UK Power Networks response to A smart, flexible energy system

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Executive summary

The priorities for Government and Ofgem in 2017

Distribution networks have already responded to the challenge of the changing energy market, connecting 27GW of distributed generation (DG), of which 8.5GW has connected across UK Power Networks' service area (with a further 2.4GW contracted to connect). We have already begun the roll-out of active network management of DG allowing 330MW of generation to connect saving over £100m to DG customers. Current forecasts for the development of low carbon technologies indicate that the capability to use flexibility extensively will be needed from the mid-2020s.

Research undertaken by Imperial College for our Low Carbon London project[1], The Carbon Trust[2] and E3G[3] clearly demonstrate the benefits from a smart, flexible energy system which will be enabled by the transition of Distribution Network Operators (DNOs) to Distribution System Operators (DSOs).

In developing our response, we have actively engaged with stakeholders, including renewable generators, storage providers, aggregators, suppliers and new IT platform providers. Our engagement has provided us with first-hand experience of the issues which these stakeholders face, both in their interaction with us as a network operator and also the wider market place. We have used this experience to inform this response.

We consider that Ofgem and BEIS's should:

- Start the work needed to build on the RIIO regulatory framework to develop aligned incentives for transmission and distribution in time for RIIO-T2 and RIIO-ED2, to deliver whole system flexibility benefits and cost effective decarbonisation;
- Engage with DNOs and the System Operator (SO) to understand the additional costs of developing the advanced monitoring and control systems and enhanced organisational capabilities which will be critical to ensure an efficient flexible energy system, and the additional costs that will need to be incurred developing and deploying these capabilities;
- Clarify the regulatory framework to ensure DSOs can build storage as the least cost technical solution to provide security of supply if specific local circumstances inhibit those services being provided by third parties;
- Support the development of the commercial frameworks and platforms that will allow markets and DSOs to support the complex interactions of a smart, flexible energy system including the visibility of actions to all parties; and
- Support the development of standards to ensure the visibility and control of smart EV charging in conjunction with the Department for Transport and their work on the Modern Transport Bill.

The role of different parties in system and network operation: DNOs must become DSOs and lead the transition to a smart, flexible energy system

The benefits of smart, flexible systems are estimated to be up to £8bn a year by 2050[4] and rely on the optimisation of distribution connected resources. Since 2010 we have invested heavily in innovation to understand how to deliver these benefits and our highly successful innovation projects are helping us to develop DSO capabilities across our business. Our response draws on the learning from successful projects including:

[1] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf

[3] https://www.e3g.org/library/plugging-the-energy-gap

[4] Imperial College & The Carbon Trust 'An analysis of electricity system flexibility in GB': https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf November 2016

- The Low Carbon London (UK Power Networks) and Customer Led Network Revolution (Northern PowerGrid) trials on many of the elements of flexible networks needed for a DSO, testing smart tariffs, EV charging, and demand-side response (DSR);
- The Flexible Plug and Play (UK Power Networks) project which pioneered flexible connections using active network management to allow customers to connect more quickly and at a lower cost;
- The Smarter Network Storage (UK Power Networks) project which demonstrated the value of grid scale storage and highlighted many of the issues raised in the call for evidence;
- The Kent Active System Management (UK Power Networks) and Equilibrium (Western Power Distribution) projects are developing the tools DSOs will need to optimise the use of distribution networks to increase the output of distributed energy;
- The My Electric Avenue (SSE Power Distribution) project which was the first project to look at smart domestic EV charging;
- The Flexible Approaches to Low Carbon Optimised Networks (FALCON) (Western Power Distribution) and Flexible Networks for a Low Carbon Future (Scottish Power Energy Networks) projects which demonstrated tools and techniques including dynamic ratings and network modelling and monitoring to optimise the use of networks;
- The Customer Load Active System Services (CLASS) (Electricity North West) project which has proven that distribution network management can provide cost effective solutions to wider system management;
- The energywise (UK Power Networks) project which is looking at how to engage fuel poor and vulnerable customers in the smart energy transition; and
- The TDI 2.0 (National Grid and UK Power Networks) project which will pioneer the integration of systems and commercial arrangements between SO and DSO to optimise the whole system benefits of flexibility.

In the past few years, our networks have been at the forefront of the low carbon transition. We have issued connection offers to 54GW of storage and generation since 2012, requiring us to change the way we operate as a business to meet the associated challenges. This has involved deploying the DSO capability from innovation trials into our business, particularly in our Eastern and South Eastern regions. This has been successful in helping to reduce the cost of connecting for generation customers by over £100m. UK Power Networks will continue to develop our work on flexible generation connections, using the pioneering tools being developed in our Kent Active System Management project and our other innovation projects to see how we can minimise system constraints and optimise the use of the generation connected to our networks.

The anticipated uptake of low carbon technologies such as electric vehicles, storage and distributed generation means that, by the mid-2020s, we could see over two million active devices providing flexibility on our three distribution networks. To deliver the scale of benefits cited in the Call for Evidence, DSO capabilities will need to be focussed on optimising the resources on our distribution network, not only to avoid distribution reinforcement but to deliver whole system solutions that support cost effective decarbonisation. We are actively working with National Grid, including through the joint TDI 2.0 innovation project, to further develop our capabilities in this area.

The transition to DSO represents a paradigm shift in the complexity of system operation and the smart control systems needed to support it. Network operators should be empowered to develop and deploy the supporting DSO infrastructure so that flexibility can develop efficiently in response to local and whole system needs. The regulatory framework should fully recognise the risks and costs associated with the development and deployment of new technologies, and clear incentives are needed to facilitate a timely evolution towards a smart DSO future. Clearly, enhancing the present commercial and regulatory framework.

Incentive regulation in Great Britain has been successful in promoting innovation to deliver efficiency and service improvements within the individual parts of the energy system. Indeed, regulators in

many parts of the world are looking at the totex incentives used in the RIIO framework as a good foundation for developing flexible energy systems. We believe that the current RIIO model can be adapted to support DNOs to complete the transition to DSOs and optimally manage the resources on their networks. We would like to see Ofgem and BEIS build on this Call for Evidence by establishing a work programme with industry to develop the regulatory incentive frameworks to incentivise transmission and distribution network investments to reduce whole system costs in time for the start of RIIO-ED2 and RIIO-T2. We believe that our track record in delivering safe, reliable networks with excellent customer service puts DNOs in a good position to develop into effective DSOs.

The DSO model will need to be supported by appropriate commercial frameworks that provide a level playing field for all technologies. We believe that contractual frameworks for flexibility services can best provide the conditions to support investment needed to develop new flexible resources (including storage and demand side flexibility), particularly where these are being used as alternatives to traditional solutions to provide security of supply. As the number of flexible distributed energy resources grow, more complex market platform arrangements for flexibility may be required. We are therefore supporting and learning from a number of novel commercial platforms that are being proposed and trialled, for example Centrica's Cornwall Local Energy Market, and a recent bid for EEF funding by Open Utility, looking at both marginal price platforms and peer to peer markets. We believe DNOs, Ofgem and BEIS should support these to explore the different information needs and interfaces they will require from the DSO.

Removing policy and regulatory barriers: Enabling storage

Our Smarter Network Storage (SNS) project has demonstrated that clear benefits to network customers are deliverable by DNOs using storage to manage the network. SNS first highlighted many of the issues which are raised in the Call for Evidence.

Storage is a key technology in ensuring security of supply at an efficient cost as it provides:

- An alternative customer for generation output that is local to the point of production, and able to relieve export constraints;
- An option that allows DSOs to balance supply and demand local to needs;
- An alternative to traditional network reinforcement, or allowing it to be deferred thereby creating option value where there is uncertainty in load forecasts;
- A fast response to address frequency control for the whole system and address power quality issues in distribution networks where there are many variable loads; and
- A source of voltage control to manage issues such as high voltages at times of low demand and high generation.

We are fully supportive of the development of a competitive market in this fast moving sector, so that storage can provide services to the whole value chain. Over the last 15 months we have witnessed a buoyant storage market. We have received over 600 applications for the connection of 12GW of storage.

Many DSO services needs are likely to be very specific and highly locational. When procuring flexibility services for specific constraints it will be important for DSOs to have the least cost technical option, including storage, available to ensure customers get the most efficient outcome. Where storage is developed by the networks, the enduring framework that we are putting in place for SNS should be considered as the template for arrangements to maximise the value of the investment to the benefit of customers.

The typical size of a storage application we have seen to date is 20MW (the equivalent to a small town of 9,000 domestic homes) often with complex and specific technical requirements which we need to assess and accommodate. It is therefore not surprising that connections costs can be high where there is not the capacity to accommodate such large demands without reinforcement. The scale of applications for storage connections has represented a significant challenge for us as a

business. We have responded by undertaking substantial engagement with storage providers to understand their needs and improve the service we provide to them and have taken the following steps:

- Introduced a connections guide specifically for storage providers which provides clarity to new entrants on how their application will be treated from a network design perspective. This guidance is now becoming industry best practice;
- Introduced a simple and clear common connections application template for storage which has since been adopted as industry best practice through the Energy Networks Association (ENA);
- Introduced demand heat maps (alongside our existing generation ones) to provide a transparent picture of where there is available capacity on our networks;
- Run customer surgeries to improve our understanding of the needs of stakeholders and collect feedback on the processes we have introduced to improve our service; and
- Offered flexible connections to storage providers whose connection request triggers reinforcement. The availability requirements of the first Enhanced Frequency Response (EFR) tender from National Grid did not favour flexible connections but we strongly believe that future service requirements should be developed to facilitate these.

Whilst these initiatives have been successful to a large degree, we are identifying further improvements through our ongoing engagement with customers. For example: we are considering whether allowing developers to specify a range of capacities on their application could allow a more effective and efficient discussion with planning engineers. Equally, developers still find they need access to planners with knowledge of the system and status of existing connection applications, which we could better support if were we able to charge assessment and design fees to cover the costs. The industry has also started the work to clarify how storage is treated under planning standards and look at the differences between transmission and distribution.

We have been supportive through our SNS project of clarifying the status of storage in the regulatory framework. We support the definitions proposed in the Call for Evidence, and are of the opinion that these make a distinction between systems developed for the purpose of storing electricity and devices such as capacitors in use on the distribution networks to maintain technical compliance.

The work to codify the distinct needs of storage in the industry codes and as a category of generation needs to be undertaken whatever enduring legal arrangements are put in place. Ofgem and BEIS should consider creating a separate licence category when the opportunity arises to amend legislation.

However, we think there are some key policy aspects which Ofgem and BEIS should examine at to help the development of the storage market:

- Support the industry in the development of a whole system framework which allows storage (and other providers) to stack the value of services they can provide to different industry parties;
- Progress the introduction of assessment and design fees to recover the costs of providing better services to flexibility developers whilst providing an incentive against excessive speculative applications;
- Address the issue of undue levies on imports to energy storage systems; and
- Provide clarity on the regulatory treatment of storage to ensure that distribution networks can provide bespoke cost reflective charges to storage and own storage assets where the market does not deliver.

<u>Pricing for flexibility</u>

The development of the resources to enable flexibility needs a framework that supports investment. Current contracts for flexibility such as National Grid's Enhanced Frequency Response Contracts and

DNO demand side response services are trying to provide this. We currently see contracts as key to allow resources to be procured as an alternative to traditional assets. Contracts for flexibility help ensure that they are available when needed, and can provide an appropriate fixed term income against which flexibility providers can invest in new services. Price based flexibility has not provided sufficient certainty to avoid the need for the Capacity Mechanism in the wholesale market and we are concerned that, on its own, it would not support a flexibility market either. However as the volume of flexible resources increases, price flexibility may become a more valuable tool in dispatch of resources and we would expect the market arrangements to evolve to support this.[5]

Price signals and the development of smart tariffs

Existing network tariffs already exhibit some smart characteristics. Existing DUoS tariffs provide time of day signals (CDCM) for all half hourly metered customers (including an option for domestic smart meter customers) and locational and seasonal signals (EDCM). They also have to fulfil two key objectives to provide:

- Stable forward price signals and ensure fair recovery of fixed and sunk costs; and
- Signals to promote the efficient development of the network.

Our experience gained in Low Carbon London indicates that consumers are receptive to smart tariffs but that the differentials between peak and off peak charges required to incentivise changes in behaviour need to be significant (between 2 and 6 times normal tariffs)[6]. One of the key challenges with smart tariffs will be the balance between the fair recovery of fixed and sunk costs against the need to send price signals most customers respond to as highlighted by CEPA in on the following page.

The needs of the tariffs and service contracts that emerge will be driven by the framework under which flexibility is ultimately procured or scheduled. Experience in existing markets indicates that a structure of markets and price signals is needed that:

- Incentivises or procures sufficient flexible capacity at the location required (provides predictable investable signals);
- Schedules or allocates the systems' available resources efficiently (in near real time); and
- Recovers the fixed and sunk costs of the system in a fair manner.

Industry experience is that significant tariff changes can take several years to design and implement.[7]

[5] See Berkley Labs Future Electric Utility Regulation 'Distribution Systems in a high distributed energy resource future', October 2015: https://emp.lbl.gov/sites/all/files/FEUR_2%20distribution%20systems%2020151023.pdf and also Scottish Power Energy Network's DSO paper: http://www.spenergynetworks.co.uk/userfiles/file/SPEN%20DSO%20Vision%20210116.pdf
MIT Energy Initiative: Utility of the future: http://energy.mit.edu/research/utility-future-study/ December 2016

[6] Low Carbon London report A3 Sept 2014 'Residential consumer responsiveness to time of use pricing': http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A3%20-%20Residential%20consumer%20responsiveness%20to%20time%20varying%20pricing.pdf
Department of Energy and Climate Change July 2014: Electricity Price Signals and Demand Response. https://www.gov.uk/government/publications/electricity-price-signals-and-demand-response
Customer Led Network Revolution Jan 2015: High Level Summary of Learning: Domestic Smart Meter Customers on Time of Use Tariffs http://www.networkrevolution.co.uk/wp-content/uploads/2015/01/CLNR-L243-High-Level-Summary-of-Learning-Domestic-Smart-Meter-Customers-on-Time-of-Use-Tariffs.pdf

[7] The distribution structure of charges projects started in 2000 and did not fully conclude until 2012.

Objectives and principles for network charging in a more flexible electricity system

Electricity network charges have two primary objectives: (i) the **recovery of electricity allowed revenues**; and (ii) the **provision of price signals** to beneficially influence system user (consumer and producer) behaviour. Changes may be required in future to GB network charging methodologies to address the challenges of a more flexible electricity system and to capture the opportunities such a system creates. As is the case today, however, the underlying charging issue will be how these two primary objectives are reconciled.

To achieve this, the general principles that underlie network charging decisions today should continue to apply in a more flexible electricity system. Those principles include:

- **Cost reflectivity** – as is the case today cost reflective network access charging is important to help convey the costs market participants create at the time they make their operational or investment decisions to use the network;
- **Transparency and predictability** – in the context of practically shaping network user behaviour, the quality of price signals is also relevant, making transparency and predictability relevant principles for charging; and
- **Non-discrimination** – charges for electricity network access should be non-discriminatory, dependent on how the network is used rather than based on the particular activities that it is used for.

With the increasing uptake of distributed energy resources (DERs), charging structures will increasingly need to balance the following in the practical application of these principles:

- The expected or necessary spatial and temporal granularity of network charge signals to encourage the **efficient use of and investment in resources** to deliver the services the electricity system needs;
- Transparency and predictability are generally achieved through simple tariffs, but this may create some tension with the principle of cost-reflectivity as truly **cost-reflective network tariffs should capture network costs that are specific to (i) capacity; (ii) volume; (iii) location; and (iv) time**;
- Competition between different resources and solutions to system needs based **on a level playing field**;
- Tariff structures that create a **fair and sustainable basis** for cost allocation and recovery between network user groups; and
- A future basis for cost recovery that distorts price signals and decisions of potential flexibility providers as little as possible from cost reflective levels, while remaining non-discriminatory.

Reconciling the primary objectives of network charging (recovering allowed revenue and providing price signals to beneficially influence system user behaviour) may as a consequence not be easy to achieve in a more flexible electricity system.

The emphasis which is placed on the different principles may need to adapt as the system and other aspects of the electricity market architecture evolve.

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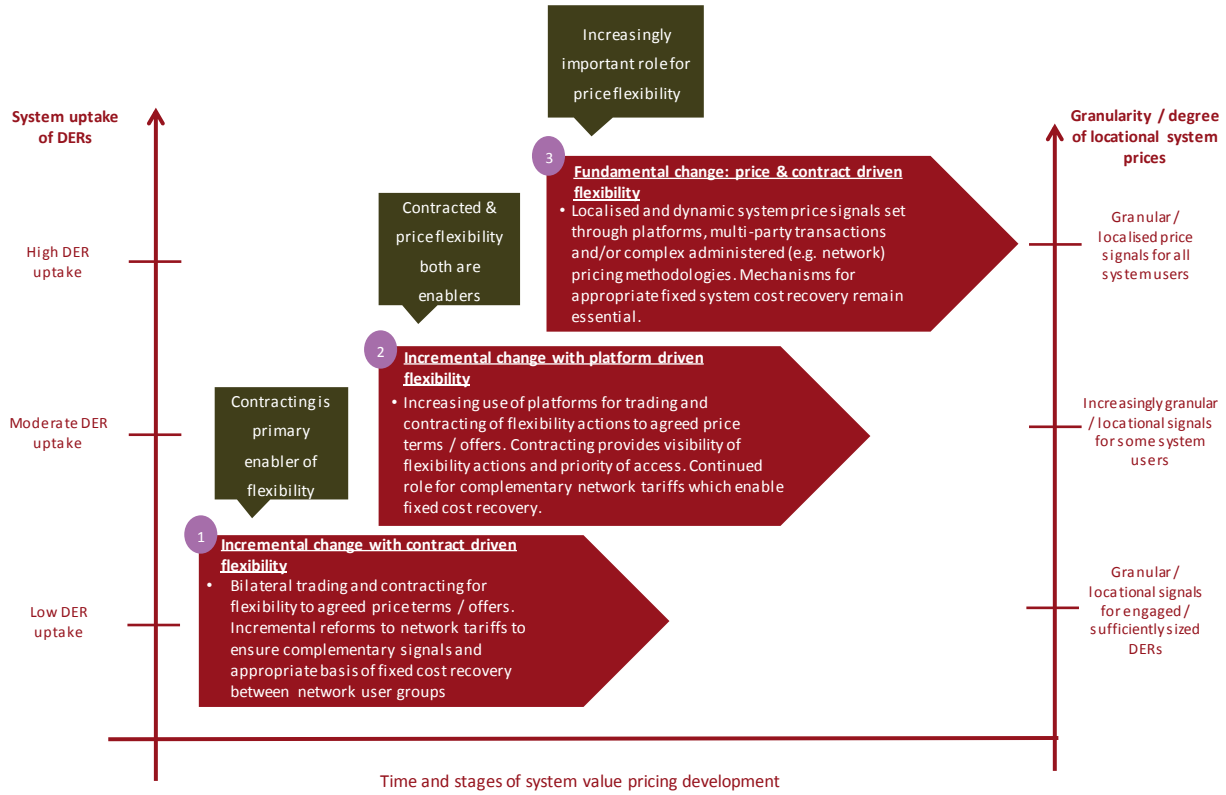
We believe that a practical way forward as illustrated in Figure 1 will be to:

- Use contracted flexibility routes to provide the price signals and incentives for flexibility actions and stimulate the development of flexibility resources in the market in the near term;
- Make incremental changes to current (e.g. network) charging methodologies when issues are identified to ensure that: price signals complement the value signals for flexibility from contracted system services; and there continues to be appropriate contributions to fixed system cost recovery between system user groups; and
- In the longer term, as the number of DER and system user price responsiveness increases, price driven flexibility can increasingly enable response through localised, granular, marginal energy and network price signals.

Figure 1 Role and complexity of system value pricing in different stages of future distribution flexibility system development – CEPA adapted from Berkley Labs[8]



In the longer term, there needs to be further thought about the contributions different network users make to DNO cost recovery through tariffs. We see the potential for prosumers and local community energy groups start to be more self-sufficient for their energy needs but they will still rely and benefit from network infrastructure for security of supply, and therefore need to contribute to networks' capacity in a fair manner. This issue (of fixed and sunk cost recovery) must be a key focus of any future review of tariffs, along with what is needed to support the development of flexibility markets. There are a number of charging approaches (a good summary is provided in the NARUC rate design

[8] CEPA : Adapted from Berkley Labs Future Energy October 2015
https://emp.lbl.gov/sites/all/files/FEUR_2%20distribution%20systems%2020151023.pdf

manual[9]) which all have strengths and weaknesses, which we summarise in our main response. As flexibility develops, a combination of approaches over time will likely be needed.

The pricing approach used will have to support suppliers' tariffs and the commercial processes used to manage flexibility in the system. A number of novel approaches are being explored or proposed through innovation projects (including those by Centrica, Open Utility, Electron, InnovateUK and the National Grid / UK Power Networks TDI2.0 project) which we are actively engaged with, and believe this is an area which should be explored further. Our experience from our innovation projects shows that trials are the ideal way to develop the best approach for the GB system. Ofgem and BEIS should be promoting innovation in this area with a view to a common approach will being developed when active DER volumes increase.

A system for the Consumer: Ultra Low Emission Vehicles, Smart Appliances and Cyber Security

One of the most significant flexible future demands on distribution networks will come from electric vehicles (EVs). EVs will be a key enabler in achieving improvements in air quality and meeting carbon reduction targets for transport.

Optimising the use of existing networks to keep network reinforcement costs low will be key, especially given the needs of fast and high capacity charging. To facilitate the cost effective decarbonisation of transport, we believe that we will require:

- Visibility of where chargers are installed, their usage and future planned installations in order that we can plan and manage our network effectively;
- Smart tariffs to customers to incentivise charging outside network peak demand; and
- An ability to control charging to ensure network infrastructure operates within its technical capabilities and ensure efficient development of the network infrastructure required to accommodate charging points.

To support this, BEIS and Ofgem should work with vehicle manufacturers, network operators, suppliers and aggregators to:

- Develop technology and commercial standards to enable visibility and control smart charging of vehicles; and
- Develop and trial smart tariffs to support smart charging.

EV charging is a specific area where smarter charging structures may have a role. EV customers are more likely to be more engaged with and accepting of smart tariffs. The charging infrastructure or the vehicles themselves could also have in-built enabling technology to deal with complex price signals, simplifying user interactions and providing certainty of response.

As with all consumer devices, it will be important for government to support standards that enable interoperability, and provide confidence for consumers and security for the power system. The government should support the development of smart home systems with appropriate risk based cyber security controls.

Innovation: supporting the transition

Our successful innovation projects have demonstrated that using trials to develop and demonstrate solutions to the needs of a smart flexible energy system will be essential to it successful delivery. The key areas for ongoing innovation we have identified include:

- Supporting innovation that delivers value across the whole system, beyond individual network or system operator business scope, as is being trialled in TDI2.0;

[9] NARUC Distributed Energy Resources Rate Design Manual November 2016
http://pubs.naruc.org/pub/19FDF48B-AA57-5160-DBA1-BE2E9C2F7EA0

- Supporting trialling of emerging commercial and market models and platforms, not just technology to be embedded into network/system operator operations;
- Facilitating cross energy vector projects (e.g. Hydrogen or heat projects) and not just electricity in NIA/NIC;
- Supporting local energy (including community energy schemes) to ensure approaches exist to allow those least able to adopt smart flexibility technologies;
- Supporting the development of smart EV charging technologies and commercial frameworks to facilitate the development of interoperable standards and visibility of EV charging to network operators; and
- Supporting the development of vehicle to grid technologies with the UK automotive technology sector.

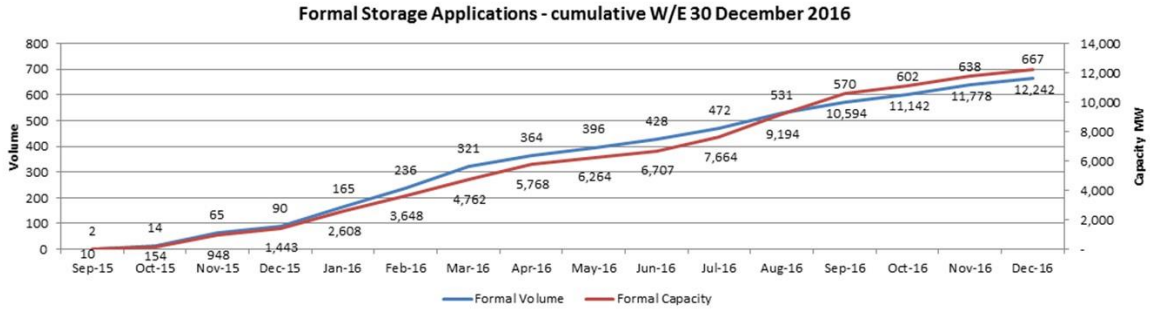
The subsequent sections of this document provided detailed responses to the questions raised in the Call for Evidence.

1. Removing policy and regulatory barriers

Enabling storage

We have practical experience of the issues highlighted in the Call for Evidence, having successfully delivered and operated the largest battery storage project in the UK (smarter network storage – SNS). We worked closely with National Grid and aggregators to use battery storage as an alternative to £6m of traditional reinforcement in Leighton Buzzard. We have also processed 12GW of applications from over 600 storage providers (as shown by Figure 2 below).

Figure 2: Storage application requests to UK Power Networks September 15 – December 16



As the first project in the country to go through the full design and implementation process, our SNS project has outlined many of the barriers mentioned in the Call for Evidence[10]. Our learning from the SNS project is that an effective market for storage providers has the potential to allow us to procure lower cost services and help to deliver network outputs at a lower cost to our customers.

Question 1: Have we identified and correctly assessed the main policy and regulatory barriers to the development of storage? Are there any additional barriers faced by industry?

The feedback we have received from storage providers mostly aligns with the regulatory barriers set out in the Call for Evidence. We draw attention below to some of the additional barriers in facilitating the whole system value of storage which, if addressed, could better facilitate the storage market.

The Call for Evidence outlines six main barriers, which we cover in turn below. We also list the additional barriers where support from Ofgem/BEIS would be welcomed.

a) New connections

We have covered new connections for storage in detail in our response to question 2. In summary, the one element missing from the Call for Evidence is an acknowledgement that the high cost for new storage connections is largely driven by their size (typically 20MW, equivalent to a small town). The current 'shallowish' connections charging boundary has been successful in incentivising customers to connect where there is existing spare capacity. However, the size of typical storage plant and its need to ramp between import and export, means that there are a limited number of areas on the network with the capacity to connect them without reinforcement.

We have trialled a number of approaches with developers to help inform where capacity is available, including heat maps. However, customer feedback continues to support access to an informed planner who can advise them and provide information on the current position on connections activity, which we support with regular customer surgeries where prospective applicants can discuss options with planners. There are clearly issues for DNOs who have limited resources with the skills and

[10] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/Report+9.5+19Oct_v2.1_%28Final+Photos%29.pdf

experience to advise on complex storage applications in providing a balance between supporting pre-application advice and meeting obligations relating to quotation timescales. However, our experience (which our discussions with developers supports) is that we need:

- Regulatory support for the introduction of reasonable assessment and design fees to support the delivery of a higher level of service and deter highly speculative enquiries; and
- To adapt our processes to allow developers to specify a range of capacity (e.g. a minimum and maximum) that they would consider in an application for a connection quote; this could improve the dialogue with the DSO as it would allow the DSO to indicate the capacity that could be taken up without reinforcement.

We have been proactive in finding solutions for our customers, including offering flexible connections through active network management. However, our experience shows that storage providers have not yet taken up our offers because they did not align with the service requirements for National Grid's first Enhanced Frequency Response (EFR) tender. We are actively working with National Grid and other DNOs to understand how better alignment can be achieved in the terms for future services to enable faster and cheaper connections to take place.

b) Network charging

The Call for Evidence raises the issue of whether storage should be treated as intermittent or non-intermittent within the charging methodologies. We treat storage as non-intermittent for the purposes of network charging because most storage customers would tend to have quite predictable import and export patterns. This is beneficial for storage providers as it allows them to claim greater credits for exports under the charging methodologies.

As fully explained in our response to question 3, analysis from our SNS project has demonstrated that the charging methodologies provide appropriate cost signals for the various impacts storage can have on the network.

One of the challenges of smarter locational price signals (such as the EDCM charges) is that it is not possible for developers to calculate these for themselves, making it difficult to predict their future costs when assessing their business case for investment. This is part of the trade-off which must be considered between flexible pricing and complexity.

c) Consumption levies

The issue highlighted in the Call for Evidence was outlined in our SNS findings; storage devices currently pay the same levies as demand customers when energy is imported. Demand customers pay these levies again when the energy is released from the storage system and consumed. The levies are therefore charged twice, making the energy derived from storage more expensive than necessary. We agree that this is a challenge government needs to address. Defining storage as a separate activity would be a clear step towards being able to create specific charging arrangements for storage that avoid discrimination issues with demand and generation.

d) Planning

As a purchaser of services from storage providers, we want to ensure that these services are low cost and available in a timely manner. Storage facilities such as SNS are not comparable to traditional generation stations in terms of the impact on the local environment (be that visual or emissions based) but are currently subject to the same process and requirement. The construction costs of the building for SNS were shown to be a significant factor in the business case assessment[11] and could be a significant issue in the development of storage to support local network issues. Therefore, we

[11] SNS The business case of storage October 2016
http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/The+business+case+of+Storage.pdf

are supportive of the development of planning rules and guidelines more suitable for storage than those in place for generation. Our experience from our SNS project is that planning changes could reduce the construction costs of storage and help to make storage a more financially viable alternative to reinforcement.

e) Use of storage for network operation

Through our SNS project, we have proved that storage is a valuable source of flexibility. Contracts for services from storage are providing an effective signal for investment in storage, as we have seen from the EFR and Capacity Markets.

We agree that the competitive provision of storage is most likely to deliver low cost solutions for customers, as has been evidenced by the prices seen in the EFR procurement. However, DSO services needs are likely to be very specific and highly locational. We believe that DSOs should always have the least cost technical solution available to them to meet network constraints, including the use of storage. When procuring flexible solutions to address network needs, the least cost network solution provides a key control on the costs customers will pay for the network service, and limiting this to traditional solutions for DSOs may be counter to delivering an efficient outcome for customers. We respond to this matter in detail on question 4.

f) Regulatory clarity

We agree with the need for greater regulatory clarity as without this there is uncertainty for investors. We believe that only by defining and creating specific rules for storage will we be able to maximise the benefits that it can deliver. We have supported the development of a separate licensed activity for storage, and this should be considered when the opportunity arises. We provide further thoughts in this area in our response to question 5.

Additional barriers faced by industry

Overall, we agree with the barriers mentioned above and in the Call for Evidence. However, we recommend that Ofgem and BEIS provide a clear policy steer to industry to help develop:

- **A whole system framework for flexibility services**. We consider that a commercial and regulatory framework that sets out the guidance to minimise exclusivity in service specifications and enables providers to stack whole system benefits is crucial.
  The development of network for services supporting supply security will need appropriate governance arrangements to ensure that such services are reliable, which could include licensing where appropriate. We can play our role in helping to develop this framework but it requires coordination of different industry parties with separate (and sometimes competing) commercial drivers. Consequently, we welcome Ofgem's participation in the ENA's TSO-DSO Project. We can see a role for Ofgem/BEIS in developing the correct regulatory incentives which empower industry to implement the roles and commercial framework to deliver these benefits. At present, regulatory incentives and commercial drivers are not well aligned across transmission and distribution which makes delivery of this framework difficult. We expand on this in our response to questions 45 and 46; and

- **A regulatory framework that permits limited network ownership of storage**. The regulatory and legal framework for storage should not deny network operators the ability to own storage where this is the least cost network solution. We expand on this further in our response to question 4.

Question 2: Have we identified and correctly assessed the issues regarding network connections for storage? Have we identified the correct areas where more progress is required?

We broadly agree with the issues identified in the Call for Evidence. We undertake extensive work with stakeholders to improve the process as part of our Incentive on Connections Engagement (ICE) plans including:

- Running two DG Fora each year, attracting around 70 participants;
- Establishing an Industry Panel of 12 invited industry experts (from the customer base) which meets regularly to review our plans and initiatives for each market sector;
- Issuing consultations on new policies and processes to ensure stakeholder input; and
- Holding over 40 surgeries with stakeholders.

Despite having customer satisfaction scores for DG customers reaching 86% in our Eastern area, there are still some areas where more progress can be made. However, we think we have put in place a range of new policies and processes in the wake of the unprecedented number of storage applications we have received:

Network Connections

a) Clarity on connections process – how to connect and where to connect

Based on extensive market engagement with our customers, we do not entirely agree with the presentation, within the Call for Evidence, of where further progress is required. Our stakeholder engagement has helped to shape our process and service offerings to storage customers. Specific improvements we have made include:

i) Clear storage process guidance

In August 2016, we issued clear guidance to help our customers understand how we will treat storage applications from a planning and design perspective[12]. This provides clarity to customers on both the network planning and technical requirements associated with their application. We acknowledged that at a domestic level there is some uncertainty on how the installation of energy storage when combined with existing generation will be treated. With this in mind we are developing a separate guidance document, through consultation with the industry, to provide clarity on the application process and costs attributable to different types of installations.

In addition, we are working within the current Electricity Safety, Quality and Continuity Regulations (ESQCR) requirements to develop a 'fast track' process for the majority of domestic schemes, allowing for quicker and cheaper connections. To further inform this process, we are now running an NIA project Domestic Energy Storage and Control (DESC)[13] where we are working closely with a small scale storage developer (Powervault) to install storage units at premises with solar generation.

The outcome of this project is threefold:

- Determine the impact of these units on the distribution network by defining the load profile changes of these households;
- Understand the potential network benefits by having control of the storage units; and

[12] http://library.ukpowernetworks.co.uk/library/en/g81/Design_and_Planning/Planning_and_Design/Documents/EDS+08-5010+Energy+Storage.pdf

[13] http://www.smarternetworks.org/Project.aspx?ProjectID=1967

- Understand how the connection process can be improved and specifically understand what information should be required from customers and how best to ensure the information and visibility is given to the network operator when these units are connected.

ii) Storage specific application form

We led the development of a specific application form for storage providers which has since become industry best practice after being adopted by the ENA[14]. The form allows storage applicants to provide specific details of how they plan to operate allowing our network design team to provide a more bespoke connection quote based on this information. This means that we do not make 'worse case' assumptions when assessing the connection assets needed to connect the storage device. We have found that the application form can stimulate a useful dialogue with storage providers on how their planned operation can be adapted to help reduce the network investment (and connection charge to the customer). Our ongoing engagement with developers continue to seek ways to improve the information gathered. For example, we are considering whether to ask developers for an indication of the range of capacities acceptable to them as part of the application process in order to allow us to explore alternative connection designs as part of a standard application.

iii) Clarification of Engineering Recommendation P2/6

There are two aspects of P2/6 which require clarification which are being taken forward in 2017 by the ENA's P2/6 working group:

- Currently P2/6 does not recognise the contribution which storage can make (when exporting) to the network, in the same way that generation does. We agree that this needs to be amended and we are working with other DNOs, through the ENA, to make the necessary changes to P2/6. Through our SNS project, we have worked with Imperial College to develop a methodology outlining how the contribution of storage can be taken into account in network planning.[15] We will be using this as an input to the ENA work on P2/6; and
- There also needs to be clarity on the treatment of storage demand under P2/6, assessing whether it is treated as a firm demand in reinforcement assessments associated with connection applications.

iv) Clarity on treatment of changes to existing applications

We have taken a lead on this issue and have been clear that the addition of storage to an existing application is a 'material change' to that connection. The addition of storage is a considerable technical change to an existing connection of application in progress, which requires a reassessment and potential redesign of the scheme. Our stance has been driven from feedback from our stakeholders, who want fair, non-discriminatory treatment.

Stakeholders have indicated that they do not think that allowing such a change while maintaining the position in the queue is fair or provides a good process. These issues have also been debated through the ENA and the consultation it produced in conjunction with stakeholders reflects the stance

[14] http://www.ukpowernetworks.co.uk/internet/en/our-services/documents/2016_Energy_Storage_System_-_Futher_Information_Request_V1-5.docx

[15] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/SNS_P2_6_SDRC9.6v1.pdf

we have taken[16] . We will continue to work through the ENA to ensure a consistent approach on this issue across all DNOs.

v) UK Power Networks' range of tools to inform providers where to connect

We have provided heat maps for generation applications since 2013 with over 700 customers now signed up to use them. To further assist our storage customers, we have recently developed additional functionality to this mapping tool to provide demand data from our networks. This has resulted in another 50 customers signing up to use the application. Our customers have told us that the addition of load data to our heat maps has been helpful in their pre-application assessment of storage schemes. However, our customers still value direct engagement with network planners on the current state of connection applications. To assist this engagement, we have conducted over 40 developer surgeries in the last year to allow customers to discuss possible storage project locations to our network infrastructure planners and identify the most accessible locations.

To support the efficient development of a more interactive service for developers, the introduction of assessment and design (A&D) fees should be expedited to allow the additional costs to be appropriately recovered and encourage developers to make best use of the freely available information published such as our Long Term Development Statements. The introduction of A&D fees would also act as a strong deterrent against speculative enquiries and allow us to provide a higher quality of service to genuine connection applications.

b) Cost and time of connecting

The Call for Evidence highlights the high cost of connection for storage. While we recognise the ongoing work highlighted by Ofgem/BEIS on releasing unused capacity, the current legal provisions to reclaim unused capacity can only be applied retrospectively by agreement with the customer. In addition, we have been offering flexible connections to storage providers but the majority have found it difficult to accept these as it impacted their ability to meet the availability criteria set out by National Grid for services such as the first enhanced frequency response tender. We have set out the issues as we see them below:

i) High cost of connecting

We do not fully agree with the way that this barrier has been presented in the Call for Evidence. The high cost of connecting storage is a feature of the typical size of storage plant (20MW, or the equivalent of 9,000 domestic homes) and the shallowish charging boundary in place. There are very few places on the network which can support this size of connection without reinforcement and the charging rules mean that the connecting customer pays a proportion of these reinforcement costs up front in a connection charge. It is important to recognise that this shallowish boundary is a vital element in keeping distribution costs down for customers, since it incentivises connection where there is existing spare capacity. It has incentivised a large volume of generation to connect to the distribution networks where there is spare capacity, avoiding the need for reinforcement.

As unconstrained capacity on our networks is becoming increasingly limited, we are looking to be innovative in how we can provide better information to our customers on the extent of constraints and likelihood they will occur. Our customers want to be able to sign up to a flexible connection agreement but still retain the ability to provide services to the SO. Ultimately this will require better co-ordination between the SO and DNO in providing contracts that optimise existing assets and get the most out of energy storage within ANM areas. We are already starting the required work with National Grid, through our TDI 2.0 project.

[16] http://www.energynetworks.org/assets/files/news/consultation-responses/Consultation%20responses%202016/Fair%20and%20Effective%20Management%20of%20DNO%20Connection%20Queues%20Treating%20Changes%20within%20Applications.pdf

ii) Storage may need to queue for a long time behind generation for a connection even if it can relieve constraints.

We agree that that this is an issue and one where the commercial relationships are as important as the physical network. Removing a generation constraint using storage requires that the storage device imports energy at the times needed to relieve the constraint. An agreement to arbitrage energy in this manner would logically be handled today by a supplier/aggregator providing a service to the generators rather than by the DSO. At present, it is not clear to the DSO if promoting the storage provider might commercially disadvantage a generator that was ahead of it in the queue. Therefore, the DSO should not make such a decision unilaterally. We believe that this can be addressed though our contracted queue process below, but we are also looking at other approaches as part of our development work on flexible connections.

The connection queue process can be considered in two parts:

- Applications Queue: All enquiries are dealt with in application date order. This is in line with the Common Connection Charging Methodology Statement (CCCMS) and the application of our interactivity methodology. Prior to making a formal application customers are encouraged to attend a developer surgery. This allows customers to discuss their potential project with our network planners and assess the viability of connection to our network, including timescales and likely costs.
- Contracted Queue: Post offer, where slow moving projects are otherwise preventing the connection of a scheme until reinforcement is completed, we will assess the possibility of expediting those customers adversely positioned in the contracted queue but ready to connect. This assessment is carried out on a case by case basis where certain criteria can be met and agreement made between parties to ensure that system security is maintained.

Question 3a): Have we identified and correctly assessed the issues regarding storage and network charging?

The Call for Evidence highlights three issues regarding storage and network charging. We broadly agree with these and provide views on each below:

i) Treated as non-intermittent or intermittent

We are currently treating storage as non-intermittent for the purposes of DUoS charging. We think this is appropriate in that it allows storage providers to access the same credits (i.e. payments for exports that are set against charges for imports) available under the use of system charging methodologies as non-intermittent generators. However, we would stress that this principle does not necessarily translate as counting as non-intermittent generation for contributions to network security within Engineering Recommendation P2/6. Any contribution to security of supply depends on exactly how storage is being used. For example, where a storage device is providing a service to the network such as peak lopping and has a contract to export at local demand peak, this is effectively non-intermittent. However, where a storage device is providing services such as frequency response, we have no guarantee that it will export and not import at local demand peak; therefore, it cannot be treated in the same way under P2/6.

ii) Cost reflective import and export charges

Our experience from operating a battery on the GB system suggests that existing tariffs do not present an undue barrier. Existing tariffs provide payments to generators for export at peak times and provide a cost signal to storage not to import energy at peak times.

In terms of the connection charge levied, if a storage provider enters into a flexible connection arrangement whereby they guarantee to export at peak load, then we can account for this in the

connection design and subsequent costs. Without the contract in place it would be wrong to make the assumption that the storage device will export at peak. The storage provider may be contracted for a service which means it imports at peak and had we assumed that it only ever exports at peak, then it would threaten system security.

We agree that network charges should represent the fair recovery of network costs and should offer a level playing field. Based on the evidence from our SNS trial, we believe that distribution charges do not prohibit the business case for storage. We consider that the current EDCM charging methodology provides cost reflective import and export changes for storage. As part of our SNS project, we modelled the DUoS charges paid by the storage device. These are shown in Figure 3 below:

Figure 3: DUoS charges paid under SNS project (E=Export, I=Import)

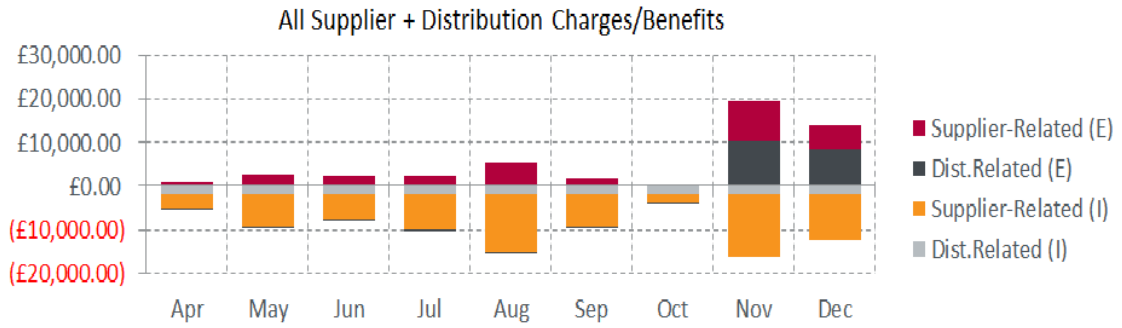


Figure 3 illustrates that DUoS charges were a very small part of the costs incurred by the battery. Due to the fact that the battery was exporting at peak demand to defer reinforcement, it received a credit under the EDCM and the net DUoS bill was a credit of £3,700 for the year. This seems appropriate since the storage device was actively supporting the network during winter months.

If the storage device was not supporting the network by exporting at network peak, we accept that there would be a different picture than that presented above. However, this would also be appropriate since the storage device would be contributing to peak and imposing costs on the network.

iii) Transparency of network charges

The Call for Evidence correctly highlights the difficulty for storage developers when estimating their network charges. We have engaged a number of our customers to understand their perspective. They have highlighted that under the EDCM, it is difficult for them to understand what DUoS charges they will be liable for once connected. Consequently, we have put in place a policy whereby we engage with customers on the likely EDCM distribution charges once they have an acceptable connection offer.

Within our Use of System Charging Statement, published in April 2015[17], we address demand-side management (DSM) and the ability for customers to have interruptible import capacity in order to benefit from a reduced Use of System charge. Specifically, we outline:

[17] https://www.ukpowernetworks.co.uk/internet/en/about-us/documents/EPN-LC14-Statement-Effective-1st-April-2015-V2-Final.pdf

> *5.8. New or existing Designated EHV Property Customers may wish to offer part of their Maximum Import Capacity (MIC) to be interruptible by us (for active network management purposes other than normal planned or unplanned outages) in order to benefit from any reduced UoS charges calculated using the EDCM. Several options exist in which we may agree for some or the entire MIC to be interruptible. Under the EDCM the applicable demand capacity costs would be based on the MIC minus the capacity subject to interruption.*
>
> *5.10. If you are interested in making part or all of your MIC interruptible as an integral irrevocable feature of a new connection or modification to an existing connection you should in the first instance contact our connections function*

In line with this statement, we have made it clear to storage providers and other customers that we are open for discussions on how to create flexible contracts and manage the application of import charges. We encourage all customers to approach us to discuss these possible arrangements.

It is important to highlight that this is an example of the trade-off between specific locational tariffs that reflect specific customer impact on the network and broader, more predictable tariffs.

Question 3b): Do you agree that flexible connection agreements could help to address issues regarding storage and network charging?

As stated above, flexible connections can help to address any issues around connection charging through providing the network operator with certainty on how the storage device will be operated. This allows our network design teams to take account of this when assessing the connection assets required.

As highlighted in our response to questions 1 and 2, our experience to date has been that despite making flexible connection offers to storage applicants, developers have not been keen to take these up. We have engaged with these providers to understand why and the feedback is that they are not compatible with the terms of National Grid's current services, particularly the EFR service. As stated elsewhere in this section and in our responses to chapter 5, this highlights the need to develop a process which allows for efficient allocation of flexible resources across the whole system.

Question 4a: Do you agree with our assessment that network operators could use storage to support their networks?

We fully agree that network operators can use storage to support their network. Our SNS project has proven that storage can be used as an alternative to network reinforcement, where our 6MW/10MWh/7.5MVAr battery has provided an alternative to £6m of conventional reinforcement at Leighton Buzzard.

The benefits of storage to networks are comprised of:

- A potentially lower cost alternative to reinforcement to meet demand needs;
- Using reactive power capabilities for:
    - Losses/power factor improvement, (the benefits passes to the customers); and
    - Voltage control.
- Allowing more generation customers to connect or reducing constraints on existing generation, therefore enabling more renewable energy; and
- Extensive adoption of domestic storage could offset the impact of increased LCT demands and reduce high voltage problems resulting for example from solar output at times of low demand.

The RIIO framework provides equalised incentives for network companies to develop the most efficient network solutions. As flexibility develops, we will increasingly contract for demand side services as a lower cost alternative to traditional reinforcement. Our SNS project demonstrated a positive NPV outcome but costs still need to fall and it requires the stacking of different services from other parties within the energy system. One of the key issues for battery storage supporting the network is the need for longer duration export capability than a similar level of frequency response capability alone requires, thus requiring a more expensive battery system. As and when the technology costs of storage fall and it is the least cost solution to meet the network needs alone, it should be available as an option to ensure that any process to procure flexibility does not result in a higher cost for consumers than is necessary (the least cost solution available to the DNO, as signalled in any long term development statements would set the benchmark for the value of any services offered).

Question 4b): Are there sufficient safeguards to enable the development of a competitive market for storage?

We would like to see active markets of all forms of flexibility including storage, as this would limit the possibility of one type of flexibility or provider from gaining excessive market power. This is particularly important for us given the highly localised nature of our constraints. It may be necessary for DSOs to procure flexibility capacity in a similar manner to the Capacity Market to ensure sufficient capability exists to defer traditional investment to secure the system or address emerging issues caused by the growth of low carbon technologies such as EVs.

Our experience is that the current framework has enabled competition. For example, the EFR tender successfully allocated 201MW to provide frequency capabilities to National Grid. However, the projects allocated will only be providing value to National Grid and will not be used, at least in the first four years of operation, to support local distribution network constraints. The wider question is how to ensure competition and enable the whole system benefits that storage can provide.

To extract maximum value from a storage asset, commercial capabilities are required across a number of services, interfacing with the system operator, network operator, suppliers and generators. Establishing commercial relationships with aggregators and suppliers will enable DNOs to interface with the commercial markets for further revenues, which at this point are critical for the business case of storage to add up.

Question 4c): Are there any circumstances in which network companies should own storage?

We have demonstrated in our SNS project that storage has the potential to provide benefits to the network. To deliver these benefits, the storage must be at a specific location on the network and available when needed. At the Leighton Buzzard site, we successfully used a 6MW battery for peak demand shaving instead of a £6m traditional network reinforcement[18]. Demand side services, including storage, potentially create option value compared to incremental investment in traditional assets and may be highly valuable given current unpredictable demand and generation patterns.

Wherever possible we agree these services should be provided through an active market. This should allow network companies to highlight where they need a service from storage or other demand side service and tender to see if providers can meet the requirements at a cost lower than other alternatives. Storage providers should be able to optimise the use of the storage asset by selling services to others when the DSO does not require it, thereby reducing the cost to the DSO. To ensure that these services offer the lowest cost solution for customers, the DSO must have the least cost network option available to it, and this should include storage assets (even if limited to network use only).

[18] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/

For a highly specific constraint service there may be some circumstances where the market cannot deliver the precise service at the specific location which meets network companies' needs. Any system operator needs confidence that a service will be available at the location it is needed where it is providing security of supply. This is an important consideration in allowing ownership.

Ideal markets should provide the lowest cost services to the DSO. However, this relies on there being sufficient numbers of providers to ensure a competitive process. We note there are examples in the connections market where competition has not developed despite efforts to promote it and demand side markets that have not provided the required response to calls[19]. We have set out scenarios where the market may not deliver the least cost solutions for customers without the ability of DSOs to develop storage:

i) Incremental storage required

Network operators may already be managing constraints through flexibility and need a small amount of available storage to supplement current contracts. The storage would have a high option value to the network company in avoiding investment. The local market may be constrained on locations and participants (e.g. in a residential area where some domestic storage exists). If economical, yet not provided by the market, it seems unfair to prevent network companies building the limited storage asset themselves to provide this option value and save the reinforcement.

ii) Driving lowest cost solution from the market

Allowing network companies to own storage for network purposes can help extract the lowest cost solution from markets. For example, take the following hypothetical cost scenario:

- Standard DNO reinforcement costs – £15m
- Costs to DNO of procuring and operating storage to alleviate constraint (no other use) – £10m
- Cost of DNO service for market storage provider allowing for other revenue streams – £7m

Without the option of DNO owned storage, a market provider will know from the DNO's long term development statement that the baseline costs for a traditional network solution would be £15m. In a perfect market the costs for a storage operator to provide an equivalent solution to meet the DNO's needs, taking into account other revenue streams would be £7m. However, the DNO's minimum intervention is likely to be known to bidders which would encourage bids as close to this value as possible, say £12m to win the contract. If the DNO is allowed to own storage to resolve constraints, and could do this for say £10m then bidders would be encouraged to bid closer to the true cost to them of £7m, ensuring that the market provides an efficient outcome for consumers.

Keeping the door open on network ownership

As the storage and wider flexibility market develops, there may be other circumstances where the market cannot deliver. At this stage, we do not think Ofgem and BEIS should rule out network ownership of storage in specific circumstances where it can provide benefits to customers.

We fully recognise the competition issues surrounding selling services from a storage asset funded by regulated allowances. We believe that the enduring model for SNS provides a solution to these issues. Under SNS, all market transactions were undertaken through a supplier or aggregator. This allows for the stacking of benefits required to make storage viable but without direct DNO involvement in the market. This demonstrates that network ownership of storage does not need to equate to participating in the market and therefore any competition issues can be avoided.

[19] WPD did not secure the service it sought in the 2016 demand turn up service http://www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=8589938135

We note that other regulators and the European Commission are recognising that in specific circumstances network ownership of storage can be permitted. The recent 'Winter Package' released by the European Commission outlines that unbundled DNOs should be able to own storage where the market has not delivered in order to deliver efficient and secure network operation. Other regulators in Europe and Australia[20] are also supportive of limited network ownership of storage. We think our SNS model is broadly consistent with this approach. Consequently, we would urge Ofgem and BEIS to develop a regulatory framework for storage which outlines the specific circumstances where network companies can own storage.

Question 5: Do you agree with our assessment of the regulatory approaches available to provide greater clarity for storage?

The Call for Evidence adequately captures the range of regulatory approaches available to provide clarity for storage. As a network operator, there are two key things which the regulatory approach for storage needs to deliver:

i) Ability to provide cost reflective charges

In the future, we may need to develop commercial arrangements which are specific to storage. We have some concerns that our ability to do this may be restricted if storage remains defined as generation. We have a licence requirement not to restrict, prevent or distort competition in the generation of electricity[21]. If the legal and regulatory definition of storage is as generation, we may be limited in our ability to treat the two differently (i.e. not able to discriminate between types of generation), even where there are legitimate reasons to do so.

ii) Allowing network ownership where the market cannot deliver

As outlined in our response to question 4c) above, we think it is essential that network companies are not denied the ability to own storage in specific circumstances where the market has not been able to deliver the service needed. Our preference is that specific circumstances for network ownership and safeguards (such as no participation in the market) are outlined as part of the regulatory approach.

Given the above, we do not think it is ideal to continue treating storage as generation for licensing purposes (option a in the Call for Evidence). We think that options b, c and d could deliver our two objectives. We would highlight that if BEIS goes to the time and effort of defining storage in primary legislation (option c) then it will be worthwhile going the extra step of creating the new licensable activity (option d).

Question 6: Do you agree with any of the proposed definitions of storage?

We support the definition proposed by the Electricity Storage Network which is outlined in the Call for Evidence. This is on the basis that it is specific to electricity storage and it covers the conversion of electrical energy, not its generation. We consider that both of these elements are important in order to distinguish electricity storage from other network systems such as capacitors.

[20] http://www.aemc.gov.au/Major-Pages/Technology-impacts/Documents/AEMC-Integration-of-energy-storage,-final-report.aspx

[21] Standard licence condition 4 of the Electricity Distribution Licence.

Our view is supported through our discussions at the BEIS/Ofgem storage working group, which has been debating these issues, and the specific work we undertook on a proposed storage licence as part of the SNS project.[22]

Aggregators

Question 7: What are the impacts of the perceived barriers for aggregators and other market participants? Please provide your views on:

- **balancing services;**
- **extracting value from the balancing mechanism and wholesale market;**
- **other market barriers; and**
- **consumer protection.**

Do you have evidence of the benefits that could accrue to consumers from removing or reducing them?

Ofgem and BEIS have identified a number of barriers which we recognise. Removing these barriers requires a clear framework for flexibility in wholesale and balancing services.

Product design and procurement

If the SO procures services to support the system and aims to be technology agnostic, then it must set out its requirements for these services. The challenge for the SO is to set out its requirements in a manner that allows new technologies to contribute, while maintaining security of supply. It is relatively straightforward to specify services that replicate existing system requirements (e.g. for frequency response) and this might allow existing providers to deliver these services but seem to exclude new entrants.

Real time services are certain to have more stringent requirements than those aimed at supplier balancing positions (half hourly flexibility). For demand-side services there is more work to be undertaken to ensure that actions taken by DSR providers are clearly visible to the procurer of the service. This is particularly the case for real time services (where half hourly metering is inadequate). It may be important to ensure that new service providers have a framework through which they can demonstrate capability ahead of contracting for system security services (critical constraint management, reserve or frequency services).

Cross party impacts

We agree that actions taken by aggregators should have the impact reflected on related parties. The points raised in the Call for Evidence identify a number of issues with regards to the design and operation of markets supporting the operation of the system.

The impact depends on the relationship of the aggregator to the other parties:

- The aggregator is providing flexibility to a supplier within the wholesale markets: the aggregator should be responsible for the costs of any transaction costs between suppliers where it is contracting services from DERs; and
- The aggregator is providing services to the system through balancing services: we would agree that suppliers' imbalance positions should be mitigated.

As a DSO we believe that there is a need for transparency of DER contracted to respond to any participant in the operation of the system. This transparency is needed to ensure that:

[22] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/Report+9.5+19Oct_v2.1_%28Final+Photos%29.pdf

- The extent of flexibility being used and the net-demand position is understood for planning, developing and operating an efficient system; and
- Resources are not called upon that are already in use and are unable to respond (there is a linkage here to the value of services provided – flexibility providers should see fair value for the services provided).

There is a need to have clear roles for the different market functions in the operation of the system so that parties understand where the value is derived and managed. There is also a need to identify means to assess whether behind the meter actions have had the contracted effect. Actions taken that reduce demand that are offset by other uncontrolled increases within the same metered demand are not possible to determine.

Suppliers, aggregators and customers will all seek value through flexibility services, so consideration should be given as to whether there should be separate licensing for:

- Retail services to customers (and associated customer protection); and
- Flexibility services (to suppliers and system services) with conditions associated with inter market actions.

Question 8: What are your views on these different approaches to dealing with the barriers set out above?

Ofgem should develop a range of approaches to the barriers described. It may be appropriate that there are different entry requirements for different flexibility services. For example, it may be appropriate to have lower entry requirements for services that are provided to suppliers for commercial positions in the wholesale markets than it is for providers of Balancing Market services or constraint management services where system security or the maintenance of customer supplies is at risk. It is important to start developing these entry requirements now so that they are in place before the volumes of aggregated services increase dramatically.

Question 9: What are your views on the pros and cons of the options outlined in Table 5? Please provide evidence for your answers.

Ofgem should keep a watching brief to see if providers of flexibility and system operators can find suitable service offerings for flexibility to access all markets. We are observing a number of aggregators and suppliers offering converging capabilities, particularly demand-side frequency response.

We support a clear regulatory framework for all participants in delivering system services. Contracts for services can mandate obligations on to providers, but there may be merit in licensing to avoid duplication or inconsistencies. In our response to question 10 below we highlight that licensing for those wishing to participate in system critical services may be appropriate to ensure the security of the system, as many of those services are now procured from licence exempt flexible resources not operating under a licence framework.

Question 10: Do you agree with our assessment of the risks to system stability if aggregators' systems are not robust and secure? Do you have views on the tools outlined to mitigate this risk?

It is inevitable that loads behind the meter will be controlled through bypassing smart meters, and this creates a risk that large amounts of load could be switched simultaneously. These devices will almost certainly be controlled though internet technologies with the inherent risk of cyber-attack or communications failure. It is therefore important that those systems be made as reliable and secure as possible.

We agree that this will require cross system thinking including those manufacturing and selling smart devices, but it is likely that different services would require different specifications. For example, a demand-side service providing frequency services (should this be possible) would be likely to require much faster ramp rates than normal balancing services. As such it should be for the system operator to set the required service standards.

As with a number of services supporting system security, the merits of licensing need to be considered. It is unclear whether purely contractual terms for non-delivery or failure to meet underpinning standards (e.g. for IT security) are sufficient. This is because commercial contracts require penalty mechanisms that are linked to damages and it might be difficult to make these appropriate for managing system security risks. Any associated provisions could be seen as excessive risks producing barriers to entry. For example, it is conceivable that a service provider could establish individual corporate entities, to deliver individual services. This could leave the SO unable to enforce any penalties wider than for that service or discriminate against the operator in other services. However, a licensing regime could place responsibilities on the controlling shareholders, while minimising barriers to entry.

Ofgem should consider the merits of licensing participants in such services in order to underpin 'good behaviour' and essential service rules.

General Authorisation Regimes similar to those used in IT may be appropriate to ensure transparency in services to wholesale markets but it is not clear that they provide sufficient powers to support system critical services, therefore licensing for such services may have some merit.

2. Providing price signals for flexibility

System value pricing

Question 11: What types of enablers do you think could make accessing flexibility, and seeing a benefit from offering it, easier in future?

Our view is that the enablers that could make accessing flexibility, and seeing a benefit from offering it, easier in the future will include:

i) Development of half hourly settlement as a minimum;

The development of half hourly settlement (as a minimum, as shorter time periods are being considered) will be essential in ensuring value signals to domestic customers (or intermediaries offering energy management services). Existing DUoS tariffs' design has been developed to provide price signals that should encourage the usage 'off peak'. However, DUoS tariffs are only one component of the charges to customers and it will be up to suppliers to provide them with smart tariffs or other incentives.

ii) Sufficient flexibility in licence arrangements to allow us to set charges or procure services to promote efficient use of the network;

In theory, price flexibility could indicate full system cost variations, locationally and over time, and this could then provide the right amount of flexibility. Price flexibility already drives many large customers' flexibility to avoid high peak energy charges and triad costs, but this is to some degree allowing users to avoid fixed and sunk costs. There are practical challenges to price flexibility. For example, for EV users it would require producing different price signals, in real time, in several thousand locations across our network. Highly local constraints affecting small numbers of users also may not result in effective flexibility markets. Complexity can be a disincentive for customers but this is likely to be moderated for end users by smart intermediaries and technology.

There are other charging considerations, including stability, transparency and non-discrimination, which need to be addressed. Network charges are strongly defined by the need to recover allowed revenue in a non-discriminatory manner. Highly locational charges, where customers pay different prices in adjacent streets, may not be seen to be fair. DNOs' revenue recovery licence compliance should not be a barrier to the use of seasonal time period charges. Consequently, licence charge restrictions should have sufficient flexibility so that they do not penalise DNOs who are targeting their charges to provide minimum long term cost to consumers by incentivising efficient use of their network.

The final charges consumers responding to price signals see are a composite of fixed and variable costs, generation costs (which combine fixed charges from investment and mechanisms such as FiT and CfD with variable production costs), network charges (which could be considered to be fixed), and suppliers' operating costs. Network charges (including transmission) currently represent approximately 25% of the final costs, so reliance on price flexibility to secure demand response to meet local constraints may not be sufficient, as it is only a proportion of the energy bill[23].

iii) Visibility of resources that exhibit flexibility (and their use);

Visibility of resources that exhibit flexibility (and their likely use) will be critical to enabling system operators to forecast demand, plan and develop the network to provide the most efficient outcome for consumers (whether they provide contracted services or not). The current market arrangements do

[23] https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/understand-your-gas-and-electricity-bills

not promote the visibility of which customers are providing flexibility (for example, to suppliers to manage triad positions).

We are actively engaging with projects looking at how these challenges might be addressed, such as Centrica's Cornwall Local Energy Market that uses learning from California, Open Utility's proposals for a flexibility trial under EEF using learning from their peer to peer Piclo project, and Electron's ideas for block chain driven systems.

We intend to start recruiting and procuring flexibility in 2017, using the engagement experiences under LCL and relationships with aggregators and directly with industrial and commercial consumers. As a SO, using contracted or market procured flexibility as is the case of balancing services, is more likely to provide the certainty required for services vital to ensuring continuity of supply. Transparent market places that allow visibility of available resources and service requirements could assist this.

iv) the development of commercial and market models for flexibility, where procurers of flexibility share costs according to the priority of access required.

We support the development of commercial and market models for flexibility to complement the existing industry systems and in doing so develop a more adaptable future system that can adapt to the widespread flexibility that domestic storage and smart appliances may provide. A key issue in making use of and remunerating demand side services is visibility of the actions occurring amongst other variables on the system. As noted above, we are aware and supportive of the initiatives being developed by Centrica, Electron, Open Utility and InnovateUK and would encourage support for these as the industry determines its future needs. Block chain technology, distributed settlement platforms, and smart contracts that implement merit orders in procuring flexibility all need to be explored and developed in parallel with existing improvements to settlement systems to improve current markets.

There are two ways of stacking the value of flexibility:

- Providers of flexibility buy into multiple revenue streams, with the ability to extract value providing the incentive to act flexibly; or
- Flexibility providers offer their services at a price which the procurers of flexibility then share according to the priority of access required (which could change over time).

It is probable that the first option will drive the initial development of flexibility but future flexibility platforms could enable the second and permit greater optimisation of the system.

We are already seeing examples of the potential challenges from the first option:

- Price sensitive flexible demand will be responsive to the largest price risk it faces, e.g. flexibility will be used to manage exposure to high half hourly imbalance costs rather than provide lower value demand side response services;
- Service offerings have to be designed to be complementary, not exclusive, but avoid paying twice for the value provided to the system; and
- Customers/providers of flexibility have to navigate a complex array of services.

As we have seen with the generation capacity, marginal price driven markets may not provide capability ahead of need and establishing markets for future flexibility equivalent to the Capacity Market may be necessary to drive the business case for the incremental costs of investing in flexibility.

Question 12: If you are a potential or existing provider of flexibility could you provide evidence on the extent to which you are currently able to access and combine different revenue streams? Where do you see the most attractive opportunities for combining revenues and what do you see as the main barriers preventing you from doing so?

Our experience from SNS as a provider of flexibility to National Grid is that a key barrier to combining revenues can be the definition of the services themselves, e.g. STOR and EFR. We note that flexibility is procured through individual contracts: for example, National Grid has 12 frequency and reserve services and distribution services are currently procured through specific contracts to address specific network issues. The development of effective market places for the forward procurement and real time despatch of flexibility resources may reduce the barriers created by this complexity.

Question 13: If you are a potential or existing provider of flexibility are there benefits of your technology which are not currently remunerated or are undervalued? What is preventing you from capturing the full value of these benefits?

As a DSO we are incentivised to procure demand-side flexibility where we are certain of the requirement in order to minimise costs to our customers. Demand growth has been low and uncertain over recent years and this has created only a limited need for flexibility. This uncertainty 'limits' our ability to create a wider market for demand-side flexibility services to our system and may be seen by some to be limiting their ability to enter the market.

We intend to start recruiting and procuring flexibility in 2017, using the engagement experiences under Low Carbon London and relationships forged with aggregators and directly with industrial and commercial consumers. As the use of flexible connections expands and more storage looks to connect, demand-side flexibility will need to be facilitated through the connections process and agreement, which we are well positioned to enable.

Given that we are a procurer of flexibility we will leave it to providers to comment on technologies which are not currently remunerated or are undervalued.

Question 14: Can you provide evidence to support changes to market and regulatory arrangements that would allow the efficient use of flexibility and what might be the Government's, Ofgem's, and System Operator's role in making these changes?

Flexibility is already used both in the balancing system and by customers and suppliers to mitigate high peak charges and triads. We are also using it from export customers in order to connect them without the need for reinforcement. In developing efficient markets for flexibility, procurers of flexibility need to understand the resources that are acting in the system and therefore forecast the additional resources that need to be procured. In designing an overall framework, we need to understand the relative opportunity value of different services and how resources will respond.

It should also be clear for providers of flexibility where services would be remunerated, for example.

- Price driven flexibility provided to the wholesale market to match supply and demand is remunerated through those markets and use of system charges; and
- System operators procure additional flexibility to meet the needs of the system and remunerate this through contractual payments, or through flexibility markets.

Inherent price driven flexibility is not directly visible to system operators. As we have stated above, future markets should have visibility of all flexibility in order to allow system operators to efficiently develop the network and extend future services.

Government and Ofgem have a role in developing a regulatory framework that supports flexibility. Ofgem should look at where incremental changes to the existing systems and codes will not suffice and drive the development of systems which will support future markets, much as it did with previous market reforms.

Ofgem must also enable industry to collaborate across the value chain – for example, on flexibility platforms – to develop the solutions needed in collaboration with new entrants. Ofgem's role should be to ensure that these are developed in an open manner that does not create barriers to entry and supports a market for flexibility, but should encourage innovation. System operators (SO and particularly DSOs) should be incentivised to lead these developments for two reasons:

- They have a critical role in optimising use of resources, including networks, to ensure the best outcome for customers; and
- They can be incentivised to have no interest in excluding providers of services as their incomes are regulated (i.e. they have no incentive to limit competition in services in order to extract value from providing flexibility).

As explained in our response to question 46, Government and Ofgem have a role in ensuring there is a clear regulatory framework to promote flexibility, recognising the risks, costs and benefits that the shift to a smart, flexible network represents. If this framework can be put in place then it allows industry to develop the commercial incentives and tariffs for customers to provide flexibility.

Smart tariffs

Question 15: To what extent do you believe Government and Ofgem should play a role in promoting smart tariffs or enabling new business models in this area? Please provide a rationale for your answer, and, if you feel Government and Ofgem should play a role, examples of the sort of interventions which might be helpful.

We believe the industry should be allowed to develop products and services to meet customers' needs, consistent with the recent findings from the CMA markets review. Ofgem and Government's role should be to encourage the industry to develop the right frameworks to meet customers' needs. There are many approaches to developing smart tariffs (the NARUC rate design manual is a good summary of the approaches[24]), as highlighted in Table 1 below. There are competing needs between long term signals and short term optimisation.

We can develop smart network tariffs but are reliant on suppliers to reflect these on to our customers. Different suppliers have different appetites, simpler distribution tariffs can be easier to administer, but complex pricing and optimisation can offer a competitive advantage for suppliers.

[24]NARUC Distributed Energy Resources Rate Design Manual November 2016
http://pubs.naruc.org/pub/19FDF48B-AA57-5160-DBA1-BE2E9C2F7EA0

Table 1: Strengths and weaknesses of different charging approaches

Charging approach	Strengths	Weaknesses
Fixed capacity charges	Equitable charges for access to capacity and standby services; revenue certainty	No price signals to promote efficient utilisation of the networks
Demand charges (kW)	Reflect drivers of costs if largely fixed; revenue certainty	Difficult to respond to Penalises low demand low load factor customers No overall efficiency signal Drive cost avoidance (e.g. Triads)
Unit based volumetric (kWh)	Half hourly unit rates reflect demand and efficiency	Can drive fixed cost avoidance High peak charges can be difficult for some customers to avoid
Locational Marginal Pricing	Strong costs signals to optimise variable costs on the system	Complex pricing signals (day, hour, 5 minute) Variable Requires separate mechanism to recover fixed cost Certainty to promote investment needs longer term prices Advanced Metering infrastructure
Standby and Back Up	Option for recovering costs from customers who want grid availability for when they do not have enough capacity to meet their own needs	Can be seen to affect business case for DER
Flat rates	Ensure predictability	No efficiency signals
Block rates	Increasing charges in each consumption can drive efficiency	Need for consumer to understand ongoing consumption Can drive under recovery of fixed costs Decreasing block charges (fixed cost recovered up front can damage efficiency incentive)
Time Variant rates	Drives efficient use of resources	Require all customers to have time of use metering (e.g. half hourly)
Value Resources	Target value specific types of resources create	Ensure values only accounted for once (e.g. in FiTs or tariffs but not both)
Value Services	Value provided to the grid Technology neutral	Requires technology to implement
Transactive Energy Charges	Supportive of peer to peer interactions (SO earns revenue from promoting interactions) Value based on services provided	Requires technology and communications platforms Advanced Metering infrastructure

Through our Low Carbon London project, we conducted an extensive, first of its kind, dynamic time of use tariff with over 1,100 customers in our London area. We also conducted extensive analyses of both the quantified effectiveness of the tariff to flex customers' demand and domestic customers' attitudes towards flexibility[25]. We observed clear and strong support for flexibility-oriented tariffs with customers responding to surveys showing as evidence of customer attitudes:

- 91% of participants reported that the tariff should be offered to everyone and 81% even reported that the tariff should be a default or standard tariff. This was an impressively clear finding of support for more cost-reflective pricing, which was viewed as fairer and actually promoting efficiency for customers;
- 79% of participants reported that a dynamic, three rate time of use tariff was not experienced as complex in the course of living day-to-day with the tariff. This finding suggested that more consumers accept, or even have an appetite for some types of complexity; and
- The trial showed a clear response from customers, delivering up to an 8% reduction in their average peak consumption during high price periods.

As discussed earlier, smart tariffs may come from a combination of price signals and services. Further research may be helpful in understanding the incentives consumers react to – for example, whether negative cost avoidance incentives have the same power as positive payments for flexibility through contracts.

There are areas where Government or Ofgem could have a role in mandating smart tariffs, particularly in areas such as EV charging or electrification of heat, which will have a significant impact on the supporting network infrastructure and which could be reduced through smart tariffs.
As previously mentioned, ensuring consistent approaches such as full half hourly settlement will play an important role in driving benefit from changing consumer behaviour.

Question 16: If deemed appropriate, when would it be most sensible for Government/Ofgem to take any further action to drive the market (i.e. what are the relevant trigger points for determining whether to take action)? Please provide a rationale for your answer.

We consider that action from Government/Ofgem should focus on setting firm objectives and a timetable for implementing future change linked to the forecast uptake of DER. This approach ensures that all parties understand the priorities and their regulatory obligations. Ofgem/Government should maintain an oversight of delivery against these objectives but only intervene where necessary; for example, to prevent barriers to competition developing, or to arbitrate where industry consensus is needed but cannot be achieved.

This timetable must recognise the needs of the price control frameworks of RIIO-T2 and RIIO-ED2 that will set the incentives, obligations and funding for the network operators during the 2020s.

Question 17: What relevant evidence is there from other countries that we should take into account when considering how to encourage the development of smart tariffs?

There are many options for smart charging approached that should be monitored.
In the USA, nodal marginal pricing is being used more widely for day ahead and real time markets (e.g. PJM have a system of approximately 10,000 nodes, equivalent to pricing at the level of larger distribution primary substations (11kV))[26].

[25] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A2%20-%20Residential%20consumer%20attitudes%20to%20time%20varying%20pricing.pdf
[26] http://www.pjm.com/about-pjm.aspx

Question 18: Do you recognise the reasons we have identified for why suppliers may not offer or why larger non-domestic consumers may not take up, smart tariffs? If so, please provide details, especially if you have experienced them. Have we missed any?

Our experience in Low Carbon London echoes the Call for Evidence in terms of consumers' appetite for smart tariffs but also identified that significant price signals were required to invoke any behavioural change.

Larger non-domestic consumers may be indifferent to smart tariffs simply because understanding energy use is not part of their core business or immediate priorities. They may also feel that there is no scope for changing consumption patterns due to their business needs, or it may simply be that the business cost disturbance of a meter change is an unnecessary event. There may also be inertia due to expectation that energy costs may increase and that consumers do not expect decreasing costs as change happens.

We believe that half hourly tariffs will see lower cost consumers 'cherry picked' by innovative suppliers who offer appropriate products. These products will make use of seasonal time-banded tariffs which will benefit those consumers who are currently paying a 'penalty' on single unit rate average tariffs due to the consumer's actual lower cost usage. Over time the consumers who remain on tariffs that are not cost-reflective will face increases to reflect their higher than average costs as the low cost consumers migrate to the seasonal tariffs.

Smart Distribution tariffs: Incremental change

Question 19: Are distribution charges currently acting as a barrier to the development of a more flexible system? Please provide details, including experiences/case studies where relevant.

We do not think that distribution tariffs are acting as a barrier to a more flexible system. Distribution charges are designed, within limitations, to reflect the time when the system is most congested and therefore promote flexible use of the system. They are limited in that CDCM charges are not locational within the distribution service area. However, for larger customers, the EDCM produces a 'bespoke' charge that recognises their location in the system and the impact their actions have on the network.

We consider that the distribution charges provide a basis on which to layer other flexible products, such as contractual flexibility. As highlighted earlier in this response, contractual flexibility can provide the certainty of response which we need as well as the certainty of income required by providers of flexibility. We consider that trying to deliver flexibility solely through tariffs will make those tariffs too complex. DNOs have already been challenged about the differential in prices between service areas by suppliers desiring to reduce their costs, which illustrates one of the challenges that will emerge between smart tariffs and the opposing desire for simplicity/predictability.

Question 20: What are the incremental changes that could be made to distribution charges to overcome any barriers you have identified, and to better enable flexibility?

Since the introduction of the CDCM in 2010 and EDCM in 2012, many types of incremental change have been implemented. Some of the changes implemented have been to improve the stability of prices so that a consistent or predictable cost signal is provided and the risk of volatility is removed. Having a consistent cost message has been promoted as a way to reduce supply costs by removing unnecessary risk premiums applied by suppliers.

Feedback from our stakeholder engagement with suppliers and aggregators has revealed that incremental changes to the DUoS charging mechanism, through change modifications, can be seen to drive uncertainty and affect the business case for investment.

It is likely that changes to enable flexibility will have an effect of removing consistency and predictability. With this in mind it would be better to enact flexibility with 'active' flexible network participants such as demand aggregators (e.g. through contracts or market places), who will be best placed to manage the volatility of the charges. A separate charging regime for electric vehicles may also be an opportunity for 'incremental' change using smarter tariffs.

A clear path forward needs to be signalled to allow a flexible system to be developed and business cases made for users to participate.

Question 21: How problematic and urgent are any disparities between the treatment of different types of distribution connected users? An example could be that that in the Common Distribution Charging Methodology generators are paid 'charges' which would suggest they add no network cost and only net demand.

Given the average principles of the CDCM we feel that the current array of charges for demand and credits for generators are appropriately applied for the different types of users. One of the main underpinning concepts of the charging methodologies is that demand consumers are the ones who will ultimately pay for any charges applied to generators. With this in mind there should be no arbitrary charging of generators unless there is a real time cost driver for that generator.

However, there are issues relating to the interaction of the generation connection arrangements and the need to reinforce or constrain generation which may interact with generation use of system charges. Connection charges are currently used to signal where it is efficient to connect generation, but as constraints become more remote from the location of a generator, these signals are weakened by the connections charging framework (in particular the voltage rule which limits charges to one voltage above the point of connection). This may require DSOs to begin constraining generation off or to require a flexible connection, because of the high costs of addressing constraints. As constraints that are addressed by flexible connections are removed there will also be a need to ensure that the costs are appropriately assigned to those who benefit from their removal. This may require consideration of generation use of system charges in conjunction with the connections framework to ensure fair recovery of costs.

Smart Distribution tariffs: Fundamental change

Question 22: Do you anticipate that underlying network cost drivers are likely to substantively change as the use of the distribution network changes? If so, in what way and how should DUoS charges change as a result?

Potentially, the main way that the underlying network cost drivers will change is in the way that the costs of system operation (e.g. for services from DER) will vary from the costs of network asset provision. System operation will change as network operators become more innovative in seeking alternative solutions to traditional network problems. This will drive dynamic approaches that will be designed to reduce long term cost and improve system reliability. The costs of traditional network provision are likely to change over time as localised generation replaces the need for upstream reinforcement and the consequential maintenance of those assets.

With the advent of new low carbon technologies such as EVs, heat pumps and domestic storage, it is possible that some customers' demands will increase and others' will decrease or become more intermittent, and there will be a need to ensure that costs are recovered fairly from all users. It will be important to monitor the balance between fixed charges to recover the provision of standby capacity and variable charges that promote flexible response.

The other area of interaction is that between connection charges and flexibility, noted in question 21 above. Our current flexible connections provide the benefits of flexibility to the generators through lower upfront charges, with the DSO not incurring costs to curtail for the relevant constraints.

Question 23: Network charges can send both short term signals to support efficient operation and flexibility needs in close to real time as well as longer term signals relating to new investments, and connections to, the distribution network. Can DUoS charges send both short term and long term signals at the same time effectively? Should they do so? And if so, how?

While prices can in theory send long term signals, many market mechanisms seem to require longer term signals in addition to network charges (e.g. capacity payments) to provide sufficient certainty to enable investments in flexibility. The complexity of using DUoS for short term price signals may make transparency and predictability difficult as the system changes to support growing low carbon technologies. It may therefore be better to allow DUoS to provide long term signals and use separate flexibility charges/services to manage short term system requirements, initially through contracts, but eventually through flexibility markets.

Short term pricing signals are best placed with those who can contribute to active network management. We feel that those that will be able to contribute most will be active network participants such as aggregators. The costs and benefits of active network management will need to be split from longer term cost signals and should be reflective of specific network problems and reinforcement alternatives.

Longer term pricing signals are best placed to recover the DNOs' longer term or sunk costs that form the majority of the current allowed revenue. While these costs will only change over the longer term, it is still important that appropriate cost signals are synchronised so that consumers avoid behaviour which would drive the need to reinforce.

Question 24: In the context of the DSO transition and the models set out in Chapter 5 we would be interested to understand your views of the interaction between potential distribution charges and this thinking.

Our view is that in the short to medium term i.e. the next 10 years, the DSO will continue to evolve around purchasing contractual flexibility. This can provide the certainty needed for both DNOs (in knowing resources are available) and for providers of flexibility (in terms of certainty of revenue). In the longer term, it may become possible and potentially more practical to use pricing as a way to procure flexibility once there is an abundance of active distributed energy resources connected.

For example, as the demand and resources served by the networks develop greater flexibility, both the DSO model and the energy markets will evolve and charging structures will need to evolve to support them. There are also challenges in flexible systems in determining rights to capacity (currently a connections issue), particularly as the system evolves. Charges may therefore need to reflect users' rights to capacity as well as their actual use of it. We will use our TDI 2.0 project to look at how flexible capacity rights can be assigned using more market based mechanisms.

We are already seeing local and peer to peer services emerge where local trading reduces some users' reliance on upstream infrastructure. These customers will still need to contribute fairly to the maintenance of upstream capacity (physical or flexible) if they want to retain rights to secure capacity in all circumstances, in which instance an element of fixed capacity charges may also be appropriate.

Other Government policies

Question 25: Can you provide evidence to show how existing Government policies can help or hinder the transition to a smart energy future?

One example of where Government policy impacts the transition to a smart energy future is around connection charging. The current connection charging regime at distribution levels reflects, in part, the deep connection costs (one voltage level above the point of connection) and encourages generation to connect where there is capacity or to make best use of capacity. Transmission connected generators have a different regime where the charges are shallow and use of system and constraint payments are used to manage access (connect and manage). This can impact decisions generators make over whether to connect at distribution or transmission level.

If DNOs were to trigger transmission reinforcement because of generation connections at lower voltages, then these costs can only be recovered by being passed through to the generators. These costs are typically significant such that the generators cannot fund them and thus they limit the capacity available, prohibiting our ability to make further connections. Our TDI 2.0 project will look at interfacing active network management across the T&D boundary to enable more connections without the need for reinforcement. A consistent commercial framework is needed across this boundary.

In addition, we would support changes to renewable incentives that support the co-location of storage with generation where this supports the networks through reduced intermittency. At a system level, intermittency can be addressed by storage located remotely from generation, but this does not have the same overall benefit as energy has to be transported between the two locations.

Question 26: What changes to CM application/verification processes could reduce barriers to flexibility in the near term, and what longer term evolutions within/alongside the CM might be needed to enable newer forms of flexibility (such as storage and DSR) to contribute in light of future smart system developments?

A suitable framework is needed to promote investment in flexibility ahead of need, both storage and demand flexibility, but there should be a debate as to whether a single mechanism can procure the underlying capacity needs and the flexibility needs. Flexibility will have different values in different localities, and to the system as a whole, and it is not evident that the current capacity market is designed to deliver local needs.

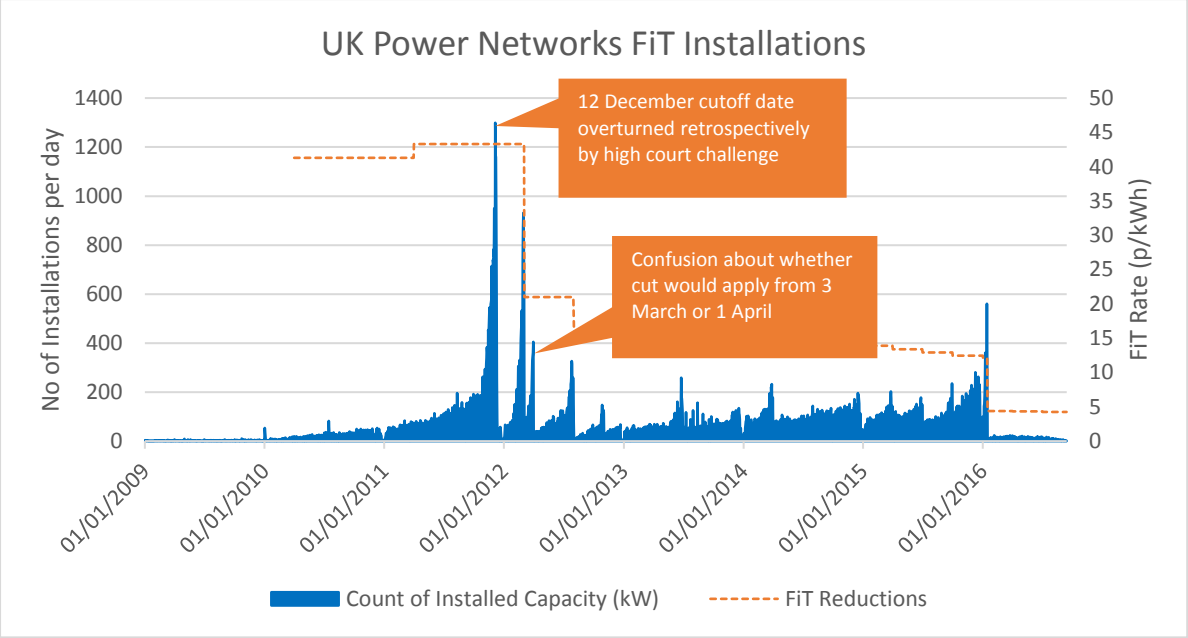
Question 27: Do you have any evidence to support measures that would best incentivise renewable generation, but fully account for the costs and benefits of distributed generation on a smart system?

The American NARUC Distributed Energy Resources Rate Design Manual (November 2016) considers approaches to valuing resources. This discusses designing the tariffs or rates to value the many aspects of renewable energy value. A clear and enduring framework will both promote investment and allow the SO and DSO to plan to integrate renewables, sending clear cost signals about the costs/value they can bring. An enduring framework would also ensure clarity on where benefits provided are credited and costs are met. For example, if carbon benefits are credited to generators through mechanisms such as renewable obligations, then any mechanism should make clear where the costs should fall for addressing constraints justified by reduced carbon emissions from increased exports.

We have clear evidence that Government support measures (and their level) can have a significant impact on the take-up of renewables in a way that can affect network operation and our business investment needs. Changes to renewable subsidies can create bursts of activity, shown in Figure 4

below, as investors seek to access the incentives. It is therefore important for Government to set out a long term, clear plan on where it will provide support and to what extent.

Figure 4: Number of FIT installation in UK Power Networks



3. A system for the consumer

Smart appliances

Question 28: Do you agree with the 4 principles for smart appliances set out above (interoperability, data privacy, grid security, energy consumption)? Yes or No (please explain)

We broadly agree. In order to maximise the benefits that smart appliances offer to customers, networks would require visibility of where these devices are acting in order to coordinate with demands for the network. Standards would also be crucial to allow scalability with networks interacting with smart appliances from various manufacturers. This would also mitigate 'consumer lock in'.

In our Low Carbon London Learning Laboratory, we utilised data from over 2,800 detailed customer appliance surveys to complete an analysis of the flexibility available from smart appliances. This survey data was used to populate a device-level household model developed by Imperial College London that used real network data. This work showed a peak reduction opportunity of between 8.8% and 12.9% for those customers on the trial, when industry coordination of appliance demand is assumed. However, this model also showed that uncoordinated smart appliances create a clear possibility of significant new network peaks as a consequence of loss of demand diversity and widespread (i.e. coordinated) price incentives. We take this to be clear evidence that both visibility and the ability to maintain or promote diversity in the use of smart appliances is essential.

Question 29: What evidence do you have in favour of or against any of the options set out to incentivise/ensure that these principles are followed? Please select below which options you would like to submit evidence for, specify if these relate to a particular sector(s), and use the text box/attachments to provide your evidence.

- **Option A: Smart appliance labelling**
- **Option B: Regulate smart appliances**
- **Option C: Require appliances to be smart**
- **Other/none of the above (please explain why**)

We view consumer trust, understanding and therefore informed and confident adoption as essential success factors to allowing smart appliances and services to drive the flexible energy system of the future. The requirements are likely to be dependent on the technologies in question.

Product labelling and British Standards (option A) can promote or advertise equipment meeting minimum standards. This might be an appropriate approach for consumer goods where British standards will have to align with international standards.

Technologies that provide key flexibility or have a very significant impact on system demand (e.g. EVs and heat pumps) may require more stringent regulation (option B) and potentially have to have minimum levels of functionality mandated (e.g. public EV charging infrastructure).

Robust, agile and scalable approaches to cyber security will be critical in developing and maintaining consumer trust, understanding and adoption. Smart appliances that are vulnerable to disruption are unlikely to be accepted or made use of.

Question 30: Do you have any evidence to support actions focused on any particular category of appliance? Please select below which category or categories of appliances you would like to submit evidence for, and use the text box/attachments to provide your evidence:

- **Wet appliances (dishwashers, washing machines, washer-dryers, tumble dryers)**
- **Cold appliances (refrigeration units, freezers)**
- **Heating, ventilation and air conditioning**
- **Battery storage systems**
- **Others (please specify)**

We do not have any specific evidence to submit.

Question 31: Are there any other barriers or risks to the uptake of smart appliances in addition to those already identified?

The perceived value of enabling the smart functionality over user convenience may be a barrier. Many non-smart devices such as dishwashers and washer/dryers offer users flexibility (e.g. deferred operation) and additional functionality may not be perceived to have sufficient added value, in a similar manner to Industrial and Commercial customers, who do not engage in flexibility.

Internet of Things (IoT) devices have already been used in internet denial of service events. Public perception of the risk to their own data security from such devices could limit their uptake.

We have highlighted our experience and observations about cyber security in our response to question 41.

Question 32: Are there any other options that we should be considering with regards to mitigating potential risks, in particular with relation to vulnerable consumers?

The fuel poor may be the biggest beneficiaries of flexibility but least able to access it through smart devices. Our energywise project has used a flexible approach to engagement that can be tailored for different groups. The energywise recruitment strategy was based on:

- Contact from a local trusted organisation with an excellent understanding of the local area and languages;
- An engagement strategy and materials tailored to the target population; and
- Face-to-face communication and support.

We would recommend that Ofgem and BEIS consider further engagement with community groups and support for community energy schemes as worthwhile initiatives to help engagement with fuel poor customers.

Ultra-low emissions vehicles

Question 33: How might Government and industry best engage electric vehicle users to promote smart charging for system benefit?

We believe that there are three key elements that will require a coordinated effort from Government, the transport industry and the energy industry:

i) Information and education at the time of purchase

Informed and engaged customers will improve the user acceptance of smart charging. EV users already tend to be more engaged as the technology requires a change in behaviour. At the early stage, where EV purchase is being considered, the consumers can/should be engaged to promote the value/benefits of smart charging. Better informed customers can be empowered to take control over when and where their vehicle receives a charge.

ii) Ensuring the smart option is simple and easy to choose

Our Low Carbon London project demonstrated the value of smart charging to shift electricity consumption during vehicle charging and release capacity on constrained networks[27]. This would enable increased demand on the network at a lower cost to customers. The EV trials in the Low Carbon London project highlighted that there are two interventions that can be applied in relation to smart charging of EVs:

- Behavioural interventions: such as time-of-use tariffs which require the customer to take action. This could be supported by offerings from energy suppliers, vehicle manufacturers and suppliers, which could minimise the costs of charging to customers; and
- Technical interventions: which automate the process for customers. In order to maintain safe and secure supplies to customers, technical interventions offer more scalable, reliable and sustained responses.

To ensure the smart option is simple and easy to choose, it clearly requires vehicle manufacturers, Government and the energy industry to develop a technical and commercial framework that supports smart charging being the default choice for customers. This will require standards for smart charging infrastructure, development of supporting energy products and infrastructure to allow the vehicles to be used as smart devices by the energy system.

iii) Ensuring smart tariffs are available and benefit smart users

While it must be easy to choose the smart option, smart tariffs that support both technical coordination of smart charging and can be used to indicate the benefits of smart charging to customers will be a necessary innovation.

We are already thinking about these areas as part of developing a strategy to manage EV take-up across our networks. To achieve the three outcomes above we propose the following:

1. The EV Network Group[28] is used to promote wider engagement and knowledge dissemination between vehicle manufacturers, aggregators, energy suppliers, networks and system operators to promote the understanding of the benefits of smart charging and kindle the development of smart charging solutions;
2. There are further Innovation trials building on the work of Low Carbon London and My Electric Avenue[29] to develop smart charging standards; and
3. The Modern Transport Bill is used to ensure the development of the technical standards and interoperable systems needed to underpin smart charging.

[27] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A10%20-%20Smart%20appliances%20for%20residential%20demand%20response.pdf
[28] http://www.lowcvp.org.uk/projects/fuels-working-group/EVNetworkGroup.htm
[29] http://myelectricavenue.info/

Question 34: What barriers are there for vehicle and electricity system participants (e.g. vehicle manufacturers, aggregators, energy suppliers, networks and system operators) to develop consumer propositions for the:

- **control or shift of electricity consumption during vehicle charging; or**
- **utilisation of an electric vehicle battery for putting electricity back into homes, businesses or the network?**

There is clearly a need for the electricity system participants to work with the vehicle and transport providers to develop products that enable the system to work for consumers. We have identified two key barriers, discussed below.

i) Visibility of Information

The visibility of the location, characteristics and use of chargepoints will be vital to enabling smart charging to support the efficient development of the supporting electricity networks. We would welcome mandating this visibility.

Maximising the benefits to customers from smart charging is inextricably linked to the location of the chargepoints on the network. Demands on the network are by their nature typically limited to specific locations as a result of the local load and generation. Therefore, in order to maximise the benefit to customers from the smart functionality in chargepoints and vehicles, it is vital that DSOs have access to static data such as the geographical location and dynamic data such as the availability and usage of chargepoints. This would provide the minimum information required for the DNO to value and request a smart intervention for that network. The case for visibility is a key recommendation from our Low Carbon London report on smart charging[30]. We do recognise that there will be data privacy concerns, as there have been with smart meter data, but we believe that these can and must be addressed to enable smart charging that enables network operators to deliver a service that will meet customers' expectations.

DNOs currently capture public chargepoints through their connections processes. The ENA has established a notification process[31] to capture data on the location and rating of behind the meter chargepoints through the EV chargepoint installation notification process. This is recommended in the IET Code of Practice on chargepoint installations. This is a voluntary recommendation which there is no means of currently enforcing. We therefore welcome and support initiatives that set out clear requirements on chargepoint installers to notify the DNO in order to facilitate the benefits of smart charging to customers. We are also proactively engaging with local authorities and EV chargepoint manufacturers to understand where larger scale roll-outs of EVs are planned.

Considering evidence from a similar example of the notification requirement that DG installers have to inform a DNO when a small-scale generator (e.g. G83 classified) is commissioned: When we gained access to the feed in tariff (FIT) register of G83 connected devices in our networks, we discovered that we had only been notified of around 40% of devices through the voluntary mechanism. We would propose this evidence as justification for a more formal or enforceable position on DNO notification of electric vehicle connection. For example, enabling vehicle registration data to be shared with DNOs, and/or a data sharing agreement between charging infrastructure providers facilitated by OLEV or another body.

Visibility would entail the following data fields being provided, as a minimum, to inform the DNO on the suitability of smart enabled EV chargepoints to mitigate a local network constraint:

[30] LCL report **B5** 'Opportunities for smart optimisation of new heat and transport loads'
[31] http://www.energynetworks.org/electricity/futures/electric-vehicle-infrastructure.html

- Static data: location of chargepoint, number of sockets, rated power (kW) per socket, mode of charge (AC/DC), smart functionality e.g. stop charge, vary charge rate; and
- Dynamic data: charge rate, charging status.

We have established views, which have been presented in papers[32] such as the IET Hybrid Electric Vehicle Conference on the importance of dynamic data to facilitate the benefits of smart charging. The 'availability' of an EV charging load which is described as the volume of EV chargepoints in use, and their associated load, at the time of constraint on the network is an important metric informing the value of smart charging. With the right level of availability, a given volume of EV chargepoints will be able to provide a suitable level of response to mitigate the network constraint. Dynamic data is particularly vital to the management of the network in response to the live load and generation on the network – this is described as active management of the network.

The visibility of this data coupled with smart charging options will provide the opportunity for EVs to provide network services, such as constraint management. This has the potential to ensure the costs of facilitating the low carbon transition are minimised, which will also result in lower customer costs.

ii) Standards

Standards allow for safe, secure and interoperable smart charging to be realised. Standards also enable smart functionality to be scaled and applied consistently to ensure the realisation of the benefits to customers.

Standards are particularly important to ensure that customers have safe and secure smart functionality designed into a system that is also open, interoperable and scalable. Standards can be designed to allow consistent interaction and information exchange between the smart chargepoint and grid management systems as well as protection from cyber-attack. An additional benefit of standards is the opportunity to maintain consumer confidence without hindering the competitive development of chargepoints. These open standards can be developed akin to 3G/4G/5G in the telecoms industry, which have allowed the market for smart phones to thrive and grow with various offerings.

We are aware that similar work is underway in the Netherlands by ElaadNL. ElaadNL is the knowledge and innovation centre in the field of smart charging infrastructure in the Netherlands. Their work to develop smart charging standards could provide valuable learning for the UK. ElaadNL's 'Living Lab Smart Charging' demonstrator has involved a sizeable upgrade operation across the country to ensure the existing charging stations will be able to technically facilitate smart charging and all new installed chargepoints are smart charging ready[33]. The proposals under this consultation present an opportunity for the UK to take the lead as the international frontrunner for smart charging.

Standards can also be designed to accommodate varying degrees of energy supply balancing including:

- Simple On/Off instruction; This could be established as the minimum requirements or standard for smart functionality in chargepoints;
- Instruction to vary the rate of charge;
- Varying the rate and duration of charge disruption relative to the EV battery state of charge; and
- Bi-directional power transfer through 'Vehicle-to-Grid' (V2G) applications. Demonstrators such as the V2G project[34] have investigated the potential of battery-powered vehicles to use their

[32] Regulating EV demand: Distribution Network Operator perspective on Electric Vehicles.' HEVC 2016 conference publication
[33] https://www.elaad.nl/nieuws/nederland-als-living-lab-voor-het-slim-opladen-van-elektrische-autos/
[34] http://www.smarternetworks.org/Project.aspx?ProjectID=1291

excess rechargeable battery capacity to provide power to the grid in response to peak load demands. This project involved retro-fitting an EV to allow bi-directional power flows from the EV as well as the development of a bespoke V2G chargepoint. The project successfully demonstrated this but concluded that in the long term the vehicle and chargepoint manufactures would need to see the value of V2G to develop the technology at a scale that would allow benefits to the customers and grid. With V2G applications, utilisation of an electric vehicle battery for putting electricity back into homes, businesses or the network is possible. There are currently very few vehicles and chargepoints which allow for bi-directional power transfer to facilitate this. Nissan and ENEL are most notable for trialling this technology currently with the Nissan Leaf and a suitable V2G chargepoint respectively.

Visibility and standards go hand in hand towards realising the value of smart charging and we would welcome initiatives from manufacturers, aggregators, energy suppliers, network and system operators to develop these standards. We have developed a strategy to help facilitate electric vehicles on our network and this includes the continual development of innovative solutions, using learning from innovation projects such as 'My Electric Avenue'[35].

Question 35: What barriers (regulatory or otherwise) are there to the use of hydrogen water electrolysis as a renewable energy storage medium?

As a DNO we would be agnostic to the storage technology used and cannot comment on the barriers to this technology. We encourage early engagement from customers seeking to utilise this technology in order to adequately meet their needs and support the adoption of the technology. Clearly the impacts on the system will depend largely on where the storage occurs. Co-located with generation (and using its output) is likely to have a much lower impact than if it presents an additional demand like any other storage system.

Consumer engagement with demand side response

Question 36: Can you provide any evidence demonstrating how large non-domestic consumers currently find out about and provide DSR services?

Since the completion of our Low Carbon London project in 2014 there has been an increase in activities from established buyers. This includes National Grid's Power Responsive campaign and the new Enhanced Frequency Response (EFR) service. Changes in imbalance pricing have also created new supplier-specific products/service offerings such as DONG Energy's Renewable Balancing Reserve (RBR), as new aggregators are entering the market[36]. DNOs will also become increasingly active in the market for flexibility and will be raising awareness of the DNO DSR requirements. We see the bigger challenge in converting awareness into participation.

Our four-year Low Carbon London project investigated the impact of a wide range of low carbon technologies on London's electricity distribution network, including DSR. A key learning from the Low Carbon London trial was that the industrial and commercial sector are largely familiar with established DSR services such as peak demand avoidance and short term operating reserve (STOR) marketed through suppliers and National Grid, as well as aggregators.

In the Low Carbon London project, we marketed a new service offering, requiring significant up-front and continuous engagement with providers and aggregator partners played a significant role in recruitment. There were trial-specific challenges, such as some reluctance to sign up to a trial of short duration and an unclear business case (the purpose of the trial). However more generally, the

[35] http://myelectricavenue.info/about-project
[36] http://www.dongenergy.co.uk/news/press-releases/articles/dong-energy-launches-flexibility-service-to-balance-renewable-portfolio

challenges and approaches taken in the project gave us good insight into how non-domestic consumers engage with DSR[37]. This learning will inform our approach when we go out to tender for further demand side services later this year.

Question 37: Do you recognise the barriers we have identified to large non-domestic customers providing DSR? Can you provide evidence of additional barriers that we have not identified?

We completed a detailed survey and analysis of larger, non-domestic customer's attitudes towards participation in DSR schemes on the Low Carbon London programme in 2012. This analysis identified that the most significant barriers related to:

- Negative perceptions of potential risks to comfort if building services are turned down; and
- Effects on service levels to customers and building residents, costs, time, equipment and other resources.

These negative perceptions were found to outweigh technical and financial barriers to participation. An additional, important point that we noted during the Low Carbon London programme is that the different layers of owners, operators, and users of flexible assets which all need to be involved to support participation in DSR. For example, a CHP generator may be owned (e.g. a property owner), operated (e.g. a facilities company), and utilised (the business tenant) by three different companies who would all need to approve participation in flexibility programmes.

These findings are consistent with that of Ofgem's survey that identified that the most commonly quoted risk was "risk to business from providing (further) DSR, including third party control of processes"[38].

Question 38: Do you think that existing initiatives are the best way to engage large non-domestic consumers with DSR? If not, what else do you think we should be doing?

The current engagement initiatives have raised awareness of DSR amongst non-domestic consumers. However, it is important that these initiatives try to address the barriers, otherwise increased awareness will not necessarily lead to greater up-take.

We launched the first of our ED1 DSR schemes in our Eastern area in 2016. We intend to start recruiting and procuring further flexibility in 2017. These programmes benefit from the engagement experiences under Low Carbon London, relationships with aggregators, and relationships with direct with industrial and commercial consumers. We will continue to share our experiences with Ofgem and BEIS as we embark on this programme.

We would urge Ofgem and BEIS to clarify the market structure and the role and responsibilities within it to facilitate the development of DSR. We expand on this comment in our response to questions 45 and 46.

[37] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A4%20-%20Industrial%20and%20Commercial%20Demand%20Side%20Response%20for%20outage%20management%20and%20as%20an%20alternative%20to%20network%20reinforcement.pdf

[38] https://www.ofgem.gov.uk/publications-and-updates/electricity-system-flexibility-demand-side-response-survey

Question 39: When does engaging/informing domestic and smaller non-domestic consumers about the transition to a smarter energy system become a top priority and why (i.e. in terms of trigger points)?

We believe that the need to engage with smaller customers has already arisen. Customers are starting to be exposed to low carbon technologies, such as smart meters, electric vehicles, neighbours installing solar panels in their rooftops. As this rapidly changing world evolves it is really important that all consumers start to understand the future impacts and opportunities that, for example, energy efficiency and demand response measures, could provide them.

Consumer engagement will occur through many channels, suppliers and the roll-out of smart metering, home automation technology and service providers, smart appliance providers and vehicle and transport providers.

Our LCNF funded projects have consistently engaged with smaller customers and communicated the challenges and opportunities the transition represents. These projects are providing useful learning on how to engage and revealing the issues that will need to be overcome to get smaller customer to engage.

- Our Low Carbon London project installed 5,815 smart meters in domestic homes with a number participating in trials of dynamic time-of-use tariffs. The trial participants were also invited to complete detailed energy behaviour surveys. We found enthusiasm to participate but behavioural change required significant price signals; and
- Our energywise project is using community agencies to engage with vulnerable customers in the London Borough of Tower Hamlets (one of the most deprived areas in London) to address the best ways to engage with fuel poor customers to deliver energy efficiency (including smart meters) and DSR opportunities.

The learning from these projects is that the engagement will need to be enduring and the importance of engagement will grow as the number of controllable devices increases to the point where they have a notable impact on the system. Key developments which will need enhanced engagement include the electrification of transport and heat. Smart charging of vehicles will be one of the major opportunities to engage with customers on smart energy behaviours.

Consumer protection and cyber security

Question 40: Please provide views on what interventions might be necessary to ensure consumer protection in the following areas:

- **Social impacts**
- **Data and privacy**
- **Informed consumers**
- **Preventing abuses**
- **Other**

As the first DNO-led innovation project specifically addressing fuel poverty, energywise is seeking to understand how the industry can better engage with traditionally hard to reach groups on energy initiatives and how we can work in collaboration with energy suppliers and local trusted organisations to support them to access the benefits associated to smart technologies and new tariff structures. While the project is still running, we have already gathered key learning on what are the potential barriers in delivering smart benefits for hard to reach customers and tested a locally-based approach to overcome some of these barriers.

The consultation outlines four main areas where customer protection issues may arise within the context of a smart, more flexible system:

Social impacts

Time of Use tariffs are facilitated by the national roll-out of smart meters. The take-up of smart meters and smart tariffs is voluntary; customers have to willingly opt-in to have a smart meter installed and to switch to a new tariff. Some consumer groups are expected to be less likely to accept a smart meter and therefore will be unable to receive some of the new tariff offers. This includes those aged over 75 years, those who cannot speak English well or those who have a disability, such as being partially sighted or blind[39]. Our Low Carbon London project has also shown that the Inner City Adversity social group (in the widely used ACORN classification system for social groups, the Inner City Adversity group are low income, high unemployment groups typically earning less than £10,000 per annum) was the most prevalent to refuse to have a smart meter, owing to it being too technical or confusing. In order for the transition to a smart energy system to be successful and that the benefits are accessible to all, it is vital that it reaches all customers, including those who are vulnerable or low income.

energywise has proposed a flexible approach to engagement that can be tailored for different groups. The energywise recruitment strategy was based on:

- Contact from a local trusted organisation with an excellent understanding of the local area and languages;
- An engagement strategy and materials tailored to the target population; and
- Face-to-face communication and support.

This approach proved to be very successful in achieving the impressive 40% sign-up rate while ensuring inclusive recruitment of consumers that are considered hard to reach, including elderly households, and black or minority ethnic households which lack English as a first language. Based on our experience we recommend the following considerations in order to make sure the transition to a smart system is inclusive to those that are hard to reach:

- Consider a tailored approached for those that are most difficult to engage;
- A local approach may be preferable to target ethnic minorities living in specific areas or hard to reach communities;
- It is important to identify who are the organisations or individuals trusted by specific demographic segments and what are the messages that resonate with them;
- Work in partnership with trusted intermediaries or with champions with local intelligence and language skills;
- Consider face-to-face engagement to communicate to consumers the benefits they may realise if they opt in to smart interventions and respond to smart tariff; and
- Local champions have to be trained up professionally to identify vulnerability and to deliver key messages such as energy efficiency advice.

energywise is currently setting up the second phase of the project that will test the ability of fuel poor consumers to respond to DSR opportunities. Early considerations on how to increase the response to smart tariffs include:

- Tariff structures for those that are most vulnerable and hard to reach should be easy to communicate and understand;
- While energy efficiency advice is now very common and delivered through a multitude of channels, educational materials on how best to shift the energy consumption away from peak hours and access the benefits of different pricing signals should be made available to consumers on smart tariffs; and
- It is important to put in place a series of measures that will ensure that the change of behaviour is sustained over time, otherwise consumers may be worse off in the long term.

[39] Smart Energy GB, 2015, "Smart energy for all; identifying audience characteristics that may act as additional barriers to realising the benefits of a smart meter".

Data and privacy

We agree that the move to a smart energy system requires a careful consideration of data protection matters due to the expected increase of the amount of data that will be available to energy suppliers, network operators and other parties. We believe that this is a critical area for consumer protection.

We also agree that appropriate privacy safeguards need to be in place for handling personal data and that personal data needs to be managed in accordance to the Data Protection Act. Transparent processes should be in place to regulate how data is used only as intended for the purposes of a specific organisation. Data privacy should not be a barrier to develop new smart tariffs, new business models, or using the data to efficiently manage the system. As networks and the loads connected to them become more active then visibility, forecasting of customer behaviour will become more important for the system operator and this may require more disaggregated customer data to be available to network operators.

However, consumers' privacy should be central when defining new procedures to process their data. We already have robust processes in place to manage the customers' data which we receive, particularly for managing outages. Our innovation project energywise set up a Data Privacy Strategy to define the approach taken by the project partners in handling and processing personal data (as defined in the Data Protection Act 1998).

Informed consumers

In order to ensure that all consumers are taking part in the transition to a smart energy system by making informed decisions on how they wish to participate, we recommend that information is accessible and transparent to all community groups. These should include ethnic minorities, consumers living in areas of financial deprivation or in disadvantaged areas and households that may experience language and communication barriers.

Many customer groups are hard to reach or have vulnerabilities that limit their chances to access information. Through our engagement with vulnerable customers we have gathered invaluable learnings on best ways to engage with these groups and support them to understand the benefits available to them when accessing smart technologies and smart tariffs.

The following measures should be taken into consideration when informing consumers about the opportunities in a smart energy system:

- Develop key messages and identify trusted messengers that resonate with different consumers' groups and vulnerable people;
- When targeting hard to reach customers, tailor the communication strategy and materials to the specific demographic group; face to face engagement also works best;
- Make partnerships with trusted intermediaries that can support customers in breaking the barriers in understanding how to operate smart technologies and the benefits associated to smart interventions and smart tariffs;
- Consider using multiple languages, different media and communication channels and include as much visual content as possible; and
- Ensure that the consumers receiving the information, signing up to a smart tariff or attending the demonstration of smart technologies, are briefing others living in the household, otherwise the benefits from smart energy systems and smart tariffs will be limited.

Through our project energywise targeting households who may be struggling with their energy bills, we have learned that low income customers are likely to be primarily motivated to opt in for smart meters and DSR by the prospect of saving money on their bills. In the case of smart meters, better visibility of energy costs and easier top up methods for prepay customers are also key features that

make them attractive. This demonstrates the importance of providing clear information on what are the benefits associated to smart interventions to allow consumers to take informed decisions on the extent they wish to participate.

Preventing abuses

As a licenced operator we believe that there are robust controls in place on the network/system operators.

Question 41: Can you provide evidence demonstrating how smart technologies (domestic or industrial/commercial) could compromise the energy system and how likely this is?

A key system issue is rapid increases and decreases in demand. The system already addresses increases related to consumer behaviour before or after major events (e.g. people turning kettles on) which are predictable. Smart technologies theoretically create the risk of wider co-ordinated events that are difficult/impossible to predict. National Grid has indicated that ramp rates will continue to increase, meaning that fast, reliable actions are needed to be able to respond and maintain system stability. Robust cyber security of key smart technologies (e.g. EVs) and improvements to IoT devices should be encouraged to mitigate such risks.

Focusing on the perspective of the DSO, we recognise there's an increasing need to adapt and evolve cyber security measures to effectively manage the increased risks and attack surfaces provided by the pervasive deployment of smart technologies within our distribution networks. We consider the following scenarios as key areas of risk:

- The local IP connectivity of distributed generator owned and maintained SCADA equipment directly into the DNO's substations LAN or electrical apparatus;
- Either domestic or industrial smart devices being directly controlled and managed from the internet without sufficiently robust user access controls;
- A significant quantity of smart devices being remotely compromised by a threat actor, maybe due to a common vulnerability or management system, and these being maliciously operated to significantly adjust DSR within our distribution networks; and
- The tampering and malicious adjustment of critical messages between operators, consumers, aggregators or other participants resulting in modified generation and/or consumption patterns which cause a disruptive effect on electrical networks or market stability, operation and trust.

There are many factors, some of which are complex and interrelated in nature, that we feel will influence the likelihood of the above risks becoming of material concern such as:

- The critical mass of deployed smart technologies within our networks and the DSR capabilities and levels being supported;
- The cyber security maturity of the system design and development practices undertaken by smart solution providers, integrators and operators and their adherence to good practice cyber security measures and frameworks;
- The inherent resilience within the design of distribution networks and the diversity smart technologies deployed; and
- The sophistication and motivation of threat actors.

Designing, implementing and maintaining effective and proportionate levels of cyber security within smart appliances, data exchanges between the varied system participants and the resilience of critical supporting IT networks and systems are key to realising system security in a technology driven flexible energy system.

In these regards we consider the following approaches worthy of consideration by Ofgem and Government:

- Smart appliances and services will ultimately need to be intuitive to use and therefore have effective cyber security capabilities largely embedded into their construction and operation. Where consumers have settings and features at their control which could impact theirs or another energy system participant's cyber security, clear advice and effective agreements need to be in place to cover technical, procedural and contractual aspects to set acceptable tolerances of operation;
- Minimum cyber security standards through close collaboration between industry and government are to be established in relation to the build and operation of smart appliances supporting DSR;
- Above such minimum standards, energy system participants, including operators, aggregators and consumers, are given flexibility to use common good practice cyber security frameworks to take appropriate and proportionate 'risk' based cyber security measures;
- As the smart grid evolves with a flexible energy system playing a pivotal role in a secure, sustainable and low carbon energy supply, the need to understand and test the technology and data interdependencies between smart energy system participants is ever more vital. Again government and industry collaboration, driven through entities like the National Cyber Security Centre, can be used to undertake system level cyber assessments and attack simulation exercises to test system resilience and to drive a cycle of continuous cyber improvement in keeping with technology evolutions and cyber threats; and
- In order to effectively balance the needs of consumer flexibility and system reliability in the context of a smart energy system, further research and development of solutions to provide advanced cyber-attack detection capabilities (including unusual behaviours in IT systems and the devices or demands on the electricity system) are essential to support the adaptive management of electrical distribution networks and their supporting critical IT infrastructure and smart management components.

We believe that the cyber security risks arising from the transition to an increasingly flexible energy system are inherently manageable through the application of industry recognised good security practices, the development of minimum standards with all stakeholders where required and the continued healthy industry and government collaboration on cyber security.

To this end, in the last year we have:

- Undertaken a full review of our cyber security operating model against recognised global best practice to inform ongoing continuous improvements;
- Increased our level of investment in cyber security by 32%;
- Contributed extensively at industry and government information groups exchanges in support of Critical National Infrastructure Protection; and
- Taken on the chair of the ENA Cyber Security Forum to lead the future development of security standards and good practices as relevant to DNOs.

Question 42: What risks would you highlight in the context of securing the energy system? Please provide evidence on the current likelihood and impact.

We have set out the risks in our answers to the earlier questions on cyber security. There is current evidence that IoT devices have been co-opted to support internet denial of service actions and therefore are clearly vulnerable to cyber risks.

As IoT devices become more numerous a risk based approach to establishing the necessary system contingencies will be necessary.

4. The roles of different parties in system and network operation

This is a crucial section of the Call for Evidence and we are already utilising our portfolio of cutting-edge innovation projects to understand how our role is changing and are feeding this learning directly into our business. We are already displaying many aspects of the DSO role which is described in the Call for Evidence. We would like Ofgem to expand the current regulatory framework, in time for ED2, to provide the correct incentives across network companies to invest and deliver whole system benefits in the most efficient way. We also want to ensure that in meeting the immediate actions outlined in the Call for Evidence, we retain the flexibility to make changes to roles and arrangements in the future.

In response to the specific questions posed in the Call for Evidence we have set out the current situation on our networks, how this is likely to evolve in the future and where new roles and arrangements can help us maintain security of supply and deliver substantial whole system benefits.

Roles and responsibilities

Question 43: Do you agree with the emerging system requirements we have identified)? Are any missing?

We broadly agree with the emerging system requirements presented in the Call for Evidence and have provided examples in our response to question 44 of where we are already seeing evidence of the drivers for change on our networks.

The key priority for us will be to have visibility of the actions which others will be taking on our network and ensuring other parties have visibility of the actions we take. For example, we will need visibility of services provided from DERs, the SO and aggregators. Limited visibility may impact our ability to optimally manage the network and maintain system security in the future, as well as limiting the ability of the SO, generators and suppliers to operate efficiency. Again, we expand on this in our response to question 44.

Many of the aspects listed in the emerging requirements are already being implemented as business as usual. We have experienced rapid change in a number of our network areas, particularly with the high volume of DG and storage applications mentioned previously in this response. In addition, to ensure a resilient network we have undertaken bi-lateral work with National Grid to ensure that our connection contracts allow for emergency disconnection of DG when National Gird require it. We have also revised our process and procedures to manage a black start scenario.

In addition, we believe there are three important aspects which should be included in the emerging requirements.

- Forecasting of load and generation growth across the transmission and distribution networks. Accurate forecasting is a critical first step of network planning and important in enabling efficient system operation;
- The importance of providing transparent information to stakeholders. This includes where there is spare capacity available (through our heat maps) and also helping customers understand their potential DUoS charges under the EDCM and how they may vary depending on where they connect; and
- The need to start developing, advanced real time system-wide control. This will be a critical enabler of allowing the optimal operation of the networks (across transmission and distribution) to deliver whole system benefits. We are already embarking on the trajectory towards greater real time control through the TDI 2.0 project and we expand on this theme in our response to question 44.

Question 44: Do you have any data which illustrates:

a) the current scale and cost of the system impacts described in table 7, and how these might change in the future?
b) the potential efficiency savings which could be achieved, now and in the future, through a more co-ordinated approach to managing these impacts?

a) the current scale and cost of the system impacts described in table 7, and how these might change in the future?

Table 7 in your consultation outlines three separate (if intrinsically linked) network impacts. We have looked at each of these in turn and where possible set out the costs and impacts in a qualitative and quantitative way.

Growth of Distributed Generation (DG)

The last few years have seen a rapid increase in not just the volume of DG connected but in the number of connection requests. We also have a substantial volume of DG which has accepted offers and are waiting to connect. We have set this out in Table 2 below:

Table 2: DG offers, contracted and connected

Category	Eastern Power Networks plc	South Eastern Power Networks plc	London Power Networks plc	Total
Offers issued (GW)[40]	36	17	1	**54**
Contracted and waiting to connect (GW)	1.6	0.73	0.04	**2.41**
Connected[41] (GW)	5.39	2.41	0.66	**8.46**

As a result of the above, our networks are becoming increasingly constrained. For example, in our Eastern region, a fifth of our GSPs could not accommodate a 25MW generator at EHV without reinforcement and over a tenth could not accommodate a 5MW generator at HV without reinforcement. As a consequence of these constraints we are offering flexible connections to customers, with ambitious plan to roll-out active network management across our Eastern and South Eastern networks by 2021.

As outlined earlier in our response, in addition to the DG connections, we have also received close to 12GW of applications from over 600 storage providers. This adds further complexity to assessing new connections as storage providers can be import and export. While we wait to see if storage providers accept a connection offer, we need to treat new connection requests on the basis that the storage providers accepts the offer. Therefore, new connection offers become interactive with those already issued. This is a difficult position to explain to customers and to keep an orderly interactive connection queue, particularly with 2.4GW of accepted offers to manage.

We have had to adapt our business and change the way we operate to deal with these connection volumes and the increasingly constrained nature of our networks. Specifically, we have:

- Increased the size of our network design teams to ensure a responsive service whilst experiencing a doubling in application volumes in the between 2012 and 2015;
- Introduced new policy guidance to support new market entrants such as storage providers and community energy groups understand the connection process;

[40] From January 2012 to November 2016.
[41] To date

- Developed new processes to provide fair and equitable management of the interactive connection queues which have developed in the last three years;
- Increased our engagement and level of ongoing communication with connection applicants to ensure that they each understand explain the complex background to their connection request and received a bespoke service; and
- Deployed active network management across areas of our network to facilitate new connections in constrained areas without costly and time consuming reinforcement.

Exporting GSPs and whole system investment

We currently have several exporting GSPs across our networks. The impact of this is that all DG and storage connections above 1MW needs to be assessed by National Grid to understand what impact (if any) it will have on the transmission network. This is known as the statement of works process. It has resulted in considerable uncertainty for our customers in terms of the costs and timescales of connecting. In many cases where transmission network reinforcement is required, it makes the DG or storage project commercially unviable and the customer does not proceed with the connection.

We have been working with National Grid, both bi-laterally and through the ENA to try and improve the statement of works process. The aim is for National Grid to produce planning limits for each GSP which we can then use to provide better information up front to connecting customers on the time and cost of connecting. To date, it has proved very difficult for National Grid to produce these planning limits, given the complexity of the network and the constantly changing picture of DNO connection requests.

Co-ordinating local network management and system frequency requirements

The Call for Evidence correctly highlights the issues around co-ordinating local management of DG and storage with balancing actions taken by National Grid as the SO. We are currently rolling out active network management across large areas of our Eastern network. As stated above, we plan to have fully rolled out active network management across our entire Eastern and South Eastern networks (as well as where needed in London) by 2021. Therefore, co-ordinating the use of distributed resources for local and system wide benefits will become even more important in the future.

The scale of DNO active network management schemes, while ramping up, is currently low meaning that we have little evidence of actual conflicts with other services and their associated costs. However, we do have relevant evidence from the impact of National Grid's EFR tender. It was apparent that connecting customers who wished to bid for this tender were generally not interested in flexible connections for local network management. The feedback from these customers indicated that this was because the terms of the EFR tender did not lend themselves to being actively managed by the DNO.

We have been exploring these co-ordination issues through the ENA's Active Network Management group. This group has a specific work stream looking at where conflicts are likely to arise between local ANM and system wide balancing and how best to manage these conflicts. It is looking at the ownership of the ANM equipment where that equipment is used to resolve transmission and distribution constraints. The group are also looking at the process for managing the ANM scheme and the operational interface between SO, TO and DNO. As part of the strategic work stream, the ANM group is looking at whether the distribution network needs to leave some headroom for balancing actions or whether balancing and local constraints can be more optimally managed. The learning from our TDI 2.0 project will be important in informing future approaches.

Changes to cost in the future

We think there are two ways in which to look at how our costs may change in the future:

i) Network operation costs

Our forecasts (transposed from National Grid's Future Energy Scenarios) and set out in Table 3 below, are that under a high take-up scenario, we could have over two million active devices (such as EVs, DG and storage) connected to our networks by the mid-2020s[42]. These devices will not have regular consumption or export patterns and may be providing flexibility services elsewhere to the SO, suppliers or aggregators. To provide some context, the current number of active devices is in the low thousands and the flexibility markets to access these devices are only just developing. This will significantly increase the complexity of operating the system and the level of co-ordination needed between DSOs and National Grid.

Table 3: Take-up of low carbon technologies within UK Power Networks regions by 2030 based on National Grid Future Energy Scenarios[43] applied to UK Power Networks

Scenario	PV	Electric Vehicles
Now	2.6GW	0.016m
High	12.9GW	1.9m
Low	6GW	1.2m

To deliver decarbonisation at lowest cost, a paradigm shift is required in system operation. This will require investment in new IT and communications systems, along with the data and analytical processing to drive advance distribution management with strong co-ordination with National Grid. If we do not have the tools and remit to manage these devices, we will not be able to maintain the current levels of security of supply to our customers and it is also likely that the cost of decarbonisation will increase as we will be unable to optimise the use of resources on our network. As we outline in our response to question 45, it would be helpful if there was clarity of how the regulatory regime will treat the costs of investment in these areas and how transmission and distribution incentives will be aligned to ensure efficient delivery.

ii) Network infrastructure costs

We are already looking at the potential reinforcement costs associated with the Government's scenarios for the take-up of low carbon technologies in ED2. As part of our ED1 business plan we ran the Transform model[44] using our network data to provide a high level indication of potential reinforcement costs out to 2030. We ran the model across a range of scenarios based on the incremental use of the smart grid solutions. The model produced a range of potential reinforcement costs in ED2 of between £1.5bn (based on the core scenario we used in ED1) and £3.2bn (based on a 'high' take-up of heat pumps and EVs). We should emphasise that these figures are highly indicative but they are the best approximation available to us at present.

The figures emerging from the Transform model are supported to some extent by the work the ENA has undertaken for OLEV on the potential reinforcement costs for EVs. The ENA has estimated that the GB reinforcement costs of accommodating the anticipated eight million Electric Vehicles by 2030 and provided these to OLEV. We have assumed, based on the size of our network that around a third of these costs would fall to us between now and 2030.

[42] This is based on the number of EVs, active DG and storage customers on our network, according to the figures in Table 3.
[43] http://fes.nationalgrid.com/fes-document/
[44] https://www.eatechnology.com/global/middle-east-english/products-and-services/create-smarter-grids/transform-model

The evidence above suggests we could need up to a four-fold increase in reinforcement allowances for ED2 (approximately £800m for the ED1 period), should the high take up low carbon scenarios emerge.

b) the potential efficiency savings which could be achieved, now and in the future, through a more co-ordinated approach to managing these impacts?

We have split our response between savings available now and potential savings available in the future:

Savings available now

We have responded to the volume of DG connections through early deployment of our highly successful Flexible Plug & Play project, into the business as usual. We have expanded the trial zone and enabled 330MW of DG without the need for reinforcement. This has saved over £100m of reinforcement costs which would have otherwise made most of the DG schemes unviable. As outlined above, we are now planning an ambitious roll-out of the active network management infrastructure across our Eastern and South Eastern regions by 2021. Extrapolating the benefits against the current growth rate for Flexible Distributed Generation (FDG), we believe that this will allow in excess of 1GW of FDG generation/storage connect, saving customers up to £500m.

In addition, we are targeting the delivery of £43m of reinforcement savings (which are reflected in our ED1 business plan) through use of smart grid solutions, including flexibility.

Savings available in the future

It is difficult to estimate the level of potential savings with any certainty, particularly since the take-up of low carbon technologies is uncertain, along with the commercial and operational model for a more co-ordinated approach. We have looked at the evidence available to illustrate the wider system benefits as well as those which would accrue directly to our customers.

i) Wider system benefits

The Call for Evidence cites the work undertaken by Imperial College for the Carbon Trust, which estimates the benefits of co-ordinated flexibility of £17-£40bn by 2050. We have engaged with Imperial College to help understand the assumptions made on the DSOs' role in delivering these benefits. Imperial College have been clear that a DSO role is crucial in delivering the vast majority of these benefits, given that the flexible resources will be connected to the distribution networks.

It is useful to look at where the savings delivered by a DSO can accrue across the system as shown in Figure 5 below:

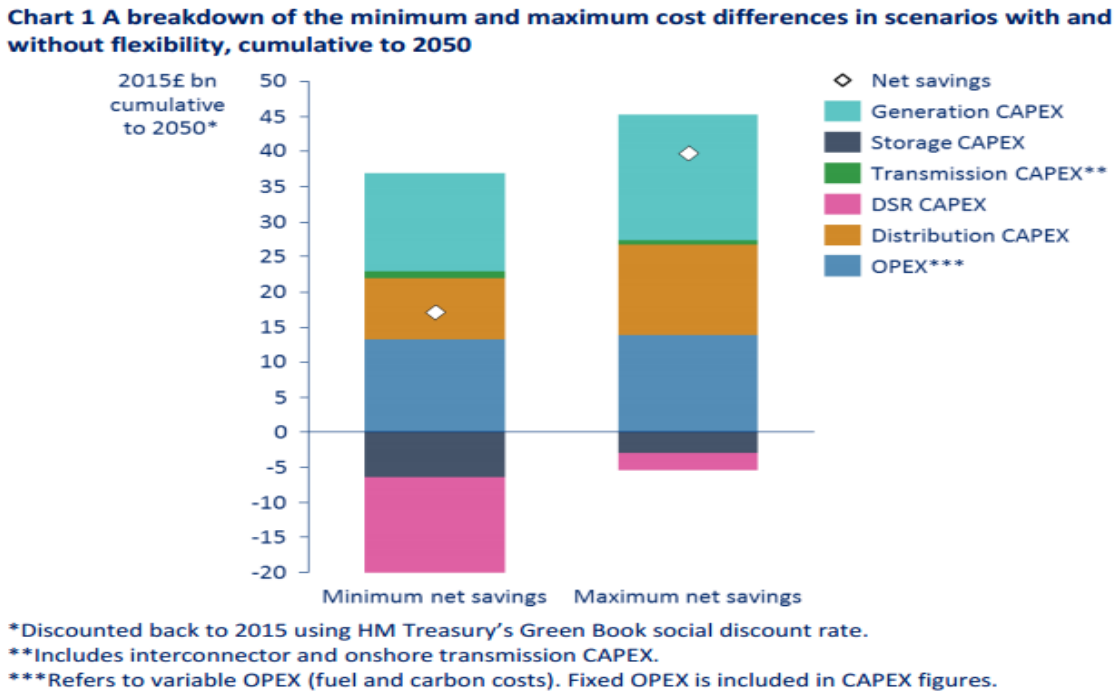
Avoided generation plant: Imperial College's research shows that optimising the system operation at distribution level allows more generation to connect to the distribution network and avoids the need for more expensive, larger, generating plant to be built. This is a substantial proportion of the overall benefits (generation capex).

Avoided Transmission investment: Management of local distribution resources can avoid the need for transmission reinforcement. This is highlighted in the Imperial College work. We are actively trialling the delivery of these benefits through the TDI 2.0 project. National Grid has estimated that the benefits of the increased co-ordination being trialled will enable an additional 3.7GW of generation to connect to the system. National Grid go on to estimate that the total GB savings achieved through successful roll-out of the trial could be over £400m by 2050[45].

[45] https://www.ofgem.gov.uk/system/files/docs/2016/11/final_submission_tdi_2.0.pdf

More efficient balancing services: Access to DER for system balancing could displace the need for more expensive balancing options such as peaking plant. Again, this features in the work undertaken by Imperial College and Carbon Trust

Figure 5: Summary of flexibility benefits: An analysis of electricity system flexibility for Great Britain by the Carbon Trust (p5)[46]



It is worth stressing that the regulatory framework does not currently allow any of the benefits to flow back to DNOs, despite our investment being needed to facilitate delivery of those benefits. Therefore, new incentives are needed to allow us to share in these benefits in order to fund the increased investment needed. We expand on this in our response to question 46 b).

ii) Distribution capex savings

Greater flexibility (and co-ordination of that flexibility by the DSO) can allow new connections to be accommodated without spending as much on reinforcing the distribution network. This can provide savings to the connecting customer, who avoid the need to pay for reinforcement and savings to wider customers who contribute to reinforcement costs through DUoS. Given projections of the take-up of low carbon technologies, these savings could be significant and account for around £8bn-£10bn of the savings cited by Imperial College. Many of the avoided connection costs will accrue to connecting customers under the shallowish connection charging policy.[47]

We are already delivering some of these benefits today. We have £43m of reinforcement savings to deliver in our ED1 reinforcement budgets from use of DSR, as part of the wider smart grid benefits we are delivering. As highlighted above, we have ambitions plans to roll-out ANM across our EPN and SPN regions. Extrapolating the benefits against the current growth rate for FDG, we believe that this will allow in excess of 1GW of FDG generation/storage to connect saving the customers close to £500m.

[46] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf

[47] This requires customers to pay a proportion of reinforcement costs up front, with the remainder funded by DUoS customer. DNOs only receive these benefits

It is important to highlight that achieving the scale of benefits highlighted by Imperial College requires investment in IT and communications systems to provide real time visibility and network operation across transmission and distribution. As discussed further in our response to question 45, we are starting to trial this in areas (particularly through our TDI 2.0 project) but wider roll-out requires investment. We need a regulatory framework with aligned incentives across transmission and distribution to provide the certainty required to help attract this investment.

Question 45a): With regard to the need for immediate action, do you agree with the proposed roles of DSOs and the need for increased coordination between DSOs, the SO and TOs in delivering efficient network planning and local/system-wide use of resources?

We agree with the proposed roles of DSOs set out in the Call for Evidence and are already displaying many of these roles in our business operations. To fully respond to this question, we have set out the approach we have taken to developing our DSO capability, explained how this covers many of the roles outline in the Call for Evidence and highlight where further joint work is required by network operators to implement those immediate actions asking for greater co-ordination between parties.

Our approach to the development of DSO

We have been developing DSO capability since 2010 when we launched our Low Carbon London project[48]. Our ED1 business plan included ambitious smart grid and innovation strategies aimed at ramping up our DSO capability[49]. We have the largest and most successful portfolio of innovation projects across DNOs, which has helped us to trial and implement the foundation capabilities underpinning a DSO. We have also been active in following the innovation projects run by other DNOs to leverage the learning from them into our business.

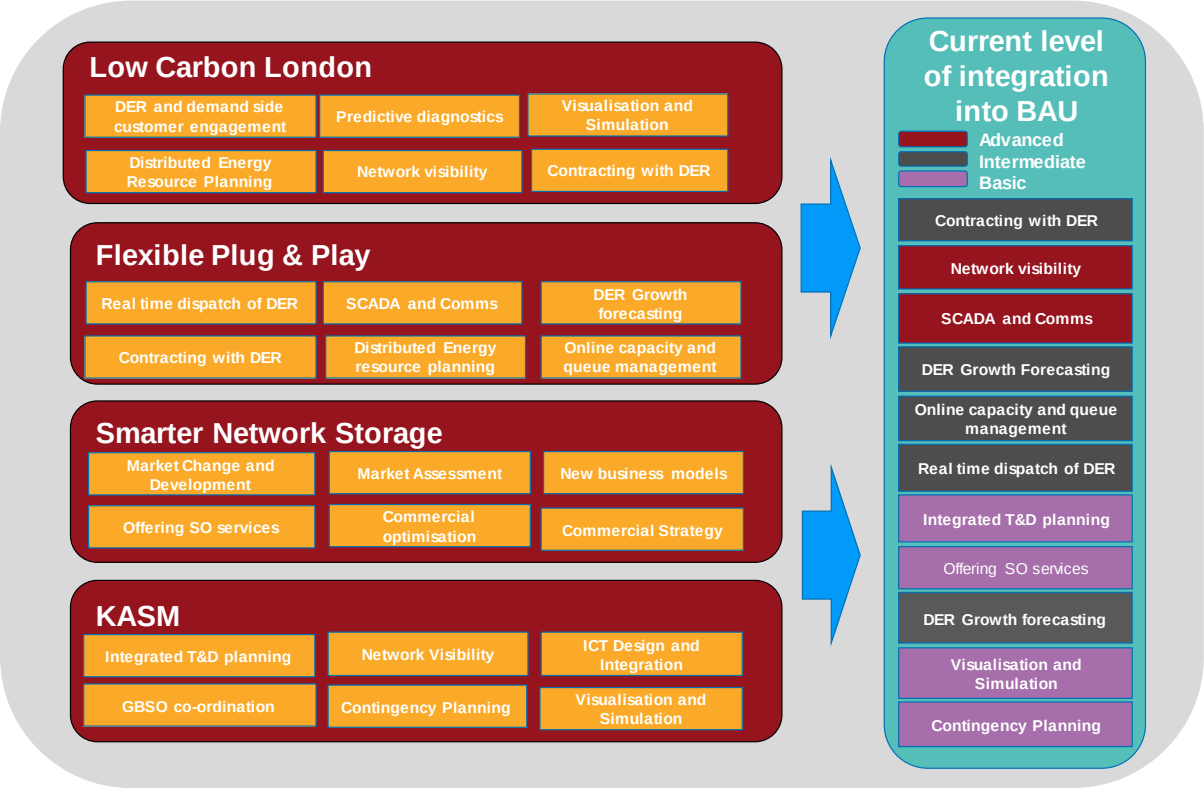
In response to the challenges we have seen on our network, we have started to deploy DSO capabilities as part of business as usual and are actively delivering over £200m of smart grid benefits within our ED1 business plan. We are actively developing other capabilities for deployment by the start of ED2.

Figure 6 shows how our innovation portfolio has defined and tested the building blocks of the DSO infrastructure. To ensure that these are deployed to provide benefits to our customers, we have restructured our business to support the delivery of the DSO capability in terms of technology, skills, data and systems that is required.

[48] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/

[49] http://library.ukpowernetworks.co.uk/library/en/RIIO/Main_Business_Plan_Documents_and_Annexes/UKPN_Smart_Grid_Strategy.pdf and https://library.ukpowernetworks.co.uk/library/en/RIIO/Main_Business_Plan_Documents_and_Annexes/UKPN_Innovation_Strategy.pdf

Figure 6: DSO capability developed through some key innovation projects:



We are moving towards a new model of delivering system security which is less reliant on replacing and upgrading assets to maintain a certain level of redundancy, and more reliant on smart, real time operation of network assets. We believe that this is the most cost effective and efficient way to accommodate low carbon technologies to our network in order to deliver the Government's carbon reduction plans.

A full description of the work we have undertaken and that currently underway is set out below in Table 4:

We believe that we are actively meeting many of the immediate actions set out in the Call for Evidence and are incorporating them into our new DSO operating model. This looks to understand in depth the capabilities needed, their priority and the necessarily business change to build these capabilities. Consequently, we consider that we are advanced in terms of integrating the ability to run the network more flexibly into our central operations models, rather than have it running as a separate innovative trial which only works in some areas.

We acknowledge there is more work to be done in terms of implementing the joint industry processes around this co-ordination. This will involve learning the lessons from various innovation projects and trials and agreeing with other DNOs and National Grid how best to deliver a co-ordinated framework for planning and use of resources. We are committed to doing this but highlight some of the risks and challenges around these specific actions in our response to part b) below.

Table 4: Detailed description our integration of DSO capabilities into our business

Component	Examples
1. Prioritising the DSO foundation capabilities, focusing on no-regret actions, that deliver customer and market needs.	• We are prioritising investment in skills, particularly energy forecasting, power systems planning and ICT, energy markets and commercial analysis • We are creating a DSO function within our Information System department, focussed on delivering the software platforms, security and data architecture and DER management systems required for DSO transition • Network technologies that enable increased visibility and controllability of the network such as monitoring and automation at all voltage levels • We are actively developing cyber defence monitoring in order to ensure our more complex IT and communications systems remain secure
2. Embedding successful innovation as business as usual to deliver customer benefits	• We have created a 15 person strong dedicated team to enable the DSO transition for UK Power Networks. The team comprises of experts in programme management and change, power systems, ICT and commercial arrangements • We have the most network under active network control in mainland UK. Covering north Norfolk, we have enabled 330MW of DG capacity that may not have been viable saving over £100m for connecting customers • We have rollout plans to enable active network management across our Eastern and South Eastern networks by 2021 • We are planning to act as purchaser of flexibility through tendering for flexibility services to help avoid reinforcement and provide support during network outages • We have developed connections policy for large scale storage and domestic LV storage in response to market demand. We have published heat maps for demand and generation constraints • We are developing a comprehensive standard for the connection of EVs
3. Working closely with the System Operator to improve co-ordination of network planning and operation	• Working with National Grid to unlock capacity for further DG and Storage in our South Eastern region. This is examining how we can refine modelling assumptions, how the regional UK Power Networks Flexible DG scheme can coordinate with the transmission operator, how storage can be integrated and how distribution networks could offer solutions to transmission constraints • Our TDI 2.0 NIC project has been designed to develop and test practical co-ordination between T&D in order to resolve real constraints across both networks in the most efficient manner • Along with National Grid, we are co-developing the Regional Development Programme for the South Eastern region which focus on ANM, storage and network planning
4. Developing Commercial Arrangements that inform future changes	• We are developing market based development of more efficient curtailment mechanisms under NIA project[50] • Developing a commercial framework for joint SO/DSO procurement of flexibility under the TDI 2.0 project. The project is a world first DSO trial and tests the local balancing unit future model described in the Ofgem/BEIS Call for Evidence

[50] This is a potential NIA project which builds on the success of our LCNF project Flexible Plug and Play

Question 45 b): With regard to the need for immediate action, how could industry best carry these activities forward? Do you agree the further progress we describe is both necessary and possible over the coming year?

Further progress is necessary and possible over the coming year

If the projections on the future growth of DER are correct then it will be vital that we make further progress on the immediate actions and longer term models. These longer term models can not only reduce the cost of accommodating that DER but co-ordinate that DER in a way that maintains the security of our network. We expand on this concept in our response to question 46 a).

Some of the aspects listed in the immediate actions such as the formalised framework for whole system network planning and co-ordinating the use of resources require co-operation and clear allocation of tasks responsibilities between network operators. The premise in the Call for Evidence is that all the immediate actions can be delivered through current roles and arrangements. We agree but are concerned that this could 'lock in' current arrangements without a full debate and assessment of more fundamental changes. In this sense, we see delivery of these aspects of the immediate actions as intrinsically linked to the consideration of the future models outlined in question 46.

As an example, we are starting to see the SO co-operate with DNOs on its latest demand turn up service.[51] Under the proposals trialled last year between National Grid and Western Power Distribution (and planned for roll-out in 2017), DNOs can access the distribution resources contracted for the demand turn up service through making a request to National Grid. National Grid then use the terms of their contract with the customer to procure the response required by the DNO. This is helpful in terms of sharing resources across SO and DNO. It starts to meet aspects of the immediate actions around co-ordinated use of resources. However, this is just one potential way of managing co-ordination and may not be the most efficient in the longer term (see Figure 7 in our response to question 46 a). We do not want to see systems and processes put in place to address the immediate actions which make changes to roles and arrangements more difficult as we move forward.

Best way to carry these actions forward

It is important that the immediate actions are implemented in a consistent way across network operators in order to provide a common set of processes and policies for our stakeholders. As such, we believe that the ENA provides the vital platform through which to share learning on how companies are addressing the immediate actions and agree how best to continue the co-ordination required. In addition, there will be some areas where it is helpful for individual network operators to work bi-laterally with National Grid to explore different options to help inform the policy debate. We are active in doing both of these to help address the immediate actions:

i) ENA work streams

We are using the knowledge gained from our innovation portfolio and practical experience of managing flexible connections to play a key role in the ENA's Transmission and Distribution Interface (TDI) work steam[52]. We chair the High Volts working group and have played a key role in developing the work programme for the Active Network Management and Statement of Works working groups. We recognise that progress across the TDI work streams have been mixed and we have supported plans to re-focus the work plan and accelerate delivery. It remains crucial to develop a common understanding of the issues and the mechanism to generate new common processes and procedures which can then be codified. Consequently, we believe that the ENA TDI work on TSO-DSO interface will develop a common roadmap which will provide a cohesive framework for DSO transition.

[51] http://www2.nationalgrid.com/UK/Services/Balancing-services/Reserve-services/Demand-Turn-Up/

[52] http://www.energynetworks.org/electricity/regulation/transmission-distribution-interface-(tdi)-steering-group/transmission-distribution-interface-(tdi)-steering-group-deliverables.html

ii) Bi-lateral work with National Grid

To supplement the work through the ENA, we are working closely with National Grid to address whole system challenges. The close collaboration has been developing over the last three years with particular focus on the complex network of our South Eastern region. We have developed a joint work stream with National Grid on overcoming the whole system challenges in the South Eastern region with the following focus:

- Data exchange at interface and revision of T&D planning assumptions;
- Optimised ANM deployment;
- Integration of storage;
- T&D planning process; and
- Impact of ROCOF protection issues.

The outputs of this work will deliver additional capacity for connections at lowest whole system cost. The collaboration will be further accelerated through the TDI 2.0 project which will be starting with National Grid shortly. This will provide practical experience of how to share flexible resources between us and optimise their use for network operation and planning. It is also worth highlighting our KASM (Kent Active System Management) project. KASM will be delivering its final trials in 2017, demonstrating how the use of contingency analysis and increased visibility of the transmission and distribution network can reduce constraints for distributed resources[53].

Question 45 c): With regard to the need for immediate action, are there any legal or regulatory barriers (e.g. including appropriate incentives), to the immediate actions we identify as necessary? If so, please state and prioritise them.

The immediate actions identified around greater co-ordination in system planning and efficient use of flexible resources are both about extracting whole system benefits. As set out in our response to question 45 b), we are conscious that the actions needed to deliver them may need to be mindful of the longer term system operation models set out in question 46.

Our view is that alongside the work industry is taking forward on the immediate actions, there needs to be work undertaken on the supporting regulatory framework through which whole system benefits can be delivered. The current regulatory framework has been hugely successful in delivering safe, reliable networks which respond to customers' needs at an efficient cost. However, the framework was not designed with the delivery of whole system benefits in mind. We provide two examples below where this is the case:

i) Incentive for DSOs to invest for whole system benefits

As highlighted by research undertaken by Imperial College and the Carbon Trust, there could be £17-£40bn of benefits from optimal system operation by 2050[54]. The vast majority of these benefits are obtained through optimising the use of resources at distribution level and therefore delivered by the DSO. Under ED1, the totex incentive mechanism encourages us to make investments where they reduce costs on our network but not where investments deliver cost savings elsewhere on the system. Equally, there is no current mechanism for us to share in the wider benefits which we could use to fund the necessary capability. We expand on these arguments in our response to question 46.

[53] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/kent-active-system-management/

[54] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf

ii) Alignment of Transmission and Distribution price controls

A whole system planning framework requires a more joined up approach to assessing the costs (and associated benefits) across transmission and distribution. DNOs can provide some services directly to National Grid to alleviate constraints, as proven in Electricity North West's CLASS project.[55] However, some of the actions DNOs can take to provide lower cost solutions to transmission can impact on distribution network performance, for example, losses or customer interruptions.

The ED1 and T1 price controls were not set with delivery of whole system solutions in mind. We are uncertain if National Grid is funded to procure these types of solutions. We were not funded to do so and it is not clear how our provision of such services relates to the rest of the balancing market. In addition, our ED1 outputs do not take account of the impact of providing such services. Our performance is measured against our network outputs and not on the wider system benefits we facilitate. Therefore, even when it could be the most economic action, our regulatory framework does not provide us sufficient clarity over funding or the incentives to provide the services required.

Adapting the regulatory framework

We believe that the strengths of the current regulatory framework (totex benchmarking; outputs led with strong incentives) can evolve to encourage DSOs to enable the successful delivery of whole system benefits and achieve decarbonisation at least cost. We consider that there would also be merits in setting out a timetable for this work to provide the certainty that these issues will be looked at. This timetable could include a commitment from Ofgem to align the T2 and ED2 price control incentives.

As outlined in our response to question 46 below, evolving the current regulatory framework can place the correct incentives for industry to develop the commercial arrangements and specific roles needed to deliver whole system benefits.

Question 46a): With regard to further future changes to arrangements, do you consider that further changes to roles and arrangements are likely to be necessary? Please provide reasons. If so, when do you consider they would be needed? Why?

As and when more flexible resources (DER) connect to the distribution network, we believe that changes will be required to roles and arrangements in order to maintain current network reliability and to provide a framework through which to deliver whole system benefits. We also consider that DSOs need to play a central role in managing the resources on their network to maximise these benefits. Our knowledge of our networks and track record of delivery under a strong regulatory framework make us an obvious choice to take on a new role.

Why changes to roles and arrangements are likely to be needed

We consider there are two key reasons why we may need changes to current roles and arrangements.

i) Maintaining system security

We have highlighted earlier in this response how the anticipated increase in DER connecting to the network will vastly complicate the operation of the network. By the mid-2020s there could be up to two million DERs on our network which do not have regular consumption or generation patterns[56]. The effective management of these devices, at lowest cost, will require DSOs to undertake a paradigm shift in system operation (enabled by advanced IT and distribution management systems). This will add significant complexity to system operation which will required co-ordination (and resolution of conflicts)

[55] http://www.enwl.co.uk/class
[56] See Table 3 under our response to Q44 a).

between DSOs and National Grid and potentially with other procurers of flexibility such as suppliers and aggregators.

Current roles and arrangements do not give us visibility of the actions of DER or the tools to manage potential conflicts over the use of DER by the DSO, SO, aggregators or suppliers. It is the inability to manage these conflicts, in a world where we will have vastly more complex system operation at distribution level which puts system security as risk. New roles and responsibilities and underpinning market frameworks will be needed to resolve this issue.

We are already concerned about this, hence our support to take forward greater visibility on the immediate actions. DNOs are the only party who are highly sensitive to the location of customers providing services. Consequently, given the more complex nature of system operation and the likely conflicts which will arise between parties on the use of DER, DNOs need to assume a new role as a neutral market facilitator of services from customers connected to their networks, in order to maintain system security. We are in a unique position to act as this facilitator, with a mandate to optimise the use of those resources for whole system benefits while maintaining the security of our network.

It is worth highlighting how co-ordination on use of DER based on current roles and responsibilities has the potential to be inefficient and compromise reliability. As briefly mentioned in our response to question 45b), the latest National Grid tender for demand turn up goes down to 1MW and generators of 0.1MW can contract with aggregators for the service[57]. Therefore, it clearly reaches down into the distribution network. National Grid is trying to co-ordinate with DNOs, however, the only option available to DNOs is to contract for a response through National Grid when required. This has been trialled with Western Power Distribution and while it is a step forward in looking to co-ordinate efficient use of resources we do not consider it provides the most efficient medium or longer term option. This is an example of where we need to be careful in putting in place processes to address the immediate actions outlined which lock industry into a specific model.

Figure 7 below depicts how this co-ordination will work based on current roles and responsibilities. Figure 8 shows how co-ordination on use of DER could be more efficient with the DNO acting as a neutral market facilitator and procuring services from DER for the SO. Under option 1, the SO is contracting for all services on DNO networks without the visibility of how the DNO network is operating. It can lead to efficient procurement decisions and reliability issues. Figure 8 below shows option 2 where a DSO procures the services needed from its customers to the SO. It is a simpler process and avoids the reliability issues.

[57] http://www2.nationalgrid.com/UK/Services/Balancing-services/Reserve-services/Demand-Turn-Up/

Figure 7: Current roles and responsibilities with SO contracting party with DER

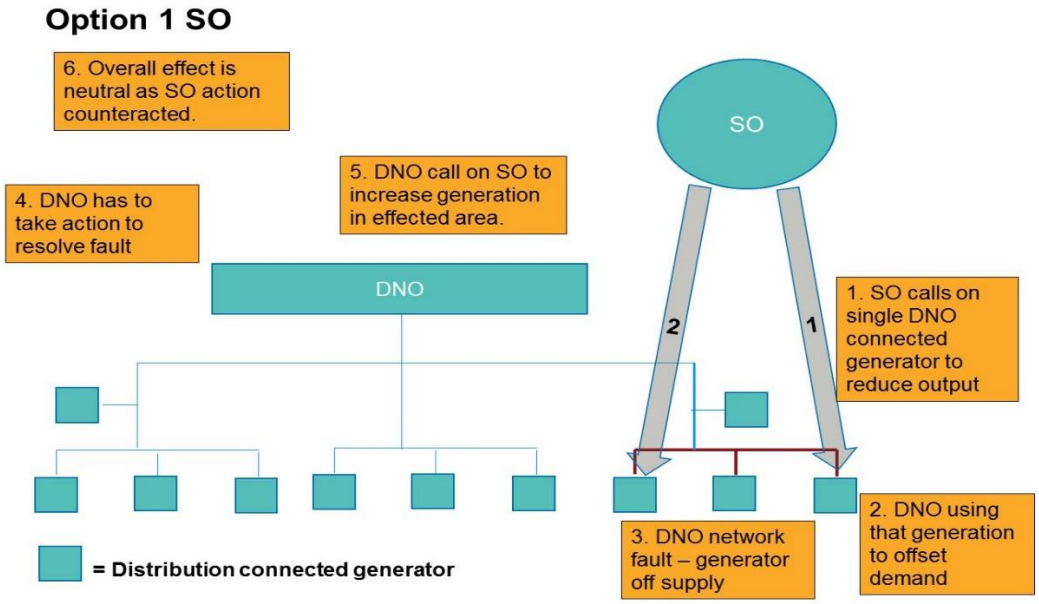
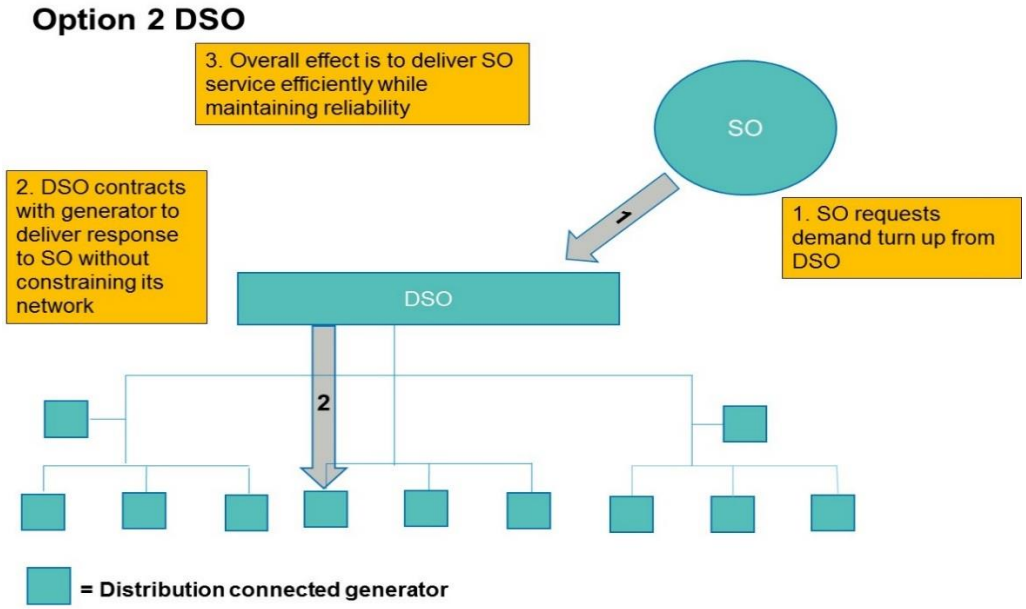


Figure 8: DSO co-ordination



ii) Delivering greatest whole system benefits

Analysis carried out in our Low Carbon London project demonstrated that the historical approach to designing distribution networks maybe suboptimal in the context of low carbon agenda[58]. The analysis stated that what was required was a whole-systems approach – joining energy, emissions, ancillary services with infrastructure design covering local and national geographies. Again, DNOs are best

[58] Low Carbon London, "Novel commercial arrangements for smart distribution networks", Report D5, Dec 2014, http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20D5%20-%20Novel%20commercial%20arrangements%20for%20smart%20distribution%20networks.pdf

placed to take a new role to deliver these benefits. The vast majority of flexible resources will be connected to DNO networks. DNOs can use the detailed knowledge they have from years of operating and developing their networks efficiently and safely to optimise the use of these resources, in a way that the transmission system operator cannot. As the number of DER increased dramatically (as predicted) we can use this knowledge to manage those resources to provide the following benefits;

- Optimise the revenue which DER can receive for providing services;
- Provide more efficient procurement of services for other parties (like the SO);
- Reduce the need for distribution reinforcement; and
- Maintain the high quality of system security.

The industry needs to be open to changes to current roles and arrangements, as well as have certainty over the regulatory treatment of the investment required in IT, communications and data processing, to deliver these benefits.

Why we are best placed to assume these new roles

In addition to our knowledge of the networks, we believe that we are well placed to take on a greater role in managing the flexible resources to our networks:

i) Strength of the current regulatory regime

The current regulatory regime has been hugely successful in delivering efficient, customer focussed networks. We think this could be adapted around an expanded DSO role to deliver whole system benefits. Such an expansion would incentivise network companies to work together to adapt roles and commercial arrangements at the pace and level needed to optimise the delivery of whole system benefits. The regulatory framework could also adapt over time as we learn more about fulfilling this role and the challenges involved.

ii) Our track record of delivering for customers

We have consistently delivered on our price control commitments and indeed gone above those to deliver for our customers. For example, we would highlight our track record of:

- Improving reliability, where we have reduced CMLs by 50% since 2010/1;
- Delivering improved customer service as demonstrated by our customer service scores which are now averaging 8.6 out of 10;
- Accepting and promoting competition in service provision in connections markets; and
- Delivering efficient totex outcomes for customers.

This demonstrates that we can be trusted to take on new responsibilities and deliver them for customers.

iii) Neutral market facilitators

We are completely unbundled from retail, generation or any other interest in the value chain. This means we are well placed to act as a neutral market facilitator for the flexible resources connected to our network. In addition, the totex approach under which we operate, means we are neutral to whether we choose a build or non-build option to meet our outputs. Consequently, we can be trusted to manage the flexible resources on our network in a way which optimises the wider system benefits they can provide to lower costs for customers.

Timing of changes to roles and arrangements

The timing on when changes are needed will be driven by the number of DER which connect to our networks[59]. We have seen significant increases in DER in the last few years, particularly in our Eastern area. Experience to date shows that the volumes of connections are not uniform across GB and that changes to roles in some DNO areas may be needed before others. It remains to be seen if the pace of change will continue at its current rate, accelerate or decrease. This is largely dependent on factors outside of our control such as technological developments, market prices, consumer behaviour and Government policy, particularly around any incentives for EVs.

Our objective is to ensure that we are ready when changes are required and this is why we have invested heavily in our innovation programme. Our best view developed from our stakeholder engagement and experience on our networks is that we need to be ready to integrate the remaining DSO capabilities into our business for the start of ED2 to be in a position to manage the expected increase in DER at the lowest possible cost to our customers. We have a plan for how we continue to ramp up our capability to be in this position outlined in Figure 9 below:

Figure 9: Timeline for our ramp-up of DSO capability

DER take-up →

2017-2019	2019-2023	ED2
• Flexible DG connections capacity exceeds 600MW • Initial flexibility tenders for reinforcement deferral/outage management completed • Commercial framework for DSO to SO services completed as part of TDI • Distributed Energy Resource Management Energy Software live as part of TDI • System monitoring enhancements underway	• DSO trials underway in our South Eastern region (specifically on the South Coast) • DSO incentives development as part of ED2 consultation • Network support services contracts are widely used to defer reinforcement or minimise constraints • Revised framework for T&D planning at the interface • Introduction of market arrangements for constraint management • EHV ANM Capability fully enabled across our Eastern and South Eastern regions • Availability of smart metering data • IT DSO system implementation	• Formalised DSO framework in operation • Distributed Energy Resource planning • Eastern and South Eastern regions operating as regional DSOs • LV visibility and automation • DSO commercial operations becoming core business capability • LV DER Dispatch • Extensive use data analytics • Creation of distribution level markets

We are conscious that it will take time to evaluate the options and implement new arrangements. Clarity on the regulatory framework for delivering whole system benefits will be crucial in empowering network operators to adapt current roles and develop the new commercial arrangements which are likely to be required.

[59] The Future Electricity Regulation paper provides an excellent overview of the evolutionary changes and different models required to respond to the stages of evolution: https://emp.lbl.gov/sites/all/files/FEUR_2%20distribution%20systems%2020151023_1.pdf

Question 46 b): With regard to further future changes to arrangements, what are your views on the different models, including:

i) whether the models presented illustrate the right range of potential arrangements to act as a basis for further thinking and analysis? Are there any other models/trials we should be aware of?

We have split our answer to this question into three sections to pick up each individual question separately:

Right range of models

The models presented represent the right range but it is important that the detail underpinning them is clear in order to properly evaluate them. We would also stress that in practice, there may need to be a hybrid of different models. Therefore, policy development should not be fixed on the three models presented in the Call for Evidence but consider aspects under each model.

Other models or trials

We think it is crucial to utilise the output of past and ongoing trials to develop the detail of the models set out in the Call for Evidence. We are already playing our role in this through the TDI 2.0 project which we are running in conjunction with National Grid. It will deliver the following outputs which can feed into policy design for the models needed:

- Commercial arrangements required to deliver a functioning local market platform for reactive and active power which can be used to resolve local constraints and transmission constraints;
- A full assessment of the costs and benefits of the local market platform and net benefit of extending the trial; and
- An assessment of the incentive framework used to make the market platform work and recommendations on an enduring incentive framework for an active DSO.

We are keen to work with Ofgem and BEIS to use learnings from the TDI 2.0 project as they emerge, to feed into the policy debate around the models and develop an evaluation framework through which to assess them.

There is substantial other work ongoing across GB, Europe and the USA as many countries wrestle with the same issue of how to coordinate the integration of DER triggered by a low carbon transition. Some of the studies worth highlighting include:

- Work by Elexon and Baringa on potential DSO models for GB in 2014/5[60];
- Centrica's Cornwall study on local energy market[61];
- The European SmartNet project which is assessing the various models for TSO/DSO interaction[62];
- The European TSO/DSO platform work on data models[63]; and
- The Californian ISO local margin pricing[64].

We have reviewed these models to help inform this response.

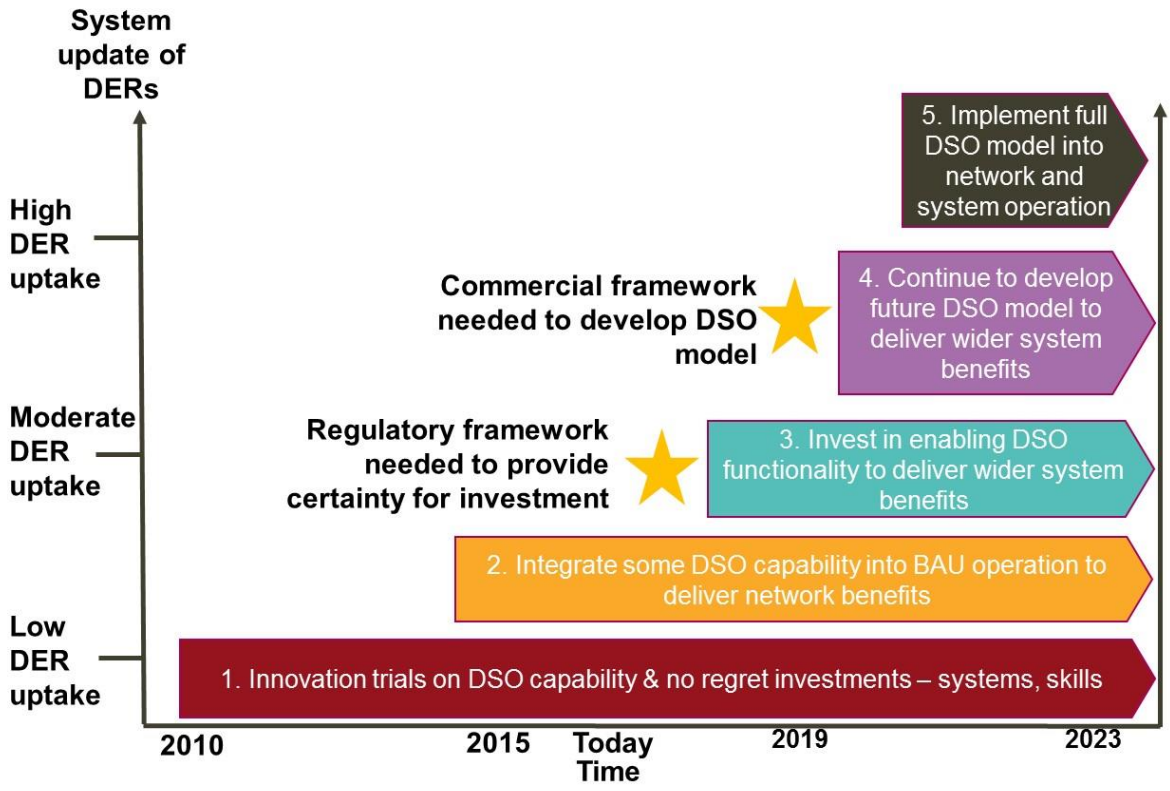
[60] https://www.elexon.co.uk/wp-content/uploads/2015/03/Active-Management-of-Distributed-Generation_March2015.pdf
[61] https://www.centrica.com/news/centrica-build-pioneering-local-energy-market-cornwall-0
[62] http://smartnet-project.eu/consultations/basic-schemes-for-tso-dso-coordination/
[63] http://www.eurelectric.org/media/285585/tso-dso_dm_rep-2016-030-0382-01-e.pdf
[64] http://www.caiso.com/pages/pricemaps.aspx

ii) which other changes or arrangements might be needed to support the adoption of different models?

The key change to support any of the different models will be the development of the underpinning regulatory regime. The current regulatory framework does not provide the funding or incentives for us to make investments which deliver savings, where those savings do not flow back to us. As highlighted in our response to questions 45 c) we think that the development of the regulatory framework needs to be a key priority as it will also help with the delivery of some of the immediate actions. Figure 10 (see below), highlights how we think the evolution of DSOs to deliver wider system benefits can be hindered by the lack of a clear regulatory framework, along with the detailed design of the commercial model.

Our experience is that we are currently at stage 2 within Figure 10 in our Eastern and South Eastern regions. In these regions we are integrating DSO capability into our operating model to connect new customers through actively managing them. The focus for our deployment is on the network benefits which can be delivered as this is what we have the commercial tools to do and the incentives under ED1 to implement. Our innovation programme is starting to develop functionality for stages 4 and 5 – particularly through the TDI 2.0 project which will develop greater co-ordination between ourselves and National Grid on the use of flexibility resources on our network.

Figure 10: Potential evolutionary stages of DSO



To encourage development beyond stage 2 in the diagram, it would help to have a regulatory framework which provided the incentives for us to invest to deliver whole system benefits. The certainty such a regulatory framework could deliver would help to attract the investment required for the roll-out of the enabling technology. An amended regulatory framework can also place the correct incentives on network operators to develop the commercial framework to deliver DSO. At present, the misalignment of incentives and different commercial drivers between DNOs, TO and SO make this difficult.

Based on the predicted take-up of low carbon technologies (see our response to question 44) we think that a commercial model and associated regulatory framework need to be in place by the start of ED2. Given typical lead times to implementation, this means that clarity of the regulatory framework is needed in the next few years. This will allow industry to deliver the commercial framework in time for ED2 and provide a clear policy basis on which to start developing ED2 business plans in the early 2020s.

iii) do you have any initial thoughts on the potential benefits, costs and risks of the models?

As highlighted in our response to question 46 a), on the basis of the expected take-up of low carbon technologies, we will need visibility and an element of control of the flexible resources on our network in order to maintain system security. Based on the detail of the models presented (and we acknowledge they are high level) we think that the 'DSO/SO procurement mechanism' and 'Total DSO' models would best meet these needs. However, it is important not to think of the models presented in isolation – there may well need to be aspects of different models which need to come together. For example, based on our experience, we can see merit in contractual procurement of flexibility through a DSO model. If and when the number of flexible resources becomes so large, it makes management of these contracts too complex, it may be worth moving to a platform that is more based around marginal pricing. This should be seen as a potential future evolution and the focus in the next few years should be around the establishing arrangements for the efficient co-ordination of contractually procured flexibility.

We have used our experience to date to undertake a high level review of the costs and benefits of each of the models set out in the Call for Evidence. These are outlined in Table 5 below. We would be keen to develop the next level of detail around these models and use experience from trials to help undertake further assessment. Our TDI 2.0 project with National Grid will provide particularly useful insights into the DSO/SO procurement model and in particular the detailed interfaces required between ourselves and National Grid.

The main risks around the models are the level of complexity they could entail and how that is simplified to market propositions which are clear and transparent for our customers. We also need to be mindful of the considerable investment they could require in IT, communications and operational systems.

<u>Evaluation of the models</u>
We think it is important that, as an industry we start to develop an evaluation framework for these types of models (or aspects of the models). For instance, we feel that it would be important to consider the following:

- The simplicity of design and lead times to implement and have the flexibility to evolve over time;
- How the models will interface with other procurers of flexibility, such as suppliers and aggregators and take account of bi-lateral arrangements between DER to aggregate their output;
- Understand how the models will work alongside settlement processes, ensuring that suppliers are not out of balance as a result of flexibility actions taken by others;
- How the models can provide a framework for the coordination of planning and operation between TSO and DSO; and
- How the models interact with the connection process to give stronger signals to customers on where they can provide value for the local network.

Table 5: Costs and benefits of DSO models in the Call for Evidence

	DSO/SO procurement mechanism	Market signals and arrangements	Responsibilities in system operation	
			"Total TSO"	"Total DSO"
Costs	• Requires effective DSO-SO coordination • Potential conflicts between DSO and SO which will require a mechanism to resolve	• High levels of complexity • Significant implementation overhead • Requires fundamental change to charging arrangements which are typically slow • May not provide certainty of income to service providers • May not provide certainty of response required for network security	• SO will not necessarily have the right information and experience to make planning decisions at D level • Adds significant complexity for SO to manage decisions at D level • May not provide DNO with tools needed to maintain reliability	• Requires significant expansion of DNOs' current capabilities, over and above those for DSO/SO procurement model
Benefits	• Allows party with best information to plan and operate own networks • Should allow effective deployment of flexible resources • Potentially supports most rapid connections process • Provides DNO will a large degree of visibility and control over the flexible resources on its network	• Expansion of market signals • Maximising competition • Reduced requirement for monopsony residual balancers	• Reduces requirement for coordination between multiple entities	• Better ability to coordinate local solutions • Provides for benchmarking and potentially competition between multiple DSOs • Provides DNO will a large degree of visibility and control over the flexible resources on its network

5. Innovation

Question 47: Can you give specific examples of types of support that would be most effective in bringing forward innovation in these areas?

As we have set out in the Executive Summary, NIA and NIC funding has been successful in promoting investment in innovation, is broadly fit for purpose and continues to be required. Government could consider how NIA and NIC funding can be made compatible with other matched funding opportunities in areas such as smart vehicle charging and the development of flexibility platforms. We have encountered the need for clarity in our discussions with Open Utility in their application to the Energy Entrepreneurs Fund, which we supported.

We also support innovation projects having sufficient time to demonstrate value, and the framework should be developed to avoid NIC, NIA and price controls limiting energy sector involvement in longer term projects.

Question 48: Do you think these are the right areas for innovation funding support? Please state reasons or, if possible, provide evidence to support your answer.

We would generally support the areas identified. The key areas for ongoing innovation we have identified along with our ENA partners include:

- Supporting innovation that delivers value across the whole system and beyond individual network or system operator business scope as is being trialled in TDI2.0;
- Supporting trialling of emerging commercial and market models and platforms, not just technology to be embedded into network/system operator operations;
- Facilitating cross-energy vector projects (e.g. Hydrogen or heat projects) and not just electricity in NIA/NIC;
- Supporting local energy (including community energy schemes) to ensure approaches exist to allow those least able to adopt smart flexibility technologies;
- Supporting the development of smart EV charging technologies and commercial frameworks to facilitate the development of interoperable standards and visibility of EV charging to network operators; and
- Supporting the development of vehicle to grid technologies with the UK automotive technology sector.

Annex 1: Stakeholder engagement

To help inform our response and to test that our messages help to deliver our stakeholders needs, we have engaged with a number of parties. We have listed these below for transparency:

- Two roundtable sessions with storage providers, to test our views on network charging and regulatory framework for storage;
- Cornwall LMP (local marginal pricing) to understand the project being run with Centrica;
- Goran Strbac from Imperial College to understand his work on the potential benefits of flexibility and the role of the DSO in delivering these benefits;
- Open Utility to understand its work on market platforms and peer to peer trading;
- Electron to understand its work on open source platforms and apps and how this technology can be used in energy sector;
- Lime Jump to understand their business model as a virtual power plant and how this relates to current market structures; and
- Innovate UK to understand the innovation funding landscape in the UK.

Annex 2: Bibliography

Berkley Labs Future Electric Utility Regulation 'Distribution Systems in a high distributed energy resource future', October 2015: https://emp.lbl.gov/sites/all/files/FEUR_2%20distribution%20systems%2020151023.pdf

Californian ISO price maps: http://www.caiso.com/pages/pricemaps.aspx

Centrica Cornwall local energy market: https://www.centrica.com/news/centrica-build-pioneering-local-energy-market-cornwall-0

Customer led Network Revolution (Northern Powergrid): http://www.networkrevolution.co.uk/

ELAAD Smart Living Lab: https://www.elaad.nl/nieuws/nederland-als-living-lab-voor-het-slim-opladen-van-elektrische-autos/

Elexon & Baringa 'Active Management of DG', March 2015: https://www.elexon.co.uk/wp-content/uploads/2015/03/Active-Management-of-Distributed-Generation_March2015.pdf

Energy Networks Association 'Fair and effective queue management of connection queues: Changes to applications' May 2016: http://www.energynetworks.org/assets/files/news/consultation-responses/Consultation%20responses%202016/Fair%20and%20Effective%20Management%20of%20DNO%20Connection%20Queues%20Treating%20Changes%20within%20Applications.pdf

ENWL 'Customer Load active system services – CLASS': http://www.enwl.co.uk/class
European TSO DSO data management report, May 2016:

http://www.eurelectric.org/media/285585/tso-dso_dm_rep-2016-030-0382-01-e.pdf

FALCON (Flexible Approaches to Low Carbon Optimised Networks) – Western Power Distribution: https://www.westernpowerinnovation.co.uk/Projects/Falcon.aspx

Flexible Networks for a low carbon future (Scottish Power Energy Networks): http://www.spenergynetworks.co.uk/pages/flexible_networks_for_a_low_carbon_future.asp

Imperial College & Carbon Trust: 'An analysis of electricity system flexibility for GB', November 2016: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf

MIT Energy Initiative: Utility of the future: http://energy.mit.edu/research/utility-future-study/
December 2016

My Electric Avenue Innovation project (Scottish & Southern Electricity Networks): http://myelectricavenue.info/about-project

National Association of Regulatory Utility Commissioners (US) 'Manual on distributed energy resources rate design and compensation', 2016: http://pubs.naruc.org/pub/19FDF48B-AA57-5160-DBA1-BE2E9C2F7EA0

Network Equilibrium (Western Power Distribution): https://www.westernpowerinnovation.co.uk/Projects/Network-Equilibrium.aspx

Regulating EV demand: Distribution Network Operator perspective on Electric Vehicles.' HEVC 2016 conference publication

Smart Energy GB, 2015, 'Smart energy for all; identifying audience characteristics that may act as additional barriers to realising the benefits of a smart meter': http://studylib.net/doc/18339617/smart-energy-for-all

Smartnet consultation on basic schemes for TSO DSO co-ordination and ancillary service provision: http://smartnet-project.eu/consultations/basic-schemes-for-tso-dso-coordination/

UKPN Low Carbon London report A1 'Residential demand side response as an alternative to network reinforcement', September 2014: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A1%20-%20Residential%20Demand%20Side%20Response%20for%20outage%20management%20and%20as%20an%20alternative%20to%20network%20reinforcement.pdf

UKPN Low Carbon London report A2 'Residential consumer attitudes to time varying pricing', September 2014: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A2%20-%20Residential%20consumer%20attitudes%20to%20time%20varying%20pricing.pdf

UKPN Low Carbon London report A3 'Residential consumer responsiveness to time of use pricing', September 2014: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A3%20-%20Residential%20consumer%20responsiveness%20to%20time%20varying%20pricing.pdf

UKPN Low Carbon London report A10 'Smart Appliances for residential demand response', September 2014: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A10%20-%20Smart%20appliances%20for%20residential%20demand%20response.pdf

UKPN Low Carbon London report B1 'Impact and opportunities of wide-scale electric vehicle deployment, September 2014: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20A1%20-%20Residential%20Demand%20Side%20Response%20for%20outage%20management%20and%20as%20an%20alternative%20to%20network%20reinforcement.pdf

UKPN Low Carbon London report B5 'Opportunities for smart optimisation of new heat and transport loads, September 2014: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20B5%20-%20Opportunities%20for%20smart%20optimisation%20of%20new%20heat%20and%20transport%20loads.pdf

UKPN Low Carbon London report D5 'Novel commercial arrangements for smart distribution networks', December 2014: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20D5%20-%20Novel%20commercial%20arrangements%20for%20smart%20distribution%20networks.pdf

UKPN Smarter Network Storage 'Electricity Storage in GB: SNS 4.7 recommendations for regulatory and legal framework', September 2015: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/Report+9.5+19Oct_v2.1_%28Final+Photos%29.pdf

UKPN Smarter Network Storage 'Analysis of integrated energy storage contribution to security of supply', January 2016: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/SNS_P2_6_SDRC9.6v1.pdf

UKPN Smarter Network Storage 'Successful demonstration of storage value streams', March 2016: http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/SDRC+9.7+Successful+Demonstrations+of+Storage+Value+Streams+LoRes+v1.pdf