and demand response; and areas in which we have requirements which are complementary and not in conflict.

In conclusion, we recognise that the low carbon economy will only take place by individuals and businesses making decisions about managing their own energy usage. Working closely with our stakeholders helps to keep our feet on the ground in telling us what is taking place practically in terms of the low carbon uptake, and opens our eyes to what might be achievable in the future.

Having set out in the last chapter the likely content of our innovation programme, and in this chapter how we take stakeholders views into account, the next chapter will provide assurance that we organise ourselves with the right skills and with value-for money in mind.

Innovation Strategy Review Panel

On 29 April 2013 this document was revised by a group of specialists with the purpose of obtaining specific feedback on three topics:

- Are the guiding principles fit to enable UK Power Networks to be leaders in innovation?
- Does the strategy encompass the right technologies?
- Has UK Power Networks considered the right innovation portfolio mix to support innovation successfully?

The main feedback circled around explaining benefits to customers, the high risks of low carbon uptake and interoperability of future technologies, how we will pick our partners going forward and the need to maintain a balanced portfolio going forward.

These concerns have been incorporated to the published version of the Innovation Strategy and highlight the importance of having external feedback on our guiding documents.

10 Delivering with partners

Key messages

The team work closely with additional technical and commercial expertise both **within and external to the business** to reach successful results.

This ensures our solutions are of the **highest quality.**

Where appropriate we use **competitive processes** to choose partners for our innovation projects.

This ensures **best value** for the customer.

We understand that innovation delivers superior results when delivered **collaboratively**, while enhancing our own capabilities and sharing learning with other DNOs. We take a balanced approach to ensure that our innovation activities deliver optimum outcomes.

We are constantly looking for the right partners to enhance our projects and deliver the best solutions to our customers. UK Power Networks has an internal team dedicated to innovation but we are aware that the innovation process is a collaborative effort, therefore we engage with partners throughout the industry to integrate the required skills for all of our projects.

The core UK Power Networks' Future Networks team

In 2005 UK Power Networks made a conscious decision to re-focus on innovation, which had garnered less attention in the preceding years, placing two full time engineers and a part time manager into an innovation team. Two other experienced employees were then brought into the fold and by 2011 the team had built up to 10 employees. In more recent times the innovation team has increased in size again to around 30 engineers and support staff, including PhDs in fields applicable to distribution networks. This structure will enable us to deliver the programme that we have committed with Ofgem and the other DNOs.

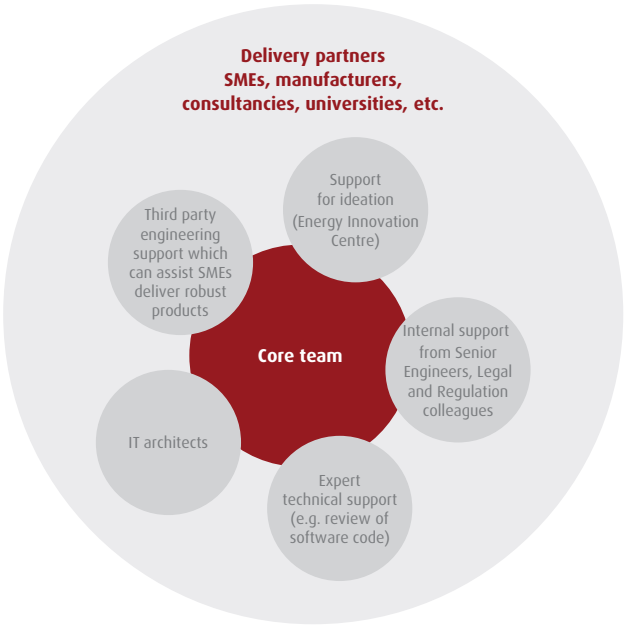
The team actively works alongside other departments within the company. The team works closely with our legal department to ensure that all commercial proposals to our customers are suitable and with our regulation and compliance department to guarantee that we are meeting our obligations. We also collaborate closely with Infrastructure Planning, Asset Management, Operations and all technical departments to ensure that our proposed solutions are addressing their daily challenges and that we get feedback from these experts on our progress made.

The decision to undertake work internally or in partnership

We now have an internal team with a great deal of experience and deep industry knowledge. However, we acknowledge that we are not interdisciplinary experts and hence we partner with other organisations to draw on their own expertise and know-how. Where possible, we select our partners via competitive processes to ensure the best value for customers. Such partnerships also provide us with new ideas and perspectives, especially from other sectors such as transport, heat and environment. Indeed, partners are a key part of our plan for delivering innovation in a flexible manner.

As shown in Figure 20, the core team of Future Networks interacts constantly with a diverse group of partners. First of all, we participate in groups that facilitate ideas such as the Energy Innovation Centre (EIC) which looks to identify project opportunities from inside and outside of the energy sector. As different ideas come up, we engage with engineering specialists and seek the technical support, both in terms of hardware and software, to help transform innovative solutions into robust products suitable for large scale deployment. Our internal partnership with IT architects recognises the fact that the Future Networks team needs specialist expertise to support the development of robust ICT architectures for smart grids.

Figure 20: A high-level summary of our approach to partnership



Finally, once we have chosen ideas and have informed our proposals, we partner with different types of enterprises, institutions and organisations to deliver our projects. We work with a variety of partners in order to achieve a balanced portfolio and add insight to our innovation solutions. Some of our Business partners include other DNOs such as Scottish Power, Western Power Distribution, Electricity Northwest, Scottish and Southern Energy, as well as the transmission network operator National Grid. We partner both with large technology companies such as Siemens, Logica, Alstom, Wilson Transformer Company, industry expert consultancy companies such as GL Hassan, PA Consulting, Accenture as well as universities and small technology companies. We are experimenting with an approach of engaging 3rd party support acting on the supplier side, in order to act as additional professional help to assist small start-ups and SMEs develop their products.

10.1 Working with other network companies to foster innovation

We stated earlier that our innovation is a collaborative effort involving many departments in the company. We also collaborate externally with other network distributors, other companies in the industry and other practices around the world.

One of the approaches to address this is participating in the Energy Innovation Centre (EIC) which was launched in June 2008 as a joint initiative within the UK energy distribution industry to actively seek out technologies beyond the boundaries of traditional network operators.

Another key example of how we enrich our activities is by participating in forums and conferences that engage us with companies in the industry that are working on similar solutions and where we interact with small enterprises to understand how to support the technological transfer of creative and implementable solutions.

10.2 Working with universities

In parallel with developing research results with the universities, we put effort into identifying and recruiting post-graduates into the business. Our university partners include:

University of Cambridge | Imperial College London | Durham University | The University of Manchester | Cardiff University | Brunel University | University of Surrey | Cranfield University | University of Birmingham | The University of Edinburgh | University of Strathclyde | Glasgow Caledonian University | University of Southampton | University of Liverpool | University of Bath | Queen's University Belfast |

Our partnership with universities varies from collaborating with departments focused on specific electrical research to engaging with them to enhance the scope of our Low Carbon Network Fund projects. They have the opportunity to provide external feedback on our ideas and become a great asset for the company to help us understand the key questions going forward, and open issues to address for each project or idea.

Not only do universities provide access to the most recent research in our subjects, but also enable UK Power Networks to present them with a clear problem and have access to dedicated resources such as PhD students to provide robust analysis and solutions.

10.3 Picking the right partners

Since the introduction of the Innovation Funding Incentive in 2005, DNOs have increasingly engaged with universities and manufacturers to develop ideas and products to improve the technical performance of the distribution networks. UK Power Networks has also engaged with universities by participating in the Supergen consortia funded by the Engineering and Physical Sciences Research Council (EPSRC). These consortia have allowed the company to describe problems and develop ideas and solutions with researchers having appropriate experience in a particular field. In 2008 UK Power Networks with a number of DNOs, EPSRC and National Grid established the Power Networks Research Academy to encourage UK students to consider PhD research. The universities in this partnership recruited students and developed topics with the DNOs. These initiatives have allowed UK Power Networks to develop a network of academic contacts.

Establishing competitive processes where suitable

We have a strong ethic of trying to find the right partners for the work, particularly mindful of delivering the best value for money for distribution customers. The competitive process and regularly testing the market is therefore central to UK Power Networks when seeking the lowest cost bids for our projects, quality notwithstanding.

A clear example of this is the approach taken for finding the supplier of the Smarter Network Storage project. In summer 2012, UK Power Networks undertook a full competitive procurement process for the large-scale energy storage device that forms part of this Tier 2 project. The aim was to reduce costs, providing the most value for money and ensuring the most appropriate technical solution was selected. Experienced members from UK Power Networks Asset Management and Capital Programme departments evaluated tenders. Approximately 30 companies registered their interest, with 14 submitted tenders received by the closing date. Four suppliers were shortlisted and participated in face-to-face evaluation meetings. A preferred supplier and reserve suppliers were selected, resulting in a strong balance between overall cost, power, energy duration and risk of earlier reinforcement of the site. The range of solutions proposed comprised several different configurations, making direct savings difficult to attribute; however the final solution selected was approximately £2.6 million less than the average solution cost proposed by all tender participants.

Another example of this good practice took place in Autumn 2011, UK Power Networks ran a competitive tender for the 'Increased capacity from Overhead Lines (OHLs)' project requiring generic technical consultant support to socialise and embed results from a number of previous research projects. Through this process we identified four companies to send an Invitation to Tender. Final contract achieved a £289,000 saving against the highest quote, and a 5 per cent rate reduction with respect to the first draft of the preferred supplier's proposal.

Independent checks to ensure we choose the right innovation partners

Because there are several companies and institutions engaged in network innovation research and activities, we strive to keep an objective view on how we select our partners. For example, we recently carried out a study of UK universities to ensure that we had a view of who is best placed to pursue results through conclusions which could be applied on the network. We engaged an independent technology transfer specialist who typically works on the universities' side and typically acts to try and elicit interest and the market size for a university's technology and with spin-out opportunities in mind.

Aside from the profiles of technical specialisations and capabilities, analysis of the interview feedback revealed that:

- UK universities are keen to engage with DNOs as partners in a range of activities
- Universities tend to emphasise capability and collaboration, rather than technology
- They generally prefer close, long-term partnerships with companies, rather than short projects or one-off licensing
- They are diverse in their commercialisation goals, resources and track records
- There appears to be a trend within universities towards devolution of commercialisation activity, from a central hub towards individual schools and departments

Overall, it was clear that there is plenty of partnership potential for UK Power Networks in UK universities, across a wide range of activities. To enable UK Power Networks to prioritise its efforts in this regard, a simple scoring system was developed, based on ten criteria drawn from the body of information generated by the interview programme and associated activities.

From this scoring process, a 'Top 12' ranking of the participating universities was deduced. Based on this, it was recommended that the next step for UK Power Networks was to contact the Top 12 in order to discuss and arrange exploratory meetings, and these meetings are underway.

11 Rolling out **successful innovation** as Business as Usual

Key messages

We have a **robust process for roll-out** of network innovation.

We understand that this process should be **flexible**.

We will follow three steps:

1. Identification of innovation opportunities
2. Systematic assessment and development
3. Scale implementation and evaluation

We are focused on **scaling the right solutions at the right time** and getting our business ready to deploy innovation as part of business as usual

UK Power Networks has developed a robust process, known as the Smart Network Plan (SNP), in which smart network-led solutions can be captured, tested, developed, rolled-out and embedded into the business. Additionally, the Smart Network Plan manages the inherent uncertainty and risks associated with innovative solutions. This allows for more informed decisions to be made about their application versus traditional solutions.

11.1 Summary of our approach

The Smart Network Plan comprises of three key business implementation steps:

Step 1: Innovative ideas → captured → allocated into innovation trays

Step 1 of the Smart Network Plan captures internal/external innovation activities or experiences that are in-line with the UK Power Networks innovation approach, the Future Network Development Plan and the derived innovation themes referred to in Chapter 6. The captured solutions will then be regularly validated, sifted and allocated to suitable price-control or stages, also known as 'Innovation Trays'.

Step 2: Systematic assessment and solution development → informed decision can be made

Step 2 of the Smart Network Plan prioritises potentially ready-to-deploy solutions for systematic assessment against a comprehensive evaluation framework. Each assessed solution will be sponsored by a member of the UK Power Networks Executive Management Team to drive clear accountability within the senior management team. This person is accountable for delivering an informed and considered decision that reflects our innovation strategy. Step 2 will conclude with a fully scoped and signed off solution that is ready to be implemented into the business (prior to 'gate A' within our investment appraisal process).

Step 3: Smart solution implemented → performance and tipping-point tracked

Step 3 of the Smart Network Plan takes a fully-scoped smart solution and embeds it into the business through UK Power Networks existing investment appraisal process ('Gate A to E'). Solution performance and tipping point will be tracked to allow refined analysis to reflect on-the-ground learning. Finally, Step 3 will help identify when a solution's tipping point has been reached for a systems-wide engineering approach to be considered.

11.2 Context

A review of traditional investment processes and procedures within UK Power Networks reveals that the nature of innovative solutions results in 'poor fit' for reasons such as sparse information, uncertainties of future costs, and potential new risks that need to be understood for health, safety or environmental compliance. This is in contrast to established network solutions where deployment experience removes most if not all unknowns.

The Smarter Network Plan facilitates innovative solutions being integrated and compared to traditional solutions, by providing the necessary information for informed decisions to be made. This implementation approach adopted by UK Power Networks has been developed with the following key requirements in mind:

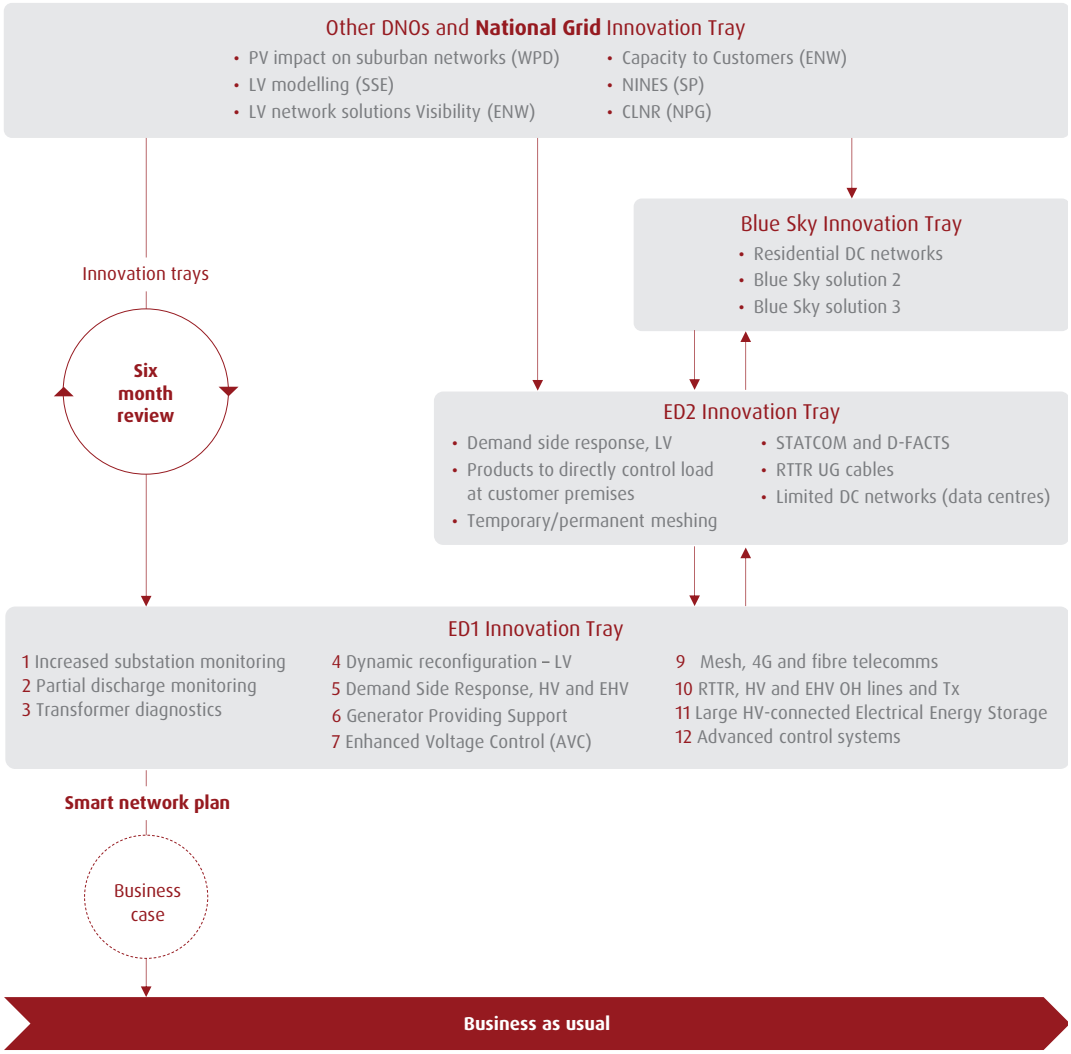
- To ensure that the potential benefits available from innovation are released
- To adapt company processes and thinking enabling innovation to be a BaU activity
- To avoid the pitfall of innovation being a marginal activity that is developed by only a few or in silo
- To recognise that innovation is continually evolving, and to capture this in a company-wide defined process
- To identify and embed innovative smart solutions cost effectively

Figure 22 at the end of this chapter encapsulates the Smart Network Plan process its rationale, transparency and effectiveness in making innovation business as usual. The process, steps and delivery of smart solutions are discussed in further detail below.

Step 1: Innovative ideas → captured → allocated into innovation trays

The Smarter Network Plan captures new ideas and potential solutions from diverse sources both internal and external to the UK Power Networks (domestically and internationally). Examples of external sources can be insight gained from other DNOs, academia, vendor companies, consultants, conferences, and publications. Any Smart Solution identified, be it internally or externally, will be allocated to an 'Innovation Tray'.

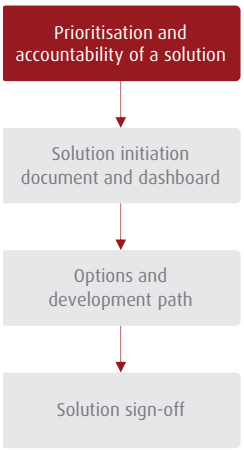
Figure 21: Innovation trays and allocation of smart solutions



The concept of 'Innovation Trays' are used to encourage an approach that reflects a progressive business process, whereby Smart Solutions move from sifting and evaluating ideas, through to these ideas being ready for Business as Usual application. Four trays have been developed, identifying a solutions potential adoption period e.g. RIIO-ED1, RIIO-ED2, or ideas at very early stages defined as Blue – Sky, or ideas that we can obtain from what others are doing in the industry, referred in the diagram as Other DNOs and National Grid Innovation Tray.

For example, the tray nearest to deployment today is described as the RIIO-ED1 'Innovation Tray', meaning that the solutions it holds are those considered likely to be ready for practical deployment during the RIIO-ED1 regulatory price control period. Innovative solutions can move 'backwards' or 'forwards' through adjacent trays as analysis and new information comes to light from both internal and external sources. This approach can change the potential deployment period of a solution, to being either sooner or later, than initially anticipated. The innovation trays and solutions within will as a result be systematically reviewed on a minimum 6-monthly basis by the Future Networks Team.

Step 2: Systematic assessment and solution development → informed decision can be made



Systematic assessment and solution development occurs throughout the SNP process by capturing innovation and allocating these solutions into suitable trays. Step 2 of the SNP process systematically assesses and develops solutions (high-level) further through the following activities:

A **process of prioritisation** will occur for smart solutions that are suitable for potential deployment, this due to the need to implement certain solutions into the business before others; or due to external drivers which 'force' the need for their systematic assessment and implementation. Each smart solution that undergoes systematic assessment will have a sponsor (Director) that is accountable for the solutions end-to-end delivery.

The **Solution Initiation Document** (SID) will be a key phase of systematically assessing a smart solution, as it identifies at a high-level the key uncertainties, the risks and the overall business case for embedding the solution within the business. As a document the SID is based on best practices for project control by adapting UK Power Networks' Project Initiation Document (PID) into a fit for purpose document. By providing a high-level overview, the SID will help summarise the smart solution's readiness and suitability for deployment into visual dashboard, also known as the SID Dashboard.

The **SID Dashboard** will visually represent key criteria using RAG status reporting to identify the risks of embedding the solution into the business. In order to limit any form of subjective bias, both the SID and weighted Dashboard will undergo an extensive peer review. The selected Design Authority consisting of members from UK Power Networks' Senior Management Team (SMT) will be responsible for this review and for defining what further development 'option' is taken.

It should be noted that there are three development paths possible depending on the level of uncertainty and risk of the solution:

1. Full Scoping: uncertainty and risks still exist. Therefore, the solution must be fully scoped for deployment into the business
2. Fast Track: some residual uncertainty and risk exists requiring a beta version of the solution to be deployed
3. ED2 Innovation Tray: high level of uncertainty and risk still exist. Therefore, the solution must move back into the ED2 Innovation Tray; until a time when it's suitable for the solution to be assessed again

As a result of either fast tracking or fully scoping the smart solution, both the SID and Solution Dashboard will be updated. This process should occur until the solution is identified as a low risk solution for the business (all green), before being finally signed off for business implementation by the Sponsor and Portfolio Board.

Step 3: Smart solution implemented → performance and tipping-point tracked

An important third step confirms that a fully scoped solution has been established, is ready to be implemented as a BaU option by network planners and designers, and is no longer under the oversight of the UK Power Networks' Future Networks team. This final step includes a tracking mechanism to monitor the approach of tipping points and out-turn solution performance. It also ensures the adaptation of any changes required for the company's business operating model.

Tracking of out-turn performance is key to quality control and cost-effectiveness; furthermore in the case of innovative solutions it is also important to monitor volume and cumulative costs of deployment so that an assessment can be made of the 'tipping point' where standardisation is likely to bring business benefits in regard to considerations such as procurement, spares, training and adaptation of wider 'systems engineering' such as integration with corporate ICT frameworks and software systems.

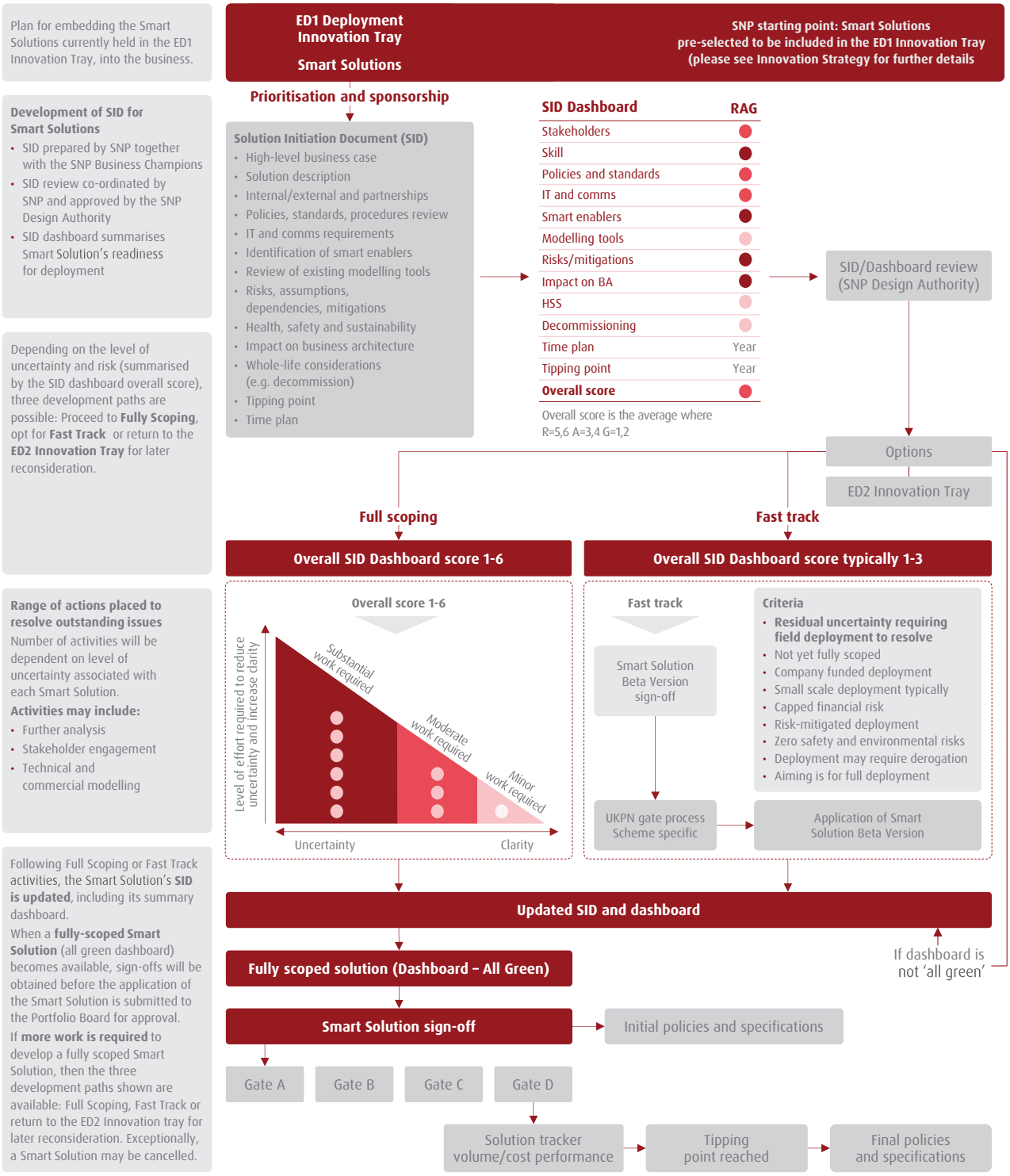
Standardisation may involve conversion from a bespoke design specification to a functional specification (open to competitive bidding by a choice of vendors); it may require alignment with national or international standards; and it may be appropriate to develop it in conjunction with other or all DNOs.

The work of the workstream 3 of the Smart Grid Forum coordinated by Ofgem, which focuses on 'Developing Networks for Low Carbon', is relevant to this process and has shown that the lead time and resource effort for establishing an 'integrating framework' at the tipping point may be non-trivial and needs to be planned in advance of the tipping point occurring – perhaps by a number of years. Finally, Step 3 marks the full handover to BaU and the end of smart network team involvement in a particular Solution.

Please refer to Figure 22 for a full diagram of the Smart Network Plan.

Figure 22: UK Power Networks implement and embed our innovation solutions via the Smart Network Plan

Smart Network Plan – embedding solutions, understanding and managing uncertainty



12 Looking back and **going forward**

Key messages

A number of the savings built into our business plan **have their roots in our early innovation** projects.

Our innovation strategy has **set out for the first time a savings commitment** and specific **list of deliverables and technologies** for the coming price control period.

During the RIIO-ED1 price control we will have a **much clearer picture** of the level of uptake of low carbon technologies from our customers that will further shape our views and requirements for ED2 and ED3.

Our strategy is to be **revised at least every two years** and will be consulted with stakeholders accordingly.

The previous chapters have set out what we aim to deliver from our innovation during RIIO ED1, the way that we govern our innovation projects, and the way in which we ensure that they take account of stakeholders' views, select the right partners on the right commercial terms and how we ensure that innovation is embedded back into our business. This final chapter looks back to some of our earliest innovation projects in order to provide confidence that these approaches are effective.

We conclude by providing a general view of how we see our innovation strategy going forward. As mentioned throughout the strategy the greatest uncertainties for the industry relate to the migration towards a low carbon economy, and the responsibility of DNOs to enable this transition and how we use innovation to minimise the effects of these uncertainties by creating flexibility.

12.1 Our early efforts are paying off

It is important to specifically assess our early portfolio of innovation, and which has had the most time to come to fruition. The chart on the following page shows a summary of the major investments within our innovation portfolio during the earlier years.

Picking some highlights, the desktop projects 'Application of Storage and Demand Side Management (DSM) and 'KEMA – DSM study' provided critical early thinking which culminated in the Demand Side Response trials built into our Low Carbon London Low Carbon Network Fund Tier 2 project, and in turn culminated in a saving of £43 million within our RIIO-ED1 business plan.

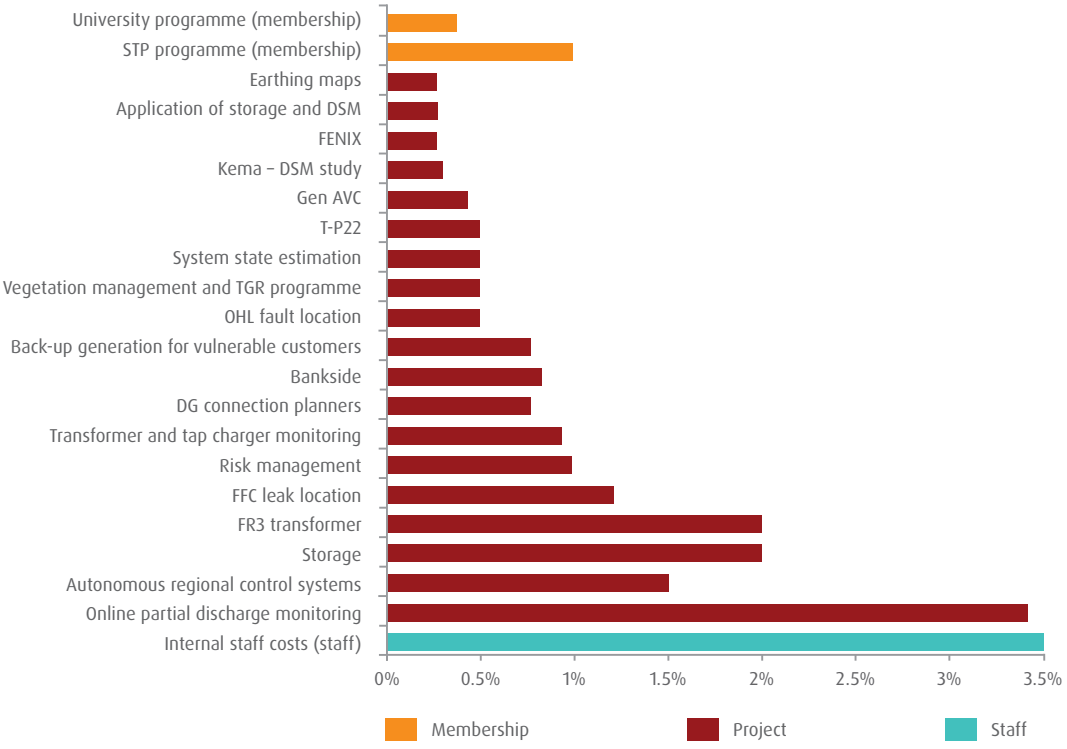
The FENIX project, a collaboration of European utilities and manufacturers, defined some of the key terms and concepts involved in the transition of the traditional utility or Distribution Network Operator (DNO) to a Distribution System Operator (DSO) and has been widely credited.

The T-P22 device now forms part of our standard suite of tools for finding intermittent faults on low voltage feeders. Once fitted to a faulting low-voltage feeder it will record fault waveforms and provide an estimated location of the fault. Leaving the device in situ enables our field engineers to efficiently trace faults which only occur from time-to-time and are therefore difficult to observe.

Our work on transformer and tap changer monitoring has given us the confidence to include £15 million of savings from applying real-time thermal ratings (RTTR) to transformers, since we have learnt both the benefits and pitfalls associated with a number of different monitoring solutions.

Our work on Online Partial Discharge Monitoring has allowed us to make a commitment to further roll-out the technology in order to track the deterioration of switchboards and thereby make a net saving of £9 million. Without remote monitoring, it becomes more cost-effective and more safe to replace switchgear which is in poor condition than to visit it frequently enough to reliably pick up a sudden deterioration.

Figure 23: Summary of significant expenditure in the early years of IFI funding



We are open in recognising items within this early portfolio which have not yet come to fruition, or which we brought to a close. A good example is our trials with back-up generation to support vulnerable customers, which was eventually felt to be too intrusive and introduced additional safety risks. The work on connection planners for Distributed Generation that would greatly assist our infrastructure planners in the early (and less skilled) assessment of options was hampered by data issues in our Geographical Information System (GIS). We expect the work to come to fruition as we carry out a major upgrade of our IT systems over the next two years. Our structured approach to innovation will keep delivering benefits.

12.2 Beyond RIIO-ED1

This document has focused on explaining the approach that UK Power Networks has to address innovation, from collecting ideas, identifying technical solutions and the commercial implications, consulting stakeholders and selecting partners to describing the processes we have in place to evaluate progress and implement as business-as-usual practices. Although this approach will remain the overarching framework of our innovation, the specific deliverables have mostly been defined for the following eight years, and it is important we address the challenges to be faced in the future, always keeping in mind our regulatory framework.

Future challenges and potential areas of opportunities

In the next few years we will have the opportunity to revise our strategy and understand from stakeholders what information and considerations we have been missing. We will also be able to make more informed decisions on the projects we decide to continue with and which we should start considering. However, we must take the time now to understand what decisions are being made in the current policy scenario that will influence the way we operate our network and the requirements we will be subject to as to provide the best service to our customers.

For example, as government defines the future energy direction, we will be directly affected by any changes on regulation and scenarios they propose. The view of government on the role of Demand Side Response or the success of the Capacity Market proposed as part of the Electricity Market Reform (EMR) will be critical to how we implement demand side response and interact with our end customers.

As building standards incorporate energy efficiency requirements as well as incentivise electricity generation, we should constantly think about how we will be able to enable such services. UK Power Networks covers three fundamental areas of the country where housing development is envisioned to grow in the next twelve years. A proposal to consider reinforcement synergies between other utilities such as gas and water might be interesting as incentives for each of these regulated industries evolve. In this way, UK Power Networks must have a clear understanding of the future of these industries and how they will affect the network and may provide collaborative efforts to avoid costs to our customers.

There are various rural communities that may alter their energy consumption habits in the near future. We must start to address how we see innovation driving progress in these parts of the network and understand how electricity supply can play a key role in their development.

Another instance of how we should monitor our innovation strategy will come towards the end of the decade when Smart Meters are effectively rolled out throughout the country. Access to information provided by these devices will play a key role on how we understand our customer's use of electricity and will influence our innovation approach going forward. In the future this will start to be quantified as energy savings which is critical for helping the government meet carbon reduction goals.

We will align our strategy constantly as RIIO-ED1 evolves and our vision of RIIO-ED2 stated in this document. Our objective as innovation develops will be to constantly revise the unknowns and bridge the gaps between where we are and where we want to arrive. This way, based on our capabilities we will have a clear idea of where we need to go. Finally, we will constantly evaluate our partnerships and be open to new ideas and players.

Finding new partners

Engagement with academia within groups such as the Supergen consortium has allowed creative thinking to take place whilst producing researchers who are familiar with distribution network issues. UK Power Networks participates with the Engineering and Physical Sciences Research Council that funds research and specifically has an Energy theme with the vision to sponsor research "to help solve some of the most serious challenges facing the UK today and in the further future." By attending events, that include academics, UK Power Networks is able to communicate its challenges and universities can present their ideas and submit proposals. In March 2013 the Technology Strategy Board's InnovateUK 2013 event allowed universities, SMEs and larger companies to demonstrate their ideas under one roof. In summary, we must continue to participate in such activities where a multidisciplinary approach to generating creative solutions for the future is enabled.

Our view on innovation during RIIO-ED2 and RIIO-ED3

In Chapter 8, we presented our deliverables for ED1, as our best view of what solutions are required to deliver improved service and enable to low carbon economy. Nevertheless, our innovation horizon expands beyond ED1 into ED2 and ED3, as all our scenarios and models are developed to look until 2050 – the government's target for decarbonisation.

Our scenarios forecast that only the initial part of the low carbon uptake will take place during the latter part of ED1, with the majority of the growth taking place during ED2. With this insight, we have already set out our Innovation Strategy and Future Network Development Plan.

Our Future Network Development Plan covers many innovative solutions that are still in its infancy at the moment and will remain so during ED1, but have the potential to make contribution in later periods. Our key strategic objectives discussed in Chapter 1 and our processes to select and embed innovation, such as the Smart Network Plan (ED2 and Blue Sky Innovation Trays) discussed in Chapter 11, are all robust and will remain valid.

We proactively continue to assess the 'future solutions' with the potential to start trialling them during late ED1/ early ED2 so we can deploy them on our networks during ED2 or ED3. This will enable UK Power Networks to be ready for the major low carbon uptake our scenarios foresee.

Table of figures

Glossary

ARP	Asset Risk and Prioritisation
CAPEX	Capital Expenditure
CHP	Combined Heat and Power
CIRED	Congrès international des réseaux électriques de distribution International Conference on Electricity Distribution
DG	Distributed Generation
DNO	Distribution Network Operator
DSO	Distributed System Operator
DSR	Demand Side Respons
ENA	Energy Networks Association
EHV	Extra High Voltage, voltages greater than 11kV, up to and including 132kV
EPN	Eastern Power Networks
FFC	Fluid Filled Cables
FPP	Flexible Plug and Play www.flexibleplugandplay.co.uk
HV	High Voltage, voltages greater than 1000V up to and including 11kV
IET	Institution of Engineering and Technology
IFI	Innovation Funding Incentive
LCL	Low Carbon London www.lowcarbonlondon.info
LCNF	Low Carbon Network Fund
LPN	London Power Networks
LRE	Load Related Expenditure
LV	Low Voltage, voltages up to and including 1000V
NIA	Network Innovation Allowance
NIC	Network Innovation Competition
NLRE	Non-Load Related Expenditure
OPEX	Operational Expenditure
QoS	Quality of Supply
RIIO-ED1	Revenue = Incentives + Innovation + Outputs (RIIO) – first electricity distribution price control (ED1)
RTU	Remote Terminal Unit
RTTR	Real Time Thermal Rating
SNP	Smart Network Plan
SPN	South Eastern Power Networks
TSO	Transmission System Operator

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