



Department  
of Energy &  
Climate Change

**ofgem**

Making a positive difference  
for energy consumers

# Smart Grid Vision and Routemap

Smart Grid Forum

February 2014

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## Foreword

Great Britain's electricity networks face a challenging future, but it is also a future of tremendous opportunity. Over this decade billions of pounds will be spent on our networks. Most of this is needed to maintain the electricity system and replace ageing infrastructure but we need to do more than just maintain the existing system. We need to make it more flexible and more adaptable. We will need investment in new, smarter technologies combined with the development of new commercial arrangements to tackle the uncertainties our network operators face and reduce the overall expenditure.

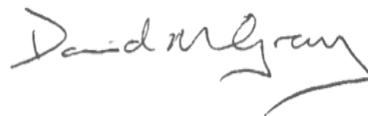
Smart grids will enable new sources of energy and new forms of demand. They can help us keep the lights on at minimum cost to consumers, while creating jobs and enhancing growth. They can support our low carbon transition and create opportunities for consumers to play an active role in the energy system alongside generators, suppliers and network companies. Many of these smart grid benefits will be realised in the 2020s and beyond. But we must not wait until then to put in place the enablers for smart grids – physical, commercial and regulatory frameworks. While many of the benefits can be captured now, longer-term benefits will only be realised if we identify and start to overcome barriers today.

We welcome the Smart Grid Forum's Vision and Routemap. It sets out the challenges for the electricity system and in particular, the electricity distribution network operators (DNOs). The next distribution Price Control period starts in April 2015. This document provides a useful reminder of the path network companies, and others have taken to date, and the challenges to be addressed over that period and beyond. Achieving the vision will require collaboration and partnership across the spectrum including the Government Ofgem, network companies, suppliers, supply chains and consumers. We are confident that the Smart Grid Forum and others will continue to rise to these challenges and facilitate the many benefits of smart grids.



**Rt. Hon Michael Fallon MP**

Minister of State for Energy



**David Gray**

Chairman, Ofgem

### **The Smart Grid Forum**

The Smart Grid Forum was created by the Department of Energy and Climate Change (DECC) and the industry regulator, Ofgem. The Forum brings together representatives from electricity network companies, consumer groups, energy suppliers and wider industry. It considers the full range of technical, commercial and regulatory issues associated with developing smart grids in order to support the UK's transition to a secure, safe, low carbon, affordable energy system. The Smart Grid Forum meets on a quarterly basis and oversees several workstreams as outlined in full in Annex 1. Membership and affiliation is listed at Annex 2.

## Executive summary

The potential of smart grids are huge. They could revolutionise the way we generate and use energy, enabling new forms of generation to connect and bringing customers into the heart of the equation with their ability to shift demand and balance the system. To realise that potential, we need to rethink the roles and responsibilities of all the players in the electricity system; we need to continue to invest in smart technologies in the near term and integrate them into existing networks; and we need to maximise the economic and commercial benefits for the country as a whole.

The Smart Grid Forum's vision for a Great Britain smart grid is:

***A smart electricity grid that develops to support an efficient, timely transition to a low carbon economy to help the UK meet its carbon reduction targets, ensure energy security and wider energy goals while minimising costs to consumers. In modernising our energy system, the smart grid will underpin flexible, efficient networks and create jobs, innovation and growth to 2020 and beyond. It will empower and incentivise consumers to manage their demand, adopt new technologies and minimise costs to their benefit and that of the electricity system as a whole.***

A smart grid could provide a range of benefits and opportunities for consumers, businesses, network operators and the wider energy industry, both day-to-day and in our transition to a low carbon economy. These benefits include:

- **Reduced costs to consumers through savings on network costs** – smart grids, enabled by the take-up of smart meters and smart appliances combined with demand side response measures, enable consumers and communities to have greater control over their energy use and benefit from shifting demand to off-peak times of the day.
- **Supporting economic growth and jobs** with faster and cheaper connections to the network and an estimated potential £13bn of Gross Value Added, £5bn of potential exports to 2050; and 9,000 jobs to 2030 associated with smart grids<sup>1</sup>.
- **Increased energy security and integration of low carbon technologies** through greater monitoring and control of the network, enabling network companies to anticipate and identify problems more quickly and manage supply and demand at a local level.

Great Britain has made significant progress to date in deploying smart grids and is recognised as a European leader with respect to the investment in smart grid research and demonstration projects. This success has been delivered through a range of work and initiatives, including

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<sup>1</sup> Source: SmartGrid GB (2013) *Smart Grid: A race worth winning*, available at: [www.smartgridgb.org/benefits-of-smart-grid/item/2-smart-grid-development-saves-billions-when-compared-to-cost-of-conventional-technologies.html](http://www.smartgridgb.org/benefits-of-smart-grid/item/2-smart-grid-development-saves-billions-when-compared-to-cost-of-conventional-technologies.html)

Ofgem's new RIIO Price Control model that places greater emphasis on supporting network innovation and the creation of the £500 million Low Carbon Networks Fund, which provides funding for network company innovation projects that test and trial new smart grid technologies and solutions. Great Britain has also begun the nationwide rollout of smart meters, which will help improve network management and facilitate demand shifting.

Great Britain needs to build on the initial success and begin rolling out smart grid technologies and solutions across the country, embedding proven innovations into business as usual, so that benefits can be realised from the earliest opportunity. In order to maintain progress, we need to:

- Provide the **strategic direction on the future of the electricity system and value of smart grids**, through for example: strengthening further the underlying evidence base and the analysis of the economic benefits of smart, particularly for wider energy systems such as heat; implementing key Government policies like Electricity Market Reform (EMR); and developing strong network operator leadership in rolling out successful smart grid pilots into business as usual solutions.
- **Ensure regulatory and commercial frameworks enable and support the deployment of smart technologies and new commercial practices**, through for example: successful application of the new RIIO-ED1 Price Control Process; enabling investment in monitoring and communication systems to realise immediate benefits including strategic planning and a platform to provide optionality for the future; and ensuring that time of use tariff approaches can be introduced to support demand side response.
- **Ensure that consumers understand and are convinced by the benefits of installing smart meters and shifting demand**. The Government, Ofgem and industry need to develop a greater understanding of what motivates consumers to change the way they use energy and of which bodies which are best placed to engage with consumers. They also need to ensure the opportunities to present the benefits of smart grids alongside the rollout of smart meters are maximised.
- **Maximise the economic opportunities for jobs and growth** through continued investment in research and development; better engagement with SMEs of the commercial opportunities that smart grids present to grow our domestic industry and actively promote UK smart grid products and expertise in overseas markets; greater engagement in the development of European product standards; and improved cooperation between industry and research communities.

The Vision and Routemap reflects on the implications of the development of smart grids for the energy system as a whole, but is primarily focused on the distribution network where we believe most action is needed at this stage. This document does not attempt to outline a precise path to reaching our vision as this will evolve over time as innovations emerge and as the needs of the network users evolve. However, we do have a sense of the direction of travel and this is what the Routemap is seeking to convey.

# 1. Smart Grids: Vision and Benefits

## The role of a smart electricity grid

1. The significant potential of smart grids could revolutionise the way we generate and use energy, enabling new forms of generation to connect and bringing customers into the heart of the equation with their ability to shift demand and help balance the system. To realise that potential, we need to rethink the roles and responsibilities of all the players in the electricity system; we need to continue to invest in smart technologies in the near term and integrate them into existing networks; and we need to maximise the economic and commercial benefits for the UK. This document sets out our vision for a smart electricity grid in Great Britain and describes what more needs to be done to deliver that promising future.
2. The Smart Grid Forum's Vision for a Great Britain smart grid is:

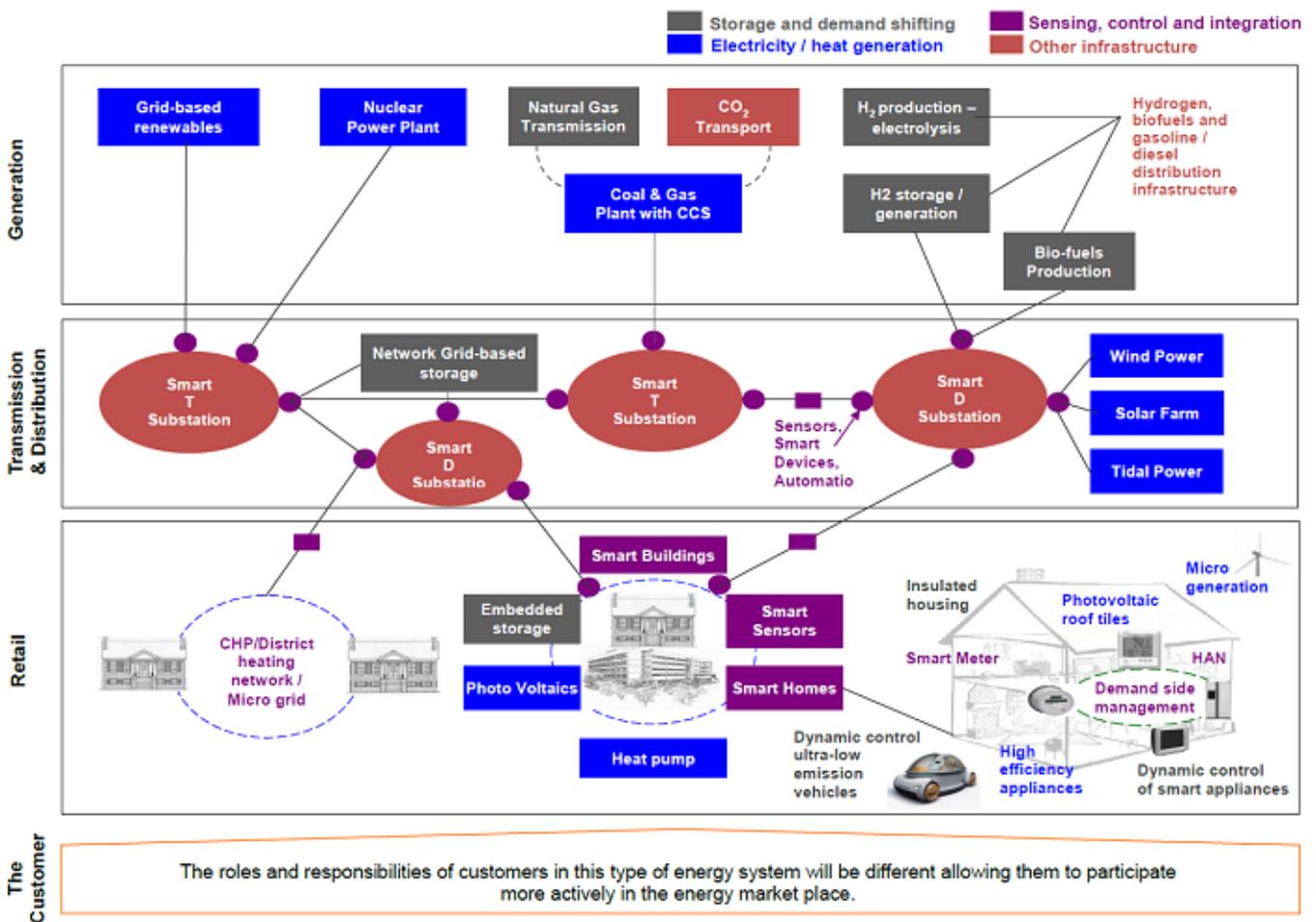
A smart electricity grid that develops to support an efficient, timely transition to a low carbon economy to help the UK meet its carbon reduction targets, ensure energy security and wider energy goals while minimising costs to consumers. In modernising our energy system, the smart grid will underpin flexible, efficient networks and create jobs, innovation and growth to 2020 and beyond. It will empower and incentivise consumers to manage their demand, adopt new technologies and minimise costs to their benefit and that of the electricity system as a whole.

3. In a technical sense, a smart grid is a modernised electricity grid that uses information and communications technology to monitor and actively control generation and demand in near real-time, which provides a more reliable and cost effective system for transporting electricity from generators to homes, businesses and industry. Smart meters are a key enabler of a smart grid, providing information to help improve network management as well as facilitating demand shifting and supporting distributed and renewable energy generation.
4. In practice, the smart grid can help network operators spot problems earlier and re-route power helping to ensure a more reliable and secure supply. The increased control over the network also enables a wider, more sophisticated range of smart methods to support renewable generation and storage and manage supply and demand at a more local level. Furthermore, with increasing demand for electricity through the increasing electrification of heating and transport, smart grids will help the electricity system cope with the demands placed upon it. With smart meters providing near real-time energy use information, consumers and communities will be able play a much more active role in the energy system,

for example, through demand side response, where they are incentivised to use energy away from peak times to help reduce pressure on the system as a whole and to take advantage of lower price periods.

- Smart grids do not remove the need for conventional reinforcement of networks, but with more efficient use of infrastructure they can minimise or defer the need for investment helping to reduce costs and incorporate low carbon technologies at a faster rate. The diagram below outlines the role and relationships between different elements of the smart grid as it evolves incrementally to enable whole energy system integration.

**Figure 1: Role and relationships between different elements of the smart grid<sup>2</sup>**



Source: DECC

<sup>2</sup> Adapted from an earlier diagram published by the Electricity Networks Strategy Group

## Benefits of a smart electricity grid

6. Smart grids bring a range of benefits that will be felt in both the short and long-term:

### Consumer and customer benefits

- **Minimise consumer bills** – more efficient use of network assets helps reduce the need to invest in costly infrastructure and ultimately reduces the costs passed through to consumer bills. It is estimated that by 2050, smart grids will reduce the cost of additional distribution reinforcement needed to accommodate the connection of low carbon technologies such as heat pumps, solar PV and electric vehicles by between £2.5bn and £12bn (a 20 to 30 per cent reduction)<sup>3</sup>.
- **Enable greater consumer and community participation** – the smart grid can have a transformational impact on consumer and community interaction with the energy system. Smart meter systems will provide consumers with more accurate information on their energy use and suppliers will be able to offer more cost reflective tariffs that reward consumers for using energy at off-peak and lower price times or generating energy at peak times. Some community groups have already undertaken energy management projects using smart technologies, for example, the village of Ashton Hayes<sup>4</sup>.

### Wider economic benefits

- **Create jobs and support economic growth** – smart grids present exciting opportunities for UK businesses. An Ernst and Young report for SmartGrid GB<sup>5</sup>, stated that the development of smart grids could lead to approximately £13bn of Gross Value Added between now and 2050; export earnings of £5bn to 2050 and jobs could be boosted by an average of 8,000 during the 2020s rising to 9,000 during the 2030s if sufficient investment is made. The enabling benefits of smart grid, for example facilitating take-up of low carbon technologies, are also considerable.
- **Release existing network capacity to enable faster, cheaper connections for generators and business customers** – with accurate and real time technical information on supply and demand, and options for balancing supply locally (e.g. Demand Side Response, storage), complemented by new commercial arrangements such as flexible connection agreements, network operators will be able to free up existing capacity and make better use of existing assets. This can help deliver faster and cheaper connections for businesses and generators and helps to defer or avoid the need for costly reinforcement of the wider network.

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<sup>3</sup> <https://www.ofgem.gov.uk/ofgem-publications/56816/ws3-phase-3-84170-complete-issue-1.1.pdf> The figures quoted are in net present value terms discounted using a rate of 3.5% pa, 2012 prices.

<sup>4</sup> [http://www.spenergynetworks.co.uk/userfiles/file/Flyer\\_AshtonHayes.pdf](http://www.spenergynetworks.co.uk/userfiles/file/Flyer_AshtonHayes.pdf)

<sup>5</sup> <http://www.smartgridgb.org/benefits-of-smart-grid/item/2-smart-grid-development-saves-billions-when-compared-to-cost-of-conventional-technologies.html>

## Energy security and low carbon transition benefits

- **Improve energy security and reliability** - a more intelligent network that increases the visibility of real-time network use, as well as a means to control and manage the network more responsively, will improve the stability and reliability of the network. This will assist in the timely and efficient replacement of equipment, reducing the risk of any localised power outages or interruptions and ensure that power is restored more quickly when faults do occur.
- **Enable new low carbon technology to be deployed** - heat pumps and electric vehicles will deliver significant carbon reductions, but will increase demand on the electricity network. Using smart grid technology to phase operating times, these devices can be incorporated into the network in conjunction with distributed generation to balance supply and demand, reducing the need for costly network reinforcement.
- **Wider energy system benefits** – a smart grid can provide the gateway to wider energy system integration, embracing gas and heat networks so that further synergies and opportunities around arbitrage become accessible. For example, by using Combined Heat and Power (CHP) or Combined Cooling, Heating and Power (CCHP) and gas fired heat pumps more flexibly (perhaps in conjunction with heat storage), can support both heat and electricity networks and optimise overall capacity of energy infrastructure. To that end, smart grids will help facilitate the ‘Smart City’ and community energy scheme initiatives.
- **Better targeting of initiatives to save carbon emissions:** The granularity of information on energy use available with a smart grid will enable the Government and other bodies to target more efficiently carbon saving initiatives. For example, knowledge of how buildings use energy as the outside temperature varies could be used to target investment in buildings that waste energy through poor insulation. By combining the smart grid with zonal temperature controls and user presence sensors, heating can be optimised to match occupancy rates at different times of day and optimise the use of energy in off-peak periods.

## The role of a Smart Grid Vision and Routemap

7. The development of a smart grid in Great Britain requires coordinated action by the Government, the regulator, the energy industry and consumers. In 2009 and 2010, the Electricity Networks Strategy Group (ENSG)<sup>6</sup> published a smart grid Vision<sup>7</sup> and Routemap<sup>8</sup> to help guide transmission and distribution network operators in their development of demonstration projects for the Low Carbon Networks Fund (see Technology Innovation and Growth section for more information) and to inform discussions on what might be needed from smart meters to support the development of a smart grid. Since that time, significant progress has been made and we have developed a more detailed understanding of the

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<sup>6</sup> <https://www.gov.uk/government/policy-advisory-groups/electricity-networks-strategy-group>

<sup>7</sup> [http://webarchive.nationalarchives.gov.uk/20100919181607/http://www.ensg.gov.uk/assets/ensg\\_smart\\_grid\\_wg\\_smart\\_grid\\_vision\\_final\\_issue\\_1.pdf](http://webarchive.nationalarchives.gov.uk/20100919181607/http://www.ensg.gov.uk/assets/ensg_smart_grid_wg_smart_grid_vision_final_issue_1.pdf)

<sup>8</sup> [http://webarchive.nationalarchives.gov.uk/20100919181607/http://www.ensg.gov.uk/assets/ensg\\_routemap\\_final.pdf](http://webarchive.nationalarchives.gov.uk/20100919181607/http://www.ensg.gov.uk/assets/ensg_routemap_final.pdf)

benefits of smart grids, the challenges and the action needed to address them. The purpose of this refreshed Smart Grid Vision and Routemap is therefore to:

- Refresh and re-state our common vision for the future that has been developed jointly by the Smart Grid Forum;
- Communicate the wide-ranging benefits associated with developing smart grids to build wider support and recognition for smart technologies;
- Reflect on the progress made to date and set out the key challenges to smart grid deployment, in order to stimulate action and support strategic planning; and
- Provide a framework to enable the tracking of progress in addressing the challenges to smart grid deployment by Smart Grid Forum members and wider stakeholders.

8. The scope and focus of this Vision and Routemap is set out below.

### **Scope and focus**

To realise the full potential of smart grids, the entire electricity system including transmission and distribution networks, the system operator, suppliers, generators, and consumers and markets will need to evolve. Whilst this document reflects on the implications of smart grids for the system as a whole, **the primary focus is on the challenges facing electricity distribution networks as these are the part of the electricity system with the greatest opportunity for smart interventions and where investment is required to ensure it can cope with the increasing demands and new requirements that are already emerging.**

This Smart Grid Vision and Routemap intentionally avoids being prescriptive on the path to achieving our Smart Grid Vision. It is not a project plan. Whilst we can be confident that renewable generation will continue to grow, and that we will see increasing electrification of heating and transport and therefore growing demand, we cannot accurately predict the precise trajectories of deployment. This Routemap therefore needs to be adaptable in its application to benefit from the new learning and insights that will emerge during its lifetime. The Vision and Routemap therefore looks to set out a direction of travel and will be refreshed as the energy landscape develops.



## 2. Smart grids: Context and Progress

### The context

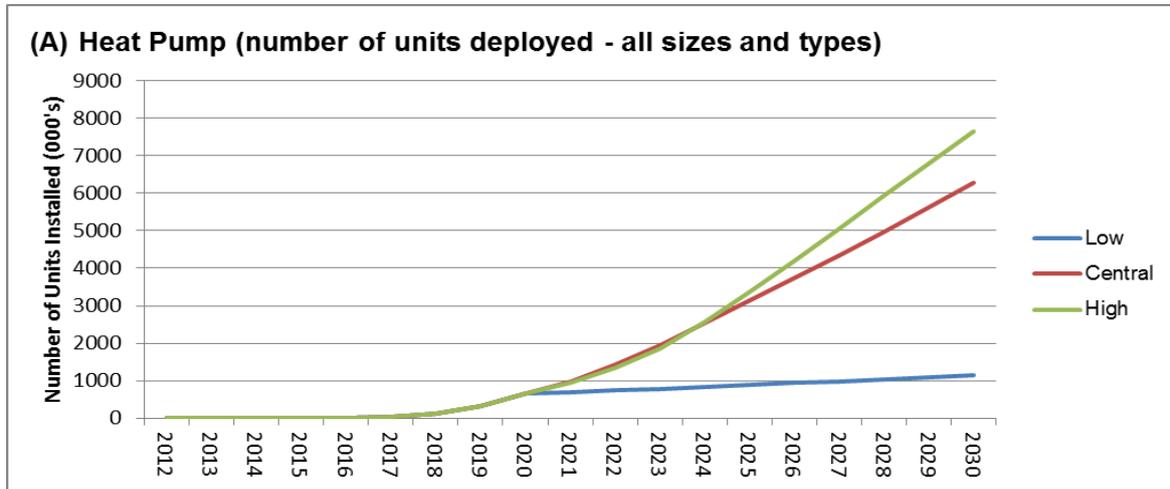
9. Great Britain is already seeing the impacts of the transition to a low carbon economy. Our electricity generation mix is changing with an increasing level of renewable and other low carbon generation. At distribution system level, the increasing requests for connection of solar PV installations, onshore wind farms, and other forms of distributed generation are creating technical challenges, which have knock-on impacts for the transmission system as well. For example, solar PV and wind generators do not normally contribute to 'system inertia'<sup>9</sup>, which is essential for maintaining the system frequency stability and resilience to sudden changes arising from loss of generation or transmission faults. There are also already wider variations in system voltages in some parts of Britain particularly overnight, creating operational challenges in managing the transmission network.
10. Electrical demand patterns are changing too. An emerging challenge is the increasing electrification of heat and transport, a key part of decarbonisation<sup>10</sup>. Comprehensive modelling undertaken by DECC, network companies and academia illustrates clearly that electricity consumption and, in particular, peak demand (which ultimately drives the need for both generation and network capacity), has the potential to exceed anything previously designed for (see section on Strategic Direction on the Transform Model for more information).
11. The ability to respond effectively and efficiently to these future challenges and engage the active participation of consumers will depend critically on the continued development of a smart grid that is fit for purpose for Britain's future electricity system.

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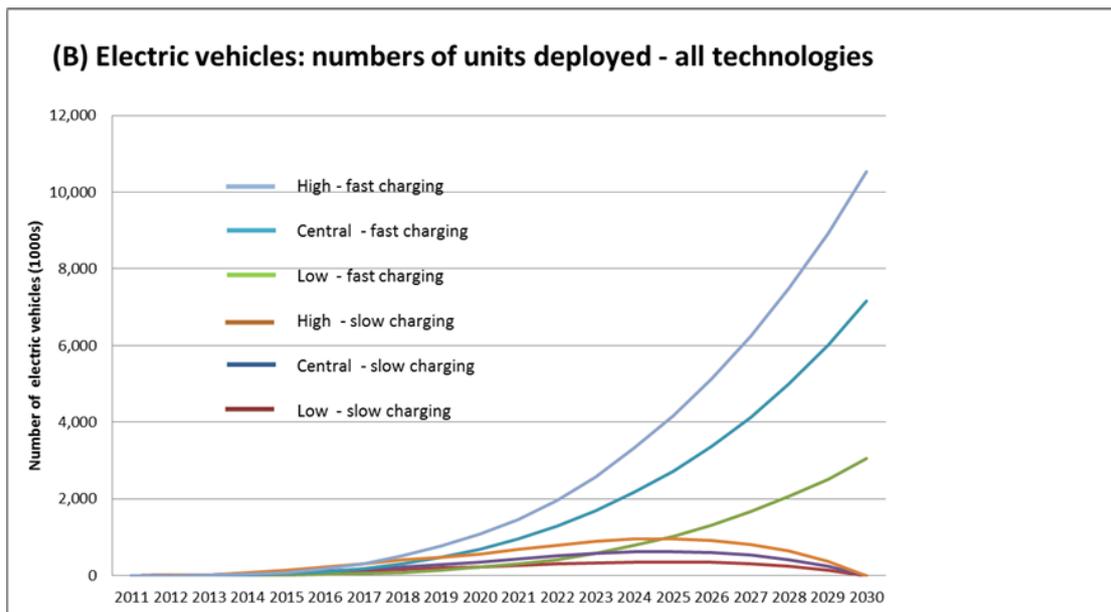
<sup>9</sup> System inertia is one of the key measures of the strength of the electrical power system in response to sudden changes. System Inertia is the sum of the energy stored within the rotating mass of the machines (both generators, and directly connected motor loads) on the system. The increase in the penetration of generation technologies such as Solar PV, and Windfarms which have very little or inherent inertia (as a result of the absence of any directly connected rotating mass in some of these technologies) reduces the system inertia. Low system inertia increases the risk that rapid system changes (i.e. loss of generation or load, faults on the system, etc.) will lead to instability

<sup>10</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf)

**Figure 2: (A & B) Low carbon technology take-up scenarios to meet the 4<sup>th</sup> Carbon Budget**



Source: DECC



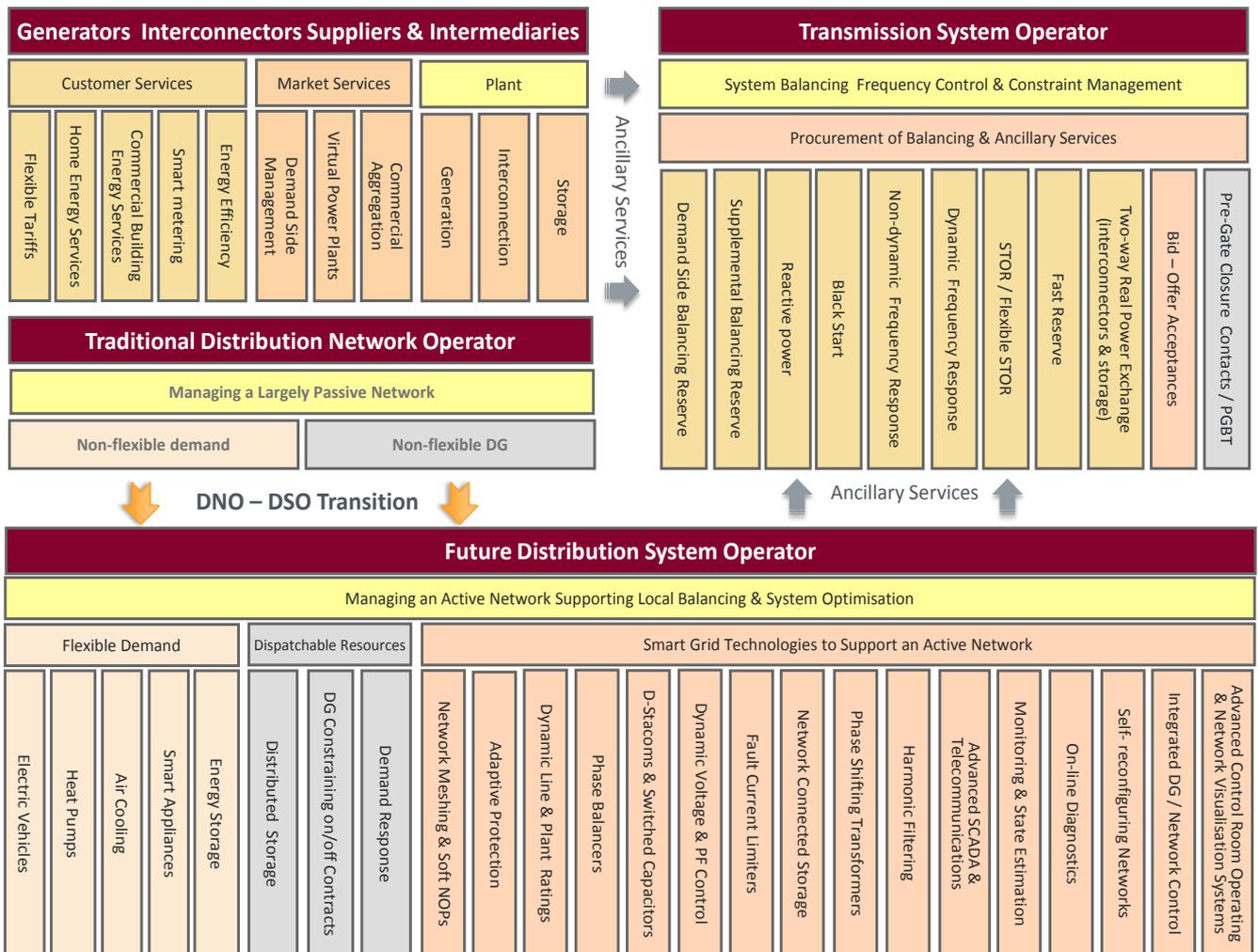
Source: Office for Low Emission Vehicles (OLEV)

## The evolving role of distribution network operators

12. The development of smart grids will present new roles and relationships for all those that interact with the electricity system – suppliers, consumers, generators and network operators. Suppliers will be responsible for installing smart meters across Great Britain and will be able to introduce new time of use tariffs that reward consumers for shifting demand away from peak times. Distributed generators will play a more active role in meeting local energy demand. Consumers, through demand management, will play a more active role in helping to balance supply and demand. However, in the short term, distribution network operators (DNO) face some of the greatest challenges.

13. The traditional 'passive' role of the DNO must evolve such that the distribution system becomes more actively managed, taking advantage of opportunities afforded by flexible demand, distributed generation and energy storage to support efficient network operation. This will require network operators deploy the necessary technology to allow them to better manage supply and demand at the local level. System integration of emerging solutions may benefit from forward thinking and anticipatory investment such as installing sensors, enabling automated action of power switches, and provision of communication cabling when laying power cables. However, while this makes practical sense, it also challenges network operators to take investment decisions in the short-term that reflect longer term needs while avoiding the risk of stranded assets and inevitably some first generation smart technologies may be superseded by superior and more advanced technologies over time.
14. Network operators also need be ready to up-scale new solutions in the event that, for example, take-up of low carbon technologies (e.g. electric vehicles, heat pumps, solar PV) exceed expectations. Capabilities to respond will depend on a range of factors including the development of standards for innovative solutions, supply chain capacities, skills and partners, and thought-through systems engineering that accommodates critical aspects such as data management-at-scale, control centre integration, and commercial and consumer interfaces. The network companies have started to address these issues as evidenced by their RIIO business plans and innovation strategies, informed by the Smart Grid Forum's scenario analysis and its Transform Model modelling.
15. As the deployment of new solutions increases, current norms and approaches will require fresh thinking. For example, the resilience of the power distribution system today is assured by redundancy of infrastructure. There is a degree of over-capacity built in allowing sections of our networks to be shut down to accommodate routine maintenance, new connections, reinforcement and equipment failures without loss of power to our homes and businesses. This form of risk management is likely to become integrated with improved network operational visibility, the use of real-time asset capabilities, and the active control of demand, generation and storage.
16. The network industry and regulator will need to address these challenges head on as the new possibilities offered by a smart grid will increasingly open up new customer relationships and open up questions about industry structure, incentives, and responsibilities. This will need strong leadership and a commitment to smart grids that runs throughout the organisation.
17. Figure 3 provides an overview of the potential role that the key players and DNOs in particular, might be expected to play once a smart grid is fully established. As this diagram shows, the traditional distribution network operator will evolve from its current role managing a largely passive network to operating as a distribution system operator supporting local balancing and system optimisation.

**Figure 3: Potential roles and relationships of the energy industry within a smart grid.**



Source: UK Power Networks

## Progress in developing smart grids

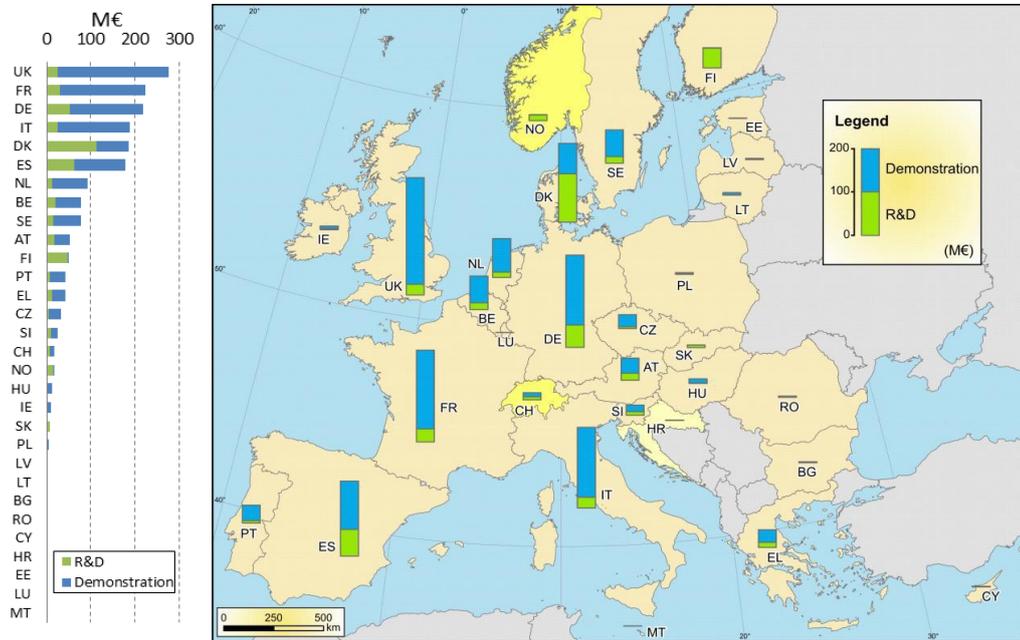
18. Interest in and commitment to developing smart grids has been growing internationally over the last decade. The pace of development seen in Great Britain is encouraging and distinctive in having a significant proportion of practical activity through applied demonstration projects that are already delivering performance and cost benefits to customers (e.g. quicker and cheaper connections and integration of local storage). Furthermore, the nationwide roll-out of smart meters shows that Britain is already putting in place the critical building blocks to establish a smart grid.

## Innovation

19. The United Kingdom can legitimately claim to be European leaders in deploying a wide range of viable smart grid solutions. An independent (Joint Research Council) European

report<sup>11</sup> - *Smart Grid Projects in Europe – Lessons Learned and Current Developments* - showed that the UK has attained a leading position in terms of levels of investment in smart grid research and demonstration projects, as Figure 4 demonstrates.

**Figure 4 Map showing investment in smart grids research and development projects**



Source: Joint Research Centre, European Commission

20. The Innovation Funding Incentive and Registered Power Zone incentives introduced by Ofgem in 2005<sup>12</sup>, and the introduction of the Low Carbon Network Fund in 2010, have been instrumental in catalysing innovation in the management of electricity distribution networks and development of smart solutions. The Network Innovation Allowance and Competition will ensure that this momentum is maintained into the next decade, both for the distribution and transmission networks (see Technology, Innovation and Growth section for more details).

<sup>11</sup> Smart Grid Projects in Europe – Lessons Learned and Current Developments:

[http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/documents/ld-na-25815-en-n\\_final\\_online\\_version\\_april\\_15\\_smart\\_grid\\_projects\\_in\\_europe\\_-\\_lessons\\_learned\\_and\\_current\\_developments\\_-2012\\_update.pdf](http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/documents/ld-na-25815-en-n_final_online_version_april_15_smart_grid_projects_in_europe_-_lessons_learned_and_current_developments_-2012_update.pdf)

<sup>12</sup> An ‘early adopter provision allowed some projects to commence late in 2004, i.e. prior to the beginning of the 2005/06 regulatory year

### **Low Carbon Network Fund**

As part of the electricity distribution price control that runs until 31 March 2015, Ofgem established the Low Carbon Networks (LCN) Fund. The LCN Fund (£500m) supports projects sponsored by the Distribution Network Operators (DNOs) to trial new technology, operating and commercial arrangements. The aim of the projects is to help all DNOs understand how they can provide security of supply at value for money as Britain moves to a low carbon economy.

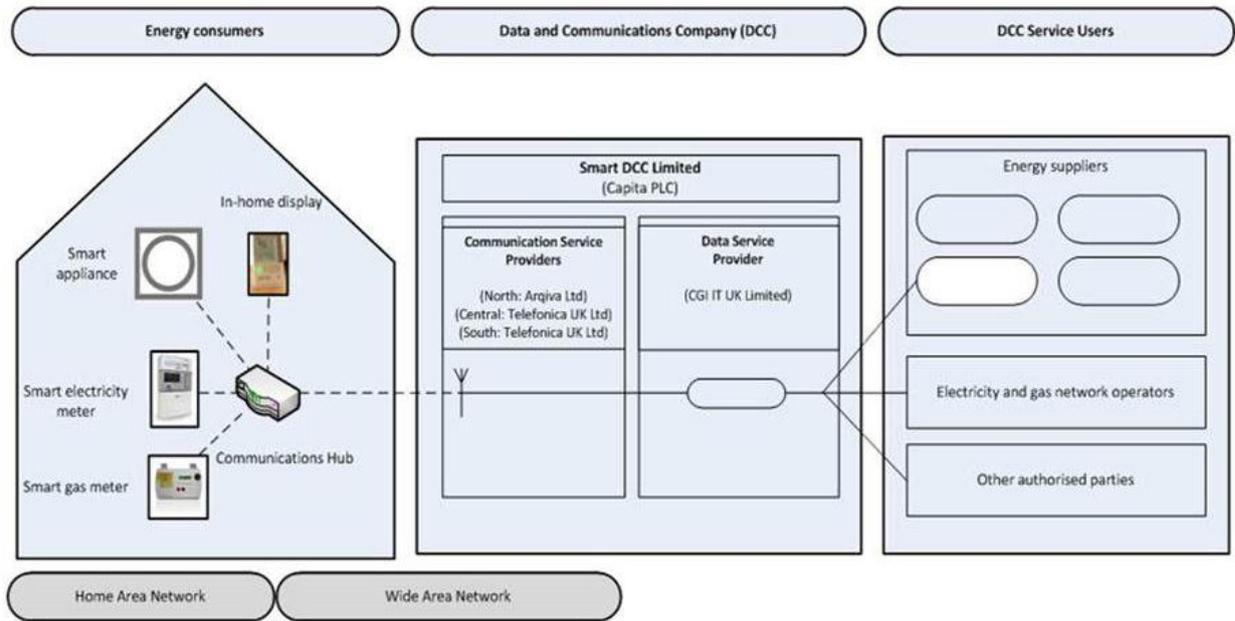
There are two tiers of funding under the LCN Fund. The First Tier allows DNOs to recover a proportion of expenditure incurred on small scale projects. Under the Second Tier of the LCN Fund, Ofgem run an annual competition for an allocation of up to £64 million to help fund a small number of flagship projects.

DNOs explore how networks can facilitate the take up of low carbon and energy saving initiatives such as electric vehicles, heat pumps, micro and local generation and demand side management. They also investigate the opportunities that the smart meter roll out provides to network companies. As such, the LCN Fund provides valuable learning for the DNOs and wider energy industry.

### **Smart meter rollout**

21. A key development in the deployment of a GB smart grid is the roll out of smart meters. The Government's Smart Metering Implementation Programme aims to roll out 53 million smart meters to all domestic consumers and smaller non-domestic premises in Great Britain by the end of 2020. These devices and their associated communications and display units have the potential to be valuable smart network enablers through their capabilities as sensors and interface devices to homes and small businesses. This will change the way industry, consumers and other stakeholders interact with electricity networks and wider energy systems. Figure 5 illustrates the main parts of the smart metering system, including the equipment and communications within premises and the system provided by the Data and Communications Company (DCC) that links the organisations that will use the information provided by smart meters (DCC Service Users) and the meters themselves.

**Figure 5: The smart metering system**



Source: DECC

22. The Government is working with the regulator and industry to put in place the legislative, commercial and delivery framework to provide the nationwide rollout of smart gas and electricity meters, which will provide the platform to enable smart grid solutions to be deployed. For example, DECC has been working with DNOs and other stakeholders to ensure that the specification of the smart meters and the communications network provide the functionality required to implement future smart grids solutions.
23. Electricity distribution networks are making their own preparations for the roll-out of smart metering which is expected to begin in earnest in autumn 2015. The activities that they will undertake to support the programme include:
  - Providing meter registration data to support the DCC in delivering communications between smart meters and energy suppliers, network operators and other authorised service users.
  - Providing operational support to energy suppliers during the installation process.
  - Preparing plans concerning the aggregation and anonymisation of energy consumption data.
  - Utilising smart meter data to improve their operations and provide benefits to customers, both in terms of cost savings and the quality of service they can offer.

24. Several key developments have taken place recently to prepare for the roll-out of smart meters.<sup>13</sup> In June 2013, the Central Delivery Body (CDB) was set-up to support the consumer engagement activities of energy suppliers. The CDB will be responsible for building consumer confidence in the installation of smart meters and awareness of how to use them and the information obtained from them. The larger energy suppliers are responsible for funding the CDB<sup>14</sup> and for ensuring it achieves its objectives. The CDB is governed by a board with an independent chair and includes consumer representatives. The Board is required to act in an impartial manner.
25. In September 2013, the Government awarded a licence to the DCC, and completed the procurement processes for the data and communication service providers so that the DCC could sign contracts with service providers at the time that its licence was awarded. A new industry code, the Smart Energy Code (SEC), came into force under the DCC licence in September 2013. The SEC is a multiparty agreement that sets out the contractual relationship between the DCC and its users, including the detailed day-to-day rules, rights and obligations for the different industry parties that use smart metering equipment and the information it provides.

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<sup>13</sup> For further details on progress in delivering the smart metering programme, please see the Government's *Second Annual Report on the roll-out of Smart Meters* (2013), available at: [www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/266685/second\\_annual\\_report\\_smart\\_meters.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266685/second_annual_report_smart_meters.pdf)

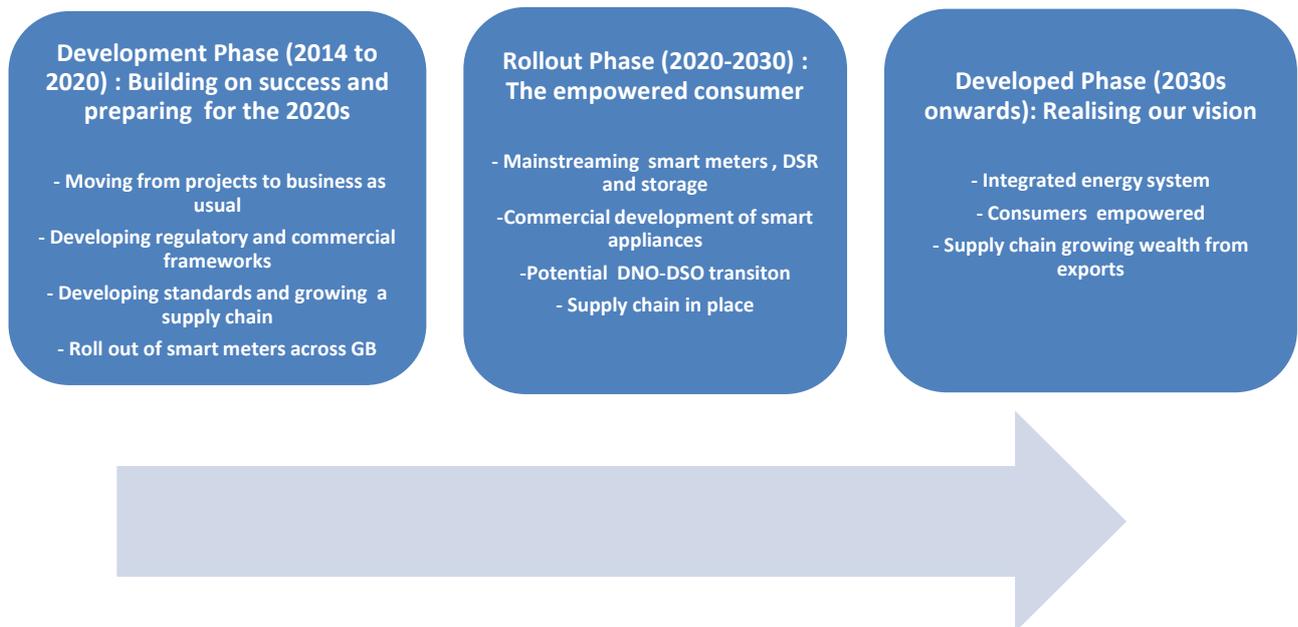
<sup>14</sup> Smaller suppliers contribute to fixed operating costs.

### 3. Smart Grids: The Way Ahead

#### Phases of development

26. Good progress has been made in developing and testing smart technologies. It is vital to maintain momentum and consider what further work should be prioritised in the coming years. It is neither possible nor desirable to map out a precise path to implementation. The range of scenarios and uncertainty on the level and pace of change to generation and demand which will shape the evolution of our electricity networks means it will be important for networks to evolve flexibly and retain opportunities for innovation. Nevertheless, there is value in outlining at a high-level a broad sense of direction for the development of a GB smart grid over the coming decades. Figure 6 below breaks down the path to achieving our vision into three phases.

**Figure 6: Key stages in the development of a smart grid**



27. **The first phase of smart grid deployment is focused on capturing the short-term benefits of deploying smart technologies and solutions, whilst also preparing for the accelerated deployment of distributed generation and increasing electrification of heating and transport projected to take place in the 2020s.** During this phase, network companies build on the success of the Low Carbon Network Fund trials to move from participating in trials to integrating successful pilots into business as usual activities. In parallel, changes in regulatory and commercial frameworks to support demand side management and storage are made, as are provisions that support DNO access to smart

meter data while safeguarding consumer privacy. Strengthened engagement of the UK in EU negotiations on standards development, increasing inclusion of smart approaches into business as usual and clear policy direction from the Government, help foster the development of a GB smart grid supply chain.

28. **The second phase of smart grid deployment sees a much greater role for the consumer, following the successful roll-out of smart meters across Great Britain.** Consumers view the visibility and control they have over their energy use as routine, and this contributes to the further development of the smart appliances industry. Increasingly, community energy groups and local authorities look to develop local sources of renewable energy to reduce costs, increasing the trend towards decentralised energy development. The increasing electrification of heat and transport and more distributed generation, increase the need to balance the electricity system at local levels. The advances made in the first phase, coupled with advances in storage and amendments to regulatory regime, open the way for DNOs to play a local system operator role to manage local system constraints and possibly offer balancing services. The GB smart grid supply chain expands having developed in the first phase, building on the experience of the Low Carbon Network Fund demonstration projects and standards development.
29. **The third phase will see GB achieve its vision objectives**, where a smart grid enables GB to develop a fully integrated smart energy system and a platform for the further development of technologies to support the increasing electrification of the heating and transport sector as well as smarter homes and businesses. These developments are also contributing to the evolution of smart cities. The knowledge, expertise and skills developed means a mature GB supply chain has developed and is now exploiting significant export opportunities.

## Near-term challenge and focus

30. Whilst retaining a view on the longer term vision, it is important that we outline and focus on the nearer term steps that need be taken over the next few years. The challenges that need to be addressed can broadly be divided into four key themes - these are outlined in more detail in the following sections:
- **Strategic direction** – The Government, Ofgem, network operators, suppliers and all those that interact with the electricity networks need to maintain a shared and compelling long term vision of smart grid deployment and the drivers for it. This will support deployment in the near term so that consumers and customers can benefit sooner rather than later and help facilitate the UK's low carbon transition.
  - **Regulatory and commercial frameworks** - which facilitate the deployment of smart technologies and smart solutions. These frameworks must incentivise innovation and efficiency and support new commercial arrangements, whilst protecting consumer and customer interests.
  - **Customer participation** – The Government, Ofgem and the electricity industry communicate effectively the benefits that will accrue to customers and the energy system more generally, through the adoption of smart grids, changing market structures and engaging willing consumers in active management of their demand or distributed generation.

- **Technological Innovation and growth** - the UK smart grid supply chain and SMEs in particular must be able to support the development of a smart grid in the UK and benefit from the commercial and growth opportunities presented both in the UK and overseas.



## 4. Strategic Direction

### The challenge

31. The challenge is to ensure that the Government, Ofgem, network operators, suppliers and all those that interact with electricity networks maintain a shared and compelling long term vision of smart grid deployment and the drivers for it. This will support deployment in the near term so that consumers and customers benefit sooner rather than later and can help facilitate the UK's low carbon transition.

### Why important

32. The pace and precise path of the low carbon transition is uncertain, which makes assessing where and when to invest in the necessary technologies complex. Furthermore, power system development is not a 'green field' context and innovative solutions must be integrated with legacy systems, both technically and commercially. As new solutions move to 'Business as Usual' there is a need to consider further dimensions such as standardisation, procurement efficiencies, and 'whole-systems' integration – these are non-trivial aspects which require time and resources. The installation of new solutions also requires careful risk management to ensure that supplies are safeguarded. Day-to-day business for network companies, such as connecting new customers or reinforcing the networks, is under continual pressure to achieve service improvements and minimise costs.

33. There is a risk that network companies stay with proven approaches, rather than incur the uncertainties of innovation. However, to do so could risk losing the benefits of smart grids or having to make up ground at a later stage, which could increase costs, weaken system resilience and hamper the low carbon transition. Clear strategic direction is therefore needed and leadership at all levels, backed by a sound evidence base, to ensure a shared vision and common understanding of the role and benefits of smart grids to ensure the necessary steps to deploying smart grids are taken and momentum is maintained.

### Progress to date

34. Significant progress has already been made. A number of important developments have helped provide the strategic direction.

35. **DECC and the Department for Transport have published a number of documents** that have provided greater clarity on the direction and future of our electricity system, through publishing a number of key documents including:

- **UK Carbon Plan <sup>15</sup> (2011)**, which outlined different pathways (scenarios) to meet the 4<sup>th</sup> Carbon Budget and 2050 emissions target. This has provided a starting-point to assess the potential impact of the low carbon transition on electricity distribution networks.
- **Renewable Energy Roadmap (2011)**, in which DECC presented a framework and set of actions for the delivery of renewable energy deployment. Together with technology specific actions, this set out six key areas where activity was needed to tackle cross-cutting barriers including facilitating access to the grid. This roadmap was updated in November 2013.<sup>16</sup>
- **Electricity System Assessment of Future Challenges (2012)<sup>17</sup>** concluded that balancing technologies and smarter networks will be crucial to the cost-effective matching of electricity supply and demand. Multiple factors will influence the actual trajectory of generation and demand so a full range of solutions will likely be deployed. The Government will have a key role to help ensure market frameworks and networks develop in a way that is fit for purpose, and in removing barriers to widespread deployment of balancing technologies.
- **Community Energy Strategy (2014)<sup>18</sup>** recognises that as we move towards smarter energy management, communities can help pilot new approaches to balancing supply and demand, providing valuable learning that can be applied elsewhere. Independent modelling undertaken for DECC shows that under some scenarios, by 2020, community electricity could provide between 0.5GW and 3GW of installed capacity through solar photovoltaic, onshore wind and hydro projects – representing between 2.2 per cent and 14 per cent of the total capacity of these technologies, and generating between 0.3 per cent and 1.4 per cent of the UK's entire electricity consumption in 2020, or enough to meet the electricity needs of 1 million homes.<sup>19</sup>
- **The Smart Energy Code is the legal framework which sets out the day-to-day rules, rights and obligations regarding smart metering equipment and the information it provides.** Given the key role of smart metering in enabling the development of a smart grid, network operators are working closely with the Government in the development of preparations for the smart meter roll-out.
- **Driving the future today - a strategy for ultra-low emission vehicles in the UK (2013)<sup>20</sup>** set out the Government's strategy to drive forward the ultra-low emission vehicles (ULEVs) industry. It announced a call for evidence on how best to invest £500 million of funding for the period 2015 - 2020 to drive the revolution and establish the UK as a premier market.

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<sup>15</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf)

<sup>16</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/255182/UK\\_Renewable\\_Energy\\_Roadmap\\_-\\_5\\_November\\_-\\_FINAL\\_DOCUMENT\\_FOR\\_PUBLICATION\\_.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/255182/UK_Renewable_Energy_Roadmap_-_5_November_-_FINAL_DOCUMENT_FOR_PUBLICATION_.pdf)

<sup>17</sup> <https://www.gov.uk/government/publications/electricity-system-assessment-of-future-challenges>

<sup>18</sup> <https://www.gov.uk/government/publications/community-energy-strategy>

<sup>19</sup> <https://www.gov.uk/government/publications/community-renewable-electricity-generation-potential-sector-growth-to-2020>

<sup>20</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/239317/ultra-low-emission-vehicle-strategy.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239317/ultra-low-emission-vehicle-strategy.pdf)

- **Future of Heating: A strategic framework for low carbon heating in the UK (2012)**<sup>21</sup> set out the challenge of decarbonising the UK’s heat demand and identified key enabling activities DECC will undertake in order to deliver the step-change in heating necessary to meet it. This includes looking at the most effective ways to bring about a large-scale transition to low carbon heating over the coming decades, to meet our carbon budgets whilst putting us on a pathway to achieve our 2050 carbon targets.
- **Ofgem has developed the new RIIO regulatory framework to incentivise network operators to rise to the challenge of delivering a low carbon Britain.** RIIO is a significant departure from the previous regulatory approach to regulation (RPI-X), which was largely aimed at reducing costs and getting efficiencies out of the existing assets. RIIO requires companies to plan earlier for different scenarios and to engage more with stakeholders when preparing business plans and throughout the price control period (see the Commercial and Regulatory Frameworks section for more information).
- The Smart Grid Forum **developed a parametric model, Transform Model (see below), to assess the costs and benefits of smart grid deployment** in terms of deferred or avoided reinforcement costs under different low carbon transition pathways and investment strategies.

### **Transform Model**

The Smart Grid Forum oversaw the creation of a ground-breaking new model, *Transform Model*, which was designed to assess the costs and benefits of smart developments of the GB distribution system. The Transform Model, which draws on the Government’s Carbon Plan, is used to estimate the related network reinforcement that is required, the smart and conventional solutions that could be used, and the cost. This allows estimates of the savings associated by using smart solutions compared to conventional approaches to be made.

Recent outputs confirmed that a mix of smart and conventional solutions is the optimum long term development, offering significant savings in the order of 25-30 per cent of total reinforcement costs to 2050. The model also showed that while the bulk of network investment needed to accommodate low carbon technologies arises in the RIIO-ED2 price control period (2023-2031), investment is also needed in the RIIO-ED1 period (2015-2023) and particularly in relation to investment in monitoring and communication systems to realise immediate benefits including strategic planning and a platform to provide future optionality.

The Transform Model provides DNOs with a robust evidence base for assessing the investment needs of accommodating low carbon technologies across any scenario for the next price control period. These estimates have informed the DNO investment proposals set out in their RIIO-ED1 Business Plans.

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<sup>21</sup> <https://www.gov.uk/government/publications/the-future-of-heating-a-strategic-framework-for-low-carbon-heat>

## Work underway

36. As well as successes to date, there are number of activities in train that will provide further strategic direction.

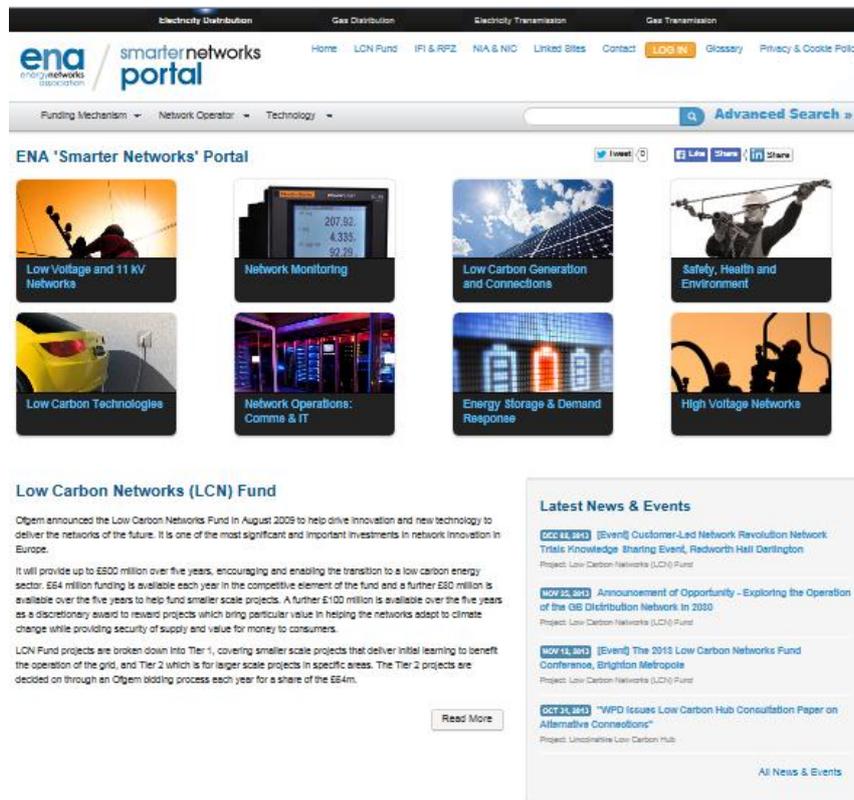
- The **Distribution Network Operators are in the process of agreeing their Business Plans with Ofgem as part of the RIIO-ED1 process**. These plans, which include documented innovation strategies and projections on the uptake of low carbon technologies, outlined the proposed investment in their respective distribution networks between 2015 and 2023, and included planned investment in deploying smart solutions.
- **Energy Networks Association (ENA) is currently working on the benefits and development of new data management and analytics technologies, consistent with security and privacy requirements**. This will help to ensure that data collected from smart meters and other sources, comply with security provisions and provide the basis for network operators to make the best use of this information to manage the network.
- **DECC is in the process of introducing its Electricity Market Reforms (EMR)**, which will introduce **Contracts for Difference** as the central means for incentivising the deployment of large-scale low carbon electricity generation; and a **Capacity Market**, which will ensure sufficient capacity margin exists in the GB power market through a series of capacity auctions. DECC is also planning two years of transitional auctions to provide local storage and demand side response (DSR) services that will be natural users of the smart grid.
- DECC will publish a **Solar PV strategy** in the Spring 2014 setting out the policy trajectory for Solar PV out to 2020. The first iteration of the strategy was published in October 2012, based on four key principles: affordability; carbon reduction; appropriate siting; and grid connection and balancing.
- The Smart Grid Forum has recently launched a **study to carry out the technical analysis necessary to confirm how the networks described by the Transform Model outputs will be realised by 2030**. This will both confirm their technical viability and provide an understanding of their characteristics, for example to identify what control and co-ordination may be required to ensure reliable and robust whole-system operation. Importantly, it will highlight any new roles and responsibilities from a largely technical perspective that a DNO will be required to accept.
- The **Technology Strategy Board<sup>22</sup> Energy Systems Catapult will be considering 'whole systems' approaches to meeting our energy needs**, including electricity, combustible gases and district heating. The Energy Systems Catapult will support DECC with its work in whole system modelling and is likely to develop a suite of software tools and data to that end. The tools and data will also be available to industry to support the simulation, testing and demonstration of potential new products and services to enable smart grids.
- The **ENA has established an annual two day Low Carbon Network Fund conference** designed to share learning from the LCN Fund trials. The conference has grown in recent

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<sup>22</sup> TSB is sponsored by BIS and its goal is to accelerate economic growth by stimulating and supporting business-led innovation.

years (some 650 people attended in 2013) and attracted a significant trade exhibition with world-class innovation evident. It has also created a portal for showcasing the innovation projects being demonstrated by the network companies (see Figure 7 below).

**Figure 7: The ENA Smarter Networks Portal (with permission of ENA)**



Source: Energy Networks Association (ENA)

- **The National Skills Academy for Power is developing a smart grid skills strategy**, which includes undertaking resource planning forecasts, identifying emerging skills and ensuring sufficient education and training provision. This will help to ensure that Great Britain has sufficient skilled workforce to deliver a smart grid.
- **The Institution of Engineering and Technology (IET) has convened an expert group called Power Network Joint Vision to consider the changes to system characteristics and complexity now emerging.** It has made recommendations for addressing whole-systems thinking that will be important to ensure the secure operation of the British power system as the penetration of automation and intelligent devices rises and interdependencies grow between consumers, distribution networks, and transmission networks. The IET published a position statement, *'Electricity Networks – Handling a Shock to the System'* and a technical report in December 2013. Work is continuing to scope the next stage<sup>23</sup>.

<sup>23</sup> Electricity Networks – Handling a Shock to the System: IET Position Statement on the whole system challenges facing the UK electricity network, IET, December 2013, <http://mycommunity.theiet.org/energy/pnjv>

- The **Energy Technologies Institute's Smart Systems and Heat Programme** is identifying possible locations for demonstration projects for its £100 million programme which is focused on developing solutions and systems which will help to deliver efficient heat and comfort to meet local requirements across the UK. It aims to develop a detailed understanding of consumer needs, responses and behaviour for heat consumption, infrastructure and ICT requirements to support a smart energy system, supportive business models, the needs for an effective supply chain and technology development, and analysis of efficient network transition.
- In terms of the foundations for wider developments, **the Smart Cities' initiative** was launched by the Department for Business Innovation and Skills in October 2013<sup>24</sup>. This initiative looks beyond a smart grid to provide the foundations for how all smart sectors including smart grids, will contribute to delivering smart cities which are seen as increasingly important.

## Gaps and further actions

37. The Government has published policies over recent years to clarify the nature and scope of the low carbon transition and the future of the electricity system. The regulatory framework has been reformed to rise to the challenges of delivering a low carbon Britain. Concerted action by DNOs with a wide range of stakeholders to test smart grid approaches has put us in a leading position in Europe, and the development of a parametric model by the Smart Grid Forum (the Transform Model) has been useful in supporting decision making and provided a catalyst for cross industry working.
38. These positive developments have prepared the ground for the next steps but there is continuing need to provide strategic direction on the future of the electricity system and smart grids to build and sustain confidence in the direction Great Britain is taking. Without this it is difficult for the industry, consumers and the supply chain to invest for the future.
39. Building on this, it is important that we move from field trials and testing to deployment of smart technologies as business as usual. Strong leadership from network operators to implement the changes in working practices to enable this to happen will be critical at this time of major transition for the industry. The development of smart grids in Great Britain will falter if network operators and their supply chains do not rise to the challenge. The whole system integration challenges mentioned earlier will need to be addressed in this transition.
40. The focus of much of the work to date has been on the electricity system. A better understanding of how smart systems might operate in an energy system wide context and the contribution smart technologies can make in integrating other energy sources and approaches such as heat storage is also needed.
41. As we move from these early steps towards implementation, monitoring progress will be important. A comprehensive set of indicators is not yet available and their development will help track progress and see where more work is necessary.

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<sup>24</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/249423/bis-13-1217-smart-city-market-opportunities-uk.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249423/bis-13-1217-smart-city-market-opportunities-uk.pdf)

42. Specific actions to address these strategic gaps will help us in the 'Development Phase' of the Routemap which is focused on realising short-term benefits and preparing the ground for the expanded deployment of distributed generation and increased electrification of heating and transport in the 2020s:

- **All DNOs must continue to show strong leadership in deployment of successful smart grid pilots as business as usual.** Building on their positive work to date, DNOs need to ensure strong links between engineering, operations and IT departments within their organisations to enhance data collection in support of operational and strategic planning over the next price control period (2015 to 2023). This will show that smart approaches can deliver tangible benefits for peoples' everyday lives, and help maintain and boost support.
- **DECC will make available to the Smart Grid Forum scenarios and data** to ensure the Transform Model remains up to date. This includes data underpinning the delivery of the 5<sup>th</sup> Carbon Budget (2028-2032). This will strengthen the evidence base for smart grids and provide the link between government ambition and implementation, and provide a foundation stone for collective action.
- **The Smart Grid Forum to consider widening the scope of the Transform Model.** In 2014 the Smart Grid Forum will discuss with EA Technology, the ENA, ETI and other interested parties, on whether the Transform Model might be adapted to provide estimates of cost savings and what data inputs are necessary to evaluate the benefits of Combined Heat and Power, District Heating and storage into an economic analysis of smart grids.
- **The Smart Grid Forum will consider how to develop a set of indicators of smart grid implementation to help track progress.** Now that there is a significant amount of work underway it is increasingly important that we can track progress so we can identify where additional effort is needed to maintain progress, otherwise there is a risk of losing momentum and focussing on the wrong areas.



## 5. Commercial and Regulatory Frameworks

### The challenge

43. The challenge is to ensure that regulatory and commercial frameworks facilitate the deployment of smart technologies and smart solutions. These frameworks must incentivise innovation and efficiency and support new commercial arrangements, whilst protecting consumer and customer interests.

### Why important

44. The development of a smart grid is raising new issues and questions for our existing regulatory and commercial framework. Network operators, suppliers and regulators need to facilitate low carbon deployment in generation, supply and consumption, while ensuring security of supply. The system is becoming much more complex as the need to balance supply and demand at local levels intensifies and there is a need for technologies that enable the intelligent control of the network, including a much greater role for storage.

45. Investment will be required in the short-term to develop these systems in order to start preparing for the projected take-up of low carbon technologies. As the investment that will be needed in the future may be significant, it is also beneficial to spread the cost now through shorter term investment. Existing regulatory and commercial frameworks need to evolve to incentivise this investment, while at the same time, ensure that all stakeholders (network operators, suppliers, generators and consumers) are able to participate fully in the deployment of smart grids and that benefits are fairly distributed along the value chain. They need to enable the introduction of new consumer incentives, for example, time of use tariffs, which encourage consumers to use energy at times of the day when it is cheaper to do so (e.g. off-peak).

### Progress to date

46. Significant progress has already been made:

- **The Low Carbon Network Fund was introduced in 2010 to encourage network companies to sponsor projects, which trial innovative technological operating and commercial arrangements**, to facilitate the transition to a low carbon future. The aim of the Tier 2 annual competitions is to help network companies to understand what they need to do to provide security of supply at value for money, as Britain moves towards a low carbon economy. (See Technology Innovation and Growth section for more information).
- **Ofgem has introduced the new RIIO framework** to enable distribution networks to help deliver a low carbon Britain (see box).

**RIIO-ED1 Price Control (2015-2023)**

The RIIO model includes incentives to drive the innovation needed for a smarter energy network at value for money for existing and future energy customers. Under this model, network companies are expected to adopt smart solutions where they are cost-effective in comparison to conventional solutions.

The package of incentives contained in RIIO-ED1 is designed to ensure that network companies consider these solutions upfront, while also delivering during the RIIO-ED1 period. The interruptions incentive puts a strong motivation on companies to anticipate the increased loads from low carbon technologies, and ensure that they do not overload network assets. The efficiency incentive ensures that the DNOs do not over-invest to avoid interruptions. It incentivises the companies to look for the most cost efficient solution, which will drive the DNOs to adopt smart solutions, including Demand Side Response, in many cases.

The package of connections incentives (time to connect incentive, customer satisfaction and connection engagement) are designed to encourage the DNOs to consider the needs of customers connecting low carbon technologies and distributed generation. Network companies are also expected to maximise the benefits they can achieve from all forms of data, including but not limited to, data from smart meters.

- **In December 2013 Ofgem published the response to a consultation on DSR<sup>25</sup>.** The document summarised stakeholder views on the key challenges to the efficient system-wide use of DSR. A key gap identified by stakeholders was the lack of a DSR framework which formalises cross-party interactions. Working with the Smart Grid Forum, Ofgem will aim to fill this gap by developing a framework for DSR that accommodates cross-party efforts to improve practices and decision-making across the value chain.
- **In July 2013 Consumer Futures published a detailed paper on DSR and the domestic consumer<sup>26</sup>.** This paper estimated that with the correct regulatory framework, smart solutions including DSR could save between £2 billion and £4 billion throughout the value chain to 2050, compared to conventional grid upgrades and that the regulatory framework must ensure that the resulting savings from such investment are passed back to consumers in a fair and proportionate manner. The paper sets out a number of recommendations, one of which states that investment in the smart grid should be planned in consumers' best interests, including with regard to the timing and magnitude of major investments, and consider how these interact with periods of higher cost burdens in other areas of the energy system, particularly generation.

<sup>25</sup> <https://www.ofgem.gov.uk/publications-and-updates/creating-right-environment-demand-side-response-next-steps>

<sup>26</sup> <http://www.consumerfutures.org.uk/files/2013/07/Smart-grids.pdf>

## Work underway

47. There is a range of work underway that will help strengthen regulatory and commercial frameworks further.

- **The Smart Grid Forum is considering the commercial and regulatory barriers** to the deployment of smart grids in GB and working with a wide range of stakeholders (see box below).

### **Smart Grid Forum consideration of regulatory and commercial barriers to smart grid deployment**

The Smart Grid Forum established a workstream in May 2013 to identify and address any regulatory or commercial barriers to implementing the smart grids solutions DNOs may deploy in RIIO-ED1. In particular, the workstream, which will report later in 2014 will consider: the barriers to deploying smart solutions; identify new commercial arrangements (i.e. the contractual arrangements between customers, DNOs, suppliers and other industry parties) that provide the most efficient outcomes across the value chain; outline options for customer engagement with potential parties (supplier, DNO, system operator, aggregator) in the supply chain to undertake this engagement; and highlight the potential barriers to the most efficient development of the commercial arrangements to support smart grid solutions in the longer term.

- **The Smart Grid Forum is considering how scalable commercial models for non-firm connections (i.e. where connected parties sign up to interruptible connections) can be rolled out across Great Britain**, as a means of speeding up connection times and helping to avoid the need for network reinforcement.
- **The ENA is working to revise Engineering Recommendation P-2/6 to make it clear that demand side response can be taken into account** as an alternative to network reinforcement, whilst maintaining security of supply. In doing so it is drawing on the learning from Electricity North West's Capacity to Customer project.
- **The ENA has formed a working group to propose models of how DSR can be 'shared' across network companies** in the first instance with a view to outline how such a model could work across all interested parties e.g. suppliers, aggregators, DNOs, Transmission Owners, and National Grid.
- **DECC has chosen a market-wide Capacity Market open to parties who are able to provide reliable capacity, including DSR and storage.** Transitional auctions for DSR and storage will be held in 2015 and 2016 for delivery in 2016/17 and 2017/18, to enable parties to build capacity and capability ahead of the first delivery year.
- **DECC, Ofgem, the ENA and network operators are working together to help shape the new European Network codes** being developed as part of the Third Energy Package<sup>27</sup> to ensure they reflect the needs of Great Britain's networks.

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<sup>27</sup> The European Third Energy Package came into law on 3rd March 2011 and is the next step forward towards developing a more harmonised European Energy market.

## Gaps and further actions

48. Initial work focused on whether the current regulatory and commercial arrangement can support smart approaches to accommodate pre-2020 levels of low carbon technologies. It has become evident that as the scale of decarbonisation intensifies and the potential value of DSR and storage increases, the regulatory and commercial structures will need reform.
  49. A DSR framework formalising cross-party interactions does not exist and establishing this will be important to leverage the full benefit of DSR. At its core, smart systems are about collecting and using data, so further work is needed to ensure that access to consumer data in support of DSR is accompanied by safeguards to protect privacy. Increasingly, Europe is shaping the regulatory environment in which member states will operate and there is a need to ensure we are fully engaged so that developments in the EU support our smart grid vision in Great Britain.
  50. The specific actions (noted below) designed to help address these gaps will help build the foundations for the second phase of smart grid deployment, which is characterised by a greater role for the consumer, the enlargement of community energy, and increasing electrification of heat, transport and more distributed generation. This will also contribute to supporting the increasing need to balance the electricity system at local levels opening the way for DNOs to potentially play a local system operator role to manage local system constraints and offer balancing services.
    - **The Smart Grid Forum is exploring different smart pathways to deliver DSR and examine the commercial and regulatory arrangements and requirements for consumer engagement.** For each potential pathway, the roles and relationships for each party in the value chain will need to be defined. This work, along with an assessment of how storage can be accommodated within the regulatory and commercial framework, will be published by Smart Grid Forum later in 2014 to provide an understanding of what changes will be needed to maximise the benefits of DSR and storage.
    - **Work will be carried out to maximise the value of smart meter data, while ensuring customer privacy provisions are in place.** This will help ensure network operators have the means to deploy demand side management and storage without undermining consumer confidence in smart approaches. It will also provide a means to measure and potentially manage electricity system losses. Both DECC and Ofgem are involved in assessing DNOs' data aggregation plans for the use of smart meter data to ensure they strike the right balance between a level of data access for DNOs proportionate to their needs and protecting consumers interests so that they remain confident their privacy is protected.
    - **Ofgem will respond to a public consultation by the Council of European Regulators on the future role of Distribution Service Operators, to be completed in late 2014.** As smart grids are rolled out across Europe, it is important to consider whether the framework of regulation as it currently applies at distribution level is adequate to accommodate the changes which are likely to occur.
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## 6. Customer Participation

### The challenge

51. The challenge is to ensure that the Government, Ofgem and the electricity industry communicate effectively the benefits that will accrue to customers<sup>28</sup> and the energy system more generally, through the adoption of smart grids, changing market structures and engaging willing consumers in active management of their demand or distributed generation.

### Why important

52. Smart grids are a major shift from the way the industry operates today. Whilst most industry stakeholders are familiar with the changes, few residential or business customers are. Creating new and adapting existing regulatory and commercial frameworks will be essential (see the Commercial and Regulatory Frameworks section), but the more novel change will be establishing new or different relationships with customers. By managing their energy use patterns according to price signals through demand side response, customers can make significant contributions to energy system management, often at lower cost and lower carbon than traditional approaches.

53. Apart from some commercial and industrial customers, most customers have relatively passive relationships with their electricity consumption today. As the smart grid evolves, however, there will be more active roles for customers of different sizes to play - for example, domestic customers with smart meters could choose tariffs and make use of smart appliances that shift demand away from peak times; large industrial and commercial customers can participate in an expanded range of demand response schemes and the capacity market; and small-scale generators can participate in demand response schemes and the capacity market by adjusting export to the grid.

54. Customer participation is strongly influenced by the structure of the electricity and gas markets. Changes to market structure could therefore be beneficial as the technology develops. For example, the use of the smart grid could enable much finer granularity of pricing to be achieved. Locational pricing might reflect the availability of locally generated power or difficulties of pinch-points in the distribution network.

55. A number of studies have demonstrated that consumers appreciate automated load shifting systems and tend to shift more energy when control systems are provided that respond to price signals to delay energy usage. Consequently, it is expected that automated appliances (e.g. washing machines, dishwashers) and heating systems will appear on the market that respond automatically to price signals to help decrease bills. There are considerable challenges of integrating these into the smart grid network using industry standards and in a manner that is acceptable to the consumer.

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<sup>28</sup> The term 'customer' encompasses both consumers of energy and producers of energy in this section

56. Demand Side Response (DSR) should beneficially help to reduce the requirement for additional network capacity by shifting demand away from peak periods. However, with strong contributions from zero carbon, but intermittent, generation such as wind and solar PV, a strong and potentially competing market call on DSR will be for system balancing and matching demand more closely with variations in output from zero marginal cost generation.

### **Demand Side Response**

Demand Side Response (DSR) is an active, short-term reduction/shifting in consumption of energy demand at a particular time. This usually means shifting demand away from periods where the cost of electricity is higher, to periods where the price is less. In practice, this could mean for example, exploiting time of use tariffs by setting the dishwasher to run at a time when it is cheaper to do so. In this way DSR could reduce the total capacity needed on the system, reducing the need for fossil-fuelled peaking plant and network reinforcement.

Engaging customers in DSR activities presents a significant opportunity and challenge for DNOs and suppliers. At a domestic level, customers will expect to be rewarded for their involvement, and will also expect to be able to make use of the latest technology (in the form of smart appliances) to ensure they are getting the best deal available. Locational pricing may reflect the availability of local generation in the network.

Commercial customers may well see the use of DSR as a significant opportunity to reduce energy costs within their business by changing operating practices (such as running certain processes or performing various tasks at 'off-peak' times).

## **Progress to date**

57. There has been significant progress to date, including:

- As part of the Smart Metering Implementation Programme, **the Central Delivery Body (CDB) has been established by suppliers to centralise consumer engagement activity. The CDB's objectives are primarily to build awareness, understanding and willingness for the smart meter rollout amongst consumers, including vulnerable groups and microbusinesses.** This could be a channel for communicating the wider benefits of the Smart Grid as well.
- **Smart Grid GB has published *Smart Grid: A great consumer opportunity*<sup>29</sup> which outlines customer benefits and best practice for engaging consumers.** The report also describes the future role and responsibilities of customers, and barriers for industry stakeholders in engaging customers in more active roles.

<sup>29</sup> <http://www.smartgridgb.org/benefits-of-smart-grid/item/327-sggb-holds-briefing-in-uk-parliament-on-their-report-smart-grid-a-great-consumer-opportunity.html>

## Work underway

58. Industry stakeholders have acknowledged the importance of customer engagement and many activities are underway to explore how customers can be part of Smart Grid solutions in future:

- A number of the **Low Carbon Network Fund trials are addressing the role of different stakeholders** in identifying, recruiting and rewarding customers to actively manage their energy use, through behaviour change and control technologies.
- In addition to the smart meter rollout, **many UK energy suppliers are trialling and deploying ‘smart home’ energy technologies**. Through this work suppliers are learning about customers’ willingness to engage with automation technologies and the incentives that may be most appropriate.
- The **ENA is developing the necessary systems and processes to ensure data privacy and security** can be accommodated through appropriate aggregation of consumption data provided by smart meters. These plans for data aggregation are subject to Government approval.<sup>30</sup> This work will help provide the correct balance between enabling network operators to use data to support DSR and protecting consumer privacy.
- There are a **number of research projects underway exploring the potential of customer involvement in demand side management and engagement techniques which will help us to understand how to engage customers**. For example, Sustainability First<sup>31</sup> is leading a major three-year project to understand the potential out to 2025 of the GB electricity DSR across all sectors of the economy. The project has a strong practical focus on policy, regulatory, commercial and consumer issues and its work is co-ordinated through a multi-partner Smart Demand Forum. The Energy Technologies Institute is developing Smart Systems and Heat capability with the ambition to create future-proof and economic local heating solutions for the UK.

## Gaps and further actions

59. Despite some good progress through a number of initiatives, we are still at an early stage in understanding what influences customer behaviour in the field of smart grids. There is, therefore, a need to engage customers in a dialogue to understand their requirements and potential issues. This includes consideration of disadvantaged consumers to ensure that the benefits of smart grids are widely dispersed. Allied to this is the need to learn how best to engage with customers. This is important because unless customers are engaged in the active management of their demand or distributed generation, the full potential of smart systems will not be realised.

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<sup>30</sup> Plans submitted up to 31 December 2014 are subject to approval by the Secretary of State; plans submitted after this date are subject to approval by Ofgem.

<sup>31</sup> GB Electricity Demand Project – realising the resource’. Sustainability First - [www.sustainabilityfirst.org.uk](http://www.sustainabilityfirst.org.uk)

60. The following specific actions complemented with on-going work, will help to realise the 'empowered consumer' stage of the Routemap. In particular, the Smart Grid Forum will take forward work to:

- **Improve understanding about who is best placed to understand, engage and inform consumers** to help them participate in different aspects of new smart electricity markets. Potential actors include suppliers, DNOs, aggregators, local authorities, product retailers, electric heating installers, electric vehicle or heat pump retailers, and potentially, future Distribution Service Operators. This will help build credibility and trust.
- **Understand how best to balance benefits amongst active customers, through direct rewards or cost-reflective tariffs, and the customer base as a whole** through lower Distribution Use of System (DUoS) or wholesale charges. This is important to ensure that not only the active or those with the greatest means or interest, benefit.
- **Further our understanding about factors which influence consumer behaviour**, such as cost, carbon reduction, convenience, new technology, as well as social attitudes and context, and what incentives are needed, to achieve lasting change to ensure consumers offers are tailored to customer needs, which will help take-up.
- **Explore in the near-term the opportunities to articulate the wider benefits of smart grids alongside the roll-out of smart meters with the Smart Meter Central Delivery Body**. This could provide a key opportunity for dialogue with customers.
- **Ofgem and DECC to consider the role of multiple tariffs in encouraging DSR** in the context of the simplification of household tariffs delivered by Ofgem's Retail Market Reforms.

## 7. Technological Innovation and Growth

### The challenge

61. The challenge is to ensure that the UK smart grid supply chain and SMEs in particular are able to support the development of smart grids and benefit from the commercial and growth opportunities presented both in the UK and overseas.

### Why important

62. Smart grids present significant commercial opportunities for innovation, technological development and the development of new skills and employment – we need to be on the front-foot to maximise benefits for UK industry both domestically and internationally. If the opportunities are seized, the UK can benefit from increased investment, new jobs and exports of both products and expertise.

### Smart Grid: A Race worth Winning?

In 2012, SmartGrid GB produced a report<sup>32</sup> that provided the broadest assessment to date of the potential economic impact that innovation in smart grid technologies could have for UK industry.

The report estimated that to 2050, smart grids could be worth approximately £13bn of Gross Value Added and £5bn in exports. It also found that smart grids could support 8,000 jobs to 2020 and 9,000 jobs to 2030.

The report examined the benefits that generate value across the whole British supply chain and particularly from the expansion of secondary industries in areas where the UK is especially strong.

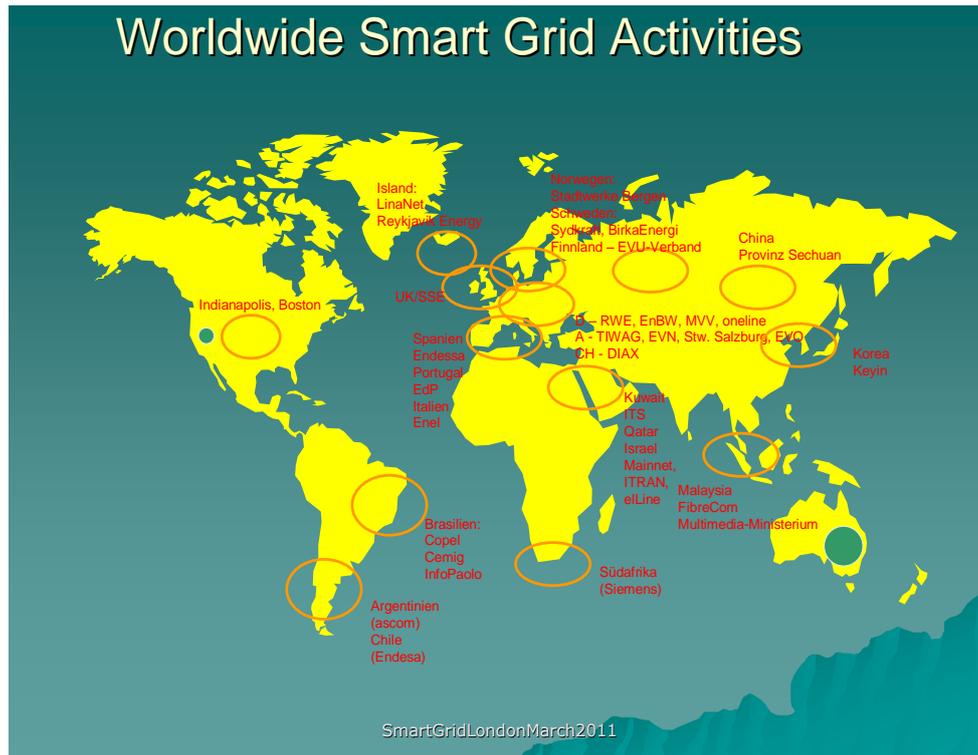
The economic analysis in the report points to two major findings. Firstly, the investment case for the creation of smart grid networks is strong in many countries around the globe, not just the UK. Secondly, the timely development of smart grid technology has the potential to unlock significant benefits in the UK across both the smart grid supply chain and in other industries, resulting in economic growth, jobs and exports.

Source: SmartGrid GB

<sup>32</sup> Smart Grid: A Race worth Winning' <http://www.smartgridgb.org/benefits-of-smart-grid/item/46-smartgrid-gb-report-assesses-economic-impact-of-smart-grid-development-in-great-britain.html>

63. The global market for smart grids is considerable. Zpryme Research<sup>33</sup> estimated a global market size of \$220 billion by 2020 for smart grid technology, rising to \$500 billion by 2030. The US Department of Energy (DOE) report, '*Economic Impact of Recovery Act Investment in the Smart Grid*' states that smart grid projects in the USA funded through the American Recovery and Reinvestment Act (ARRA), created nearly \$7 billion total economic output, nearly 50,000 jobs, and over \$1 billion in tax revenue<sup>34</sup>. The map in Figure 8 shows where the major smart grid projects are now occurring.

**Figure 8: Smart Grid developments around the World**



Source: (Original Prof John Newbury, Open University)

64. SMEs have participated in the ground-breaking Low Carbon Network Fund projects and there is an opportunity to help grow a service market in smart grids. The supply chain is critical to the successful deployment of innovative solutions and to scale deployment. Vendors are represented on the Smart Grid Forum and its working groups (through relevant trade associations) and their contribution will be valuable to addressing issues now emerging.

65. These include the entry of start-up SME companies into a sector that for many years has purchased equipment from large international manufacturers. Small companies often pioneer innovation but report concerns such as the treatment of Intellectual Property,

<sup>33</sup> Global Smart Grid Technology Forecast (2012-2020), December 2012, Zpryme Research

<http://smartgridinsights.com/market-data/global-smart-grid-technologies-market-forecasts-2012-2020/>

<sup>34</sup> <http://www.smartgrid.gov/sites/default/files/doc/files/Smart%20Grid%20Economic%20Impact%20Report.pdf>

procurement processes and contracts that are geared for large vendors, and stop/start work programmes that are problematic for staffing and cash flow. Today's multi-party supply chains may also result in situations where the party making an investment may not be the party that gains the benefit; where this concern arises it is not restricted to SME companies.

66. The challenge for UK industry therefore is to ensure we have an environment that both supports UK innovation to influence the development of the standards and then allows the UK to commercialise the resulting products and develop export opportunities.

## Progress to date

67. There has been significant progress to date, including:

- Building on the success of the Registered Power Zone incentive and the LCN Fund, **Ofgem has now introduced the Network Innovation Allowance and Competition to fund innovation across gas and electricity transmission and distribution.** The Innovation Competitions under the RIIO framework, will encourage network companies to compete for funding for research, development and demonstration of new technologies and operating and commercial arrangements. The aim of these annual competitions is to help network companies to understand what they need to do to provide security of supply at value for money, as Britain moves towards a low carbon economy.
- **Horizon 2020, the next EU Framework Programme for Research and Innovation, will run from January 2014 to December 2020.** Horizon 2020 aims to secure the EU's global position in research, innovation and technology and is designed to create new growth and jobs in Europe and help to implement the EU's Strategic Energy Technology Plan to achieve the EU's 2020 energy and emission targets and its 2050 vision. It puts strong emphasis on pooling national innovation efforts into wider European co-operation.
- A recent Arup report<sup>35</sup> commissioned by the Government as part of the Smart Cities initiative has made a number of recommendations for future work in smart energy. In particular, this report suggests **increased cooperation is needed between industry and research communities to ensure learning is shared and to help inform product development.**
- **DECC, through its Energy Entrepreneurs Fund is funding around 100 small companies in developing innovative products** to lower carbon emissions, including projects relevant to load shifting, smart grid communications and automated demand control equipment. It is also investing £35 million with SMEs to develop a variety of innovative products that are allowing SMEs to obtain a foothold in this market.
- **In the UK there is much on-going standardisation activity, co-ordinated through L13, in BSI, committee on smart grids<sup>36</sup>.** Through the national standards committees, L13, there are strong links forged with other European and international standards bodies

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<sup>35</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/249423/bis-13-1217-smart-city-market-opportunities-uk.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249423/bis-13-1217-smart-city-market-opportunities-uk.pdf)

<sup>36</sup> <http://standardsdevelopment.bsigroup.com/Home/Committee/50222359>

and BEAMA<sup>37</sup> that represents the electro technical industry, are active participants in this work at UK and EU level providing representation from the UK supply chain.

- **Smart appliances are a key component to the smart grid and BEAMA is already taking work forward** through the BEAMA Smart Housing Association and Smart Grid Task Force, developing specifications for how the smart control within a home will operate, to ensure interoperability of systems and connection with the grid.

## Work underway

68. There is a range of work underway that will strengthen further the position for UK companies:

- **A large number of organisations are developing the UK's position in the smart grid industry, to influence the design of standards and specifications that EU bodies will be progressively introducing over the next three to five years.** The European Parliament, in conjunction with the European Commission, has established a 'Smart Grid' working committee for Europe. The aim is the establishment of a framework of standards forming the basis for a smart grid for all residential homes, industrial buildings and associated buildings. BSI, trade associations from across the supply chain (such as BEAMA, Tech UK, EUTC and the ENA), and Institutions (such as the Institution of Engineering and Technology) are engaged on international and European standards development. Many trade associations have close engagement with the EU Commission's Smart Grids Task Force<sup>38</sup>.
- **DECC is managing two schemes that provide support for innovation in energy storage<sup>39</sup>** - a large-scale Energy Storage Technology Demonstration Competition and a Component Research and Feasibility Study Scheme – the competitions, which have a combined total budget of up to £20m, are intended to support innovation in storage technologies to secure cost-reduction, enable wider deployment of energy storage and bring the technologies closer to market.
- **The Energy Technology Institute (ETI)** is planning<sup>40</sup> a major smart energy system demonstrator to start in 2015, through its industry and Government membership.
- **UK Trade and Investment, SGGB, BEAMA, and Tech UK are involved in identifying the UK supply chain for smart grids, and developing export opportunities.**
- **Smart Grid GB is currently scoping further work on the broader economic benefits case for smart grid development** that will include detailed analysis of how benefits will flow across the supply chain. This work will provide a greater appreciation of the wider economic benefits of smart grids in terms of supporting new industries such as electric vehicles.

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<sup>37</sup> <http://www.beama.org.uk>

<sup>38</sup> [http://ec.europa.eu/energy/gas\\_electricity/smartgrids/taskforce\\_en.htm](http://ec.europa.eu/energy/gas_electricity/smartgrids/taskforce_en.htm)

<sup>39</sup> Further details of the projects being supported by these schemes can be found at: <https://www.gov.uk/innovation-funding-for-low-carbon-technologies-opportunities-for-bidders#closed-schemes-still-current>

<sup>40</sup> [http://eti.co.uk/downloads/related\\_documents/Smart\\_Cities\\_Richard\\_Knight\\_17th\\_April\\_2012.pdf](http://eti.co.uk/downloads/related_documents/Smart_Cities_Richard_Knight_17th_April_2012.pdf)

- **BEAMA recently co-hosted an event which focused on the future of the smart grid market and opportunities for SMEs and start-ups in the UK and abroad.** The event, which looked at addressing the current barriers to market for SMEs was attended by over 40 SMEs working in the smart grid sector. Work is now on-going to develop a longer term initiative to support SMEs and provide a link for SMEs to inform policy, regulations and standards for the industry as the market develops. This is in addition to on-going trade association activity, supporting manufactures in the smart grid supply chain.
- **The Engineering and Physical Science Research Council (EPSRC) is funding a number of university groups to both model and demonstrate concepts in the smart grid as part of the Highly Distributed Energy Futures SuperGen<sup>41</sup>.** The group has delivered a number of initiatives which include improving the reliability of energy supply at a minimum cost and to deploy renewable and distributed generation in the context of Asset Management.
- **The Technology Strategy Board will launch a new Energy Systems Catapult<sup>42</sup> in April 2015** to bring together a critical mass of energy systems engineering design, simulation and demonstration capability and is currently running R&D competitions to develop local energy systems and the supply chain. This will give the opportunity to pilot and demonstrate full energy system integration not just electricity systems.
- **The Low Carbon Innovation Coordination Group (LCICG) Strategic Framework**, to be published in early 2014, is intended to guide technology prioritisation and innovation programme planning over the next decade by the 17 government funders of low carbon innovation in the UK. It builds on previous LCICG work to build the evidence base - the TINA project<sup>43</sup>. The Strategic Framework covers technology areas, including electricity networks and electricity storage.
- A range of smart grid pilots are noted in the following box.

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<sup>41</sup> [www.epsrc.ac.uk](http://www.epsrc.ac.uk)

<sup>42</sup> <https://www.catapult.org.uk/>

<sup>43</sup> TINAs (Technology Innovation Needs Assessments) are a collaborative LCICG project, creating an evidence base to guide innovation programme planning. TINAs focus on meeting targets at lowest cost and boosting economic growth.

### Smart grid pilots

There are a wide range of smart grids pilot programmes that will strengthen knowledge and understanding of smart grid potential. A sample of projects that highlight some of the challenges facing the distribution network and show a variety of potential commercial and technical solutions, are noted below. A more comprehensive list of the project can be found on the ENA smart grid portal<sup>44</sup>

- **Low Carbon London project** – led by UK Power Networks in conjunction with Imperial College and EDF. This project seeks to learn the effect on relieving networks by the introduction of widespread industrial and commercial demand side response (DSR).
- **New Thames Valley Vision** – a Low Carbon Networks Fund project led by Scottish and Southern Electric Power Distribution. This project seeks to develop a tool that helps predict the take-up of low carbon technologies by consumers.
- **The Customer-led Network Revolution project** – led by Northern Powergrid in conjunction with Durham University, Newcastle University, EA Technology and British Gas. This project seeks to trial how a combination of smart network technologies and flexible customer demand response, can reduce the network costs associated with the mass take-up of low carbon technologies
- **Capacity to Customers, C<sub>2</sub>C, project** – led by Electricity North West. This project trials ways to avoid conventional reinforcement by using latent capacity in High Voltage and Extra High Voltage networks.
- The **So La BRISTOL project** – led by WPD. This project aims to address network constraints arising on low voltage networks due to the adoption of solar by using domestic storage.
- **Orkney Active Network Management Scheme** – led by Scottish Hydro Electric Power Distribution. This project uses Active Network management technologies and innovative commercial arrangements to optimise capacity on remote networks to allow increased connection of renewable technologies
- **Accelerating Renewable Connections (ARC)** - led by Scottish Power, this project looks at how to tackle barriers to timely connection of renewables and investigate the role communities can play in the connection process.

<sup>44</sup> <http://www.smarternetworks.org/>

- **Ofgem and the Government are also ensuring the right regulatory and policy frameworks are in place to foster the necessary innovation.** For example, DECC is ensuring that the smart metering equipment that is being installed in Great Britain provides the required physical functionality (e.g. load control, Time of Use tariffs, outage management) to work in conjunction with the smart grid and have ensured that the smart meter communications services are flexible and scalable to support smart grid capability. BEAMA are working with DECC to define the technical requirements for Consumer Access Devices, which will provide a potential link between significant loads in the premises and the smart meter, a critical element for smart housing.
- The **smart grid also forms the backbone of a much wider Government initiative<sup>45</sup> looking at developing ‘Smart Cities’.** This initiative, being supported by both the Department for Business and the Cabinet Office, seeks to enable the UK to gain at least 10 per cent (£40bn) of the worldwide global market for smart systems, including £22bn for smart power control systems. The European Commission has signalled its commitment to developing a Europe-wide capability in Smart Cities by establishing a European Innovation Partnership on Smart Cities and Communities. The European Commission is being advised by a High Level Group, which in turn is supported by a team of experts drawn from business. Representatives from the UK are actively shaping this activity.

## Gaps and further actions

69. It is clear that the potential for jobs and growth is significant and already being realised in some parts of the world, and there is a significant amount of work underway. However, the UK needs to build on the extensive expertise and experience it has developed in trialling smart grid technologies over the past decade and translate this into commercial opportunities. Whilst many smart technologies have been trialled, we need increasingly to move from proof of concept to reality. Some of the UK deployments are fully commercial and clearly beyond demonstration stage, others are fully-functioning and operational, but they are at a ‘pre-commercial’ stage.
70. More work is needed to improve communication to SMEs of the commercial opportunities that smart grids present, to grow our domestic industry and actively promote UK smart grid products and expertise in overseas markets. If the challenge is not met, there is a risk that a valuable opportunity to benefit from past investment in research and development, which has been a highlight of the UK experience to date, is wasted.
71. Product standards are also a key element informing the direction of technology development. Whilst we have been engaged in international and European Standards setting bodies, we need to intensify our participation and raise our efforts in shaping these standards to ensure smart grid products will support our vision, align with EU and international expectations and boost our growing supply chain. The recent development of the European Smart Grid Architecture Model (SGAM) is a case in point where UK engagement and alignment would strengthen our position and influence the evolution of

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<sup>45</sup> <https://www.gov.uk/government/news/new-initiative-to-support-40-billion-smart-cities-in-the-uk>

smart grid standards and methodologies. The following actions are will help ensure we reach the third phase of the Routemap, which is to provide benefit from export opportunities:

- **Work is needed to better understand the opportunities for UK businesses, export opportunities and the barriers to realising this.** Importantly, the step-change in the market from pilot level implementation to business as usual needs to be effectively managed and manufacturers need a clear understanding of the market potential in order to develop a strong UK supply chain. This is being taken forward by BEAMA and SGGB. SSGB intends to address these issues through in its further work on the economic benefits case for smart grid development which will be published later in 2014. **ENA will work with SGGB and BEAMA to strengthen this element in the Low Carbon Network Fund Annual Conference in 2014.**
- **More engagement is needed to influence the European agenda.** There is likely to be far more activity in the near future and therefore the development of a coherent UK strategy for smart grid standards will help strengthen the UK commitment and develop negotiations at European and international level. With the degree of innovation in the UK market there is an opportunity to shape standards to influence international markets. **The Smart Grid Forum will work with supply chain trade associations to consider how to influence the European agenda on the development of product and other standards for smart grids and develop recommendations on next steps later in 2014, and will explore the opportunities provided by the new EU Smart Grid Architecture Model.**
- **Smart appliances are a key component of the smart grid, and impact on consumer energy use, but the interface between smart networks and in-home appliances will benefit from far deeper exploration.** Network operators could, for example, develop demonstrations projects under the Low Carbon Network Fund on how network and in-home appliances might interact as well as looking to develop closer links with the data analytics industry. In order to support the further development of the smart grid market, the network operators, suppliers, intermediaries and supply chain should work in close collaboration giving opportunities and support to UK businesses. BEAMA will ensure close liaison with DNOs in order to inform the scope of future innovation projects that may focus on this area. **BEAMA will work with supply chain trade associations and other relevant organisations to facilitate this objective and present their findings to the Smart Grid Forum on progress and recommended next steps later in 2014.**
- Work is needed to **draw on the lessons learnt from similar industries (e.g. the mobile phones, consumer electronics, television, computer and security industries) to see how market change can be effected quickly** and to the benefit of the UK supply industry overall. **The Smart Grid Forum will consider including this in its work programme later in 2014.**
- **EU Energy Focus<sup>46</sup>** will engage with the **Smart Grid Forum** and its members, to explore opportunities for UK institutions, companies and researchers to develop bids and then to benefit from appropriate Horizon 2020 Grids and Smart Cities project funding support.

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<sup>46</sup> EU Energy Focus is contracted by DECC to act as the UK's National Contact Point service, offering advice and assistance in engaging with and bidding for European Commission energy technology development programme funding

## 8. Conclusion

72. Great Britain has made significant progress to date in developing and deploying smart grids. It is recognised as a European leader with respect to investment in smart grid research and demonstration projects. Success has been delivered through a range of work and initiatives, including the £500m Low Carbon Network Fund, which funds network company innovation projects designed to test and trial new smart grid technologies and solutions. This will be further encouraged through Ofgem's new RII Price Control model that places greater emphasis on supporting network innovation. The nationwide rollout of smart meters has also begun, which will help improve network management and facilitate demand response. Great Britain now needs to build on its initial successes and ensure it remains on track to delivering its Smart Grid Vision.

### Strategic direction

73. The nature of the work to date has been focussed on preparing the ground for, and testing and piloting of, smart grid solutions. It is important that this continues and a degree of flexibility is retained to ensure smart responses can evolve as more is learnt. It is also vital that, where solutions are proven, they are incorporated into business as usual operations to deliver tangible benefits in the short-term. This will require strong leadership at all levels and challenges to the status-quo, across the energy industry, particularly within network companies. Realising early benefits will help build confidence and support for the smart grids development of amongst stakeholders, including consumers, which in turn can help stimulate further action and momentum.

### Commercial and regulatory frameworks and customer participation

74. The anticipated significant increase in the take-up of low carbon technologies in the 2020s together with the rollout of smart meters and smarter networks will provide the foundation for implementing demand response measures as a tool to help balance supply and demand locally and nationally, enabling a more efficient use of network infrastructure. However, consumers will need to be sufficiently convinced of the benefits to play an active role – their participation cannot be taken for granted.

75. Action is therefore needed in the short-term to strengthen understanding of the role of consumers within the smart systems, their motivations and how to engage them effectively. The nationwide rollout of smart meters provides a valuable opportunity to learn more about consumers and present to them the wider benefits and possibilities that a smart grid presents. A supportive regulatory and commercial environment that enables the required incentives to be introduced must also be developed.

## Technological innovation and growth

76. To maximise economic opportunities arising from the development of smart grids, action is needed now to ensure UK companies can benefit at the earliest stage. Better engagement with SMEs on commercial opportunities domestically and in overseas markets, is crucial. The step-change from successful smart grid trials, to incorporating innovation into business as usual is challenging, but service providers and product manufacturers need a clear signal from technology users of market potential in order to develop a strong UK supply chain.
77. Greater engagement in the development of European product standards is also needed. This area is likely to be more active in the near future and has important implications for smart markets and trade. A more coherent UK strategy will strengthen UK's commitment and support negotiations in Europe and Internationally. The degree of innovation in the UK market puts us in a strong position to shape these standards and influence international markets.
78. Smart home appliances are key components of the smart grid and impact on consumer energy use. However, the interface between the smart network and in-home appliances is underdeveloped and more could be done to investigate these linkages in research programmes.

## How progress will be monitored

79. This Vision and Routemap outlines the steps needed to maintain momentum in the development of a smart grid in Great Britain. It notes what progress has been made to date, the work already underway and what further actions are needed. It is through implementation of the actions outlined in this Routemap that Great Britain will address the key near-term challenges to achieving our Smart Grid Vision.
80. The focus of this Vision and Routemap is on the near-term, but it will be reviewed as the energy landscape develops and as new findings emerge. In this respect it is a living document that will be updated at strategically important points. Some actions can be taken forward by the Smart Grid Forum but there is a significant body of work underway that falls outside its remit. This document notes the work that is on-going in order to reduce duplication and to ensure the Smart Grid Forum's work is coherent and complementary. The Smart Grid Forum will publish progress reports as part of its Annual Report and discuss what actions to take on any identified gaps.
81. It is neither possible nor desirable to map out the precise path to implementation. However, it is important to begin measuring the deployment of smart grid on the ground. While some developments can already be monitored, such as the rollout of smart meters, more work is needed to establish a broader set of indicators. This is something the Smart Grid Forum has committed to do. A summary of gaps and actions can be found at Annex 3.

## Annex 1 – Smart Grid Forum workstreams

The Smart Grid Forum has the following workstreams:

- **WS1 – Assumptions and scenarios:** this work is led by DECC. It has the role of developing the assumptions and scenarios necessary for the work of the Forum and for the network companies as an input to their business plans so that they are consistent with DECC's low carbon transition.
- **WS2 – Evaluation Framework:** Ofgem led this work to develop an evaluation framework to assess, at high level, alternative network development options. This was successfully completed and published on the Smart Grid Forum website. This workstream has therefore now closed.
- **WS3 – Developing Networks for Low Carbon:** the Distribution Network Operators (DNOs) are leading this work to assess the network impacts of the assumptions and scenarios from WS1. This work fed into the development of the DNOs' RIIO-ED1 business plans.
- **WS4 – Closing Doors:** this work stream brings together stakeholders to identify credible risks to the development of smart grids as a consequence of forthcoming policy decisions which might fail to take full account of the necessary enablers for smart grid development.
- **WS5 – Ways of Working:** this work stream looks at how the Forum can communicate effectively with stakeholders.
- **WS6 - Commercial and Regulatory issues:** this work stream brings together stakeholders to investigate the commercial and regulatory challenges of implementing the smart grid solutions.
- **WS7 – Whole system design:** this technical work looks at how the whole electricity system might operate most efficiently and resiliently in a 2030 scenario but with a clear focus on the impacts for our distribution networks and the impacts on the roles and responsibilities of the parties that own, operate and interface with the electricity system. This workstream provides the lead point of contact with The IET's expert group (PNJV) in regard to establishing a stronger whole-systems approach to smart grid developments.
- **WS8 – Vision and Routemap:** led by DECC, this work stream informed the development of the Vision and Routemap.



## Annex 2 – Smart Grid Forum Membership and Affiliations

Member	Affiliation
Sandy Sheard (co-chair)	DECC
Hannah Nixon (co-chair)	Ofgem
Roger Critchley	BEAMA
John Mulcahy	British Gas
Professor Nick Jenkins	Cardiff University
John Scott	Chiltern Power
Tim Rotheray	Combined Heat and Power Association
Ash Pocock	EDF
Gavin Jones	ElectraLink
Steve Johnson	Electricity North West
Duncan Botting	Global Smart Transformation Ltd
Chris Welby	Good Energy
Marina Hodd	Kiwi Power
Mike Calviou	National Grid
Phil Jones	Northern Powergrid
Steve Unger	Ofcom
Richard Bruce	Office of Low Emission Vehicles
Mark Mathieson	Scottish & Southern Energy
Jim Sutherland	Scottish Power
Judith Ward	Sustainability First
Dave Openshaw	UK Power Networks
Robert Symons	Western Power Distribution



## Annex 3 – Summary of gaps and actions

Actions	
<b>Strategic direction</b>	<p>All DNOs show strong leadership in rolling out successful smart grid pilots into business as usual activity.</p> <p>DECC will make available to the Smart Grid Forum low carbon technology scenarios and data to inform strategic planning.</p> <p>Smart Grid Forum will consider widening the scope of the Transform Model to evaluate the value of heat storage in smart grids.</p> <p>Smart Grid Forum will consider how to develop a set of indicators of smart grid implementation to help track progress.</p>
<b>Commercial and regulatory frameworks</b>	<p>The Smart Grid Forum will explore different smart pathways to deliver DSR and examine the commercial and regulatory arrangements and requirements for consumer engagement.</p> <p>DECC, Ofgem and DNOs will look to maximise the value of smart meter data, while ensuring customer privacy provisions are in place.</p> <p>Ofgem will input to a public consultation in 2014 by the European Council of European Regulators on the future role of DSOs (Distribution Service Operators).</p>
<b>Customer Participation</b>	<p>The Smart Grid Forum will take work forward to:</p> <ul style="list-style-type: none"> <li>- Further understanding of factors which influence customer behaviour and what incentives are needed, to achieve lasting change to ensure consumers offers are tailored to customer needs.</li> <li>- Improve understanding about who is best placed to engage and inform consumers to help them participate in new smart electricity markets.</li> <li>- Explore the opportunities to articulate the wider benefits of smart grids alongside the roll-out of smart meters with the Smart Meter Central Delivery Body.</li> <li>- Improve understanding of how best to balance benefits amongst active 'smart' customers and the customer base as a whole.</li> </ul> <p>Ofgem and DECC to consider the role of multiple tariffs in encouraging DSR in the context of the simplification of household tariffs delivered by Ofgem's Retail Market Reforms.</p>
Technological innovation and growth	<p>SGGB and BEAMA will work to better understand the opportunities for UK businesses, export opportunities and the barriers to realising this and SGGB will publish a report in 2014.</p> <p>The ENA will work with SGGB and BEAMA to strengthen understanding of the market potential of smart grid technologies at its LCN Fund Annual Conference in 2014.</p> <p>Smart Grid Forum will work with supply chain trade associations to consider how to influence the European agenda on the development of product and other standards for smart grids and develop recommendations in 2014, and will explore the opportunities provided by the new EU Smart Grid Architecture Model.</p> <p>BEAMA will work with supply chain trade associations and other relevant organisations to improve understanding of interface between a smart networks and in-home appliances. BEAMA will present their findings and recommended next steps to the Smart Grid Forum in 2014.</p> <p>The Smart Grid Forum will consider including in its work programme in 2014 lessons from the mobile phone, consumer electronics, and other related industries on how market change can be effected quickly and to the benefit of the UK smart grid supply-chain industry.</p> <p>EU Energy Focus will engage with the Smart Grid Forum and its members, to explore opportunities for UK institutions, companies and researchers to develop bids and benefit from Horizon 2020 Grids and Smart Cities project funding support.</p>





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