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Commission Secretariat
National Infrastructure Commission
1 Horse Guards Road
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By e-mail to energyevidence@Infrastructure-Commission.gsi.gov.uk

Dear Sirs

National Infrastructure Call for Evidence

Thank you for the opportunity to respond to the above call for information. This letter should be treated as a consolidated response on behalf of UK Power Networks' three licensed distribution network operators (DNOs): Eastern Power Networks plc, London Power Networks plc, and South Eastern Power Networks plc. Our response is not confidential and can be published on your website.

UK Power Networks is one of the UK's largest electricity distribution businesses and we welcome the opportunity to respond to this inquiry. We are dedicated to delivering a safe, secure electricity supply to 8.1 million homes and businesses across London, the East and South East of England.

Our response therefore addresses only the questions raised regarding electricity interconnection and storage. Strong distribution and transmission networks will continue to be at the heart of delivering and affordable, secure, low carbon energy system. UK Power Networks has already been playing a crucial role in supporting the low carbon transition. In total, we have around 5,800MW of distributed generation (DG) connected to our networks. In the last five years we have connected 3,100MW of DG – this is enough to power 58 Olympic Parks and more than 20% of our combined network peak demand.

UK Power Networks also operates the UK's largest battery storage facility as part of our Low Carbon Networks Fund project Smarter Network Storage (SNS). The SNS facility now represents the first known battery storage facility to have been qualified and performing balancing services in the GB market. The reports produced by SNS, including our recommendations of the regulatory and legal framework for storage, are accessible through the innovation pages of our website

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

With the rise of DG, we expect that we, and other DNOs, will need to take on the challenge of managing the intermittency inherent in renewable generation in order to meet the increase in demand. We are likely to see significant blurring of the boundaries and changes in the use of transmission and distribution networks. Government and Ofgem have a role to ensure that the legislative and regulatory framework will allow the transition to a low carbon network at the lowest possible cost.

Yours sincerely

Suleman Alli
Director of Safety, Strategy and Support Services
UK Power Networks

UK Power Networks response to the questions on Electricity interconnection and storage

Question 1. What changes may need to be made to the electricity market to ensure that supply and demand are balanced, whilst minimising cost to consumers, over the long-term?

- What role can changes to the market framework play to incentivise this outcome:
  - Is there a need for an independent system operator (SO)? How could the incentives faced by the SO be set to minimise long-run balancing costs?
  - Is there a need to further reform the "balancing market" and which market participants are responsible for imbalances?
- To what extent can demand-side management measures and embedded generation be used to increase the flexibility of the electricity system?

DNOs have in the last years seen a shift in their networks as a result of Distributed Energy Resources (DER), such as DG, Demand Side Response (DSR) and most recently storage. As a result, DNOs have now started to consider how to best balance their networks to help the system as a whole and minimise costs to consumers. As energy resources become increasingly distributed, the market will need to develop to ensure that both transmission and distribution constraints are recognised and are visible to market participants so that the system operation and investment costs can be optimised to ensure the most affordable long term solution for customers. In the last five years we have connected 3,100MW of DG – almost the same capacity as the proposed new nuclear power station at Hinckley.

DER are emerging that play an active part in system ancillary services, for example storage providing short term operating reserve and enhanced frequency response, or demand response giving turn up/down capability. These resources can also provide services to both the transmission and distribution networks allowing the potential for active management of capacity, power flows and network voltage, maximising the use of existing assets. They also have the potential to allow more generation and demand to connect without reinforcement. Our Flexible Plug and Play project trialled a range of smart grid technologies and offered curtailment contracts to distributed generation customers to allow them to connect to our network at a significantly reduced rate in return for allowing us to reduce their output in the event of a temporary network constraint.

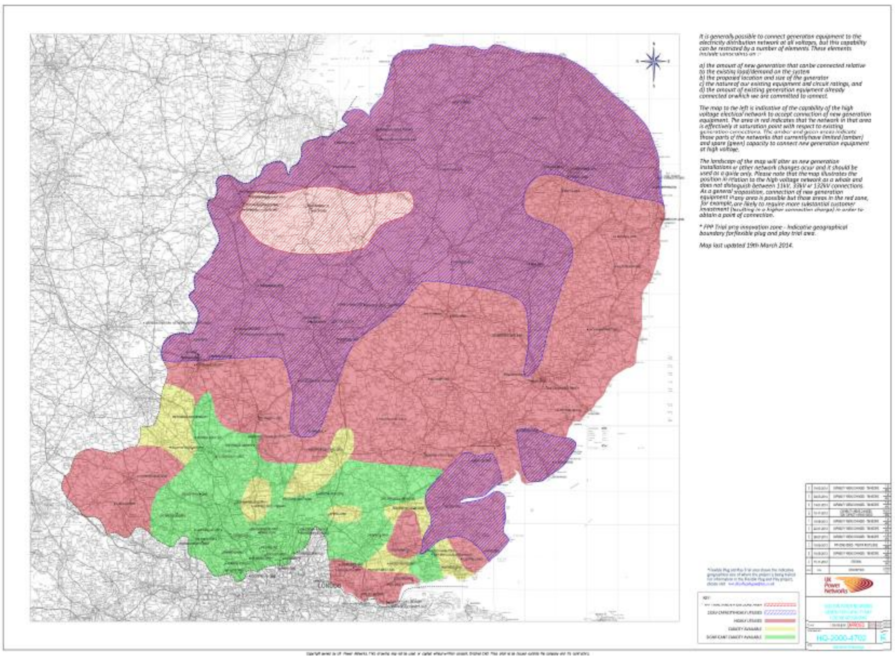
These services and resources make networks more dynamic and imply new capabilities for DNOs to address the challenges of a system operator. For example, DNOs may need to be able to actively manage DG export, providing network security and resilience, monitor the network in a coordinated wide-scale once smart meters are rolled out, to manage voltage within statutory limits and potentially use DERs to balance the system.

It has become apparent from the recent SO tender for enhanced frequency response services that the balancing market approach favouring high availability services may not be aligned with minimising the total system costs. For storage to provide frequency response services to National Grid, storage systems ideally require unconstrained import and export, as offered by most transmission connected generators. In their recent tender for enhanced frequency response National Grid do value different levels of availability, but the connection applications we have received are asking for unconstrained access to enable them to maximise their income. DNOs can provide this but such access is unlikely to offer distribution networks considerable benefits. The locations where unconstrained access is most economic are unlikely to be where there are high penetrations of embedded generation or where there are network constraints that could make use of the storage technology's potential. UK Power Networks has received over 1GW of connection applications for storage driven by this SO request, although we expect only a small proportion to proceed should the SO procure only 200MW of response.

It is also evident that the need for enhanced frequency response is driven in part by the impact of the intermittency and lower inertia of renewable energy sources. Storage would have the potential to address this at source by acting as a buffer to intermittent inputs whilst also providing the ability to store excess renewable energy where network constraints limit its export (and make use of it at an alternative time).

Intuitively the use of spare network capacity elsewhere on the network to provide access for fast responding storage devices to compensate for this intermittency creates the potential for higher overall system costs, be they the costs of connecting the additional storage or because subsequent demand connections experience reinforcement charges that otherwise would not have occurred as the additional storage has used this capacity. It is therefore important that the markets reveal and value these costs, providing the participants and network operators with the information and incentives to make the right long term choices to minimise system costs. This requires a consideration of both the balancing and wholesale markets to ensure they are working together to minimise costs.

Distribution networks in the UK communicate their constraints and investment costs through connection charges, where new users pay for some or all reinforcement costs, and ongoing capacity charges (with an element of peak time usage charges) for large customers (connected directly to larger substations). We publish capacity 'heat maps' (please see an example shown below) on our website to make visible the areas where network constraints affect the connection of generation.



Providing a framework where these embedded sources can provide services to all parts of the system will be a focus for the work the industry is conducting with Ofgem through the Energy Network Association's (ENA) Transmission and Distribution Interface working group and Ofgem's Flexibility programme of work.

We are actively looking to procure services as alternatives to reinforcement from embedded resources such as responsive demand, embedded generation and storage, where these are available. We are actively discussing in the ENA Transmission and Distribution Interface working group how these resources may also provide services such as voltage and reactive power support, and whether these should be procured by the distribution network operators, transmission network operators or the system operator. These discussions will consider what changes to existing regulatory frameworks this might require. Procuring capacity and potentially balancing services in conjunction with the system operator and other market participants such as aggregators is a new area for DNOs where greater knowledge of the markets and operations has to be developed. We are exploring how these services may be provided in our SNS project and are looking closely at the learning from Electricity North West's CLASS project.

We would support a stronger role for the DNOs in managing intermittency as the distinction between 'distribution' and' transmission' becomes increasingly opaque with greater generation capacity connecting to more actively managed distribution networks. We believe this will lead to an evolution from traditional DNOs to regional "Distribution System Operators" (DSOs). A DSO would undertake the conventional role of a DNO but would also make full use of smart techniques to create value for the wider electricity system e.g. by undertaking an element of regional balancing and providing reserve and frequency response services to the national system operator. Such services will become increasingly important to maintaining a stable balanced national electricity system as conventional 'synchronous' generation associated with coal and gas fired power stations gives way to higher volumes of intermittent renewables generation technologies.

Alignment of electricity market mechanisms to maximise whole system efficiency will require mechanism for code governance which is sufficiently inclusive, agile and flexible and considers integrated design and operation of both transmission and distribution networks to allow the system to innovate and evolve as these technologies develop.

Question 2. What are the barriers to the deployment of energy storage capacity?

- Are there specific market failures/barriers that prevent investment in energy storage that are not faced by other 'balancing' technologies? How might these be overcome?
- What is the most appropriate scale for future energy storage technologies in the UK? (i.e. transmission network scale, the distributed network or the domestic scale.)

The key issue for storage technology has been the cost, particularly of batteries. The economics of battery storage are changing rapidly with forecasts that the costs of battery capacity could fall by as much as 80%. The interest in battery storage for the enhanced frequency response tender is evidence that these improvements are likely.

Storage has the potential to provide many different services and may have advantages over other balancing technologies in being widely deployable and adaptable to multiple services. We believe energy storage, in various forms and scales, will form an important part of future low carbon networks. Storage can provide a key source of flexibility to the networks, enabling greater renewables uptake, reduced system operating costs and avoiding or deferring reinforcement. Energy storage systems are ideally suited to performing frequency response services as, once the frequency change is detected, they can transition from zero output to full power response in as little as 100ms, which means they can deliver a more significant stabilising effect to the system than a traditional generator which takes longer to ramp up to full output. At scale, this could allow National Grid to procure a smaller volume of MW response from storage devices, compared to that needed from spinning plant. Our SNS project is demonstrating these grid scale capabilities and allowing the network operators to understand how these devices can be integrated into networks.

The work being carried out by Ofgem on flexibility needs to consider if balancing services can be from distribution connected assets without the high availability normally associated with transmission connected assets. Whether it is economic to procure more potential services from a wider population of providers (either directly or through aggregated services) than from specific high availability assets is not yet clear but the market frameworks should not discriminate and allow such services to develop.

A cohesive framework of services from storage may provide a better approach than storage operators trying to optimise their revenues between the many opportunities. The system operator procuring balancing services, network operators procuring capacity and time of day pricing in the wholesale markets may optimise this over time but a clear framework for the services and the drivers would help all participants.

We are exploring the many services battery storage can provide though our SNS project. Our SNS system has undergone an extensive period of testing, including formal testing to prove that it is capable of performing beneficial wider system services, such as Short Term Operating Reserve (STOR). This has also provided valuable learning for the transmission system operator about the nature of storage devices, and the SNS facility now represents the first known battery storage facility to have been qualified and performing balancing services in the GB market.

As a network operator we are open to all scales of technology and work to identify the value that can be obtained through these technologies. It is likely that storage technologies will develop at all of these scales and these will need to be integrated. We are presently seeing storage enquiries with capacities in the range of 5MW to 50MW. Such energy resources are by their nature likely to connect to the distribution networks rather than transmission, but their effects are national, e.g. domestic storage could be aggregated and allow best use of domestic solar energy sources reducing stability issues at low load and also reducing system peak demand.

We are aware that a local DSO may be required to maximise the use of new technologies in local networks. We are engaged in DECC’s Future Power System Architecture to identify the processes and systems that need to be developed to access these potential benefits and ensure that the networks are able to fulfil the role that is required.

Question 3. What level of electricity interconnection is likely to be in the best interests of consumers?

- Is there a case for building interconnection out to a greater capacity or more rapidly than the current ‘cap and floor’ regime would allow beyond 2020? If so, why do you think the current arrangements are not sufficient to incentivise this investment?
- Are there specific market failures/barriers that prevent investment in electricity interconnection that are not faced by other ‘balancing’ technologies? How might these be overcome?

As a distribution network operator we have no comment to make on wider interconnections to other systems within Europe.

Question 4. What can the UK learn from international best practice in terms of dealing with changes in energy technology when planning to balance supply and demand?

We are following developments in energy markets around the world and particularly in the USA and Australia where similar issues for the local network impacts on markets are also being explored, to identify the best approach for distribution networks.

California is one of the areas with most storage installed capacity. This uptake has been driven by government incentives. Understanding the challenges and solutions to the balancing system should provide the UK insight to potential solutions to optimise the network, for example how to use long run marginal price signals should be considered in Ofgem's work on flexibility. However, vertically integrated utilities have different incentives for exploring these solutions and we need to understand how the learning can be applied to the design of UK markets.

In Australia there have been significant increases in solar PV installation since 2010. This has not been constrained by networks and as such the main benefits of the deployment of storage would be time of day arbitrage, with limited opportunities for value from transmission and distribution services.

Germany is another country that will continue to pursue the uptake of storage as their PV installed capacity increases.