WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

INNOVATION STRATEGY

February 2015

Contents

Executive Summary

Role of innovation within WPD

Innovation is core to our business strategy. We always seek to find better ways of working. We have adopted many innovative ideas into day to day operations that improve the efficiency and effectiveness of the way we deliver our services to customers. Our track record of innovation and change spans from the implementation of good innovative ad-hoc ideas from staff all the way through to formal innovation projects.

We look for innovative developments across five broad areas;

- Network performance and efficiency - searching out better processes, equipment and technology that ensure we continue to be efficient.
- low carbon networks – supporting future electricity demand and generation requirements;
- smart grids and meters – developing new techniques and utilising enhanced data to help develop more dynamic network control;
- environment – reducing our business impact on the environment;
- customer service – developing smarter ways of delivering better customer service

These areas of work are interdependent and progress in one area will often help to enhance innovation development in another.

The objectives of WPD's innovation are to:

- develop new smart techniques that will accommodate increased load and generation at lower costs than conventional reinforcement;
- improve performance against one or more of our core goals of safety, customer service, reliability, the environment or cost effectiveness;
- ensure solutions are compatible with the existing network;
- deliver solutions so that they become business as usual;
- provide value for money.

The way that we approach innovation is fundamental to delivering the objectives efficiently. WPD's Innovation Strategy is to:

- actively involve staff from across the business in the generation of ideas, development of solutions and implementation of projects;
- work with our stakeholders to understand their needs;
- make use of innovation incentives and funding provided by the Government, the regulator and other funding organisations;
- use a small core team to coordinate innovation projects;

- define clear objectives for each project so that delivery can be focused and progress can be tracked;
- avoid theoretical research or innovation which does not have clear objectives;
- incorporate innovative solutions into existing equipment and processes
- share what we learn with other organisations and learn from others.

Customers and stakeholders are a valuable source of ideas as they are directly affected by our performance. Our stakeholder engagement process for innovation is the same as for all other areas of our business. Innovation is a key theme of our stakeholder engagement sessions. Stakeholders understand that innovation cuts across all areas of our business and provides improvements and benefits to all the areas.

New ideas also come from several other sources. They can come from within WPD and are often based on improvements to existing practice or recent experiences. They can also incorporate learning from other DNO projects. In some cases academia will approach us with a theoretical idea which we can develop into a solution. We also look for ideas in other sectors where there is the potential for technology developed outside of the electricity industry to be brought in, modified and used.

Our existing portfolio of innovation projects is already shaping how we are thinking about the future. We will continue to innovate and undertake new projects that will build upon what we have already learnt from the projects we and other DNOs have carried out. We set out within this Innovation Strategy the progress we have already made, the projected output from the various projects currently being undertaken and the future projects planned.

1 Document purpose

This document sets out the detailed Innovation Strategy for Western Power Distribution (WPD). It describes our approach to innovation and describes how we continue to innovate within our business to improve efficiency and set the foundations for smart grids.

It will be reviewed and re-issued annually to reflect changing external factors, business priorities and to incorporate learning from the previous 12 months. The document applies to all four WPD distribution licences of West Midlands, East Midlands, South Wales and South West.

The Innovation Strategy looks at the long term development of our distribution assets and customer service caused by changing customer needs. The Strategy looks through to 2030, yet naturally provides more detail on the shorter term priorities, requirements and proposed initiatives.

This document provides all the information that Ofgem requires in an Innovation Strategy for a licenced network operator, namely:

- evidence of how DPCR5 innovation funding (i.e. IFI & LCN Fund) has been used effectively and resulted in improved outcomes for consumers (Sections 3 and 9);
- the high-level problem(s) and/or challenge(s) which the sector/company expects to face over the period, and the justification for initiating projects to address these (Section 4);
- the consequences of innovation(s) not occurring (Section 4)
- the process or methodology by which we will focus on innovation during RIIO-ED1 (Section 5);
- demonstration that the problems/challenges have been identified/prioritised and justified in consultation with stakeholders (Section 5);
- discussion of the relative priorities, risks, benefits, value for money and potential customer impacts (Section 5);
- deliverables and potential deliverables from the research or development or trials, such as defined learning on an issue, revised codes, new charging methodologies etc. (Section 6);
- a description of our processes for reviewing and updating the innovation strategy within the price control period. (Section 7);
- a description of our approach to ensuring the efficient roll-out of successful innovation into business as usual (including innovation developed by other DNOs) (Section 8).

2 Introduction

2.1 What is innovation?

Innovation is the process of having new ideas, developing them into practical solutions and implementing them into equipment or processes in order to improve network performance or customer service. It will provide solutions that are better, cheaper or quicker than the current ways of doing things. The Network Innovation Incentives and the Government's Carbon Plan bring huge change and significant opportunities to innovate. Innovation does not have to be on a large scale; sometimes improvements can be achieved through evolutionary change, involving incremental improvement to existing methods.

2.2 Why do we innovate?

We rely on innovation to maintain our position as a frontier performer in network performance and customer service. Innovation is targeted at all of the key outputs of safety, cost efficiency, customer service, reliability and environment. In the past innovation has proved beneficial by allowing us to continually improve in these areas. Future innovation will allow us to continue these improvements and will also help us to address the challenges brought about by the Carbon Plan.

2.3 How do we innovate?

Innovation is core to our business strategy. We have a small innovation team dedicated to exploring innovative ideas including the delivery of smart grid projects. Our projects are predominantly generated from ideas from staff and stakeholders. When our projects involve the installation of equipment on our network or require a change to business processes we do this in the same way as our standard engineering activities using the skills and efficiencies of our engineering teams. We also draw on the expertise of our suppliers and help them develop solutions. Furthermore, we work with a range of research establishments utilising their specialist skills.

2.4 Stakeholder involvement

Innovation is a key theme of all stakeholder engagement sessions. Our stakeholder engagement process for innovation is the same as for all other areas of our business. Stakeholders understand that innovation cuts across all areas of our business and can provide improvements and benefits to all the areas. We welcome ideas from our stakeholders and openly encourage them to put forward their suggestions.

3 Background

3.1 Government and regulation

Our main sources of innovation funding are managed by Ofgem, the industry regulator. Ofgem has established a variety of funding mechanisms to develop future networks that support the Government's Carbon Plan. We work with both Ofgem and the Department of Energy and Climate Change (DECC) to support their ambitions, targets and meet their and our obligations.

We also engage with DECC on related matters such as Climate Change Adaptation (CCA) that looks to the longer term effects of climate change on the UK electricity industry.

We actively engage in the development of regulatory and legislative policy and our learning from innovation projects informs the proposals we make in our responses to consultations. The results from our projects are published and freely available via our website, which enables all stakeholders to benefit from our learning.

3.2 Innovation funding within the UK

In the period between 2005 and 2010, Ofgem set up the Innovation Funding Incentive (IFI). Its purpose was to improve the quality of research and development within the UK electricity industry. The Registered Power Zone scheme (RPZ) was also set up to support network demonstration projects.

In 2010, and continuing through to 2015, Ofgem introduced the Low Carbon Networks Fund (LCNF). The LCNF is designed to support the development of low carbon technologies within the UK electricity industry and facilitate the changes brought about by the Carbon Plan. It contains three elements; large scale projects funded through a competitive process (Tier 2); smaller scale projects that are self-certified (Tier 1) and a discretionary reward where Ofgem will provide an additional allowance for companies that successfully develop learning that generates benefits for the industry.

We are undertaking the highest proportion of innovation projects of the UK DNOs.

DNO	LCNF Tier 1	LCNF Tier 2	Other major projects (non LCNF)	Total
WPD	13	6	2	**21**
SSE	9	5	0	**14**
UKPN	6	6	1	**12**
ENW	7	4	0	**11**
SP	6	2	0	**8**
NPG	1	1	0	**2**

In RIIO-ED1 the Network Innovation Allowance (NIA) and Network Innovation Competition (NIC) will replace the current funding schemes. The competitive element will have a greater value and will also be open to the electricity transmission companies. We will continue to develop innovation projects through these mechanisms.

We have also secured support and funding from the Engineering and Physical Sciences Research Council (EPSRC), Energy Technologies Institute (ETI) and Innovate UK (previously called the Technology Strategy Board).

3.3 Benefits from research and development

The Innovation Funding Incentive (IFI) & Registered Power Zone (RPZ) mechanisms were designed to deliver value to end consumers through safety improvements, increased cost efficiency, improved customer service and reliability and also environmental improvements. A definition of technical terms and project assessment methodology is set out in the Electricity Network Association (ENA) standard G85/2.

Examples of successful IFI projects completed since 2005 are listed in the table below along with which outputs they benefit. This is followed by a brief description of each project.

IFI Projects	Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
Reference network model		✓	✓	✓	✓
Impact of climate change and weather analysis	✓	✓	✓	✓	✓
Control system automation algorithm		✓	✓		✓
Harmonic issues on distribution networks		✓	✓	✓	✓
Electric vehicles	✓	✓	✓		✓
Earthing information system	✓	✓		✓	✓
Generating value from smart meter data		✓	✓	✓	
Condition based risk management	✓	✓		✓	✓
Management of Electricity Distribution Network Losses		✓			✓
Power Communications Meter		✓	✓	✓	✓
Domestic Demand Response Network Study		✓	✓		✓

3.3.1 Reference network model

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓	✓	✓

The project created a model that could represent different circuit groups, to allow power system analysis of network performance. Parameters can be changed allowing us to predict the effects of different investment options. The output has been used subsequently within further IFI studies including in the support of Smart Grid Forum modelling work.

3.3.2 Impact of climate change and weather analysis

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓	✓	✓

A DEFRA funded project involving climate projections was used to develop new methodologies and probabilistic predictions to assess specific energy industry impacts. The project has improved our knowledge allowing us to better plan for future scenarios including the increase risks of both flooding and lightning as well as changes to the thermal loading of overhead lines.

3.3.3 Control system automation algorithm

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓		✓

The project developed and demonstrated the benefits of self-healing networks using an automated switching algorithm that could carry out real time circuit status analysis and tracing to identify source and alternative supplies. The project led to a wider trial and rollout of the algorithm to the WPD region. The project has led to this type of functionality becoming a core offering within Network Management Systems (NMS).

3.3.4 Harmonic issues on distribution networks

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓	✓	✓

This analysis and research project produced a report on the harmonic problems due to converter plant being installed on electricity networks. The learning allowed us to further develop ENA planning guidelines and continues to inform the on-going industry review of the industry standards such as the ENA’s Engineering Recommendation G5/4.

3.3.5 Electric vehicles

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓		✓

The project investigated the impact of charging electric vehicles on conventionally designed distribution networks. It demonstrated different connection scenarios and mitigation options. The project confirmed that the impact on distribution network from a modest uptake of small electric vehicles is low. The project learning has subsequently led to further studies into power quality and harmonics caused by larger electric vehicles under the LCNF Tier 1 project entitled Electric Boulevards.

3.3.6 Earthing information system

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓		✓	✓

This project developed a Geographic Information System (GIS) to assist DNOs in the installation of rural ground earthing systems. Carried out in conjunction with the British Geological Survey, it provides a graphical presentation of ground conditions and estimates the likelihood of suitable earthing resistance being met. The system has recently been further developed and is now provided as an overlay in our GIS systems used regularly by network planners.

3.3.7 Generating value from smart meter data

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓	✓	

This Technology Strategy Board (TSB) funded project was delivered jointly with the Centre for Sustainable Energy (CSE). It looked at possible methods of undertaking data mining on the vast pool of data that will be available following the smart meter roll out, and how the information produced can be of maximum use to WPD and the wider industry.

3.3.8 Condition Based Risk Management (CBRM)

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓		✓	✓

The Condition Based Risk Management project has delivered a tool to determine optimum replacement triggers for network assets. CBRM data is also being used to optimise maintenance periods based on condition.

3.3.9 Management of Electricity Distribution Network Losses

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓			✓

The project investigated the concept of making distribution networks as energy efficient as economically possible. It raised awareness of issues and proposed solutions which take more account of losses in network design. The project created a set of recommendations which are being addressed through our Losses Strategy.

3.3.10 Power Communications Meter

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓	✓	✓

The project developed a simpler remote telemetry unit (RTU) for use at smaller distributed generation sites. It allows our control room to have the visibility they require without the complexity of a conventional RTU. The unit now forms a part of our standard set of solutions for the connection of new generators.

3.3.11 Domestic Demand Response Network Study

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓		✓

The project investigated the potential of using domestic energy control systems to manage demand and offset the impact in locally connected generation. The study results are being used to develop a follow on Tier 1 project called Sunshine Tariff.

3.4 Business innovation during DPCR5

3.4.1 Innovation performance to date

Innovation has always been a key part of WPD's development strategy and our ability to take an innovative approach to day to day working and problems that we face has made us the most successful DNO in the UK.

Innovation projects often come from ideas that have flowed from staff and these have helped us to deliver excellent levels of performance in safety, reliability, customer service, the environment and cost efficiency.

Some recent examples of our day to day business innovation are detailed within the table below, which also identifies the areas where improvements have been achieved.

Business Innovation during DPCR5	Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
ENMAC Mobile	✓	✓	✓	✓	
LV monitoring	✓	✓	✓		
Pre-installed LV monitoring	✓	✓	✓		
LV design templates		✓	✓	✓	✓
Dynamic line ratings		✓	✓		✓

3.4.2 ENMAC Mobile (operational innovation)

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓	✓	

We were the first DNO to use hand held devices in 'real time' to control and manage high voltage switching operations. The hand held devices are in constant communication with our network management system ENMAC.

Our operational staff use the hand held device to receive operational instructions and confirm completed action back to control. This has enabled us to reduce the volume of voice traffic into our control centres. Staff in the field are able to be more efficient as the number of jobs that can be processed concurrently by the NMS is significantly improved. This is of particular benefit at peak times of the day when operational staff in the field are starting or finishing planned works at similar times.

Real time communications also allow the operational status of the network to be updated as soon as alterations occur on the system. These immediate updates improve the information available for our contact centre staff and High Volume Call Taker (HVCT) systems, which in turn improves the information we can provide to customers.

After the successful implementation of the high voltage switching element we added a low voltage incident management system to the package. This addition allows field staff to take details of faults and incidents directly on the device and provide updates from site that previously relied upon voice updates being provided after completion of work.

As with high voltage operations the low voltage updates from the field are used to keep the operational status of incidents up to date and to ensure that customers receive accurate messaging and good information from our contact centre or HVCT about what is happening. This system has been in use in South West and South Wales since 2007 and became business as usual in West Midlands and East Midlands during 2013.

3.4.3 LV Monitoring

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓		

Our LV monitoring Tier 1 project sought, in conjunction with UKPN, to compare the options available for retro-fit monitoring solutions. The project rated commercially available products against a range of factors including safety, ease of installation, accuracy and longevity. As a result of the project findings we have established a specification for retro-fit monitoring and have let a framework contract for the supply of devices.

3.4.4 Pre-installed LV monitoring capability

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓		

LV cabinets are normally supplied with relatively simple peak demand indicators built into them. We specify cabinets that have high quality current transformers installed so that, if required in the future, more accurate monitoring equipment can be fitted without interrupting customer supplies or replacing the cabinet.

3.4.5 Pre-installed automation capability

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓		

Switchgear for our distribution network can be pre-wired to accept automation equipment and can have current transformers (CTs) fitted to detect the passage of fault current. Pre-wiring all of our new switchgear allows us to provide flexibility in placing automation equipment as our networks develop. Automation can be fitted where it is needed without replacing the switchgear.

3.4.6 LV design templates

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓	✓	✓

Our PVs in Suburbia project helped demonstrate the actual impact of domestic photovoltaic generation in a densely populated area. The results of the project were used in conjunction with the larger LV Templates project to amend our Low Voltage design tools and amend our ratings of solar installations. As a result, more distributed generation is able to connect to our low voltage network without the need for monitoring or control systems.

3.4.7 Dynamic line ratings

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓		✓

The success of the Registered Power Zone project, RPZ1, showed that we can establish dynamic line ratings on our 132kV overhead line network. This allows us to accommodate more demand or generation when the network or environmental conditions allow it.

3.5 DPCR5 Smart Enablers

3.5.1 Continuing with plans set in place during DPCR5

Whilst we are developing new smarter techniques to support low carbon technology (LCT) developments, we will continue to provide electricity to customers by constructing new network and maintaining our existing assets. We will also be reinforcing the network in response to load increases.

Whenever this work is done we have an opportunity to look ahead to the future. Assets commissioned today are likely to still be in place beyond 2050 and in preparation for future load growth, we can take advantage of installing assets with a higher specification or with functionality inbuilt for future use.

We already provide some preparation for the future and will continue to develop a wider range of 'future-proof' innovative options in RIIO-ED1.

3.5.2 Pre-installing LV monitoring capability

It is anticipated that we will require more data about the LV network to inform automatic network management schemes. Whilst the data requirements are simple (e.g. near real time voltage and current readings) they are not currently available. The easiest place to obtain this data is at the low voltage distribution cabinets at distribution substations. These cabinets have historically been fitted with simple CTs to give an indication of peak load on a local meter.

When the cabinets are manufactured it is a cost effective process to uprate the CT to a more accurate unit and wire it to a terminal block where monitoring equipment can be connected when required. This prewiring enables the use of more complex monitoring equipment without the need to interrupt customers or work on the cabinet. The additional cost of these CTs is low relative to the full cost of the cabinet (1.4% of the total cost). WPD has been specifying this arrangement since 2010 and we will continue to do so.

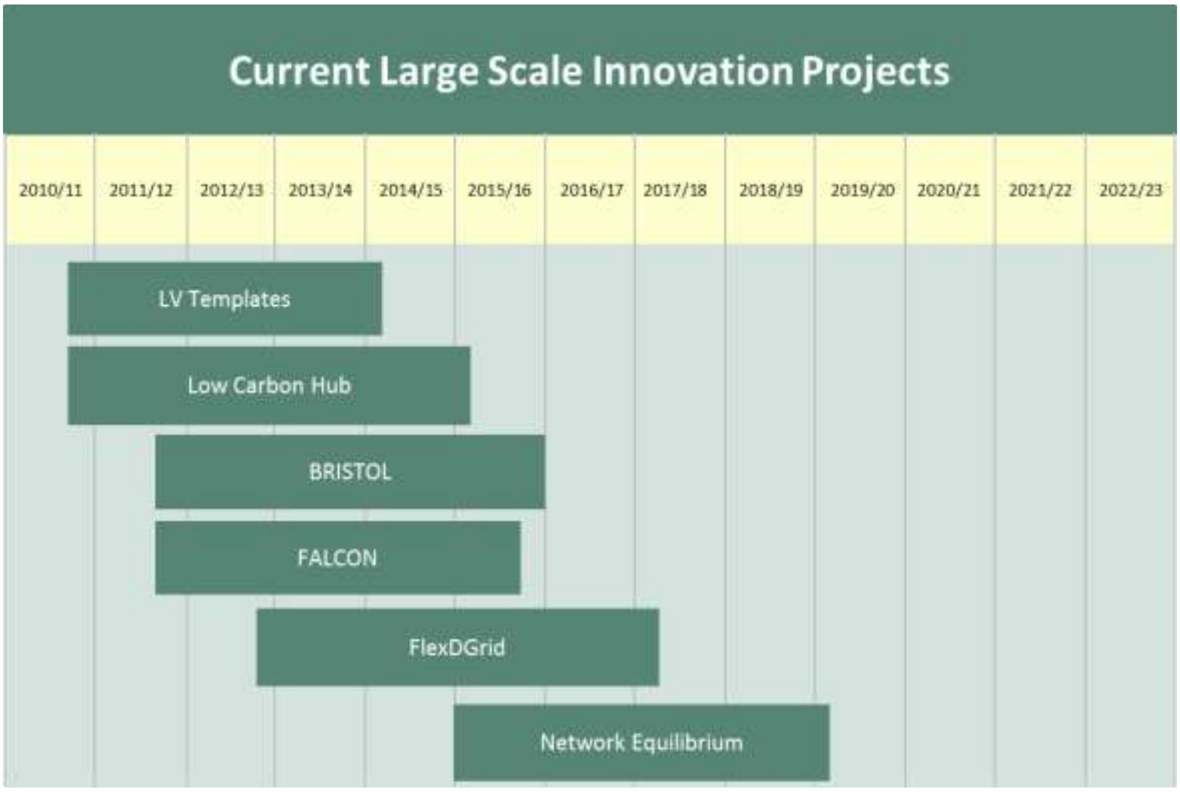
3.5.3 HV switchgear automation

It is likely that in the future we will need to move load from one part of the HV network to another to make the most use of network capacity. The most efficient way of moving load is to operate 11kV switches remotely. At this stage we do not have sufficient data to know specifically where this functionality will be required but we can plan ahead by purchasing switchgear which is prepared for automatic operation.

The actuators that drive operating mechanism are relatively expensive, but factory fitted wiring, CTs and connections to accept the actuators can be incorporated into switchgear units with a minimal cost increase. Installing switchgear that is prewired for automation avoids the need to change switchgear at a later date. The cost of the prewiring is low (1.5% of the total cost) and WPD has been specifying this arrangement since 2009 and will continue to do so.

3.6 Major DPCR5 low carbon and smart grid projects

During DPCR5 we have been successful in receiving funding for six Tier 2 projects. The projects investigate a range of network issues from 132kV active network management to rewiring of customer homes with DC systems (as opposed to standard AC).



3.6.1 LV Templates

The electricity network was designed to carry power from large, centralised power stations and major grid infeed points to distant load centres in town and villages. Historic load profiling data for network design used this basic operating model.

The shift to distributed low carbon generation such as from wind or solar sources has already moved a significant amount of generation closer to the customer load. At the same time homes are being made more energy efficient through better insulation. These changes require an overhaul of the basic planning assumptions that have been used when assessing power flows and energy consumption.

The LV Templates project was used to evaluate how low voltage (LV) electricity networks can best accommodate the low carbon future.

In 2011, 951 substation sites in South Wales were fitted with data monitors and communication equipment. The project also required voltage monitors to be fitted at the ends of the LV circuits that are fed from these substations. This required over 3,500 monitors to be installed to collect the data and send it remotely back to WPD.

The project monitored energy usage and used statistical clustering techniques to identify more accurate patterns in electricity consumption. This allowed us to develop new planning assumptions and embed them in templates that can be used to facilitate more accurate network planning.

This project ended in 2013 and has shown that low voltage solar generation normally generates onto the network at around 80% of its rating. We have now altered our design assumptions to reflect this, which has increased the volume of photo voltaic (PV or solar generation) that can be accepted onto the network.

We have also shown that voltage rise effects from PV are less than expected. Both these results will be used within the business and will influence national design policies and solar generation acceptance criteria.

We published network templates data making it available for all DNOs to use in planning LV network solutions. The final project reports published in the autumn of 2013 provide full template data and conclusions.

We will use the results from the LV Templates project to inform future ways of designing networks. This will allow us to better predict the effect of low voltage generation and load and ultimately enable us to accept more on to our existing network. We will also incorporate the learning from SSE's 'Thames Valley Vision' project in our implementation. Scottish Power's (SP) 'Flexible Networks for Low Carbon Future' project will also provide additional knowledge on the acceptance of low voltage generation and the design of flexible ratings.

Although the project is formally closed we are continuing to collect data and process it. This will allow us to identify demand profile changes as customers adopt LCTs and we will re-model the templates accordingly. The data collection and network monitoring infrastructure will also be upgraded and used to support new innovation projects without the need to recreate a monitored network.

We published a discussion paper on the possibility of harmonising statutory voltage limits with those in the rest of the EU. The paper has been presented to industry groups including DECC, the Welsh Assembly Government and Ofgem. The consequences and benefits have also been debated at the ENA and with National Grid.

We have introduced a policy to reduce voltage within the South Wales area. We are collecting data so that the impact of the voltage reduction on energy consumption can be measured. Findings of several Electricity North West (ENW) projects will also help determine next steps.

3.6.2 Lincolnshire Low Carbon Hub

The Lincolnshire Low Carbon Hub has been designed to test a variety of new and innovative techniques for integrating additional low carbon generation onto electricity networks with limited capacity. The aim is to avoid the costs that would normally be associated with more conventional reinforcement.

We are exploring how the existing electricity network can be better utilised to accommodate more generation than traditionally would be accepted. The outcome of the project will lead to solutions that can be applied on other parts of the network where a large amount of distributed generation would like to connect.

We will offer Dynamic Line Rating solutions and Flexible Generation Capacity Agreements on this project. Both of these will improve the utilisation of our assets. The cost of connections and time to connect for generation customers will also reduce as a result of these initiatives.
Using these techniques more widely will require generators to be coordinated so that adjacent systems can operate effectively together.
When the Lincolnshire Low Carbon Hub project was originally proposed it predicted that the solution would be replicable across the UK electricity industry in around two locations per DNO licence area. We now expect the solution to be deployed in more locations than originally predicted and we have already identified the following sites in WPD where the solution will be deployed. This will increase the amount of generation that can be connected at these sites.

GSP Group	Active BSP Group	Quoting form	Building during
Bicker fen	Skegness	Active	Active
Grendon	Corby	Active	Apr-15
	Northampton	Apr-16	Apr-17
Bridgwater	Bridgwater	Active	Nov-15
	Street		Nov-15
West Burton	Horncastle	Apr-15	Apr-16
Indian Queens	Truro	Nov-15	Nov-16
Swansea North	Swansea Pembroke	Nov-16	Nov-17
		Nov-16	Nov-17

The locations and dates are under continual review with the latest information available on the WPD website.

3.6.3 Project FALCON

Project FALCON is focused on providing an understanding of the dynamic nature of the utilisation of the 11kV network. The aims of FALCON are to facilitate the installation of low carbon technologies by delivering faster and cheaper connections on the 11kV network.

It will be used to assess a number of alternative solutions to conventional network reinforcement. Four technical and two commercial intervention techniques are being designed and tested to address network constraints.

The project will develop modelling tools that use real-time data to inform network planning decisions, rather than traditional indicators such as total demand and generic engineering guidelines.

The project will deliver a Scenario Investment Model (SIM) planning tool for both 11kV network design and strategic forecasting. The 11kV design tool will be developed into a production model and rolled out during the project. The strategic planning tool will be used for business planning and scenario analysis.

The FALCON telecommunications solution, based on mesh radio, will be the basis for our future telecoms needs at primary and distribution substations. It will be developed further during RIIO-ED1 after the completion of FALCON.
The uptake of demand side response within the FALCON project has exceeded the planned 9MW target. This has been achieved through a mix of bilateral contracts and services provided through aggregators. Uniquely, the service is being offered as complementary to the National Grid STOR service, meaning that customers can engage with us and National Grid at different times. We are currently working with the other DNOs and National Grid on a common framework.

The outcomes from the FALCON project will produce an energy modelling simulator that will be used to design and operate the network in a more efficient way. Functionality from this simulator will be used to provide 11kV design templates for planners and provide more real time analysis for control engineers.

The network management techniques trialled in FALCON will be implemented into WPD's control systems, and the prototype system subsequently decommissioned. The new techniques will become available to be implemented across the WPD networks, although further modelling will be required to understand the locations where it is cost effective.

3.6.4 BRISTOL

The BRISTOL project aims to provide an innovative approach to operating networks utilising battery storage in a customer's premises. The battery will store output from PV generation and utilise it in many ways. A DC network for lighting and USB type charging, an inverter controlled by the customer and WPD and new tariffs will help manage the PV generation locally. The project will seek to address issues associated with the large-scale deployment of PV generation.

In this project WPD is working with:

- Bristol City Council which is deploying the technology at its sites;
- Knowle West Media Centre which is coordinating customer engagement;
- Siemens who are providing the technology; and
- University of Bath (working with RWE npower) who are our academic partner.

The technologies will be implemented in five schools, one office and 26 homes; all connected to 13 distribution substations.

The project is testing the coordination of a local micro-grid but has also provided an excellent storage and DC power test bed. The BRISTOL solution will not immediately be ready for rollout by DNOs as it will require further refinement and standardisation, as a proportion of the installation is beyond the customer's meter.

3.6.5 FlexDGrid

The connection of generation to urban HV networks can lead to fault levels that exceed the design capability of existing networks. Traditionally, higher capacity assets would need to be installed to enable the generation to connect, but this project investigates alternative ways to accommodate the connection of generation.

The FlexDGrid project is based in Birmingham and seeks to explore the potential benefits from three complimentary methods:

- enhanced fault level assessment;
- real-time measurement of fault level; and
- fault level mitigation technologies.

Recent forecasts by National Grid and ETI point toward an increase in the use of Combined Heat and Power (CHP) in urban areas. This increase in distributed generation will lead to potentially higher fault levels in most of the larger cities in the WPD area during the latter part of RIIO-ED1.

The project is already providing data which will change how we calculate fault level and allow us to accept more local generation and CHP onto our network. As this assessment work completes and reports, it will be used to alter design principles.

Real time measurement of fault level has shown that the fault level assessment calculations are correct. The project has now moved into the third phase with the first fault level limiter installed in the Winter of 2014/15.

3.7 Low carbon and smart grid small project portfolio

In addition to the five large LCNF project, WPD has established a portfolio of smaller low carbon projects.

3.7.1 D-SVC Integration

Working with Hitachi of Japan, we are testing large power electronic devices to control system voltage at remote ends of our networks where renewable generation is connected. The devices were initially tested under an earlier Tier 1 project demonstrated that Static VAR Compensators (SVCs) at 11kV are an effective way of smoothing voltage on rural networks to allow distributed generation to connect. This project will develop the solution to allow integration of SVCs with primary substation voltage control schemes and optimise the operational effectiveness of the units.

3.7.2 Active Fault Level Management

Generation connections are limited by three network factors; load carrying capability, voltage and fault level. Until now is has not been possible to measure the fault level, it could only be modelled on computer simulations. We have developed a tool to solve this problem. The learning has already fed into our Tier 2 FlexDGrid project. .

3.7.3 Community Energy Action

Working with 10 communities across WPD we are demonstrating the management of network constraints using demand side response (DSR). The project aims to identify the most effective arrangements to engage customers in the modification of their electricity demand and through these initiate practical DSR arrangements.

3.7.4 Electric Boulevards

Working with partner organisations including Arriva Buses, Wright Bus and ARUP we are transforming one bus route in Milton Keynes by replacing diesel buses with wirelessly charged electric units. WPD is installing and testing the charging equipment and laying the cables to charge the buses. We will move energy around the city to match the bus route. We have demonstrated that LV connection of these charging units is possible in some urban areas using the existing network. This will assist in the deployment of electric buses in towns.

3.7.5 ECHO

The ECHO (Energy Control and Household Optimisation) project is testing the effect on household electricity demand from Demand Side Response (DSR) payments (customers receiving payment for modifying their electricity usage). Delivered in conjunction with the Energy Savings Trust the project will provide insight into the financial, technological and behavioural aspects of DSR.

3.7.6 Sunshine Tariff

The project is identifying appropriate controls and incentives to increase electricity demand at times of peak solar generator output. Using a mixture of technology and tariff based solutions the project will assess the degree to which these solutions negate the need to carry out conventional reinforcement.

3.7.7 Solar Storage

The Solar Storage project is demonstrating the use of batteries located at solar generation sites. A series of tests will provide our project partners, British Solar Renewables, with data enabling them to report on the cost effectiveness of energy storage. The tests include a range of operating modes replicating market and network conditions.

3.8 Smart Grid Forum

The Smart Grid Forum (SGF) was set up in 2011 to bring together key stakeholders in the development of a GB smart grid. The SGF helps network companies address future network challenges and ensures system benefits are considered in the development of smart grids.

We are active in many of the workstreams that have developed.Workstream 3 led to the development of the 'Transform' model; an enhancement of the DECC scenarios developed under Workstream 1. We have actively participated and supported the Transform model and have taken it further by including socio-economic and housing stock details to develop a view of future electricity usage specifically tailored to our areas of operation.

Workstream 5 has developed the Smarter Networks Knowledge Portal, which has recently been launched by the ENA and we are also represented on this group.

Workstream 6 deals with Commercial and Regulatory Matters. We have been involved in knowledge sharing events for this group, where we explained the experiences of customer engagement and DSR.

Workstream 7 considers the future of distribution networks out to 2030. It is modelling representative real networks to validate the findings from Transform.

4 Why do we innovate?

4.1 External factors and trends

The changing global attitude towards fossil fuels is driving customers towards greater electrical solutions for heating and transport. The generation sources which support this increased demand are more likely to be renewable and distributed.

Creating a network that supports this increased electricity usage would be expensive using purely conventional methods. Our innovation strategy seeks, investigates and evaluates affordable alternatives. The alternatives may include solutions that postpone expensive investment whilst there is uncertainty.

Innovative solutions can also improve the security of electricity supplies by ensuring generation matches demand in local areas. Solutions could enable sections of the electricity network to be run in isolation for short periods of time.

Distribution network technology will continue to advance and we can gain benefits by adopting it. Our experience shows that new solutions available today will become standard in the near future. For example, distribution substation monitoring was bespoke when our LV Templates project started in 2010. By 2012 we were able to test a variety of off the shelf products in a joint project with UK Power Networks.

The information, communications and technology sector will continue to grow in significance. The trend in "always online" devices is likely to accelerate leading to the vision of an "internet of things" where smart devices interact with one another without the need for human intervention. We will need to ensure that the distribution network can integrate with such devices to meet customer expectations.

There will also be an evolution in the capability of LCTs such as electric vehicles and heating solutions. Technology breakthroughs are also likely, for example, in the cost and density of energy storage devices. Network innovations we are developing today will need to adapt or be replaced with new solutions over time.

4.2 Responding to Government policy

Concerns about climate change have led the Government to produce the Carbon Plan setting out the UK's commitment to reducing greenhouse gases by 80% by 2050. New challenges will emerge for DNOs because the Carbon Plan seeks to drive down the levels of carbon released by both heating and transport activities thereby shifting demand from oil and gas to electricity. The scale and pace of the changes are uncertain but we need to be ready to accommodate the changes when they arise.

The aspirations within the Government's Carbon Plan will increase demand on the network and there will also be more DG.

We have already observed the effects that changes to Government policy can have. The feed-in-tariff for generation has led to a significant increase in the volume of applications for generation connections, with many applications being received just prior to when incentive strength is reduced as generator developers seek to maximise their returns from incentive mechanisms.

Devolved Government policy in Wales may lead to specific demands and need for innovative solutions. Our plan is flexible and therefore able to accommodate these.

We expect that some LCTs will also see a high level of uptake which will be influenced by Government subsidies or incentives. The strength of incentives will alter the speed and volume of uptake.

In preparation for future changes we will engage with developers, local authorities and other expert groups to ensure that our preparation plans are targeted in the most beneficial areas.

Our work with the CSE has identified that heat pumps are only likely to be deployed in areas where the housing stock is suitable for them. Likewise, the numbers of electric vehicles are likely to grow in areas where the social demographic suits early adoption. This means that it is highly likely that LCTs will be clustered closely together leading to a compound effect on specific parts of the network.

In the future customers will use electricity in different ways. They will be more aware of their own generation and demand, with some customers becoming more self-sufficient. The existing passive use of electricity will turn into a more interactive and dynamic system.

The impact of new forms of generation and demand will become clearer during RIIO-ED1 and into RIIO-ED2 and our plans need to be flexible to respond to changing circumstances. We will accommodate any changing requirements into our Innovation Strategy as part of the annual review.

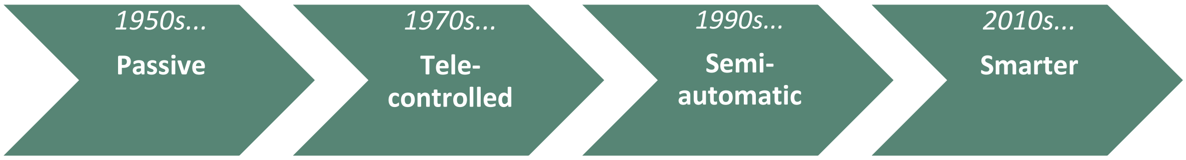
The rollout of smart meters will provide new data capture opportunities. We will develop systems to analyse the data that will become available to assist in understanding where issues are arising and enable the deployment of domestic Demand Side Response (DSR) where appropriate.

4.3 The need for innovation

DNOs will have to become more creative and develop new ways of delivering a network that can respond quickly to both the increased demands from LCTs, such as heat pumps and electric vehicle charging, but also to accommodate the connection of more locally based DG such as photo voltaic and wind.

Networks have evolved progressively since the major electrification of the UK in the 1950s and 1960s but the challenges arising from adoption of the Carbon Plan will require us to change the way we operate more quickly than has been necessary in the past.

Over the last fifty years our network has become far more sophisticated and responsive, but more change will be required during RIIO-ED1 for it to become 'Smarter'.



4.3.1 Passive

Early electricity networks operated in a simple and passive way. All network switching actions required manual intervention and responses to a loss of supply required people to be on site to understand what had happened and make the changes. If a network required reconfiguration it was done manually.

4.3.2 Telecontrolled with remote operation

Advances in communication technology allowed us to provide a network that could in part be operated remotely. This was applied to the higher voltage levels and was predominantly limited to control of source circuit breakers at primary substations. Manual switching on site was replaced by remote control at a control centre. The communication systems also allowed more real time data about the loading of the network and configuration of running arrangements to be brought back to the control centre.

4.3.3 Semi-automatic / automatic response to specific events

Further advances in communication enabled remote control to be installed more widely on the networks. This allowed more operations to be conducted on the network without the need for manual switching.

Developments in control systems also allowed this equipment to be controlled automatically using logic sequences. Ever more sophisticated NMSs could check and reconfigure networks automatically to provide quick restoration of customers' supplies in a high proportion of HV faults.

4.3.4 Smarter

We are now developing networks that will be more autonomous in the future. The networks will use data from various sources to determine their state and respond accordingly. The data will include weather data, metering data and other information obtained from dedicated monitoring.

In addition to reconfiguring running arrangements in response to faults, the smarter networks of the future will dynamically respond to network loading, output from distributed generators, weather conditions and other parameters to maximise the utilisation of available network capacity. They will enable the most amount of generation to be exported, reconfigure networks or adjusting demand to make best use of the assets. Smarter networks will also allow us to reduce technical losses.

4.4 Consequences of innovation not occurring

The need for innovation has been set out in the section above. It shows the way that we expect the use of the network to change in the future. It is clear that the Carbon Plan will introduce significant challenges that increase the importance of maintaining reliability and customer service to customers during a time when customers change their electricity usage habits.

If innovations did not continue to be made, our overall performance would suffer and costs for customers would be higher as the volume of LCTs overwhelmed the capacity of the network and increased volumes of more expensive traditional solutions were used.

For our main output areas of safety, reliability, customer service, the environment and cost efficiency we have been a frontier performer for many years. This performance is founded on a strong belief in innovation and continual improvement in all the key output areas.

The consequence of innovation not occurring would be that our performance would not improve further and could potentially decline. Over time, all the output areas of safety, reliability, customer service, the environment and cost efficiency would suffer. If this were to continue over the long term, the work and funding required to restore performance levels would be immense.

For the future networks areas of innovation, the consequences relate directly back to the Carbon Plan and the targets set by Government. Achieving the Carbon Plan places a new set of demands on the electricity distribution network where the majority of LCTs will be connected. Without the innovative and flexible arrangements we are introducing, we would need to build a large passive network to accept the proposed volumes of LCTs.

The cost of a passive network to accept the level of LCTs that we expect within the RIIO-ED1 period would be £128m more than the innovative and flexible network we plan to build.

4.5 Dealing with uncertainty

A high degree of uncertainty exists with respect to the uptake of LCTs and it is therefore important that we seek and use key sources of external data and guidance to ensure that we have the best forecasts possible.

Whilst we are guided by scenarios developed by DECC we also employ organisations such as Energy Savings Trust and the Centre for Sustainable Energy to help model these scenarios further and to enhance the levels of detail.

The detailed understanding that we gain guides the development of our innovation projects to deliver solutions for the potential problems we expect to encounter.

Wherever possible we also ensure that our projects are capable of providing more generic solutions that can be adopted irrespective of the specific type and level of LCTs that drive increases in electricity usage in the future and can also be transferable to other DNOs.

5 Prioritising innovation topics

5.1 Scope of innovation

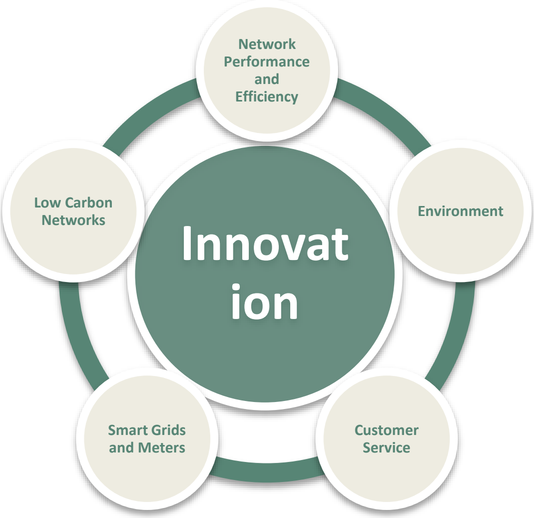
We always look for better ways of working. We have adopted many innovative ideas into day to day operations that improve the efficiency and effectiveness of the way we deliver our services to customers.

Our track record of innovation and change has been developed from the implementation of good innovative ad-hoc ideas from staff all the way through to formal innovation projects.

Our innovation developments can be described across five broad areas;

- Network performance and efficiency - searching out better processes, equipment and technology that ensure we continue to be efficient.
- low carbon networks – supporting future electricity demand and generation requirements;
- smart grids and meters – developing new techniques and utilising enhanced data to help develop more dynamic network control;
- environment – reducing our business impact on the environment;
- customer service – developing smarter ways of delivering better customer service;

These areas of work are interdependent and progress in one area will often help to enhance innovation development in another.



Our existing portfolio of innovation projects is already shaping how we are thinking about the future. We will continue to innovate and carry out new projects that will build upon what we have already learnt from the projects we and other DNOs have carried out.

5.2 Innovation objectives

The objectives of WPD's innovation are to:

- develop new smart techniques that will accommodate increased load and generation at lower costs than conventional reinforcement;
- improve performance against one or more of our core goals of safety, customer service, reliability, the environment or cost effectiveness;
- ensure solutions are compatible with the existing network;
- deliver solutions so that they become business as usual;
- provide value for money.

5.3 Approach to innovation

The way that we approach innovation is fundamental to delivering the objectives efficiently. WPD's innovation strategy is to:

- actively involve staff from across the business in the generation of ideas, development of solutions and implementation of projects;
- work with our stakeholders to understand their needs;
- make use of innovation incentives and funding provided by the government, the regulator and other funding organisations;
- use a small core team to coordinate innovation projects;
- define clear objectives for each project so that delivery can be focused and progress can be tracked;
- avoid theoretical research or innovation which does not have clear objectives;
- incorporate innovative solutions into existing equipment and processes share what we learn with other organisations and learn from others.

5.4 Generating ideas

Customers and stakeholders are a great source of ideas as they are directly affected by our performance.

New ideas also come from several other sources. They can come from within WPD and are based around improvements or recent experiences. They can also incorporate learning from other DNO projects. In some cases academia will approach us with a theoretical idea which we could develop into a solution. We also look for ideas in other sectors where there is the potential for technology developed outside of the electricity industry to be brought in and modified For example the FALCON project has network control algorithms which are based on those developed for aircraft flight control. .

5.5 Selecting and prioritising ideas

Ideas that are generated are grouped against the five broad areas of innovation development. They are then assessed against the innovation objectives and subsequently prioritised.

All potential projects are subject to a cost benefit assessment as part of our standard business approvals process.

The positive impact of projects on our customers is considered as part of the selection and prioritisation process. We also consider the possible negative impact to customers, for example the effect on short term network performance whilst the work to deliver a project is ongoing.

5.6 Developing plans for innovation

Innovation in smart solutions will help us to accommodate LCTs without the need for vast amounts of investment being required to reinforce the network in the latter years of RIIO-ED1 and into RIIO-ED2. We forecast that smart interventions have reduced our investment plans and will save around £128m across RIIO-ED1.

Our innovation plans will also be regularly reviewed against new information from UK industry, worldwide research, learning from Network Innovation projects and outputs from the Smart Grid Forum.

We take account of other ideas and initiatives external to the business which can be jointly developed with our ideas. In some cases this allows us to utilise funding from bodies such as Innovate UK, ETI or EPSRC.

We also look for ideas which follow on from earlier Innovation projects to maximise the benefits of investments already made.

This includes building on successful projects delivered by other DNOs. One example of this was the research which underpins our FlexDGrid Tier 2 project. This was developed as an IFI research project by SP and was then further enhanced as a measurement technique by one of our own Tier 1 projects. Another example is where we have taken the demand side management customer contract documents from the UKPN Low Carbon London project and are using them in our own Community Energy Action project.

5.7 Stakeholder engagement for innovation

Our stakeholder engagement process for innovation is the same as for all other areas of our business. Innovation is a key theme of all stakeholder engagement sessions. Stakeholders understand that innovation cuts across all areas of our business and provides improvements and benefits to all the areas.

5.8 Stakeholder engagement in developing plans for RIIO-ED1

In phase 1 of our stakeholder engagement process we asked stakeholders if they supported our plans to facilitate increased volumes of LCTs. They formed the view that we should provide a level of "future proofing" to the network and that our steps should be taken in an incremental way in case the uptake of LCTs is slower than expected.

They also expressed the view that we should hold a "watching brief" on technologies such as electric vehicles, where the adoption is not yet established.

In phase 2 of our stakeholder engagement we presented our plans for the levels of "future proofing" that could be applied to our network. In this stage of the process our plans had a financial value so that stakeholders could establish their willingness to pay. Whilst there was high overall support for our plans, the most favoured option was to invest ahead of need in line with a medium level scenario of LCTs.

We consulted on our Business Plan in phase 3 of our stakeholder engagement process. At this stage our stakeholders asked us to scale back our assumptions for the take up of LCTs, which we did. Stakeholders also made it clear that they expected our levels of service and reliability to be maintained during the transition to LCTs.

74% of stakeholders agreed with WPD's draft plans and outputs to facilitate increased volumes of LCTs. 19% of stakeholders want WPD to do more to identify LCT hotspots to inform our decision making regarding network reinforcement.

5.9 Ongoing Stakeholder engagement

Stakeholder engagement will remain a core activity through the RIIO-ED1 period and innovation will remain a key element for consultation and feedback. Our engagement sessions in 2014 included discussions on the process for DG connection queues where there are a number of DG customers wishing to connect to the same part of the network. This considered interactivity of connection offers, payments and reservation of capacity.

Innovation remains a key theme for our Customer Panel. The panel helped us to prioritise future projects. In addition to innovation projects the panel support our work to assist the distributed generation community.

In addition to our stakeholder engagement process, we look for feedback on innovation at other panels and groups wherever possible. We work closely with Regen South West, a renewable energy group in the south west of England, who are keen to support the introduction of renewable generation across their area.

We use the Distributed Generation forums, now run by the ENA, to seek other views and to compare our initiatives with those of other DNOs. We support the Major Energy Users Council (MEUC) and have presented our innovation proposals to them for comment and feedback.

6 Innovation Priorities for RIIO-ED1

6.1 Stages of Innovation

During RIIO-ED1 projects will continue to deliver additional knowledge across all output areas. The project portfolio will remain balanced across multiple areas:

- working at various stages of development spanning higher Technology Readiness Levels (TRL) 3 to 8;
- exploring both technology and commercial solutions;
- covering the whole range of asset types and network voltages;
- assessing risk, with no projects carrying unnecessary risk;
- utilising a variety of external funding mechanisms (in addition to the NIA and NIC) to supplement our own R&D budget.

Lower TRL projects will generally be carried out by external research partners under limited supervision of WPD engineers. Higher TRL projects which, in the shorter term, are more likely to produce a solution for our network or processes will mostly be delivered in-house using business as usual teams.

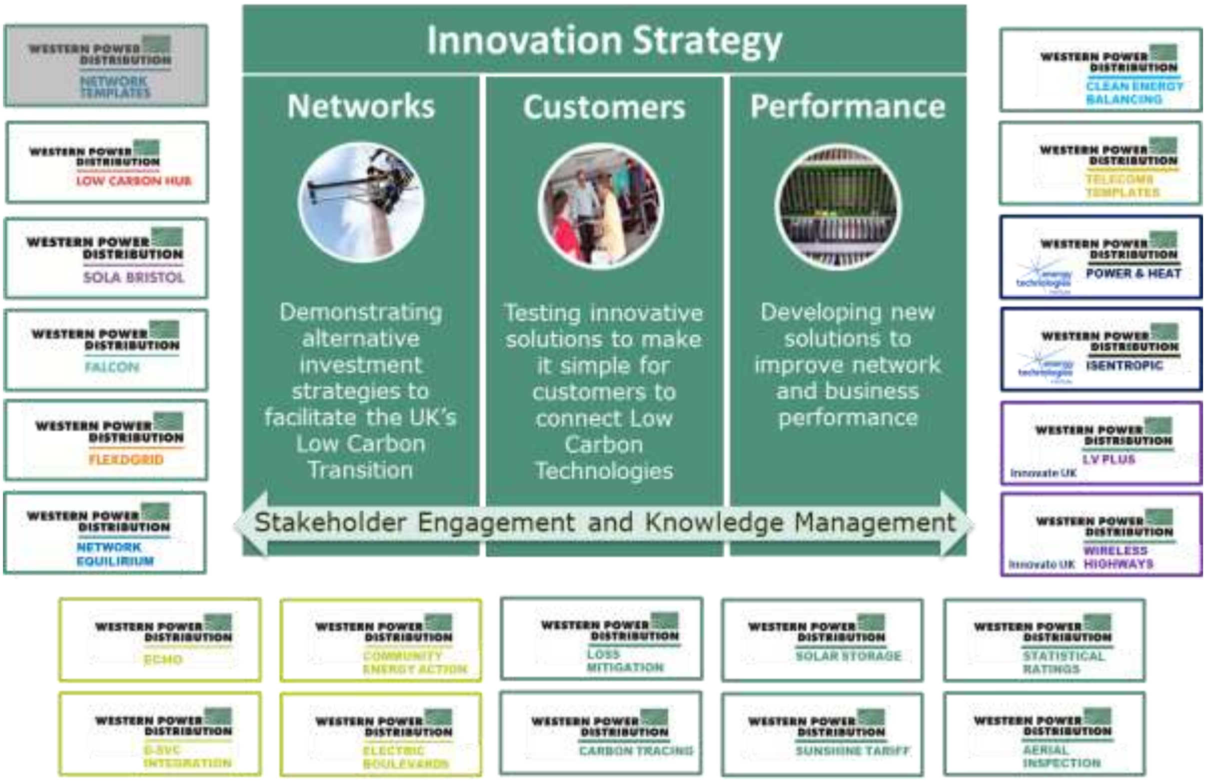
The full 'research to implementation' timescale can often take 5 to 10 years. That is why we focus internal teams on higher TRL stages, building on knowledge from earlier studies outside our own organisation. This will particularly be the case in RIIO-ED1 in order to rapidly develop new solutions to support delivery of the Carbon Plan.

6.2 Forming the innovation programme

Smart grid innovation projects are grouped into three main categories. These are:

- Networks – Projects in this category collect data from the network to enhance modelling. They also test alternative investment strategies that can postpone expensive investments.
- Customers – These projects develop new solutions to enable customers to connect low carbon technologies.

Performance – This category of projects demonstrate direct benefits to network performance from the application of technology. The projects within the innovation programme are constantly changing as new ones are initiated and existing ones completed. A snapshot of the programme is shown in the diagram below.



6.3 Funding the innovation programme

For RIIO-ED1 we have been allocated a Network Innovation Allowance (NIA) of 0.5% of total regulated revenue, around £58m throughout the period. We will also work with partners to provide innovative proposals for larger projects to be funded through the Network Innovation Competition (NIC). Together these projects will lead to investment of over £150m in innovation.

We will also continue to make use of any other available funding sources when appropriate.

In addition to NIA and NIC projects we will continue to support research and development in partnership with other DNOs.

6.4 Preparing for the future with smart enablers

We have been assessing the scale of future network investment requirements by modelling different scenarios. The EATL "Transform" model provides future load estimates and potential solutions based on the DECC scenarios using a range of generic network types. This model has enabled us to form a view of loading at distribution transformer level.

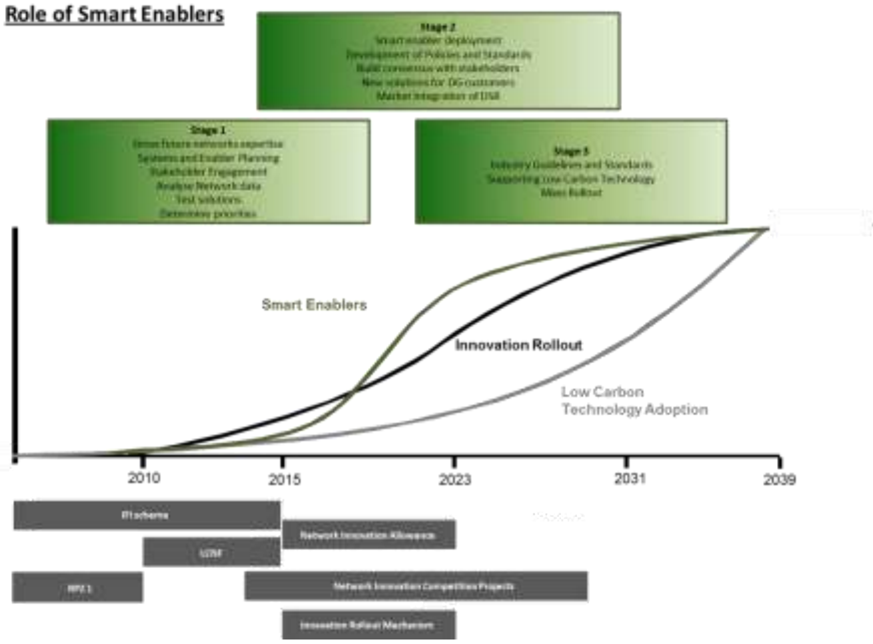
At our request, the CSE has compared the output from the Transform model to socio-economic and house stock information that they hold. This has refined our plans to make them more specific to local circumstances. For example, forecasts of heat pump installations have been reduced in areas where the housing stock is not suitable for their installation and electric vehicles demands have increased in those areas where early adoption is likely.

As we move into RIIO-ED1 we will compare the CSE forecasts with the activity levels that we are actually observing to update our forecasts and provide feedback into the CSE to refine forecasting techniques. This will allow us to more accurately forecast LCT uptake so we deliver the most efficient volume and mix of reinforcement.

Using this detailed analysis we plan to increase the size of selective transformers and cables where there is greatest likelihood of demand growth.

We also plan to invest in communication infrastructure to improve our understanding of the real time status of the distribution network, utilise metering data and enhance the sophistication of control of the network.

Investment in these enabling solutions will provide an essential foundation for the rollout of many smarter solutions. Deploying such "smart enablers" and having individual innovative solutions fully developed will allow us to be ready for the mass adoption of LCTs by customers. This three step approach is illustrated in the diagram below, annotated with how we make use of regulatory innovation incentives.



6.4.1 Selectively increasing the size of distribution transformers

Once installed, transformers are a very simple asset with no moving parts and a long life span. It is more cost effective to increase sizes when transformers are initially placed. Installing increased capacity will avoid the expense and possible customer supply interruptions of transformer changes at a later date.

The additional purchase cost of the next largest transformer is around 12% for the transformer itself, but when all the costs of installation are taken into account the actual additional cost of oversizing is 6%.

The Centre for Sustainable Energy data forecasts high uptake of LCTs on around 7% of the WPD network. By targeting larger transformers at this 7% we will install around 109 units per year. This has led to an additional cost of £0.11m per year being included in the plan.

6.4.2 Selectively increasing the size of cables

The average cost of excavation in a footpath is around £70 per metre, whereas the additional cost of moving to the next size of cable may be less than £10 per metre. When these two items are taken together it makes economic sense to upgrade the cable at the time of installation rather than return at a later date. It also reduces the excavation waste and inconvenience to road users.

It is, however, not economic to do this everywhere and must be targeted at areas where we expect future load to increase.

Using the CSE forecasts we will design to the “next size up” on our cable installation and replacement works in these areas. By targeting this 7% we will install around 74km per year at an additional incremental cost of £0.3m per year.

Cables do not provide the same losses savings as transformers but installing oversized cables will reduce the need to revisit networks and replace cables. Using an average cable replacement cost of around £70 per metre the future cost savings are around £5.1m per year.

6.4.3 Expanding the communications infrastructure

We will establish communications networks as they are needed to support smarter control of the network. We will provide sufficient capacity to take into account future requirements informed by the clustering data we have for LCTs.

Our forecast of load growth will be supplemented by data that becomes available from smart meters. As the smart meter rollout progresses, we plan to make use of this data to model and operate our network. The smart meter data will show us where our network is being fully utilised and where interventions such as operating adjacent networks in parallel (meshing) and load transfers are required.

For instance where meshing or load transfers are required we will consider establishing our own communications links to bring back monitoring data and automation control information. This will only be applied where it is more cost effective and operationally effective than using the smart meter data. Wherever possible we will connect our links directly into our existing communications network via scanning or mesh radio systems.

Our FALCON project has provided a radio solution which has provided new learning for us and will help direct the way forward for our new communication systems. The Wimax system employed has provided usage data and reliability data but does operate on a non-utility frequency. We are planning further projects which will look in more detail at the issue of a cost effective communications solution for distribution locations.

6.5 Identifying and delivering solutions from earlier LCNF projects

To ensure that we learn as much as possible from each of the innovation projects we have assigned specific individuals as points of contact for the other DNOs and their suite of projects. These staff are responsible for ensuring that we capture and apply the knowledge gained from other DNOs and assimilate it, with our own knowledge, into business as usual.

The suite of LCNF Tier 2 projects will provide an excellent source of knowledge to help develop future networks and applications. The timescales of these projects mean that the majority of the learning and outcomes will be provided in the next few years and into the RIIO-ED1 period.

6.6 Driving value from smart metering

The smart meter programme will provide every household with the option of having a smart meter fitted. We will be able to use some of the aggregated data from these meters to provide us with some additional information. The aggregated meter will provide us with details of electricity usage that may assist in refining network planning templates.

6.7 Demand side management (DSM) and demand side response (DSR)

DSM is the generic term associated with energy management activity that customers connected to the distribution network can undertake. In Industrial and Commercial (I&C) organisations DSM measures include savings made as a result of improvements in the energy efficiency of processes, but can also include predetermined time of use tariffs that influence usage patterns and the scheduling of processes. In domestic households energy efficient appliances will reduce demand but time of use tariffs are likely to provide the bulk of DSM.

DSR is a term used for agreements designed to encourage customers to make short-term reductions in energy demand triggered by an instruction from a DNO. This could include I&C organisations turning off or deferring consumption for a period of time. Alternatively, they could start up on site generation to displace load and potentially export power back to the network. In domestic households DSR may become more prevalent as smart appliances that communicate with the smart meter are developed.

We will engage with domestic and I&C customers to test different commercial arrangements, determine the scope of terms and conditions and understand the practical implications of applying DSM and DSR. Different approaches will be required for domestic and business customers.

6.7.1 Domestic customers

Our experience suggests that domestic customers are more likely to engage with a supplier than a DNO. We will make use of suppliers or third parties to manage DSM at a domestic level. Working with the Energy Saving Trust (EST) we are already trialling a system of domestic demand side management which uses plug-in controllers connected to the customer’s broadband router which receives the demand control signals. The EST are communicating with customers, arranging supply of the equipment, operating a helpdesk and delivering the demand response signals to the equipment. The trial will show how effective domestic DSR is, and what level of customer take up will be achieved.

Domestic DSM is also being trialled through the BRISTOL project where a battery is used to store energy and defer demand at peak times. In the RIIO-ED1 period we will investigate how this can be achieved through other methods. For example we may be able to use customers’ hot water storage to defer demand by storing energy in hot water systems. As more electric vehicles are used, the batteries could also be used for DSM by charging when there is spare capacity in the network and using the batteries to provide energy to the network when demand is high.

For large scale domestic DSM to work effectively for a DNO, we will need a standard set of terms and conditions with suppliers, so that a customer’s choice of supplier does not hinder the use of DSM.

6.7.2 Business customers

I&C customers are more likely to interact with their DNO. This has been evident on the FALCON project where we have found that they are willing to engage directly with us.

These customers often already operate in the Short Term Operating Reserve (STOR) markets and are informed on the opportunities that DSR can bring them. In the FALCON project we will contract over 9MW of demand reduction to support capacity on our network.

Our requirement to call on these customers is less frequent than National Grid, as presently we only plan to call against two specific scenarios;

- "Pre-fault" scenarios are where the demand is growing to a level where there is potential for the network to trip;
- "Post-fault" scenarios are where the network is abnormal as a result of a fault and the demand needs to be reduced.

As these customers operate in STOR, they are already contracted to National Grid to provide a response which may conflict with the response we require. We are working with National Grid to amend their standard terms and conditions to allow customers to operate in both markets. We have set up the DSR Forum, where DNOs, Ofgem and National Grid are represented, to discuss this in more detail.

6.7.3 Demand Side Response requests

DSR is managed in two ways, depending on the requirement of the network. For pre-fault scenarios we can schedule the response that we require. We will use load profiles to establish the time that DSR is required and request this in advance from participants. For I&C customers this will be done with a rolling two week notice period. Domestic customers will be scheduled in advance as part of predetermined time of use tariffs. For post-fault scenarios the response will be called for directly from our Control Room. Requests will be made to targeted customers that have agreed to short term demand reductions.

We are at the early stages of DSR so we will initially develop standalone systems to manage requests that we make. For most pre-fault scenarios the requirement will be fulfilled with schedules and tariffs, needing no real time intervention. For post-fault scenarios we will begin with telephone requests and as we make more use of DSR will invest in automated systems. Our long term aim will be to take proven automated systems and merge them into our Network Management System.

6.7.4 Commercial framework for DSR and DSM

The commercial framework for DSR and DSM varies for different customer groups. We will not be in direct contact with domestic customers as they will generally be communicated with via suppliers or other third parties. It is likely that we will aggregate our requirements and trade with the third parties to achieve the required reductions. In our domestic trial we are offering units as low as 2.5p/kWh for agreed reductions (representing around a quarter of a standard tariff).

I&C customers are more likely to be directly contracted to WPD. We will set up a team to deal with I&C customers throughout our area. In our I&C trial we are offering a tariff of £600/MWh for reductions.

6.7.5 Agreement periods and terminations

To provide the security that we require from DSR & DSM systems, we will contract with customers for 12 month periods with the ability by mutual consent to then roll these periods on where there is an ongoing requirement for the service.
To allow customers the ability to opt out of the system, we will allow 3 month terminations at the end of the initial fixed period. We will make the termination available to either party so that we could also terminate if our network changes and the solution is no longer required in a specific area.

6.8 Our plans for smaller scale new innovation projects

Our plans for smaller scale innovation will encompass all of the areas that we have developed in the past. We will continue to refine existing innovative solutions across the whole range of business areas and add new innovations as they arise.

We will continue to develop new ideas from a range of sources, including our own teams, our stakeholders, our customer panel, manufacturers, academia, other DNOs, other industries and international developments. As new ideas are developed, we will review and update our project plans.

The ideas we take forward are chosen to support and improve our performance in the broad areas shown on the table below. These areas feed into our main business output headings and will be used to improve our performance in these areas.

Future smaller scale innovation	Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
SF6 alternatives	✓				✓
Metal theft	✓	✓	✓	✓	
Priority Service Register	✓		✓		
State Estimation		✓		✓	✓
Smart meter data		✓	✓	✓	✓
Power electronics	✓	✓		✓	
Data Analytics	✓	✓	✓	✓	✓
Carbon Tracing			✓		✓
Solar Storage		✓	✓	✓	✓
Sunshine Tariff		✓		✓	✓
Statistical Ratings	✓	✓			✓
Airborne Inspections	✓	✓	✓	✓	

The subjects are detailed below.

6.8.1 SF6 alternatives

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓				✓

Sulphur Hexaflouride is a key gas used to provide insulation in high voltage switchgear. The excellent insulation properties of the gas have helped reduce the size of switchgear, but the environmental impact of the gas is significant as it is a potent greenhouse gas. Alternative insulation methods have been used, such as vacuum, and are now well established at higher voltages. Work continues to develop a solution for distribution voltages and we are very much supporting research. Most recently we have supplied a distribution switch unit for analysis at Cardiff University.

The development of an SF6 alternative will reduce the environmental risk by avoiding the use of SF6 in future switchgear designs. During our normal replacement works, designs using SF6 will be replaced in the same way as oil filled designs have been for many years.

6.8.2 Metal theft

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓	✓	

The theft of metal from our network continues to be a problem whilst the scrap value of metal is high. We are developing a range of initiatives to help prevent and detect theft. We are trialling the monitoring of neutral wire currents to detect theft as it occurs. We are also investigating the analysis of the verdigris on recovered copper to identify the theft location.

This work will help to deter theft, reduce the disruption caused to customers as a consequence and reduce the safety considerations of network assets being left in an unstable state. It will also lead to lower overall costs of repair, which benefits all customers through lower funding requirements.

6.8.3 Priority Service Register (PSR)

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓		✓		

WPD maintains a PSR of customers who are registered as being dependent on electricity due to age, disability or chronic illness. We are looking at further developing ways to help support these customers. We have plans to develop a simple notification system for PSR customers to contact us during a loss of supply. We are also developing a small alternative power supply system for customers who have a requirement to operate certain medical equipment during a loss of supply.

This helps us provide an excellent level of customer service to our PSR customers who, in times of loss of supply, have the greatest need for our help.

6.8.4 State Estimation

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓		✓	✓

As new planning templates are developed through innovation projects like the WPD LV Templates projects, we will work to establish them as standard assumptions throughout our planning systems. With each new project completion or learning outcome, we will refine the templates we use.

Further development of templates will help us optimise the utilisation of our network without the need for expensive monitoring systems, which will reduce costs to customers. Modelling and state estimation allow us more economically operate our network without the need for expensive monitoring systems, which will reduce costs to customers.

6.8.5 Smart meter data

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓	✓	✓

The roll out of smart meters will bring about a step change in the level of data that is available in relation to the utilisation of LV networks. The status of the LV network will be known at all times. A system of data mining will be established to interrogate the raw smart meter data that will help to refine planning templates further.
Further developments will enable us to use the data directly creating bespoke solutions for different part of the network.

6.8.6 Power electronics

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓			✓

The move to an active network with active power flow management has introduced a new range of power electronic devices onto the distribution network. Devices which are being trialled under LCNF projects will be developed into standard solutions. We will work to develop the standards and establish the rules for wider deployment of these solutions.

In all areas of new development, the generation of standards helps manufacturers design systems and products which are appropriate for our network and the other DNOs in the UK. This helps reduce costs through bulk manufacture as all DNOs purchase equipment built to the same UK standards.

6.8.7 Data Analytics

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓	✓	✓

Our projects have clearly demonstrated that network modelling and data processing will be a core capability in the operation of future networks. Our network models need to take into account measurements, estimated values and varying conditions to assess how best to operate the system. Factors such as future load growth, connection of distributed generation and weather conditions will be used to generate results. Flexible solutions such as DSR or storage might then we used to mitigate against any residual risks. New systems will be needed to predict load flows in several future time frames such as hour ahead, day ahead, week ahead, etc.

Key to successfully delivering this new capability is easily accessible and reliable data on our assets, energy flows and commercial arrangements in place with customers. This project will prototype the creation of “adapters” to harmonise data between a DNOs core systems (typically an asset register, a GIS and a control system). Using an international standard called the Common Information Model (CIM). The project will demonstrate the benefits of CIM in the delivery of new systems and capability. It will also create a practical handbook on the application of the Smart Grid Architecture Model (SGAM) being promoted by the Government. This project will establish a platform for analysing data collected from innovation projects. Where significant gaps in data are identified then additional monitoring will be installed. This will be necessary to support the more detailed analysis of network losses as set out in our Losses Strategy.

6.8.8 Carbon Tracing

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
		✓		✓

The project will build on an earlier IFI project to develop a visual representation of energy flows to individual customers homes or businesses. It will produce a user interface as well as controlled access to the back end data to energy suppliers and community groups. The data will be able to show customers the sources of their energy at different times of the day or year. In particular it will show them the proportion of their energy being delivered from renewable sources at the different times.

6.8.9 Solar Storage

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓	✓	✓

Solar Storage will deploy a battery adjacent to one of our customer's solar parks in Somerset. The objective is to measure the performance of the battery and prove how the device could be used to provide benefits to DNOs, National Grid, Energy Suppliers and End users. The allocation of costs and benefits to each of these parties is currently not well understood. Further the optimisation of which services to provide at different times has never been proven.

6.8.10 Sunshine Tariff

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
	✓	✓		✓

Working with a local community group in Wadebridge, Cornwall, this project will assess the viability and customer interest in shift electricity demand to times of excess solar generation output. The network in the Wadebridge area, like many places in the south of the UK, is saturated by solar generation at certain times. The project will demonstrate the potential to avoid network reinforcement by shifting demand consumption through low tariffs, timers and home technology.

6.8.11 Statistical Ratings

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓			✓

The Statistical Ratings project will develop formula and policies to dynamically high voltage rate overhead lines. The project will involve the construction of a test rig and collection of detailed measurement data. This will be a WPD led project but in collaboration will all the DNOs.

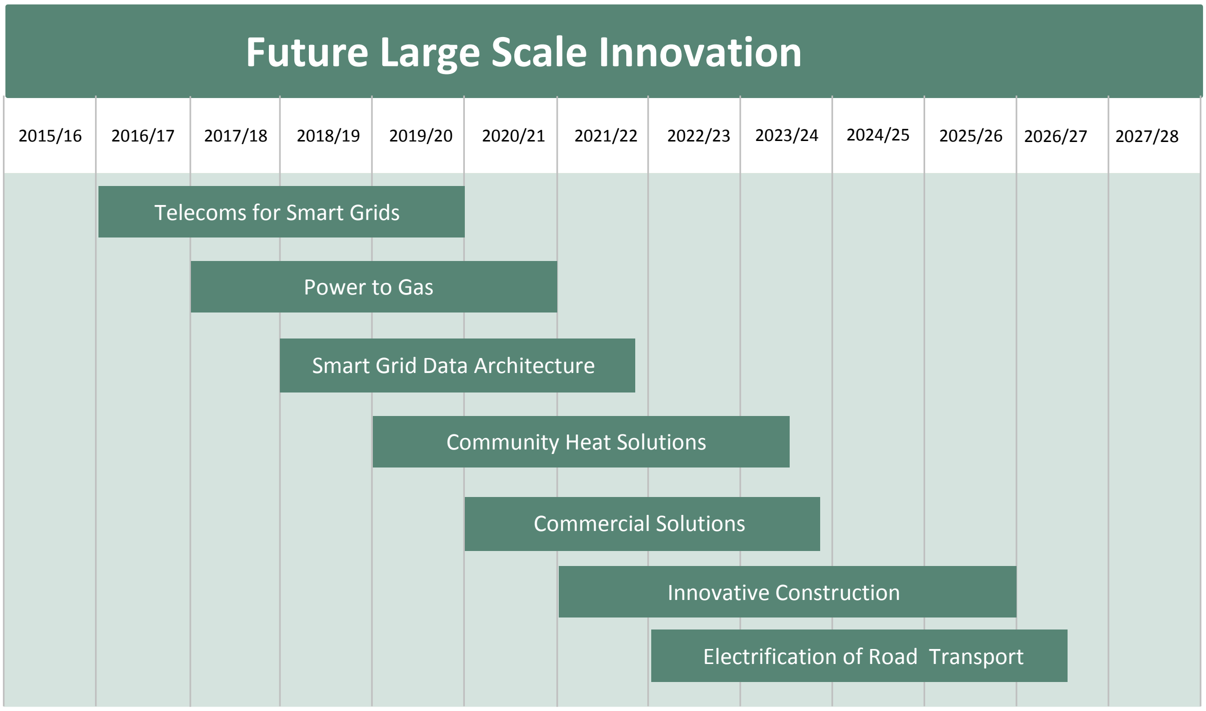
6.8.12 Airborne Inspections

Safety improvement	Cost efficiency improvement	Customer service improvement	Reliability improvement	Environmental improvement
✓	✓	✓	✓	

Significant advances have been made in other industry sectors related to automated image processing and abnormality detection. Taking learning from aerospace and security sectors the Aerial Inspections project will identify benefits of applying similar solutions to the identification of network defects. An earlier IFI project has set out the current status of the current inspection regime and made recommendations for further work. The project will be phased including evaluating data collection options (creation of datasets using multi sensor camera equipment on inspection aircraft), data processing and automated algorithm development. A parallel project will research the use of unmanned aerial vehicles for electricity network inspections.

6.9 Large scale innovation and the Network Innovation Competition

The chart below shows the areas we will explore and develop through the NIC up to the end of RIIO-ED1. Many are still at a conceptual stage and build upon anticipated learning from existing projects. The scope of each project will become clearer as current knowledge learned in WPD and other DNOs is revealed. This may also lead to different projects that have not yet been conceived.



6.9.1 Telecommunications for Smart Grids

Most of the LCNF Tier 2 projects have delivered Smart Grid network solutions but have been less successful at demonstrating appropriate telecommunications solutions to support mass rollout. The requirement for data and control at distribution substations will grow leading to a requirement for many thousands of telecoms end points. A DNO telecoms solution will also need to reach customer equipment such as distributed generation and demand side response. The project will assess alternative technologies and determine their effectiveness against a set of current and future needs. This project will deliver a guide allowing DNOs to select the most appropriate technology for each electricity network application taking into account security, reliability and other factors.

6.9.2 Power to Gas (Electricity and Gas)

There are parts of the electricity network where there is more generation output than can be accommodated. This means that the output of the generation has to be constrained, limiting the low carbon benefits of the generation capacity. Reinforcement of the network often requires the replacement of EHV or 132kV network at high cost.

This project seeks to use the excess generation output to produce hydrogen. The project will demonstrate how the hydrogen can be used as fuel for a gas fired generator, injected into the local gas network or used as a transport fuel. This project will build on development work being carried out in conjunction with Cardiff City Council and the Welsh Assembly Government.

6.9.3 Smart Grid Data Architectures (Designing Using Smart Metering Data and Dynamic Design Solutions)

The transition to smarter networks will be supported by the systems and data that control them. The project all aspects of systems and data integration including how DNOs can adopt the Smart Grid Architecture Model and standardised applications for planning, operations and mapping. Such standards will allow us to easily add metering data and gain control of distributed energy resources.

6.9.4 Community Heat Solutions

The project will explore the development of community CHP solutions as an alternative to the individual installation of heat pumps for customer homes. It will investigate the benefits of building centralised CHP stations and heat networks. The project will also assess the value of integrating waste heat from electricity assets such as transformers. The project is planned to run in parallel with an external project demonstrating heat technologies.

6.9.5 Sustainability and Diversity of Commercial Solutions (Templates is a DSR World)

Existing LCNF projects have shown the usefulness of Demand Side Response and Active Network Management in adjusting electricity profiles deferring network reinforcement. This project will assess the long term ability of these solutions to fully integrate with network investment planning to avoid reinforcement. It will include research into the level of over subscription required and methodologies for dealing with changes to commercial agreements.

6.9.6 Innovative Construction

Leading on from the development of Dynamic Line Ratings this project will look at other ways where technical changes to existing networks can release capacity. Options to be considered will include using alternative nominal voltages and using DC rather than AC for circuits. The project will also investigate innovative solutions such as super conductors. It will investigate alternatives for routes and styles of construction

6.9.7 Electrification of Road Transport (EV as a Storage Medium)

More electric vehicles (EV) are also likely to be used in the latter years of RIIO-ED1. This project will investigate how electric vehicles can be used for energy storage when there is excess generation and used to release the stored energy at times of peak demand to smooth load profiles and potentially defer network reinforcement. It will also look into options for the rapid charging of vehicles and methods to accommodate this on the network. This will build on projects we already have involving wireless charging with OLEV and the Highways Executive.

6.10 Our plans for RIIO-ED2 and beyond

In RIIO-ED2 the transition detailed in the Carbon Plan will be well underway and there will be more certainty over the eventual levels of Low Carbon Technologies. This will help us improve our forecasts for demand growth and distributed generation connections.

By RIIO-ED2 smart meters will have established a new communications link to each customer. Customers will have developed a deeper understanding of their energy consumption and will be more receptive to participating in initiatives that reduce their energy consumption. This will provide future options for more DSR when the volume of LCTs is anticipated to grow further.

By the end of RIIO-ED2 some of the domestic LCTs installed during RIIO-ED1 will be coming towards the end of their useful lives. Future generations of these technologies will provide additional services for customers and by working with manufacturers we will encourage the development of features that will also enhance our ability to manage the network.

Whilst no-one can be certain about the way that electricity usage will develop over this long period, we will continue to review our plans with our stakeholders to ensure that we have the best informed view available. Our plans will remain flexible and we will monitor developments and react appropriately to address changing requirements.

7 Innovation governance arrangements

7.1 Innovation governance

All smart grid innovation projects are delivered as part of the Future Networks Programme. The Programme is the delivery mechanism for the Innovation Strategy detailing ongoing and new projects.

All business innovation projects are delivered from the area of the business that has the specific expertise to also be able to develop the idea.

On an individual basis projects are approved in line with our financial approvals process. All projects and works are subject to the same controls and authorisations as other engineering projects in the business. Tier 1 LCNF and NIA projects are subject to project level approval by the Future Networks Manager. Projects registered in Tier 2 and NIC are subject to project level authorisation by the Operations Director.

Project process is tracked through normal monthly business reporting arrangements. For each LCNF Tier 2 project this includes the preparation of a balanced score card detailing progress against milestones, significant issues and summary financial reporting. All Tier 2 projects have a nominated senior management sponsor and progress review group.

Projects also undergo regular review by the progress review groups of each Tier 2 project and by the Future Networks Manager for Tier 1 projects. Reviews include an assessment of the risks that exist to the overall success of that project. These risk assessments allow appropriate decisions to be made to mitigate their impact.

Innovation projects are delivered in line with regulatory governance requirements and regular reports are provided to review the progress of individual projects against their targets. Six-monthly reviews are made publicly available for all our Tier 2 projects.

IFI projects delivered in line with the G85/2 ENA standard as required by Ofgem will report their closure in the final annual IFI report in July 2015..

Larger projects are managed in accordance with recognised project management methodologies. There is a suite of standard documents and templates which are tailored for the specific requirements of each project.

7.2 Research partners and supplier arrangements

We have links with a wide range of universities, research establishments and manufacturers, both in the UK and across the world (e.g. Hitachi in Japan and the Electric Power Research Institute in the USA).

We monitor UK and worldwide research to identify concepts and developments that may provide benefits to us in the future. We are active members of CIRED, the forum where the international electricity community meets. WPD chairs session 4 (Distributed Energy Resources) of CIRED's technical committee.

To maximise the effect of research and innovation we actively participate in industry wide forums. These forums bring together the best industry knowledge in a cost effective way to pool and manage research which is of use to all DNOs.

Through the ENA, the DNO trade body, we also actively participate in a variety of groups and panels which review and develop industry wide learning. The issues and challenges facing WPD are the same as those for other network operators and we share knowledge wherever possible.

We proactively support knowledge sharing and the development of best practice guides which can benefit the whole industry. It is important that we learn from others and do not spend time or energy duplicating effort on topics which have been well researched. Benefits for the industry and society can be more effectively applied when the specialist experience gained from running innovation projects is shared.

Staff in our Innovation Team review other DNO projects in tandem with their own work to deliver our projects. They become our key contact to other DNO dissemination events and ensure we learn as much as we can from the other projects which are being undertaken. We have allocated one person as the key contact to each other DNO group.

We support research that is led by suppliers and manufacturers and share our knowledge and experience to help them develop solutions. Providing this support enables us to influence the research so that it provides a benefit to us.

We work with UK based Small to Medium Enterprises (SMEs), who are playing an increasingly important role in the delivery of new technologies and solutions.

We also provide feedback on the limitations of existing products so that they can be improved. Partners can also trial products or solutions on our network which generates useful practical experience for the developer and allows WPD to understand how the products can be integrated into existing systems.

Our academic partners enable us to draw on the specific expertise which they have which enables us to cover a wide range of topics and specialisms with people who have in depth knowledge.

Some projects include technology which is not from the electricity industry and we work with partners who might not be obvious choices but provide us with the best resource. We choose product suppliers using our well established procurement systems. We use the Utilities Vendor Database system, Achilles and have worked with Achilles to develop new product codes to cover elements of network innovation.

7.3 Managing risk and future uncertainty

We identify and control project specific and generic (programme wide) risks. Dedicated project management processes periodically review and control risks for individual projects.

Generic innovation risks such as the application of new technology to the distribution network are controlled through close liaison with our Policy Team. This means that new technologies either fit into existing policies and standards or the team develop new policies and standards as a part of the innovation process. The diligence of setting policies at this stage also ensures the long term operation of new technologies by ensuring that new innovations are ready for business as usual deployment at an early stage.

In some cases the risks are associated with uncertainties such as the take up of LCTs or the Low Carbon Transition. Future uncertainty risk is mitigated by regular review of forecasts and identification of tipping points for wider application or a commitment to higher volumes. An example of a tipping point for transport would be a motor manufacturing devoting a whole factory to the production of electric vehicles.

7.4 Tracking benefits

All smart grid projects are regularly reviewed to ensure the benefits they deliver are in line with those predicted at time of approval. Smaller projects such as those delivered under IFI are reported annually in our innovation report. Larger projects report progress including benefits delivery as part of their regular reporting regime.

All projects delivering against our key outputs have their benefit measured against those outputs. For example the benefits of further developing ENMAC mobile will be measured against the output headings of safety improvements, increased cost efficiency, improved customer service and reliability and also environmental improvements. Benefits tracking is carried out at all stages of the project, from initiation to completion.

7.5 Keeping the strategy up to date

Our innovation plan is subject to review to ensure that it continues to provide solutions in line with business requirements. We review our plans with our stakeholders to ensure that we allow them to challenge our proposals and shape what we do. Our plans will remain flexible so that we are able to address changing demands.

External factors will influence our plan and feature as part of the review process. We will take account of results from our trials and other DNO projects. Manufacturers will often develop products through DNO trials and will we assess their suitability for adoption as part of our review process.

Our review will also take into account existing Government incentives and potential changes which may impact on customer behaviour.

The Innovation Strategy is approved annually by the Operations Director.

8 Innovation rollout

We deliver innovation through an in-sourced model with a small team of specialists using the resources of our operational teams to deliver tools or products onto the network. The Innovation Team is part of the company's Policy department where they interact with equipment specifiers and technical experts of the wider business. Once trials are successfully completed, the outputs are taken forward and replicated across our network.

As outputs are delivered, they are developed into new learning that can be taken forward and developed as business as usual. Outputs obtained from other DNO projects are fed into this process to ensure that we gain maximum benefit from innovation projects.

All solutions rolled out from innovation follow the same route as our other policies and techniques introduced into the company. Policies are reviewed by the senior network managers before they are introduced. The rollout process includes implementation plans and, where appropriate, training and dissemination sessions.

We monitor all the projects as they develop and make use of learning and outcomes as they are reported. An example of learning that we have used can be seen in our Tier 1 Community Energy Action project where we are using smart commercial agreements from UKPN's Flexible Plug and Play project rather than developing our own agreements.

Our RPZ1 project developed a practical application for Dynamic Line Ratings (DLR) on our 132kV overhead lines. The project results have been embedded into business as usual and are documented in a dynamic line rating policy.
Our Lincolnshire Low Carbon Hub project developed a practical application of Active Network Management which is part of our Alternative Connections policy suite. Alternative Connections are available to all generation customers seeking a connection where significant reinforcement is required.

9 Outputs

Our Tier 2 projects registered and completed under the Low Carbon Networks Fund have produced a wide range of outputs in the form of standards and specifications which are replicable within the UK electricity industry. In some areas the knowledge has created a requirement for more research and work in a particular area.

Project	Aspect	Policy/Standard	Note	Further work
LV Templates	Connection of PV	Changes to planning tool parameters	Additional diversity added to enable connection of 20% additional PV	
	Energy Saving	11kV Tap Change Control Settings	Tap changer target voltage adjusted to measure impact on consumption and losses	For DECC to assess the potential for broadening of LV statutory voltage thresholds
	Templates	Ten standard substation profiles	Profiles to enable DNOs to model their networks more effectively.	Comparison with results of other LCNF projects.
Low Carbon Hub	Connection of DG	Active Network Management (ANM)	ANM is one of our Alternative Connection solutions which are BAU	
	Voltage Control		Dynamic Voltage Control (DVC) solution prototyped	DVC will be fully developed for BAU as part of Network Equilibrium
	FACTS	FACTS Policies for I&M and Ops		
SoLa BRISTOL	Micro-grid control			
	DC Installations			
FALCON	Engineering Trials	Battery Policies for I&M and Ops at Distribution Substations	Automated Load Transfer, Network Meshing, Dynamic Asset Rating and Energy Storage	
	Commercial Trials		Despatch of Distributed Generation and signalling of demand reduction by I&C customers	Conclusions will feed into business rollout of DSR.
	Telecommunications		Development of Data Network configuration recommendations and evaluation of WIMAX radio links	Conclusions will feed into future Telecommunications for Smart Grids project

Project	Aspect	Policy/Standard	Note	Further work
	Scenario Investment Model (SIM)		The SIM has been developed as a pre-production software system to advise on optimum network designs involving innovative techniques	Relevant aspects of the SIM will be further developed beyond FALCON under NIA and other sources
FLEXDGRID	Modelling	Fault Level Policies for Application and Connection		
	Measurement	Specification for Fault Level Monitors		
	Mitigation	Specification and policies for I&M and Ops for Fault Current Limiters		

10 Knowledge sharing and dissemination

A key feature of the LCNF is the requirement for us, in common with all other DNOs, to share our learning on our projects.

The main annual event for knowledge sharing is the LCNF conference which we actively support, and which we hosted in 2012. We also host specific knowledge dissemination events for individual projects and for our whole portfolio of projects. The audiences for these events are always very broad and include academics, DNOs, Government departments, suppliers, manufacturers and research organisations.

Often the most important thing that we can share from our projects is data and results. We have two dedicated websites where interested parties can find out information on our projects. The www.westernpowerinnovation.co.uk site gives details of all our projects and the results they are producing. The www.lowcarbonuk.com site is aimed more at the research community and provides more details of the output data and results.