About National Grid

1. National Grid's job is to connect people to the energy they use, safely.

2. We hold licences under the Electricity Act and Gas Act for:
   a) Electricity transmission, which includes both the system operation of the Great Britain transmission system and ownership of the high voltage transmission assets in England & Wales),

   b) Gas transmission (system operation and ownership of the high pressure pipelines in Great Britain), and

   c) Gas distribution network serving approximately 11million customers in England, across four networks.

   d) Under separate licences, and through, independent ring fenced companies, we have entered into Joint Ventures through which we also own and operate electricity interconnector assets between the UK and France and Holland and are developing projects with Belgium and Norway.

3. National Grid owns the high voltage electricity transmission system in England and Wales, which at 99.99995% is the most reliable network in Europe.

4. As System Operator we are responsible for real time balancing of supply and demand which is around 3% of total electricity [and gas] supplied.

5. In Great Britain, National Grid does not own any electricity distribution assets neither do we own any Scottish or offshore electricity transmission assets.

Context

National Grid sits at the heart of the UK's energy system, balancing the system second by second to meet the demands of energy consumers. We have a unique and privileged perspective of the issues facing the energy system. We are facilitating the drive towards a low carbon energy system and our focus is on enabling an orderly, economic transition that maintains security of supply, facilitates the achievement of climate change targets and provides a good foundation for further change required in the period to 2050 and beyond. Over the next decade, we plan to invest around £16-20 billion to ensure that our electricity and gas networks continue to provide safe and reliable energy supplies to customers

Exec Summary:

Changes to the market: Changing consumer behaviour and new technologies are driving fundamental changes in the nature of our energy system and how it is managed. This includes current changes both in technology and regulation. As such, there are a number of changes that we need to see in the energy market to support the delivery of efficient and secure energy supplies.

- Review of the capacity market
- Encouragement of Demand Side Response (DSR)
- Greater visibility of network connected assets

The System Operator structure: The structure of the System Operator (SO) function has been a topic of discussion for a number of years, with some parties favouring an SO that is integrated with a TO (or TSO) and some parties favouring an Independent System operator (or ISO). Our analysis suggests, based on international experience, that moving to an ISO would only deliver potential benefits to consumers if it was coupled with significant market reform (e.g. the introduction of locational marginal pricing (LMPs)) and broader changes to industry governance. It is not clear that an Independent System Operator is in the best interest of consumers and distracting the SO at a time when energy security is such a high priority would introduce an unnecessary risk. The focus for the SO should be on security of supply and ensuring the evolving market arrangements bring forward new generation to replace the capacity leaving the system from legacy plants.

Opportunities in storage: Technological advances have created opportunities for energy storage which has seen significant cost reductions over the last few years. There are three key barriers to the wider deployment of energy storage capacity on the system:

- High cost of technology compared to alternatives
- Accessibility of multiple revenue streams
- Lack of a policy definition of storage which means some companies are prevented from developing the technology

Interconnection levels: Electricity interconnection reduces costs to consumers by linking higher cost energy markets to those which have lower costs. Our analysis shows that Great Britain could unlock up to £1billion of benefits to energy consumers through doubling its interconnector capacity by 2020. As well as lower energy prices for consumers more interconnection would drive enhanced energy security, a cleaner environment and wider macro-economic effects. Failure to double existing interconnector capacity to nearer the 10% proposed by the European Commission could be equivalent to foregoing wholesale electricity price reduction of nearly £3million every day.

International best practice for the changing environment:
International experience has shown us that the requirement for particular system services or the provision of targeted subsidies to technologies has resulted in the penetration of new technologies. In this response we examine Italy, Belgium and Ireland and USA which have experienced growth in new technologies, particularly storage and DSR to understand how this has been achieved.

Questions:

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?

Review of Capacity Market

Renewable technologies such as such as wind and solar provide fluctuating levels of power over multiple time horizons, known as intermittent generation. This requires National Grid to have visibility of, and access to, flexible sources of generation to manage this intermittency and ensure supply meets demand.

The closure of large scale plants and the rise of new technologies and players such as smaller scale generators, storage, DSR (flexibility through management on the demand side) and interconnection changes the way in which supply meets demand. We are actively considering the impact of those closures on security of supply. We are supporting a DECC led review of the capacity market as there is a need to consider structural solutions to reduce uncertainty regarding future supply and demand-side technology mix to 2018/19.

Stimulate Demand Side Response

National Grid is actively pursuing the development of energy solutions such as storage, interconnectors and Demand Side Response (DSR). DSR is intelligent energy usage which financially incentivises consumers to lower or shift their electricity use at peak times. This in turn helps to manage load and voltage on the electricity network, and allows businesses and consumers to save on total energy costs and reduce their carbon footprint. Demand side response (DSR) is likely to be a significant contributor to system flexibility capability in the future.

We know that roughly two-thirds of national demand sits in the Industrial and Commercial business sector and so our initial focus is on developing DSR in this sector. To facilitate the development of DSR products we have developed a framework called Power Responsive which enables businesses, suppliers and policy makers to shape the growth of demand side response collaboratively. The aim is to deliver it at scale by 2020. To achieve growth in this area there is a need for increased promotion of the opportunities in DSR and a simpler set of products with clear value for businesses

Greater visibility of what is connected to the grid

On the distribution networks, system operation has become more complex as more community energy sources are being connected. Community or "Distributed" energy sources refers to electricity generating plants or users of electricity that are connected to a lower voltage local distribution network, rather than to the high voltage national transmission network. Some new technologies at consumer premises (e.g. Electric Vehicles) may increase demand on the system, leading the Distribution Network Operator to need to manage its system in a more active way[1] rather than increase its network capacity.

It is expected that there will be a requirement to balance the whole system (including distribution/local networks) in a much more active and dynamic way. Therefore there is a need to ensure that all parties involved in system operation have full visibility and accessibility of assets that are connected to the distribution network. In the interim, as we wait for greater visibility of what is connected to the grid, we are managing increasing system fluctuations by contracting with embedded generation to provide system flexibility.

[1] Increase or reduce demand rather than increase network capacity.

Is there a need for an independent system operator (SO)?
The structure of the System Operator (SO) function has been a topic of discussion for a number of years, with some parties favouring an SO that is integrated with a TO (or TSO) and some parties favouring an Independent System operator (or ISO). In Europe the TSO model is favoured and our current structure is TSO, whereas in the US an ISO structure is more prevalent and this is the case in our own territories in the North East.

This question has become very real in recent months in the UK with the advent of the enhanced planning role under Ofgem's Integrated Transmission Planning and Regulation (ITPR) project and with the increasing pace of change in the generation sector as it moves from larger transmission based units to more distributed generation, increased intermittency, demand side activity and storage. Given these developing challenges we have engaged some independent consultants (FTI Consulting) to explore the options regarding the future structure of the SO. This work includes consideration of the pros and cons of an ISO models as well as alternative models.

As result of the work we have done so far, we do not believe that an Independent System Operator is in the best interest of consumers. We believe the current focus should be on security of supply and ensuring the evolving market arrangements bring forward new generation to replace the capacity leaving the system (e.g. the closure of coal fired plant.) There is a risk that creating an ISO at this moment in time would be a distraction from focussing on security of supply matters. Our work with FTI suggests, based on international experience, that moving to an ISO would only deliver potential benefits to consumers if it was coupled with significant market reform (e.g. the introduction of locational marginal pricing (LMPs)) and broader changes to industry governance. Evidence suggests this would require large multi-year structural changes which risks reducing investor certainty in the generation market. This in turn could inhibit the connection of the new power stations required to deliver future security of supply.

Forming an ISO would entail significant set up costs and, would not be able to provide the strong incentives required for the role. Many of the benefits in ISO overseas are due to the market arrangements, rather than the structure of the SO.

It should be recognised that the integrated TSO model has delivered significant value to consumers historically, and there is real and material consumer value in maintaining the partially integrated SO model, which maintains the deep asset knowledge and SO - TO synergies that facilitate timely and accurate decision making that deliver system security and reduced overall costs of operating the system. We would be very happy to share our analysis on this and other aspects highlighted above.

Despite the obvious drawbacks of an ISO we do recognise the increasing need to provide confidence that any potential conflicts of interest between our TO, Non-Regulated Business, Business Development and SO are properly managed. We have a lot of experience operating in an environment where this is fundamental and legal requirement of our business.

An option that could be considered is a legally separated SO within National Grid, which would retain the majority of the benefits of the current arrangements (strong synergies between the SO and TO and strong financial incentives to deliver value to consumers) but also provide greater confidence to the industry around the management of conflicts of interest.

An alternative model which could go a bit further to introduce a new independent body, with National Grid reverting to just the system balancing activity, could also have merit (if the Government wishes to have a smaller role in energy matters, leaving more matters to industry experts,) and wishes to further address the management of conflicts of interest beyond a legally separated SO with National Grid.

Further analysis will be undertaken on the models in the New Year and we would be happy to share the work with NIC as they consider their recommendations"

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

There are two key barriers to the wider deployment of energy storage capacity on the system. These are:

1. The high cost of storage technology compared with alternatives
2. The policy and regulatory framework

Technology costs: Energy storage has seen significant cost reductions over the last few years (e.g. lithium-ion battery costs have fallen by c. 60-70% since 2010[2]) yet does not compete equally with other flexibility providers. There are however promising efficiency improvements and cost projections for existing storage technologies. Storage will be cost competitive when the cost can be compared to other flexibility technologies such as interconnection for energy balancing, thermal generation or DSR for ancillary services, and traditional reinforcement for upgrade deferral. We anticipate those cost reductions to bring storage closer to compete with other flexibility providers, with battery capital costs forecast to fall by nearly 50% over the next 5 years[3].

The policy and regulatory framework: Though economic fundamentals account for slow deployment of battery storage to date we outline below additional five barriers which would depress deployment below the economically efficient level were they not to be removed:

1. <u>Lack of clarity of the classification of storage</u>: as acknowledged by Ofgem[4] the legal and commercial status of storage is unclear. This risks holding back network-led business models and so reducing investment in storage. It is noteworthy that the 2014 large scale storage project "Leighton Buzzard" required UK Power Networks (an electricity distributor) to gain special dispensation to proceed. Clarity on classification could provide the opportunity for a single storage system to provide a number of services, and therefore benefit from multiple revenue streams, which is critical to making a business case for investment. We recommend that this is done in a way which continues to prevent network owners from selling electricity in the wholesale markets.
2. <u>Network Charging</u>: due to its treatment as both generation and demand, storage can be 'double charged'. We recommend cost reflective charging for storage, as for other technologies. In most cases a cost reflective principle would lead to lower charges for storage, and so improve business cases for its deployment
3. <u>Taxes</u>: a similar issue exists where storage providers must pay environmental levies twice. Applying levies only to energy consumption would improve the business case for storage
4. <u>Lack of half hourly settlement</u>: The electricity settlement process places incentives on suppliers to buy energy to meet their customers' demand in each half hour of the day. At present, most consumers do not have meters capable of recording half-hourly consumption data. Instead, they are settled using estimates of their usage in each half hour. The roll-out of smart meters that can record half-hourly consumption and be remotely read presents an opportunity to improve the accuracy and timeliness of the settlement process. Wider adoption of half hourly settlement would accentuate temporal price differentials faced by end users and therefore the arbitrage benefits to be gained from storage (either through self-consumption or the wholesale markets)

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[2] SgurrEnergy, *The Market Opportunity for Battery Energy Storage*

[3] Lazard's *Levelised Cost of Storage* (November 2015) forecasts decline in capital costs between 2015-2020 of 47% for lithium-ion batteries and 38% for flow batteries.

[4] Ofgem, *Position Paper: Making the Electricity System More Flexible and Delivering the Benefits for Consumers* (September 2015)

5. De minimis restrictions: DNOs are restricted to investing no more than 2.5% of their share capital in non-regulated assets, which places a ceiling on DNO-backed investment.

National Grid are also reviewing the commercial services brought by the SO to ensure they are optimally designed to match the capabilities of emerging technologies (including storage and other flexibility tools) while continuing to meet traditionally high standards of reliability. Two key barriers being addressed are:

> Service exclusivity: some SO contracts prohibit the provision of multiple services from a single asset, in order to guarantee availability when it is required. This makes it harder for storage assets to provide the service, as they tend to require the ability to benefit from multiple revenue streams to be economic
>
> Little long-term certainty on ancillary revenue streams: the contract length for ancillary revenue streams is typically short (less two years) due to the SO's incentive regime, which makes it riskier for investors to develop storage, given the required longer payback period.

The opportunity:

The removal of these barriers would allow the full potential of storage to be unlocked. Our analysis of the whole GB market suggests there is significant opportunity for greater storage, equating to an extra 2-3GW by 2020 delivering over £100m p.a. of consumer value. This potential will grow strongly through the 2020s and 2030s as battery costs continue to fall, EV penetration drives increased behind the meter demand and the electrification of heat and transport creates need for network reinforcement.

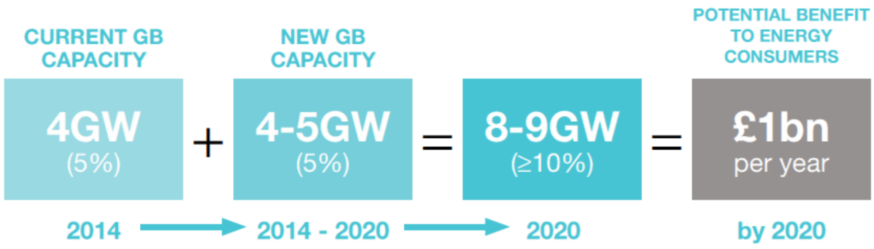
The first wave of additional storage is likely to be prompted by demand for frequency services. These can be provided by fast responding electro-chemical batteries (such as lithium-ion), flywheels and super capacitors. They can be provided from any location.

Over the longer term behind-the-meter models are likely to become economically viable, particularly following the wider adoption of smart meters and half hour settlement. This will see end users benefitting from self-consumption and/ or selling grid services via aggregators.

However, storage technologies are rapidly developing and it is not possible to forecast capabilities and cost with certainty. Furthermore, other emerging flexibility tools (such as demand side response and interconnection) can be used for many of the same applications as storage. Therefore we believe the market should remain open to accommodate future innovation and that a level playing field should exist for all flexibility tools. The changes recommended above will remove barriers which presently unduly hinder the deployment of storage

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

The benefit of increased Great Britain interconnection capacity for the energy market is clear with our analysis showing that Great Britain could unlock up to £1billion of benefits to energy consumers through doubling its interconnector capacity by 2020. Interconnection benefits include lower energy prices for consumers, enhanced energy security, a cleaner environment and wider macro-economic effects.



Electricity interconnection is a facilitating technology for reducing energy costs to consumers by linking higher cost energy markets to those which have lower costs; and over time aligning costs across the connected markets. Great Britain (GB) already has four of them, linking us to France, Ireland, The Netherlands and Northern Ireland. These links, totalling 4GW, represent around 5% of existing electricity generation capacity. However, this level remains low compared to the 10% benchmark proposed by the European Commission and there is strong consensus that this gap should be filled. Failure to double existing interconnector capacity to nearer the 10% proposed could be equivalent to foregoing wholesale electricity price reduction of nearly £3million every day.

The impact of increasing interconnection on the operation of the network is less clear. The way Europe manages interconnectors is changing with the introduction of the European network codes. This has a significant impact on how we manage GB interconnectors and presents both opportunities and threats. The opportunity is that we may get new, harmonised services across all interconnectors. However the threat is that we may lose existing capabilities as they are harmonised. Currently the network codes are at various stages of development and discussions are ongoing. Therefore the impact is unclear as the detail has yet to be discussed and agreed. The potential significant growth in GB interconnection increases the importance of achieving a satisfactory solution to the efficient management of interconnectors.

A merchant interconnector regime, such as that developed in GB, allows developers to build to an efficient level of capacity between markets, i.e. when there is no additional value to be realised between those markets. Such a position may be distorted if a developer has either generation or supply interests in either of the markets to be connected. The cap and floor regime (currently in place) provides an appropriate mechanism for remunerating developers. It allows them to have certainty of revenue recovery and ensures that the end consumer is protected and the wider benefits to the transmission system are realised. To that end each cap and floor arrangement needs to be set on a case by case basis.

Electricity interconnection requires the cooperation of multiple countries. This can itself form a barrier due to the different regulatory and legal regimes that exist between nations; placing additional costs and constraints to the development of interconnectors.

The on-going development and alignment of the electricity regulation regimes within the EU under the auspices of the Commission therefore has the potential to unlock more interconnection.

National Grid believes that a full understanding of the benefits of greater interconnection is important to inform the debate on an appropriate ambition to meet the country's need, and the timeframe within which it should be achieved. Significant progress has already been made in preparing for greater electricity interconnection. The UK Government and European institutions have provided strong support, Ofgem and its European counterpart has developed a new and innovative regulatory design, and multiple developers have come forward with proposed projects. With this regulatory and policy work we can unlock multibillion pound investment, and realise the benefits of interconnection.

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?

International experience has shown us that the requirement for particular system services or the provision of targeted subsidies to technologies has resulted in the penetration of new technologies. We examine those markets which have experienced growth in new technologies, particularly storage and DSR to understand how this has been achieved:

1. Case examples of provision of particular subsidies: **Italy**

The TSO (and DSOs) in Italy, can build and operate batteries under certain conditions. Italian network regulator (AEEGSI) passed a Decision on Provisions related to the Integration of Energy Storage Systems for Electricity in the National Electricity System (Decision 574/2014/eel of 10 November 2014) defining network access rules for energy storage.

It defines energy storage as a power generating system and makes them subject to certain obligations. Storage is required to pay connection fees in line with those for high efficiency CHP and power generation plants. Storage is also treated as programmable (dispatch-able) units if considered as single power generation systems, and as programmable or non-programmable units if considered as part of a group of generation systems, depending on the characteristics of the other units in the group (NERA 2014).

'Energy' project was launched with the 2011 Development Plan and envisages the construction of three storage systems in southern Italy for a total 34.8 MW capacity. The scope is to ensure significant flexibility is available in the management of renewable power plants, and to increment the transmission grid's capacity to absorb green power.

'Power' project approved in 2012, will install 40MW of energy storage capacity to increase security of electricity networks and develop smart grid applications. The first phase of the project comprises of 10MW Li-ion and 6MW of various other battery technologies for comparison purposes. Following positive initial results, phase 2 was announced, consisting of 20MW Li-ion battery and a 4MW sodium-nickel-chloride battery.

2. Case example of regulation aiding positive uptake of a desired service: **Belgium and Ireland**

Other international markets where the regulatory framework or the need for additional system services has driven the uptake of particular services, e.g. DSR includes Belgium where the TSO is active in contracting DSR for system balancing and Ireland which is introducing mandated Time of Use tariffs alongside its smart metering roll out.

3. Case example of using targets to achieve storage deployment ambitions: **USA**

One US example which has seen significant deployment of storage is California. In support of its renewable energy target, California Public Utilities Commission introduced storage targets in 2013 to enable renewables integration and efficient management of efficient management of networks. The three largest utilities (PG&E, San Diego Gas & Electric & Southern California Edison) are mandated to install 1.3GW of storage by 2020 (and have completed deployment by 2024). The program is weighted towards transmission connected storage although the networks have the flexibility to manage individual requirements.

We intend to work closely with the Ofgem, DECC and other parties to facilitate growth and uptake of particular technologies where needed.