SP Energy Networks 2015–2023 Business Plan

Updated March 2014

Annex

Smart Grid Strategy - Creating a Network for the Future

SP Energy Networks

March 2014

SP ENERGY NETWORKS

Smart Grid Strategy

Creating a network for the future

March 2014

Issue Date	Issue No.	Document Owner	Amendment Details
17th March 2014	1.0	Martin Hill – Future Networks Manager	First Issue

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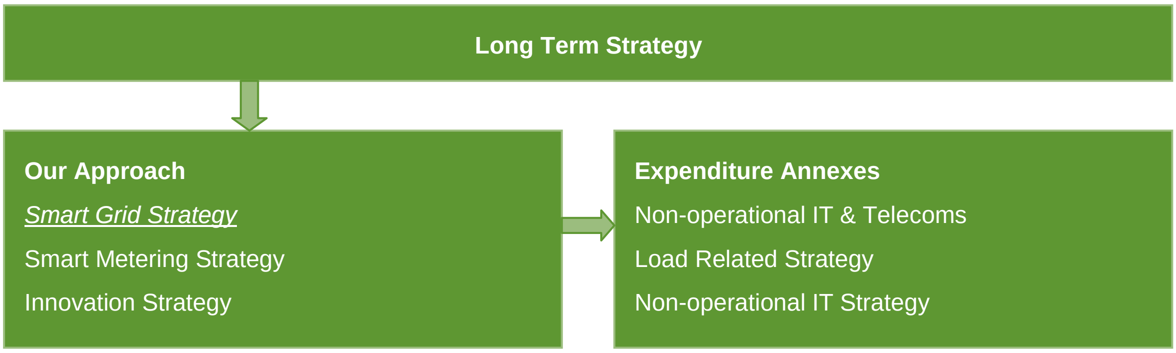
1. Scope

The Smart Grid Strategy is a new document which has been developed for RIIO ED1. This document is closely aligned with a number of other documents within our ED1 Business Plan and pulls together the relevant information from a number of different areas to consolidate our smart grid activity. Our Smart Grid Strategy details our approach to developing our network for the future, in line with our wider Long Term Strategy. This document also links into our Innovation Strategy and Smart Metering Strategy, explains how we will develop new solutions for the future network and how these will form part of our expenditure in the future.



2. Table of linkages

Document	Chapter / Section
SP Energy Networks Business Plan 2015-2023	Chapter C7 – Business Readiness
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Long Term Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C7 – Smart Meter Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C7 – Innovation Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Load Related Investment Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Non-Operational IT and Telecoms Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Operational IT and Telecoms Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes (Confidential)	Annex C6 – LCT Network Monitoring Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Heat pump and energy efficiency scenarios – Frontier Economics
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Transform Model Analysis and Support – EATL
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C7 – RIIO-ED1 Review Project – Smarter Grid Solutions

3. Introduction

The SP Energy Networks Smart Grid Strategy details our vision for a smart energy future that delivers value to our customers, whilst meeting our health, safety, environmental and security requirements. This document details the strategy for the evolution of the network to use new technical and commercial solutions as we respond to the needs for asset renewal, network strengthening to meet new customer requirements, and the changing characteristics of distributed and renewable energy.

We view the smart grid as an end-to-end transformation of the electricity system that applies advances in technology to deliver a range of new benefits to all stakeholders. The smart grid empowers customers, facilitates renewable generation, integrates electric transport and minimises carbon emissions while maintaining and improving system reliability and operational efficiency. We anticipate that investment in smart grid infrastructure will yield additional benefits as the transformation progresses and our customers, policy makers and the industry are able to apply lessons from demonstration projects and achieve the smart grid's full potential. It will also enable us to respond to industry changes that lie ahead, such as taking a new role as a 'Distribution System Operator'.

The Smart Grid Strategy has a number of facets which are detailed in this document and closely linked to other parts of the ED1 Business Plan. For a network to be truly smart, a variety of different components need to be integrated – from smart meters in customers premises, through to the distribution network and how the network interfaces with generators and the Transmission system.

4. Our strategy and future network vision

4.1. Drivers for change

As Britain's dependency on electricity increases over the next decade and beyond, the electricity network will need to be able to evolve and adapt to accommodate these requirements. The low carbon transition will place new pressures on the network as generation becomes increasingly distributed with the uptake of microgeneration, together with the development of more large scale renewable generation sites, whilst we manage an ageing asset base

The end users of electricity will also place new requirements on the electricity network. Over the next decade, it is expected electricity will become a key vector for transportation through the uptake of electric vehicles and other transport systems. Similarly, the dependency on electricity for heating and cooling will increase as new technology such as heat pumps and improved electric heating is adopted, particularly for off gas grid customers of which we have a higher proportion than most DNOs.

This increased dependency on electricity for transportation and heating, as well as general power requirements, will increase customers' expectations of the quality of service that they receive, as we have heard from our stakeholders. Interruptions to supply will have greater consequences and the time to connect new load or generation will be vitally important to allow the uptake of new technology as required by customers, and to fulfil the targets of the government's Carbon Plan. The roll-out of smart meters will also introduce new tariff arrangements for customers including Time of Use and Demand Response. The network will need to be able to facilitate the potential changing usage patterns of customers who participate in these arrangements, whilst also recognising that these tariffs could also offer benefits to the network.

We have used the 4th Carbon Budget from DECC (Department for Energy and Climate Change) and the TRANSFORM Model which was developed by all of the GB DNOs through the Smart Grid Forum, to inform our investment plans. The range of uncertainty over the next decade and beyond is unprecedented and the application of innovation and setting a Smart Grid Strategy is vital to being able to adapt and address the potential scenarios which could unfold.

We are also acutely aware of some of the developments being made in a European context which may affect us. The European Third Energy Package, which entered into force on 3 March 2011 paved the way for a more integrated and competitive energy market across all members of the European Union. These legislative proposals established the requirement for a set of common Network Codes (or rules) to be established to ensure that these markets operated effectively. Once completed these network codes will become European legislation and applicable to all EU Member States on the same basis. As a result the connection and operational codes will have implications for the design and operation of distribution networks and also for those connecting to them. The connection codes as proposed will impose stricter performance requirements on generators and place obligations on distribution network operators to ensure ongoing compliance.

European Commission have also issued Mandate M/490 which requested the three European standardisation organisations (CEN, CENELEC and ETSI) to enhance and develop standards in the field of smart grids. Work is ongoing with these organisations to develop a set of consistent standards across Europe covering such areas as interoperability and Information Security. As these standards groups undertake their work we will need to ensure that the development of smart grids in the UK is compatible with developments in Europe. These requirements will need to be accommodated within our strategy going forward.

4.2. Our future network vision

The Smart Grid Strategy sets out our vision for the electricity network in 2023 and beyond in order for us to be industry leaders in the low carbon transition and to empower our customers to fulfil their role in this journey through the creation of a smarter grid. A smart grid integrates communications, innovative network technologies and services as well as monitoring and control technologies. These techniques provide cost-effective ways of making the network more flexible and reliable. The transition to a smart grid will allow us to become a Distribution System Operator (DSO). The DSO model, as currently being explored in Britain, marks a change in being a traditional (passive) Distribution Network Operator (DNO), to managing the distribution system in real time through a range of services, many of which are commercial in nature such as demand response and generation management for system balancing.

In order to respond to these expectations of the electricity network, our system will require evolving in a number of ways. To achieve a smarter grid, we describe it as having five dimensions:

1. Visibility - Through access to the data from smart meters, we will be able to see and understand the end usage of energy that flows through our system. This will be complemented by monitoring and sensing at strategic points on the network to monitor power flows and asset health. This improved and broader visibility will allow us to better understand the loading on our assets, as well as their health and criticality, thus allowing more informed and timely investment to be made across the full asset base. This will enable asset replacement before failure and reduce the potential risk of interruptions, and optimised network design for new load and generation. Where faults do occur, the visibility of the network will also allow us to respond faster and be more informed of the nature of the problem. This will also allow for losses to be closely monitored and, where possible, minimised.

2. Controllability - Our existing automation capability will be extended to allow a greater control of the network, particularly to new levels such as residential networks. This will provide the advantage of actively managing the flow of power, faster remote restoration of faults and reduced risk to network operatives from having to directly operate live equipment. Power flows will increasingly become two-way as the penetration of distributed generation (DG) increases. Power flows on the network will be directly controllable through the timely deployment of other devices which have been developed as part of our portfolio of research, development and demonstration or adopted from the learning of other DNOs. Such devices include HV Statcoms and voltage regulation.

3. Intelligence - As a result of the improved visibility and control of the network, active management of generation output around network constraints will improve the time required to connect new demand and generation. Wide area monitoring combined with real time asset ratings, will ensure the maximum capacity is utilised before reinforcement is required. Processing of network data will also inform designers of when reinforcement is required and inform the deployment of preferred solutions.

4. Interoperability – The variety of new technologies deployed on the network will require to be interoperable such that new solutions can be readily integrated, for example through the application of technology standards such as IEC61850. We will work with the wider industry nationally and internationally to develop open-access standards. Reliable and secure communication systems will also be required to transfer data across the network combined with IT systems that can effectively

manage the new data that is generated. This will require a significant extension of our communications systems using internal and external services to achieve the necessary coverage.

5. Commercial Mechanisms – Our network will be reliant on commercial arrangements with network users as there are close linkages with many of the technology solutions. We will for example have agreements with customers for demand and generation response to manage load flows during times of peak demand or network constraints. Furthermore, the application of energy storage will provide power reserves which the DNO could access in their capacity as a DSO. Smart metering information will be an enabler for a new interface with the domestic customer. Consumers' network impact will be closely monitored and demand side response will be a widely used tool. Consumers will be incentivised to actively manage peak demand as well as total energy consumption.

To achieve these five dimensions, we consider three different ways in which we invest in the network. These investments can be described as follows:

- *Enablers – this includes smart-ready asset replacement and other investments which create a robust foundation and enabler for the smart grid applications. These are considered as "no regrets" investments which can be deployed in a top-down manner and are an essential component of the network. Having the enabling technology in place will allow us to flex between different future scenarios. Typical enablers are Remote Terminal Units for SCADA with expansion capability and the installation of additional network monitoring.*

- *Applications – this is the implementation of a solution which has an immediate application to directly address an output within ED1 such as meeting load growth, facilitating new customer connections or improving quality of service. Where we have proposed a smart application, a cost benefit analysis (CBA) will be undertaken as in most cases a comparison with a traditional solution can be made. Typical applications are real time thermal ratings, intelligent voltage control or active network management.*

- *Future Proofing – Where a positive business case exists, we will identify where additional enabling technologies are considered to be of long term benefit to customers, although not necessarily required in the short term. This category is also regarded as top-down investment as it is required to further enable other applications in the longer term. Future proofing investments are also subject to a CBA to ensure that they are efficient investments for the customer. Typical future proofing includes oversizing conductors for future load requirements and switchgear being pre-wired for sensors and automation*

The variety of new technology and commercial arrangements deployed on the network are vital to meeting the future requirements of our customers in a responsive and cost-effective way. However, it will be through the effective management and stewardship of the existing asset base that we will ensure value for money and that a sustainable network solution is delivered.

To achieve these features and address the increasing technical and commercial complexity, a whole-systems approach will be required. This will involve coordination between DNOs, the GB System Operator as well as manufacturers and other parties in the supply chain. Integration between these parties is essential to ensure that the system is aligned, without unnecessary duplication, and that the systems used by various parties integrate with each other. An example of this is the data that becomes available from Smart Meters needs to be coherent with the data from network monitoring. These data sources are delivered by different systems and will provide different information, but both need to be coordinated to ensure they inform the operation and design of the network.

4.3. Our strategy for a flexible future network

In developing our Smart Grid Strategy, we have considered an approach which is both flexible and cost effective. A variety of scenarios could emerge in the future due to different uptakes of low carbon technologies and new technology could emerge which we are not currently aware of. The uncertainty which we are trying to accommodate could result in stranded assets if a planned scenario is below our forecast, or cause a delay in our ability to respond if out-turn is greater than forecast. We have addressed this risk by taking a strategic decision to invest in a number of enabling solutions which will provide us with increased visibility and control, regardless of the scenario which emerges.

This approach provides a platform that will be flexible across a variety of scenarios. We can then use smart grid applications as required, depending on which scenario emerges. Taking this approach reduces the long term risk as future applications will be lower cost and faster to deploy, compared with not taking action until the need emerges. We will also align our smart grid investment with asset replacement to avoid duplicate investment.

Our smart grid strategy will be enacted by means of the following five implementation steps:

1. Establish Enablers: Over the course of ED1 we will establish a range of smart grid enablers which will allow for better visibility and control of the network. These enablers are required regardless of the scenario which emerges as they will help to inform us of the impact of LCTs and undertake initial interventions with minimal cost. This includes network monitoring, IT systems for data processing and smart metering data systems. Wherever possible, we will align our smart grid investment with asset replacement to minimise costs. The approach taken to the implementation of these enablers is detailed in **Annex C7 – Smart Meter Strategy – SPEN** and **Annex C6 – LCT Network Monitoring Strategy – SPEN**.

2. Use data proactively: We will draw on the information from these enablers, existing sources of network data and customer intelligence to inform us proactively where further network investment is likely to be required.

3. Maintain a solution choice: Where intervention is identified to accommodate new load, customer connections or asset replacement, we will consider the short and long term impacts on the network to evaluate whether a solution can be deployed to defer investment, or whether a more enduring solution is appropriate. The solutions used are likely to include:

    a. Smart grid applications (e.g. dynamic rating, HV Statcoms),
    b. Smart commercial applications (e.g. generator response, Active Network Management) or;
    c. A conventional solution (e.g. a larger transformer).

    CBAs will be applied to evaluate the value for money, technical feasibility and practicality of a variety of solutions in deciding which solution is optimal in both the short and long term.

4. Identify new opportunities: We will use our company innovation process to identify new solutions which can be used within this strategy, drawing on GB and international Group experience. We will also maintain a watching brief on other projects happening across the industry to adopt the learning where appropriate. (**Annex C7 – Innovation Strategy – SPEN** provides more information.)

5. Utilise econometric modelling: When evaluating a solution, we will consider longer term trends and inform our judgement based on information available as to whether the solution should be future proofed to avoid further costs being incurred. This will involve assessing our confidence in further demand or generation emerging and will use tools available such as TRANSFORM.

The approach described above reflects the findings of the TRANSFORM model analysis which indicates that a selective combination of top down enabling technologies, along with incremental investment is the most cost effective and flexible approach to future scenarios.

The transition to a DSO will also create new commercial opportunities for us. This is envisaged to create more flexibility as we have greater confidence and ability to access a wider variety of commercial mechanisms to support the future network.

4.4. Alternative options considered

We are focussed on doing the right thing for our customers, and believe that making our future network smarter is the best solution in the long term. We have considered various options of how the demands on our network, and the system design could evolve.

A default strategy would be to carry on with a conventional approach to the design and operation of the network; this would result in the use of conventional reinforcement to accommodate low carbon technologies and limited opportunity for operational efficiency or improved customer service. If we were to follow this approach, it is foreseeable that we could hinder the low carbon transition because of the time and technical limits of accommodating new customer requirements. Our modelling shows that in the long term, this approach would cost more for customers. In the development of our Load Related investment plans, we estimate that a conventional approach would have cost almost £40m more than the smart technologies approach we have taken.

A further alternative would be to have used a larger number of smart solutions, making larger investment in the enablers in the short term. Based on the results of the Transform model, this approach would have been more expensive in the short term and brings with it the risk of stranded investments, should the enablers not be used. This approach would also bring with it greater technology risk as some of the solutions are not yet fully proven and we do not have confidence in their long term performance.

This evaluation is continually being informed by the outcome of the various LCNF and IFI projects, as well as business intelligence. As new solutions are developed which we believe are most cost efficient, we will reflect these into our standards and specifications to ensure that they are used. Over the course of ED1, as part of our design and investment appraisal process, we will continue to assess the optimal balance of smart grid solutions, taking into account cost, time and technical risk. Details of the process which we use for this evaluation can be found in Appendix B of this document – Business process for solution adoption.

5. Process

5.1. Engagement with stakeholders

We have used the six priority areas identified by our stakeholders to influence our Smart Grid Strategy:

- *Managing an ageing network – we have aligned our asset replacement with the roll out of Smart Grid enablers where possible.*
- *Improving service to poorly served customers – we will establish smart grid enablers to allow the uptake of LCT without delay.*
- *Investing in storm resilience – our switchgear will be automation ready, helping to improve our response during faults*
- *Improving customer service during power cuts – smart metering systems will help to inform us of faults, and in turn keep customers better informed of what is happening*
- *Reducing the number and duration of power cuts – greater intelligence in the system will help to identify faults faster and reconfigure the network using monitoring and automation.*
- *Preparing the network for low carbon technologies – we have a range of smart grid applications which will minimise cost and time to connect new LCTs.*

Our strategy has also been informed by internal stakeholders - a number of departments from across our business have been involved in IFI and LCNF projects, and this learning has influenced our future plans. Within Iberdrola, we operate a Smart Grid group which has representation from Spain, USA and Brazil and meets on a quarterly basis to discuss progress in our respective countries and exchange experiences.

The development of our Smart Grid Strategy has also been informed by a number of other parties:

- *Other Network Operators: Through collaborative working, attendance at conferences and other events, we have built our approach on the learning and experiences of other Network Operators.*

- *Smart Grid Forum: This forum has allowed a variety of parties to come together and set out the future plans for smart grids. We have gained valuable insight into future thinking across the electricity industry.*

- *Vendors: In order to understand the technical options available, we have engaged with a variety of vendors on an ongoing basis to understand developments which we could utilise. This engagement also helps to inform our future procurement by understanding products that are available in the market place as well as allowing us to provide feedback on future products and services that we may require.*

- *Industry Groups: Involvement with Smart Grid GB, various Demand Response Working groups and the ENA Active Network Management group has allowed for collective discussions on how smart grids may evolve as a result of new services and technology.*

- *European developments: Activity from various European grid groups such as CENELEC and major European smart grid projects has been considered to ensure that we are aligned with other developments. Through Iberdrola, we are represented on a number of European working groups on smart grids.*

5.2. Scenarios we have considered

The Department for Energy and Climate Change (DECC) has published a series of four illustrative scenarios that combine different levels of carbon emissions from different sectors of the economy in order to deliver the 4th Carbon Budget. The process for developing our Smart Grid Strategy has considered the implications of each of these; however our Business Plan is built on our "best view" which has been further informed by additional evidence from historic adoption rates, the views of stakeholders and evidence from further studies which we have commissioned for our network areas.

In these scenarios, the focus is on those areas that have the most potential to contribute to carbon emissions reductions over the fourth budget period, in line with the Government's vision to 2050. The development of a model of the implications of the different scenarios was commissioned by all of the GB DNOs and developed by EA Technology. The model, called TRANSFORM, not only reflects the impact of the different scenarios, but also the different approaches that DNOs can take to address the issue that the scenarios would create. A fundamental component of the TRANSFORM Model is the assumptions associated with the LCTs. The main considerations include:

- *Heat pumps (HP)*

- *Electric Vehicles (EV)*

- *Photovoltaics (PV)*

- *Energy Efficiency (EE)*

- *National Grid "National Policy" Scenarios*

DECC developed low/medium/high forecasts for HP, EV and PV. In addition, Defra's Market Transformation Programme (MTP) provided information on likely future energy efficiency improvements, in terms of "reference", "policy" and "best available technologies". Finally, the TRANSFORM Model takes into account the scenarios analysis carried out by National Grid, looking at the impact of changes in Energy Policy (i.e. in terms of their "Slow Progression", "Gone Green" , etc.).

The Transform Model has four scenarios built into it, which are based on the four main DECC scenarios, each of which represent a different pathway to meeting the Government's 2050 Greenhouse Gas Emissions targets i.e.

1. High abatement in electric heating
2. High abatement in electric transport
3. High abatement in both heating and transport (due to poor energy efficiency improvements)
4. Low uptake of all LCTs, with obligation met through the purchase of carbon credits

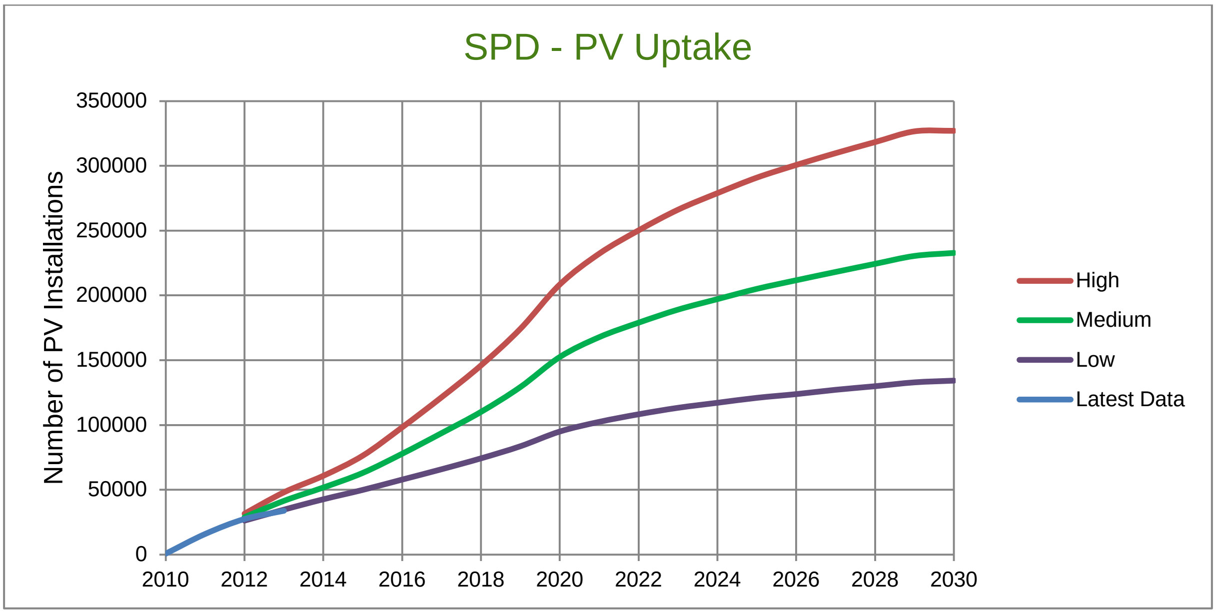
More detail on the Government's policies for the reduction of the UK's greenhouse gas emissions can be found at:https://www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/carbon-budgets.

We considered the four scenarios that DECC envisaged for meeting the UK's greenhouse gas emissions targets to describe an "envelope" of possible future scenarios and as such the most likely scenario would lie somewhere inside this. As part of our stakeholder engagement process, we invited our stakeholders to comment on DECC's forecasts for LCT uptakes. There was little stakeholder support for any of the high scenarios. The accumulated stakeholder view for LCT uptakes was typically in between the low and medium uptake forecasts, with the remainder of the Government's mandatory carbon emissions reduction obligation being made up from the purchase of carbon credits. Additionally, our stakeholders placed a higher emphasis on electric heating over electric transport as the primary mechanism for reducing greenhouse gas emissions. Our original submission in July was therefore based on a low/medium uptake of LCTs. However, when we became aware of the views taken by other DNOs (who were forecasting much lower levels of LCT uptake), we decided to carry out a review of our LCT "best-view".

5.2.1. Photovoltaics

Our review of the assumed scenario for PV found that there is now much better historical data available than at the time we developed our 2013 submission. Whilst we looked at the publicly available DECC Feed-in-Tariff (FiT) data previously, it was then difficult to draw any conclusions on future trends due to the distorting effect of the change in FiT (which caused a rapid increase in connections as customers endeavoured to beat the tariff change deadline, followed by a rapid drop-off in connections volumes once the new tariff was introduced). However, 12 months later, the effect of this tariff change is much less pronounced. The historical FiT data for PV can be compared with the DECC low/medium/high forecasts in Figure 1.

Our analysis has been validated by EA Technology and identifies the low scenario as more likely scenario to materialise than either the medium or high scenarios. By the end of the ED1 period, we anticipate that approximately 224,000 of our 3.5 million customers (about 6.5%) will have PV installed on their homes, resulting in a total of 540MW of PV connected at the domestic level. More information on our assessment of PV uptake can be found in a separate **Annex C6 – Transform Model Analysis and Support – EATL**.



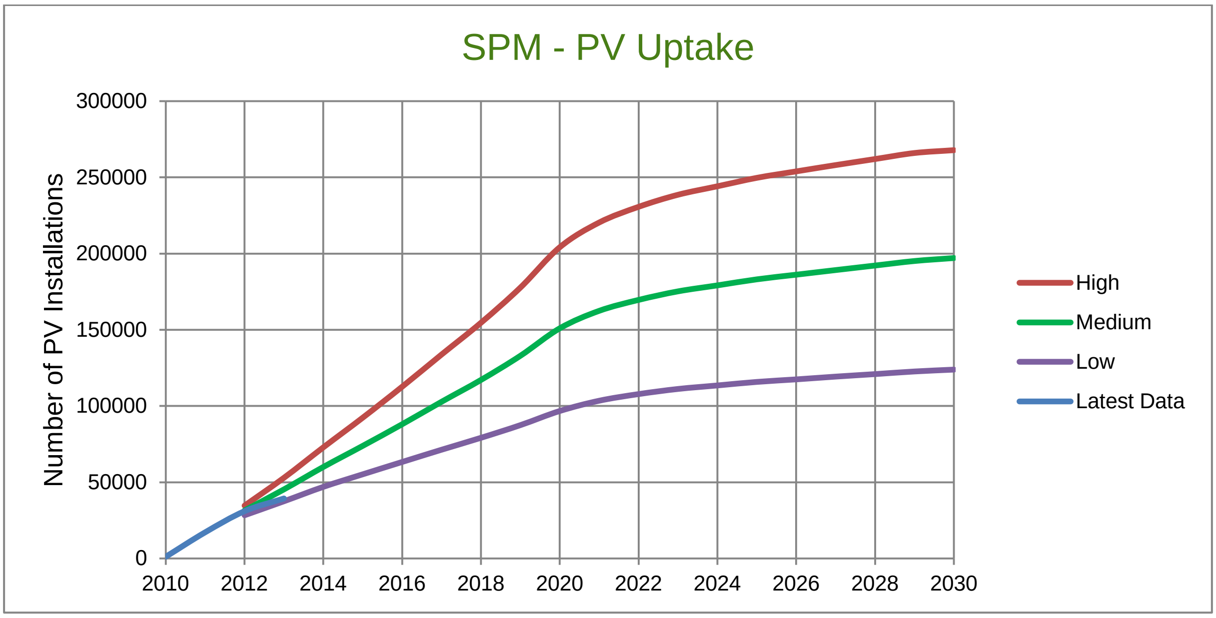


Figure 1: Forecasting PV uptakes by license area

Whilst we have reduced our estimates for domestic-scale PV, we have increased our estimates for large-scale PV which is connected at higher voltages. We have seen a rapid uptake in large-scale connection requests in only the last six months, with individual schemes of up to 50MW being proposed. The largest increase in large-scale PV activity is taking place in Scotland, where it seems that the lower cost of land compensates for the reduced solar yield. We are now forecasting in excess of 1GW of PV generation from solar farms – in line with the National Grid “Gone Green” scenario and our own assessments carried out using the TRANSFORM Model. It should be noted that the National Grid “Gone Green” scenario is used in all but one of the four DECC scenarios therefore we have used this as our best view for large scale PV.

5.2.2. Heat Pumps

The DECC heat pump low/medium/high forecasts contained within the TRANSFORM model were originally formulated for strategic forecasting out to 2050. However, these datasets lose some of their usefulness in the near-term (i.e. in the ED1 2015-2023 period), having a marked step-change in uptake in the beginning with little or no difference between the low/medium/high scenarios in the early years. We therefore commissioned Frontier Economics to undertake a sensitivity analysis around heat pump uptake out to 2030, centred around the key uncertainties in terms of:

i. Government policy on incentives,

ii. fuel and electricity prices, and,

iii. “hassle” costs

The HP forecast for both SPEN licences combined is shown in Figure 2 below.

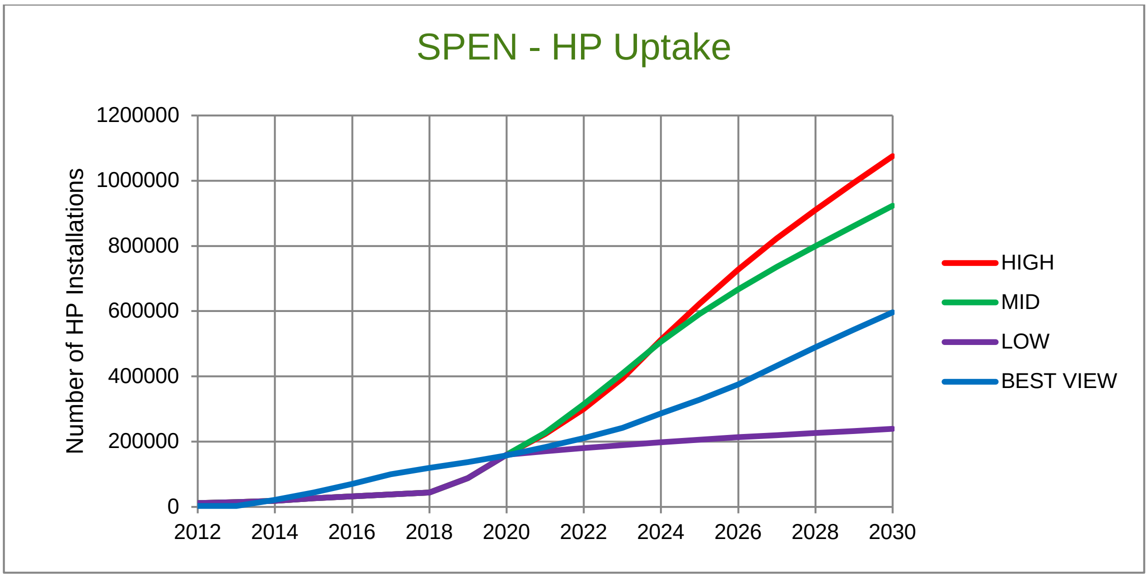


Figure 2 – Uptake of Heat Pumps

We are anticipating an earlier uptake of heat pumps than originally forecast by DECC, triggered by the Renewable Heat Incentive, with early adopters being customers who are off the gas grid (of which SPEN has a higher proportion than the UK average) as well as customers who currently have electric storage or space heating (of which SPEN also has a higher proportion than the UK average). We anticipate that approximately 238,000 of our customers (6.9%) will have heat pumps by the end of ED1. Further information on our heat pump uptake assessment can be found in **Annex C6 – Heat pump and energy efficiency scenarios – Frontier Economics**.

5.2.3. Electric Vehicles

Based on our stakeholder feedback, the uptake of electric vehicles is considered to be less attractive to consumers than the uptake of heat pumps. Therefore, considering the relatively low uptake of heat pumps and the proportionately less impact of EV charging over heat pumps (assuming that EV charging will be predominately carried out overnight), we have aligned our best view of EV uptake with the DECC low. This translates to 90,000 (1.8%) of our customers installing at-home EV chargers. This is also influenced by the geography of our network areas which largely cover rural areas and would indicate a lower propensity to adopting electric vehicles given the current limitations on EV charging.

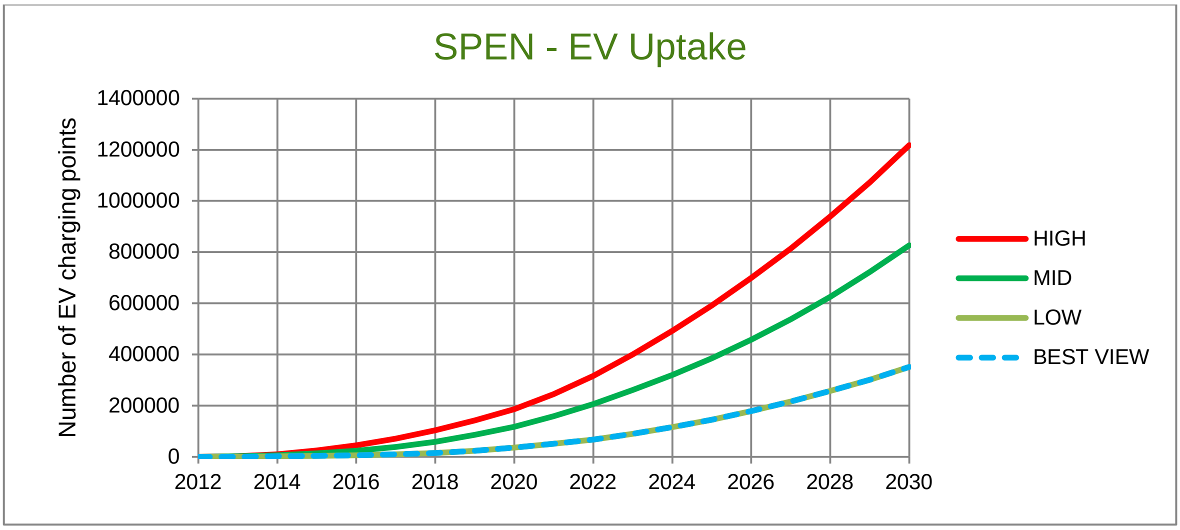


Figure 3 – Uptake of electric Vehicles

5.2.4. Energy Efficiency

We had a fully independent external review of the forecasted energy efficiency gains (as contained within the TRANSFORM Model) carried out by Frontier Economics. The original data was based on the best available data at the time, which was an extensive study carried out by DEFRA, as part of their "Market Transformation Programme" in 2009. Our review found was that actual energy efficiency out-turns tended to lag behind policy targets during the period of the study and today. Therefore, the starting point for energy efficiency improvements, measuring from today onwards required adjustment. Our best view is based on this corrected view of the DECC "policy" assumption for energy efficiency improvements, based on the revised starting point, but assuming the same policy trajectory. We refer to this revised policy curve as the "delayed policy" curve. This replaces the "reference" assumption, which was used in our original business plan submission.

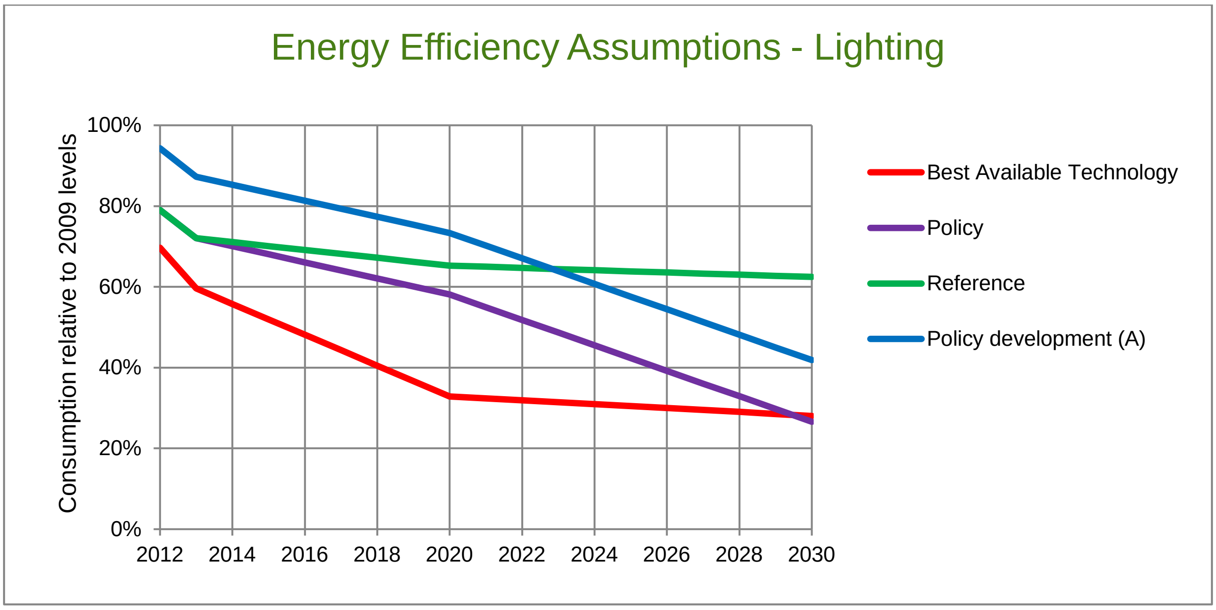


Figure 4a – Energy Efficiency Assumptions - Lighting

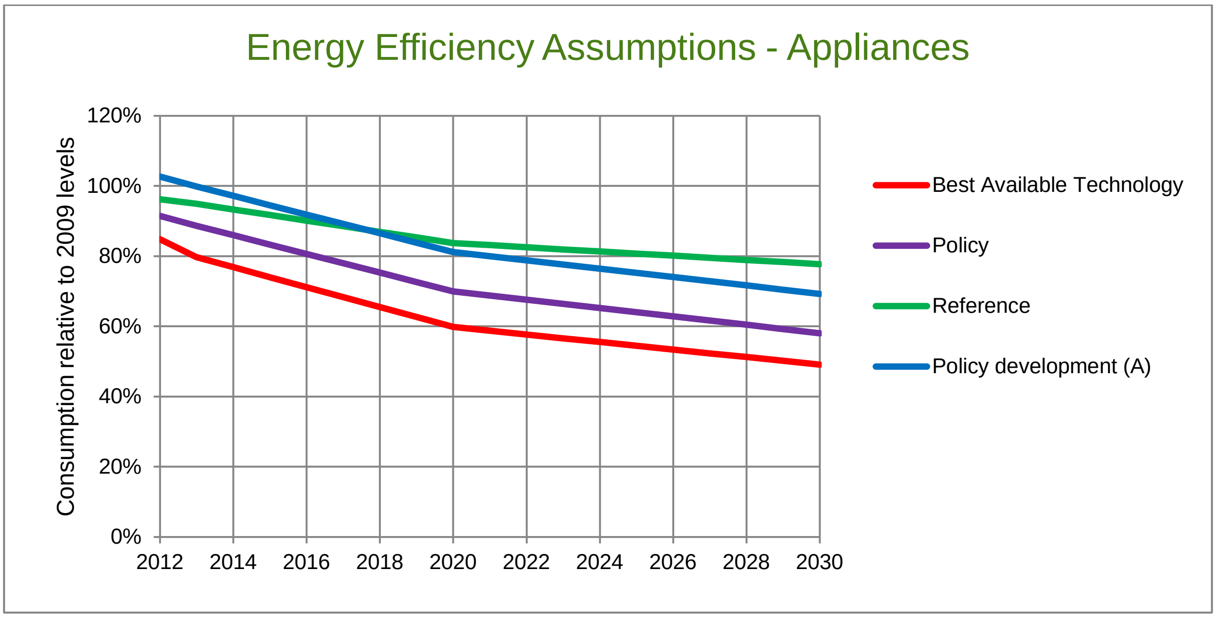


Figure 4b: Energy Efficiency Assumptions - Appliances

Further information on our energy efficiency assessment can be found in **Annex C6 – Heat pump and energy efficiency scenarios – Frontier Economics**.

In summary, the LCT forecast for our resubmission is based on the following:

- *Domestic PV: Low scenario*
- *HV & EHV connected PV: National Grid "Gone Green" scenario*
- *HP: As per the graph above*
- *EV: Low scenario*
- *Energy Efficiency – "delayed policy"*

6. Outputs & long term view

6.1. What this means for customers

The improved availability of network data will enable us to share more information with customers. We will be able to share information on the loading of the network, where constraints exist, and the options available to them through the use of new technology to improve the cost and speed of connecting new load and generation. New commercial arrangements which are already being developed through our LCNF activities will also enable a different relationship – as we move from a 'fit and forget' approach to one of 'connecting and managing'.

Smart Metering will allow us to identify where customers are off supply in real time rather than waiting on them contacting us, thus allowing us to take action to get them back on supply faster. The development of the network and improved asset management will also reduce the number and duration of interruptions to supply. Condition monitoring will allow us to make an intervention with assets before they fail, avoiding an interruption to supply.

The role of cities and communities will also change, with new transportation systems such as trams and electric vehicles having a higher reliance on electricity, as well as new buildings with different technology, and a more 'data rich' society. The network will need to ensure it meets these needs such as the uptake of electric transport, new combined heat and power building systems as well as an expansion of heat networks. All of these will have an impact on our network and require to be accommodated. The Government published its first Community Energy Strategy in 2014. This highlighted that more than 5000 groups in the UK are already working to transform how their community uses energy. The community energy strategy outlines the efforts that are being made to encourage generation projects, heat networks and energy efficiency, all of which are likely to have some form of impact on the electricity network. We have already made significant progress in this area through our support of the village of Ashton Hayes in its move to becoming Carbon Neutral.

In anticipation of long term dependency on electricity, the cost of the network is likely to increase in preparation, but ultimately this investment will pay off as the alternative and innovative solutions that can be deployed reduce the long term investment requirement. We have used a cost benefit approach to considering where these enabling investments are required to ensure that the long term value offsets the initial cost.

6.2. Outputs from our Smart Grid Strategy

6.2.1. Safety

The increase in network automation will progressively reduce the need for staff to manually operate live equipment, thus reducing the risk of injury should the equipment fail as operations can be undertaken remotely. This also has the benefit of reducing the amount of travel required between network sites, reducing the level of road risk, and the cost of network operations, as well as the environmental impact of transport. Through greater monitoring of the power system, we will be able to identify problems before they materialise into a failure. For example, the deployment of fault level monitors allow us to measure fault level in near real time, whereas previously fault level was based on analysis and modelling which would only be undertaken on an infrequent basis due to its complexity.

We also recognise that with the deployment of new technology and operating arrangements, staff will require a different skill set from the engineers and technicians who have worked on the network previously. This brings with it a challenge to ensure we maintain the same high levels of health and safety through effective training that reflects the new technology being deployed.

6.2.2. Reliability and Availability

Increased network visibility, from Smart Meters and substation monitors will help to inform us of the performance of the network, and identify faults faster, and in certain circumstances, before they even occur. This will enable asset replacement before failure and reduce the potential risk of interruptions. Where faults do occur, the improved visibility of the network will also allow us to respond faster and be more informed of the nature of the problem, thus improving reliability and availability of the network, and advice to consumers on restoration times.

Automation will also provide the advantage of actively managing the flow of power allowing for faster remote restoration of faults and reduced risk to network operatives from having to directly operate live equipment.

6.2.3. Environment

New equipment may introduce some additional environmental challenges, such as the chemicals within new technology like energy storage devices; this will be managed through risk assessment and mitigation. Lower loss assets will also be used for asset replacement, which will in turn reduce the amount of energy that the network itself consumes. Conversely, the use of new technology which maximises the utilisation of assets, such as dynamic thermal rating, will unavoidably increase losses as more current is transferred. Albeit losses may increase with the application of some new technology, these solutions avoid the need for constructing new assets. New asset manufacture and installation has an impact on the environment, including the concrete required for civil works, and the visual impact of a new substation or overhead lines.

6.2.4. Connections

Our Smart Grid Strategy is largely built around a flexible approach to facilitating the various scenarios for the additional connection of low carbon technology onto the network. A number of the smart grid application such as Active Network Management and Dynamic Thermal Rating will provide new approaches to connecting customers and these are both lower cost and faster to deploy.

6.2.5. Customer Satisfaction

As with the ‘Reliability and Availability’ output, the information which we can access from Smart Meters, and other network sensors, when combined with additional control will improve the performance of the system and consequently the service received by customers. The associated cost savings will be beneficial in applying downward pressure to customer bills. Similarly, the improvements to the speed and cost of new connections through smart grid applications will provide direct customer benefits.

6.2.6. Social Obligations

Facilitating customers and communities to play their part in the low carbon transition is a key component of our social obligations. Adoption of technology such as Electric Vehicles, Photovoltaics, Heat Pumps and uptake of other energy efficient technology will be customer led and as the DNO we must help to enable these technologies to be connected to our network. Over the course of DPCR5 we have undertaken a number of projects to improve our understanding of the impact of such technology connecting to the network including, Flexible Networks for a low carbon future, Solar PV study on Anglesey and Ashton Hayes Low Carbon Village and will look to continue to replicate our approach from these projects across ED1.

6.3. Long term view

The development of a smart grid will continue beyond ED1 as new solutions and ways of operating develop. Many of the benefits which we have highlighted above will continue in the long term. The most notable transition will be the move towards a DSO. Movement towards the DSO model would result in a fundamentally different approach to how the distribution networks are operated and designed. Such a model will have greater emphasis on commercial solutions and will involve a wider role of balancing generation, demand and storage in the distribution network. This could involve demand side response, voltage management, energy storage and load management during faults. These services could be used to actively manage the network by locally changing demand and generation patterns as required by the network. It may also be possible to trade these services with the Transmission System Operator. For example, the aggregation of localised demand response, or the proactive management of voltage could be used for balancing services. We will also continue to use the various innovation mechanisms available, and our Innovation Strategy will ensure that we consider short, medium and long term objectives.

7. Our smart grid roadmap

7.1. Our starting point

Throughout DPCR5, we have been laying the foundation by establishing a number of the enabling solutions for a smarter grid. To date we have built on a number of key dimensions, as outlined earlier:

Dimension	DPCR5 Activities to date
Visibility	• Increased monitoring at key HV substations to increase understanding of the network and identification of faults faster at 20% of primary substations. • Remote access of OHL autoreclosers to retrieve system performance data. • Development of enhanced GIS capability which allows for the presentation of heat maps for customers to understand network constraints .
Controllability	• Almost 100% of Primary substations have basic telecommunication coverage which provides basic SCADA access for visibility and control. • 30% of the 11kV network has automation which is prioritised to the least reliable circuits and those with the most customers connected. • Installation and evaluation of regulators to manage customer voltages in rural areas.
Intelligence	• Our Network Management System was refreshed in DPCR5 and provides additional functionality such as logical sequence switching to enhance intelligent network automation. • We have developed our NMS to be capable of managing dynamic thermal rating which we will be employing in ED1 as a smart solution to reinforcement.
Interoperability	• Initial integration of solutions including automation and voltage regulation such that the communications infrastructure is interoperable with different end devices. • Initial deployment of IEC 61850 (substation protocol)
Commercial Mechanisms	• Active Network Management of generation customers is being developed and demonstrated through our LCNF Project – ARC. • Application of fault initiated demand response in North Wales. This has been used as a solution for a new Industrial customer as part of our connection offer to reduce the reinforcement costs.

A number of our investments related to automation, telecoms, SCADA and IT have been designed with future smart grid requirements in mind so that separate investment only for smart grid is not required. This ensures that costs are kept as low as possible for customers in the short and long term.

The unique configuration of the SP Manweb network also provides some of the qualities of a smart grid including a meshed configuration which reduces the number of interruptions that customers experience and offers higher utilisation of its assets. The SP Manweb network is designed differently from most other distribution networks as the LV and HV networks are generally fully meshed, particularly in urban areas, opposed to a radial design which most others use. This is a legacy design, but it is now being recognised by other network operators of the benefits that this design offers and is starting to be replicated using more modern control and protection arrangements.

7.2. Smart grid within our Business Plan

Investment in smart grids is embedded across our business plan. It is not possible to directly identify all investments which could be regarded as 'smart grid' as this is now our normal approach to designing and operating the network. Within this section we highlight some of our notable investments which aid the development of a smart grid, and particularly the specific smart grid applications.

7.2.1. Smart Grid Enablers

Most of the enabling investments are embedded within our asset replacement and load related investment plans. In particular, a number of enabling technologies form part of our Operational IT and Telecoms, non-Operational IT and Load related expenditure.

One example is our RTU replacement programme. The main drivers for the replacement of RTUs are obsolescence and associated support issues. The existing RTUs communicate using bespoke protocols and are limited in their capacity to monitor and control additional plant and in their ability to integrate with other substation devices. This is an essential asset replacement programme but has been specified with a smarter grid in mind as it is a key enabler to facilitating a number of our smart grid applications. Replacement RTUs will be interoperable and capable of supporting the most common industry protocols and international standards as this will help ensure that the assets can be supported for the longest period possible and will reduce the risks associated with supplier dependency. The move to industry standard RTUs also opens up valuable possibilities for more advanced control of the network. With standardisation and interoperability, complex control and automation schemes can be integrated into the control system. Without the move to modern protocols, the control system's potential to evolve and flex to meet changing network demands would be extremely limited.

We have also included enabling projects within our load related investment where we believe that this enabler is primarily for the benefit of load/generation growth. The most notable enabler within the load related plans is the Voltage Control Relay Enhancement Programme. This project aims to enhance the functionality of the existing voltage control regime by extending the controllability of the voltage control relays (e.g. voltage set point) at both Primary and Grid substation sites via the Control Room. This enhancement will enable the network to be operated more flexibly in response to network need. An additional benefit of this project is the reduction in customer energy use.

A summary table of some of the notable enablers is shown below:

Enablers	Funding Area	Smart Grid Dimensions
RTU replacement	Operational IT and Telecoms	Interoperability – New RTUs will be interoperable with multiple devices and will avoid vendor lock-in. Intelligence – Ability to interface with a variety of intelligent electronic devices within the substation.
Telecoms upgrades	Operational IT and Telecoms	Interoperability – additional bandwidth through our planned telecoms upgrades will allow communication with multiple new devices in the field
Voltage control	Operational IT and Telecoms (where asset replacement is required) Reinforcement (where this is not for asset replacement)	Controllability – Control of system voltage set points in real time to manage voltage constraints in real time.
LV Monitoring	Reinforcement	Visibility – Monitoring of the LV network will allow for improved understanding of network operation and is a key enabler for smart grid applications.
Smart Metering IT systems	Smart Metering	Intelligence – A number of core IT systems are require to add the intelligence to the vast amount of data and alarms that will be received from smart metering.
Smart Grid IT	Non-operational IT	Intelligence –Non-operational IT systems are required to process the data acquired from network monitors and other devices to analyse and add intelligence. Visibility – Development of our GIS system and other data management to present information to users.

These enablers are embedded within our plan and will build a foundation for ED1 and beyond. They are not dependent on the uptake of low carbon technology or other changes to the network. Without the timely investment in these enablers, smart grid applications will be hindered resulting in greater cost to customers.

We are confident that the volume of enablers which we have forecast will give us sufficient coverage in ED1. Our projections on the programme for the deployment align with the projected uptake and clustering impact. For example – we are planning to deploy around 1,300 substation monitors; this should allow us to monitor the majority of LCT clusters that we are anticipating in our forecasts. Should these volumes be higher, we expect these to be clustered and as such this coverage would still provide the necessary visibility. Further information on our strategy for deploying monitoring is detailed in **Annex C6 – LCT Network Monitoring Strategy – SPEN**. The executive summary of the monitoring strategy is included in Appendix A of this document.

7.2.2. Smart Grid Applications

Across our plan, we have applied smart grid solutions to reduce costs to customers and offer better service. Most of these applications are detailed within our Load Related investment and are applied for the uptake up Low Carbon Technology as well as general reinforcement. We undertook a robust process to evaluate where smart grid solutions could be applied by reviewing all of our major reinforcement projects. This evaluation was overseen by an independent organisation, Smarter Grid Solutions Ltd, to ensure that a broader experience was available and to bring objectivity in the evaluation. Through this process, approximately 10% of our schemes were reviewed to reflect alternative solutions. Some of the solutions applied include – phase shifting transformers, HV Statcoms, Automation schemes for transferring load and dynamic thermal ratings. The full report by Smarter Grid Solutions Ltd is included in **Annex C7 – RIIO-ED1 Review Project – Smarter Grid Solutions**.

We have also used the Transform model to inform our Reinforcement investment for the uptake of Low Carbon Technologies. The Transform model considers a number of smart grid interventions to accommodate LCT uptake and we have used the results from this to inform some of the solutions we apply. The table below details some of the notable smart grid applications, where these are detailed within our plan and the benefits that they offer.

A large proportion of our reinforcement schemes have be analysed using a cost benefit approach as well as a technical review to identify the preferred option. In most instances this has considered a smart versus conventional option where that would be feasible.

Applications	Funding Source	Smart Grid Dimensions
Generator providing network support	Reinforcement (LCT)	Commercial Mechanisms – we will engage with customers who have access to dispatchable generation to provide localised support as an alternative to reinforcement.
Temporary meshing	Reinforcement (LCT)	Controllability – use of automation to reconfigure the network and create additional capacity for short periods of time.
Real-time thermal rating	Reinforcement (LCT) and General Reinforcement	Visibility, Controllability and Intelligence – through visibility of circuit loading and the ability to control power flows, we will be able to make informed judgements on the real time ratings of circuits to maximise the capacity and reduce the need for reinforcement.
Phase shifting transformer	General Reinforcement	Controllability – A PST offers the ability to interconnect two groups which are normally out of phase by accommodating the difference in phase angle and managing power flows.
HV Statcoms	General Reinforcement	Controllability – The use of power electronics to control reactive power will provide an innovative alternative to reinforcement for voltage constraints.
Active Network Management	Reinforcement (LCT) and Customer Connections	Intelligence – combining real time monitoring of generation and network constraints we will facilitate new generation of different scales, some of which will be funded by customers. Commercial Mechanisms – ANM will require a commercial framework to govern its operation in return for faster and lower cost connections.

7.2.3. Future Proofing for Smart Grid

Where a positive business case is found, we have identified additional enabling technologies that would be of long term benefit to customers, while not necessarily required in the short term. There are only a few instances where this is proposed as any investment ahead of need requires a strong justification. Where included it is due to a small additional cost for extra future proofing compared to the cost or re-visiting at a later date, which will have a higher overhead and may require an interruption to supply. Should we identify other opportunities for future proofing over the course of ED1, we will look to use the Innovation Rollout Mechanism as a means to fund this additional cost.

It is a formal consideration of our design process to consider the longer term requirements of the network and our Design Manual outlines a number of considerations for future proofing including:

- *Fault Locators – deployment of this equipment has proved to be successful on long single 33kV circuits to provide advance warning of fault conditions.*

- *Disturbance Monitor – as for transmission substations, the Disturbance Monitor will record busbar voltage, load current on the substation, tripping battery current and voltage with similar functionality and configuration to that detailed above.*

- *Operating Switch Actuators – in order that secondary substations are automation ready, the 11kV switchgear should either be inherently remotely controllable (i.e. circuit breakers) or actuators should always be installed on ring main type equipment.*

- *Secondary Substation Communications – if an 11kV substation monitoring system does not have inherent communication functionality, GPRS communication should be established where required. Otherwise, the installation should be so constructed so to easily facilitate future GPRS installations.*

Some examples of where our policies now reflect future proofing is detailed in the table below:

Future Proofing	Funding Source	Smart Grid Dimensions
Automation ready switchgear	11kV switchgear asset replacement	Controllability – All new switchgear will be capable of being automated when it is required. this will then allow for actuators and communication links to be established at a later date when the automation is required.
Fault Level monitoring	General Reinforcement	Visibility – we will deploy a number of fault level monitors to analyse system fault level in order to provide a leading indicator of where fault level issues may arise and to understand the dynamic nature of the fault level.

7.3. Embedding innovation into our plans

DPCR5 has seen a level of unprecedented investment in R&D and innovation as a result of the Innovation Funding Incentive (IFI) and Low Carbon Network Fund (LCNF). Over the course of DPCR5 we are forecasting to spend more than £20m on innovation projects through these two mechanisms alone. The summary table below indicates how some of the most notable LCNF and IFI projects have helped to inform our smart grid plans for ED1. We also recognise the work of other DNOs and have made reference to these in the tables below.

Project Title	Scope	Influence in ED1
Flexible Networks for a Low Carbon Future (SPEN - Tier 2)	Deployment of network monitoring and a number of interventions such as Dynamic Thermal Rating, automation and voltage regulation to create 20% capacity headroom.	Through the deployment of monitoring we have been able to assess the value of secondary substation monitoring. It has also allowed for the further development of DTR of primary transformers and 33kV OHLs as a solution which we will deploy.
Accelerating renewable Connections (SPEN - Tier 2)	Development of Active Network Management across the DNO/TSO interface and management of community energy.	Active Network Management will be rolled out over the course of ED1 to allow customers to connect faster. This will include the learning from ARC such as how we manage the impact on exporting GSPs.
Implementation of Real Time Thermal Ratings (SPEN - Tier 1)	Dynamic Thermal Rating of 132kV overhead circuit in North Wales demonstrated the ability to increase the circuit capacity and thus defer the need to construct further circuits.	We are adopting DTR as a solution to avoid reinforcement through constructing new circuits. This is detailed within our general reinforcement plans and is cost efficient.
Hydro Generation and Active Network Management (SPEN - Tier 1)	Development of a local management system for voltage which interfaces with distributed generation.	We have already built on this by offering connections using the approach which have developed in this project and will increasingly do so in ED1 to minimise the need for customer initiated reinforcement.
Fault Level Monitoring (SPEN – IFI)	We have developed a fault level monitor with Outram Ltd which is now proven to provide a reliable and accurate measurement of Fault Level. This is one of the first cost efficient devices to be able to make such a measurement.	We will use fault level monitoring to manage sites which are subject to fault level constraints, and also as verification for investment. Fault level monitoring allows for the network to be reconfigured to increase network security where modelling has otherwise estimated a problem could occur.
Voltage Control System (WPD – Tier 1)	WPD have demonstrated the use of HV-Statcoms on the 11kV network as an alternative to reinforcement for voltage issues. This project identified some of the challenges of integrating with protection schemes.	The use of voltage regulators and HV-Statcoms is included within our load related investment as an alternative means of voltage initiated reinforcement. We are currently examining the first application of this device on our network as part of DPCR5 reinforcement.
Distribution network visibility (UKPN – Tier 1)	This project has evaluated a number of different solutions for monitoring the LV network.	We have considered the learning from this project and others which have tested monitoring solutions in the development of our plans for network monitoring. We will also use the findings in the procurement process for the technology.
LV Templates (WPD – Tier 1)	The development of a series of LV templates which can help to inform the design of the LV network.	WPD have reviewed some templates based on our own experiences and we will use this in future LV design.
Low Carbon London/C2C/ FALCON (UKPN/ ENW/ WP –Tier 2)	The development of commercial arrangements with customers to offer generator and demand side response is being developed in a number of projects.	We will use the arrangements being developed in these projects to allow generator assistance in supporting the network.

We will continue to use the various innovation funding mechanisms throughout ED1 to develop and increase our confidence in new smart grid applications. Our Innovation Strategy sets out the particular areas of focus that will help us achieve our future network vision and deliver value to customers. We will also continue to work closely, collaborating where possible, with other parties to ensure we are accessing all available learning.

7.4. Learning from outwith SPEN

Our future network does not only build on the learning from LCNF and IFI, but also other experiences from within the Iberdrola Group. We often regard the Transmission system as being a smart grid and the process we are now going through is extending many of the concepts into the distribution network. We have the benefit of being able to transfer some of our experiences of SP Transmission into our solutions that we have used in Distribution. This is particularly relevant to the 132kV network which is classified as Transmission in Scotland, and Distribution in Manweb. SPT have made major progress in the adoption of IEC61850 as the normal substation protocol for communicating between equipment and providing open-access. We are using our experience of this deployment in SPT to inform our future design to ensure new equipment is interoperable and that vendor choice is maximised.

Within the Iberdrola Group, we have also been informed by the experiences of smart meter deployment and the network monitoring in Spain and the USA. Iberdrola has an extensive roll out of smart meters in both of these countries and we have taken the opportunity to understand the approach they have taken to both operational and non-operational IT systems to inform our smart grid plans. Iberdrola also has significant experience of R&D projects, investing €159m in 2013, a 10% increase on the previous year. A further example of where we will use this experience is the R&D activity undertaken by Iberdrola on the integration of Electric Vehicles (The GREEN, MUGIELEC and DISPENSER Projects) which we can draw upon to help inform the solutions we use to accommodate EV uptake.

8. Implementation

Across our Business Plan we have detailed the steps we have taken to prepare the business for the implementation of our plan which includes the Future Network Strategy. More specifically, the following references provide more information:

- ***Annex C7 – Innovation Strategy – SPEN*** *– details our Innovation activity which will contribute to the ongoing development of our Future Network. Our Innovation Strategy also details the process which we follow to embed innovation into our business as usual processes.*

- ***Annex C6 – Load Related Investment Strategy – SPEN*** *– details the scenarios which we have used and other processes which underpin our approach to the design of the network to accommodate load growth.*

- ***Chapter C7 - Business Readiness*** *– details our resourcing strategy for ED1 and the up-skilling which is required, part of which will be to train staff in smart grid solutions.*

8.1. Selection process for smart versus conventional approach

When considering the use of new solutions within our plans, we have assessed our confidence in the solution to deliver the expected benefits. Where we do not have sufficient confidence, these solutions are identified within **Annex C7 – Innovation Strategy – SPEN** for further development. Examples of this include demand side response, fault current limiters and energy storage. At present we do not have sufficient confidence, nor believe that they are economic to include them within our smart grid applications, but we note their potential for the future. Should the risks and costs associated with these solutions reduce to a point where we are confident in using them, we will re-evaluate the solution being used.

Appendix A shows our approach for evaluating where smart gird solutions are applied within our normal design process. This appendix also details the internal review process we undertake to assess new solutions for adoption into policy.

Investment in enablers and future proofing is also an important element in the development of the network. Our approach is to align asset replacement with the roll out of smart grid enablers as far as possible. For example in ED1 we are undertaking a significant replacement programme of RTUs in primary substations and in developing the specification for their replacement, consideration was given to the longer term requirements of these assets. This approach means we consider additional functionality with the replacement to ensure that they are fit for smart grid applications. This approach keeps cost lower as the replacement is fit for future applications rather than only providing a like-for-like replacement which may subsequently require replacement when any other new technology is installed in the substation. The evaluation of this approach is subject to an economic evaluation as well as technical to ensure that the risk of funding stranded assets is minimised.

Where new enablers or future proofing is identified through innovation activity, and cannot be aligned with asset replacement, such as the voltage control replacement programme which we have planned for ED1, this will be subject to a CBA to evaluate the benefits. Details of the CBA which we undertook for the voltage control replacement programme can be found within **Annex C6 – Cost Benefit Analysis – SPEN**. Further information on the cost benefit process is detailed below.

8.2. Economic evaluation of solutions

Across our Load Related plans, we have reduced costs of reinforcing the network by £39m. These savings have been as a result of using smart solutions rather than conventional solutions based on the process outlined above. In addition to the capital savings, we have also undertaken a Cost Benefit Analysis to evaluate the full life costs of solutions. The use of smart solutions can offer a deferment of major investment; however this can bring with it higher ongoing opex, and a shorter lifespan of the solution. The lifetime costs and benefits have been evaluated in our analysis to ensure that lower capital costs do not create higher lifetime costs.

The table below provides a summary of some of the schemes which we have evaluated with this approach which details the savings we have achieved from using innovative technology compared to the conventional approach. Full details are included within **Annex C6 – Cost Benefit Analysis – SPEN**.

License	Scheme	Conventional CAPEX (£m)	Smart CAPEX (£m)	CAPEX Saving (£m)	Solution selected
SPM	Crewe Reinforcement	20.44	7.02	13.42	Phase Shifting Transformer
SPD	Langside Reinforcement	3.90	0.50	3.40	Use of network automation to move loads
SPM	Chester FL Reinforcement	3.40	1.05	2.35	Use of monitoring and control schemes to manage load
SPM	Tarvin TX Reinforcement Upgrade	0.91	0.06	0.85	Real Time Thermal Rating to be applied to primary transformers
SPM	Coedpoeth TX Reinforcement Upgrade	0.25	0.05	0.20	Real Time Thermal Rating to be applied to primary transformers
SPM	Graig Fawr TX Reinforcement Upgrade	0.25	0.05	0.20	Real Time Thermal Rating to be applied to primary transformers
SPD	LCT Reinforcement - SPD	16.90	10.10	6.80	Various Smart Solutions as evaluated by the TRANSFORM model
SPM	LCT Reinforcement - SPM	15.50	13.60	1.90	Various Smart Solutions as evaluated by the TRANSFORM model

SPD	Stranraer - Voltage	4.22	2.50	1.72	Application of HV Stat coms
SPD	Lockerbie - Voltage	5.01	3.50	1.51	Application of HV Stat coms
SPD	Langholm - Voltage	7.14	3.80	3.34	Application of HV Stat coms
SPD	Girvan - Voltage	4.48	2.10	2.38	Application of HV Stat coms
SPD	Berwick Ring - Voltage	5.33	3.96	1.37	Application of HV Stat coms
	Total	**87.73**	**48.29**	**39.44**	

8.3. Business readiness

As our network evolves, the skills of our staff and contractors will also need to adapt to accommodate the new solutions which are being applied on the network. An increase in smart grid enablers such as IT, telecoms and control systems will require staff to have a greater knowledge of what was previously limited to standard protection and SCADA equipment. Similarly, project managers and network designers will also need to be trained on new solutions which become available such that they can be applied as part of business as usual. This increasing complexity will be addressed by up-skilling of existing staff as many of the same fundamental principles of the operation of the network will still apply. We expect that the development of new solutions which are faster and lower cost to deploy will also help with ongoing business efficiency.

In preparation for this, we have built a Future Networks team over the last 4 years which is responsible for the development of new technology solutions. We will use this team to not only develop new solutions, but also to increase the skills of the staff in that team which can then be transferred into the business as they move into new posts and other staff replace them. We believe it is important to grow our skills base progressively.

Our readiness is also dependant on the readiness of a wide variety of contractors, consultants and suppliers that we use. We have held a number of workshops over the last 12 months with our supply chain to keep them informed of our plans, and to ensure that they can support us. We have received some useful feedback from these sessions including how we can share the benefits from innovation as well as how we can become a better customer for mutual advantage. As we roll out new technology, we will be engaging with a number of new suppliers of services, including SMEs as well as large vendors. We have built a strong relationship with many of these organisations through development projects undertaken through IFI and LCNF projects, and will need to continue this into business as usual in ED1. Through a number of projects we have used a collaborative approach to developing new solutions. Further information on our collaboration can be found within the Innovation Strategy. Our Innovation Strategy also details the process which we use to identify new problems which need to be addressed, new potential solutions and how we develop these until they can be implemented into policy and adopted by the wider business.

9. Appendix A

9.1. LCT Network Monitoring Strategy – Executive Summary

A robust and cost-effective LCT monitoring strategy has been developed to support the SPEN RIIO-ED1 Business Plan submission. This details our approach to proactively identifying, monitoring and responding to the future growth of low carbon technology (LCT) on the LV network.

SPEN's vision in the long term is to have wide scale visibility and more automated analysis of our low voltage network. As technology develops, this is likely to become economically viable and will be progressed when the investment required reaches a level that would provide best value to our customers.

LV monitoring is a key deliverable under the 'Visibility' dimension of the SPEN Smart Grid Strategy. The outputs of this monitoring strategy will also support the SPEN Load Related Strategy and improve general understanding of the current behaviour of the network.

Step 1: A common database for all network data

The GIS database system will provide the underlying architecture for automated analysis and reporting processes defined in the monitoring strategy. This will ultimately provide ease of data access, analysis and improved consistency of data across the business. We will integrate network monitoring data with other sources including smart metering.

Step 2: Early Identification of LCTs on the Network

LCT uptake will be identified through analysis of existing data sources such as LV connections data, primary and secondary substation data, and asset management data. This approach recognises that data sources may not be complete and that by linking and correlating multiple data sources, sensitivity to missing or uncertain data is reduced.

Analysis of uptake figures and loading trends on the network will enable identification of LCT hotspots on the distribution network down to the LV feeder level. This will include a simple, automated analysis of loading and voltage along the LV feeder where an LCT hotspot has been identified.

Step 3: Deployment of LV Monitoring on the Network

LV monitoring will be deployed to better understand LV feeder loading characteristics and trends due to LCT uptake and to optimise selection and deployment of network solutions. The decision criteria for when and where to deploy LV network monitoring will be based on an improved understanding of LCT and LV network characteristics. Learning outcomes from the SPEN Tier 2 LCNF Flexible Networks project and other innovation projects will be incorporated into the decision tool.

The impact on the HV network will be assessed based on an aggregation of LCT uptake on LV feeders, analysis of LV and HV monitoring data and detailed modelling where required. The scale of detailed modelling at HV is expected to be limited.

Step 4: Intervention Strategy

Monitoring the LV network in areas of rapid LCT growth will enable better quantification of remaining network capacity and optimisation of network solutions. Interventions to address thermal and/or voltage issues include:

- *Primary substation voltage control in order to facilitate dynamic voltage settings.*
- *Installation of voltage regulators to manage resultant in voltage legroom issues along HV feeders*
- *Dynamic thermal ratings*

- *Installation of additional transformer capacity*

- *Splitting of HV/LV feeders.*

Domestic EV charging will require tariff lead constraints to minimise the potential impact on the LV network.

9.1.1. Benefit to Customers

The key benefit to customers results from the overall improved network performance as a result of timely interventions and the optimal selection of reinforcement solutions. This will be reflected in:

- A reduction in customer complaints (e.g. voltage excursions)
- A reduction in customer interruptions (CIs)

In addition, improved procurement and installation strategy for future network solutions required and optimisation of selection of LV network solutions should deliver some cost efficiencies.

9.1.2. Strategy Implementation

SPEN are progressing the specification and prototyping of tools and processes to facilitate the LCT monitoring strategy. This includes input from key stakeholders across the business to ensure that required functionality is captured and alignment with existing tools/processes and tools in development.

*Full detail of our LCT Network Monitoring strategy can be found in the separate **Annex C6 – LCT Network Monitoring Strategy – SPEN**.*

10. Appendix B

10.1. Application of smart grid solutions to our investments

The diagram below sets out the process by which we use the various sources of network data to inform our investments, and the considerations which we apply for the use of different solutions.

10.2. Business process for solution adoption

The figure below sets out the evaluation process which we apply to new solutions which are developed from IFI, LCNF and other sources. We take a number of steps to evaluate these solutions for our own application, and also consider how we reflect these solutions into business as usual processes.