Energy Systems Catapult Response to the BEIS/Ofgem Call for Evidence:
A Smart, Flexible Energy System

Introduction

1. This response is submitted on behalf of the Energy Systems Catapult (ESC). The ESC is part of Innovate UK and its remit is to create innovation in UK energy markets and create business opportunities. The ESC is looking at a "whole systems approach" and is responsible for the delivery of the **Smart Systems and Heat (SSH) Programme.**

2. The ESC is working with the UK government and local authorities to deliver the SSH Programme**,** determining the most effective means of decarbonising the UK's 27 million homes and contributing to the target of an 80% reduction in the UK's Greenhouse Gas emissions by 2050.

3. A key element of the SSH programme is the development of a Home Energy Systems Gateway (HESG) which will allow the smart operation of domestic heating and other applications. HESG is currently being trialed in up to 150 homes.

4. The ESC is also leading the Future Power System Architecture (FPSA) project in collaboration with the Institution of Engineering and Technology (IET). This project seeks to determine the functions that will be required to enable a future, low carbon, power system to operate in the face of transformative change, and hence to enable recommendations to be made that will inform policy and regulatory considerations.

5. If you wish to discuss the contents of this submission, please contact Tony Dicicco at tony.dicicco@es.catapult.org.uk.

Summary

6. The ESC supports BEIS/Ofgem's policy intent that undue regulatory, commercial and legal barriers do not prevent the deployment of smart technologies and processes, or new service providers competing in markets. We would stress the importance of taking a whole system perspective, as detailed in the joint ESC/IET FPSA project, when developing policy and regulatory measures to enable a *Smart, Flexible Energy System*.

7. The approach set out in the *CfE* is essentially evolutionary and industry-led. We are concerned that there are significant risks in taking this approach, in particular that the new functionalities identified in the FPSA report will be delivered in a timely way. We believe that there is a case for a more radical restructuring of the way the electricity supply chain functions, technically and commercially, and the associated governance. While we would support short-term incremental changes that can bring some benefits,

we also feel that more radical actions are likely to be needed in the longer-term. The plans to be published by BEIS/Ofgem in the Spring should set out distinct proposals for action in the short and longer terms.

8. We would support a more "hands on" approach by BEIS/Ofgem to ensure that market-based solutions are developed to meet the many challenges identified in the *CfE* and elsewhere. The pace of change in the energy markets require coherent plans in place to prepare for these challenges and to respond to them once they occur. We would expect BEIS/Ofgem, working with industry stakeholders, to ensure that such plans are in place. In the near-term, we consider that licence changes may be required to ensure that whole system approaches become business-as-usual.

9. We believe that a whole-system, consumer-centric market which drives the trade of energy through evidence-based decisions will drive investment in future technology mix decisions. We believe this is more important than focusing on the challenges of single technology areas. This type of market-structure, where industry is presented with portfolio carbon thresholds, akin to the automotive sector, would drive the responsibility and risk to the most appropriate sector of the market where such actors have the relationships with end consumers, to enable them to discover what the consumer is willing to pay for.

10. We believe that a holistic GB Energy System (GBES) should have prices that are reflective of the real-world benefits and costs experienced by a given solution provider. It is important to remember that storage, including battery technologies, provides demand smoothing rather than producing energy. This is an obvious but important distinction, and is critical when considering both domestic and commercial consumers.

11. The ESC supports the general principle that users of the energy networks should bear the costs that they impose on the system. Whilst some reduction in charges may be appropriate where there is a genuine and measurable reduction in network costs, it is not appropriate for the avoided costs to be borne by other network users. Therefore, we believe that a move away from mainly kWh-based network charging to a more capacity-based solution is required so that network fixed costs can be recovered equitably.

12. We agree that the flexibility offered by energy storage can have a positive impact and can potentially reduce a network operator's costs by offsetting the need to reinforce the network. However, there is an element of risk in relying on both energy storage and Demand Side Response (DSR) in that the expected kWh of energy increase or demand reduction may not turn up. It seems appropriate that flexibility should be rewarded with lower connection and use of system charges where it reduces network and system balancing costs but non-delivery penalties will need to apply. We believe that to deliver the full benefits of flexibility, price signals will need to develop to reflect the value to our energy system of smart technologies and processes.

13. We support the policy ambition for flexibility providers to be able to access revenues that reflect the true value of their flexibility through maximising access to a range of

existing markets including wholesale, capacity, balancing and ancillary services plus new markets, likely to be at a distribution level.

14. Cost-reflective pricing could lead to very high charges for consuming energy at the time of the peak. It may not be appropriate to expose end customers to these charges directly: customers may prefer suppliers to take this risk. In this world, suppliers would offer to manage their customers' non-time critical demands to minimise the aggregate cost of supplying their portfolio in accordance with cost reflective pricing. Suppliers who successfully managed their portfolio would be able to offer more attractive deals to customers, giving them a competitive advantage.

15. In the longer-term, energy vectors will become increasingly interconnected, such as through gas boilers hybridised with electric heat pumps, petrol engines hybridised with batteries for vehicle motive power, multiple energy conversion assets in heat network energy centres, etc. At times of electrical system stress, it should be possible to switch gas/electricity hybrid heat pumps to operate on gas for short periods, thus creating electrical demand reduction. Without hybrid solutions, the demand for electricity will become both larger and more volatile.

Detailed Response to Questions 1 - 48

Removing policy and regulatory barriers: *Enabling Storage* (Consultation Questions 1- 6)

16. We believe that this *"Call for Evidence (CfE)"* identifies and correctly assesses the **main policy and regulatory barriers to the development of storage** i.e. how storage connects to and is charged for using the electricity network, how it is defined[1] and how final consumption levies are applied to storage (to avoid "double-counting"). Another important barrier is access to finance: the Renewable Energy Association[2] (REA) has carried out interviews with a number of key stakeholders in the energy storage market and access to finance was identified as a *"major constraint on the storage market"*. There was consensus that the "*valley of death*" is a major issue in the industry as firms face no financial support between the Government R&D funds and conventional debt finance entering the market. A common conclusion was that because there is not enough visible support or funding from the government, it makes it harder for investors to fund storage projects. If there were more support from government (other than R&D funding) it would stimulate more funding from private sector investors. This support could be in the form of a high-profile strategy or a "visible" commitment to storage.

17. Addressing these barriers will help more energy storage access the energy market, including providing energy balancing and frequency response services and also through the Capacity Market. It would be easier for both energy storage and Demand Side Response (DSR) to participate in the Capacity Market and compete against diesel engines if the *"New Build"* threshold for a 15-year contract were increased from

[1] The development of technical standards for installing and using energy storage technologies may also aid the development of energy storage but it may be difficult to gain agreement on these.

[2] *"Energy Storage in the UK: An Overview"* (Winter 2015/16). The Renewable Energy Association

£250,000 to £500,000/MW, and/or "Bid Bonds" were made proportional as currently DSR is charged the same as New Build CCGT which does not seem fair.

18. We believe that it is important to adopt a whole system perspective when developing policy and regulatory measures for storage. The optimisation of power system storage requires multiple effects to be taken into account across the supply chain, both technically and commercially. Electrical storage connected at the transmission level may not help to defer investment in the reinforcement of a distribution network and therefore a whole system approach is required. One factor that will limit the deployment of storage is the need to achieve a significant number of charge/discharge cycles per annum. If this does not happen, then the fixed costs must be recovered over a small volume of energy delivered, making it financially unattractive.

19. We believe that the issues regarding **connection to, and charging for use of, the network** for storage have been identified and correctly assessed in the *CfE*. We agree that network operators need to provide more clarity on the process for storage connections. We support the work of the IET in developing a code of practice for electricity storage systems and the work of the Grid Code Working Group set up to consider appropriate technical requirements for transmission-connected storage.

20. The ESC supports simplicity when determining the connection arrangements for storage. Simple rules should be adopted to determine what constitutes a *"material change"* when storage is added to a site with an existing demand or generation connection. Milestones and associated specific time periods should be appropriate to the size and technology type of generation and voltage level of connection e.g. a storage park at LV level is likely to go through planning much faster than a large wind farm connecting at 33kV, and so the time permitted for planning milestones will need to vary to reflect this.

21. The issue of providing sufficient connection capacity in the required timescales is pertinent to both the transmission and distribution networks. We support the proposal contained in the ENA consultation on using *"Progression Milestones"*[3] in connection offers in order to help DNOs free up unused network capacity.

22. The ESC supports the general principle that users of the energy networks should bear the costs that they impose on the system. There are an increasing number of users that are seeking to avoid paying network charges – these range from embedded generators to large demand off-takers (I&C customers). Whilst some reduction in charges may be appropriate where there is a genuine and measurable reduction in network costs, it is not appropriate for the avoided costs to be borne by other network users. Therefore, a move away from kWh-based network charging to a more capacity-based solution may be required, so that network fixed costs can be recovered equitably.

[3] *"Fair and Effective Management of DNO Connection Queues: Progression Milestones"* (April 2016). Electricity Networks Association

23. We agree that the flexibility offered by energy storage can have a positive impact and can potentially reduce a network operator's costs by offsetting the need to reinforce the network. However, there is an element of risk in relying on both energy storage and DSR in that the expected kWh of energy increase or demand reduction may not turn up. It seems appropriate that flexibility should be rewarded with lower connection and use of system charges where it reduces network and system balancing costs but non-delivery penalties will need to apply.

24. The issue of "double charging" for energy storage needs to be addressed. It may not be appropriate that storage providers pay both electricity demand (when drawing power) and generation (when discharging power) network charges – a possible solution is that they pay one charge (whichever is the highest) or an average of the demand and generation charges.

25. With regards to the **assessment of the regulatory approaches for the treatment of storage** as described on pages 35-36 in the *CfE,* we agree that there are some advantages with the current licensing arrangements that treat storage as "generation" (as per "Option a"), such as providing certainty to existing storage providers. However, this option potentially constrains options for ownership and operation. In addition, the argument against storage being classified as generation is that storage simply recycles electrical energy that has already been generated, and as such, does not contribute to GB's electricity production capacity. It can however play an increasingly important role in maximising the utilisation of low carbon generation and hence reducing the need for fossil-fuelled generation. Its ability to readily provide enhanced frequency response also makes it superior to some low carbon generation technologies. We believe, therefore, that storage, and electrical energy storage in particular, is a key electricity system infrastructure asset that may justify specific recognition to encourage its use. We believe that "*Option d – creation of a separate storage licence regime*", including the option of a licensed network storage operator, needs to be explored further with storage providers.

26. The question of whether **network companies should own storage assets** is a difficult one to address. If network companies are allowed to own storage then this could undermine the market for flexibility services and lead to a lack of investment by service providers, reduced competition and hence an increase in costs. However, balanced against this, there may be some benefits in terms of improved system security from, for instance, a network operator being able to install a facility of the optimum size and at the optimum location to offset or avoid traditional network reinforcement. If the DNO is not allowed to own storage, then it will be dependent on the market to recognise the potential. If the market fails to respond, then the DNO will be left with no alternative than to apply a solution which may be less cost-effective from a whole system perspective. An alternative may be to allow the DNO to develop and own the storage asset but for a licensed network storage operator to operate it – this may alleviate any concerns about any potential abuse of market power.

27. It is important that the **definition of storage** does not constrain the provision of different types of storage. We believe that any definition needs to take due consideration of "*vector substitution*", where storage of one particular form of energy

is converted to another form, for example, electricity converted to heat or hydrogen. This heat or hydrogen may be reconverted to electricity or may be used for other purposes. We would suggest that further work needs to be done with storage providers, electricity users and network operators to agree suitable definitions.

Removing policy and regulatory barriers: *Aggregators* (Questions 7- 10)

28. DSR can participate in a number of different markets. Frontier Economics produced a report for DECC on the future potential for DSR[4] in Great Britain. This report investigated the various routes to market for DSR and stated that the the types of DSR that are likely to have the greatest impact on outcomes in the wholesale market are those that produce regular, significant changes in demand. At present, the main form of DSR that could have this effect is Triad avoidance. Installing large scale storage on the electricity network would better enable the balancing of supply and demand and assist in providing technical services such as frequency response and voltage optimisation. Energy storage is not just electrically based, as it can be applied across heat and transport, for example using hydrogen and thermal stores.

29. As well as storage's grid-scale flexibility, there remains the "behind-the-meter" use. Behind-the-meter storage is expected to make up a large proportion of deployed energy storage capacity, as it is more easily developed than at grid scale, and there are many high-energy users who would look to take advantage of this potential. According to DCLG[5], there are around two million homes, or 8% of dwellings, in Great Britain with electric storage heaters. This proportion has remained relatively constant since at least 1996. It is likely that most of these households will be part of the 3.5 million households with an Economy 7 meter. As the electrification of heat gathers pace, there will be many more appliances that can provide DSR, such as heat pumps and electrical resistive heaters.

30. The role of Aggregators will be key to providing large-scale domestic DSR. Currently, independent Aggregators do not have **a defined role in the Balancing and Settlement Code** – this needs addressing. The most effective route to participation for Aggregators in the Balancing Mechanism (BM) would be to allow them to submit BM offers and bids directly. This would, however, require the Aggregator (or Consumer) to compensate the Supplier for any unused energy. Giving Aggregators direct access to the BM could cause some issues regarding system (locational) security and the management of supplier imbalances. It would also require half hourly metering of the premises concerned and a view of what their energy consumption would have been had the bid/offer not been accepted.

31. One solution would be to set up an industry working group (reporting to the BSC Panel) to develop proposals for independent Aggregator access to the BM and address the potential barriers and issues as described in Table 5 (pages 44-45) of the *CfE*. However, this would only be addressing one specific issue when there are significant structural issues with an electricity market that has been developed for a

[4] *Future Potential for DSR in GB (October 2015).* Frontier Economics study for DECC
[5] *English Housing Survey Headline Report (2015).* DCLG

centralised, unidirectional system. A better solution might be a holistic review of the structure of the market and the roles and responsibilities of market participants in order to meet the needs of modern-day customers. A good starting point would be the outputs from the joint Energy Systems Catapult and IET FPSA project, This project has identified 35 key functions that the future electricity system needs to implement, recognising customers as an integral part of the system. Implementing a legal and market framework allied to the 35 key functions could be a better long term strategy than continually working on the barriers inherent in the current market framework. An important part of any review would be the issues of consumer protection and clarification of how the protection regime for energy consumers works with other consumer protection arrangements.

32. In addition to the BSC issues raised above, independent Aggregators also face market barriers over **access to the Capacity Market**. It would be easier for both energy storage and DSR to participate in the Capacity Market and compete against diesel engines if the *"New Build"* threshold for a 15-year contract were increased from £250,000 to £500,000/MW, and/or "Bid Bonds" were made proportional, as currently DSR is charged the same as New Build CCGTs which does not seem fair.

Providing price signals for flexibility: *System Value Pricing* (Questions 11 – 14)

33. We agree that "*to deliver the full benefits of flexibility [these] price signals will need to develop to reflect the value to our energy system of smart technologies and processes"* (p. 46 of the *CfE*). We also agree that the provision of appropriate signals in smart tariffs, charging and other industry arrangements such as half-hourly settlement have the potential to signal flexibility needs to consumers and generators. We agree strongly that smart meters and smart appliances will help enable consumers to realise the benefits of smart tariffs but this will require a customer-friendly pricing regime and well-defined equipment standards. The ESC has initiated discussions with equipment providers to explore standardisation and how any new regime can support UK innovators.

34. The ESC is responsible for delivering the Smart Systems and Heat Programme (SSH). SSH is determining the most effective means of decarbonising the UK's 27 million homes and contributing to the target of an 80% reduction in the UK's Greenhouse Gas emissions by 2050. A key element of the programme is the development of a Home Energy Systems Gateway (HESG) which will allow the smart operation of domestic heating and other applications. HESG is currently being trialed in up to 150 homes.

35. HESG will enable innovative new business models and allow the householder to automatically control energy usage and potentially help to balance the energy system. To realise the benefits form HESG, new energy supply licence arrangements and consumer protection will need to be developed to allow energy service providers to offer levels of comfort rather than merely supplying kWh of energy. Digitalisation may also have a key role, with ICT enabling integration and sophisticated customer interaction through the acquisition and use of data and information. There is a need

for the development of standard data protocols so that customers are not tied in to single service suppliers and the switching costs do not put up barriers to competition.

Providing price signals for flexibility: *Smart Tariffs* (Questions 15 – 18)

36. The ESC supports cost-reflective electricity pricing because we believe that this ensures that overall costs are minimised by incentivising the most economic use of resources, resulting in costs being allocated to customers equitably. In other words, despatch decisions should be made on a level playing field and there should be no cross-subsidies between classes of user.

37. We believe that the Government and Ofgem will have a role to play in stimulating innovation through facilitating a policy and regulatory framework that enables new ways of working. Given this, the industry will develop new business models and consumer offerings. The development of smart technologies such as HESG will enable innovative new business models.

38. The ESC supports the move to half-hourly settlement and believes that it will be a critical step in achieving the higher end of potential benefits from DSR through the aggregation of domestic demand response. There are also potential benefits from the introduction of Time of Use (ToU) Pricing but these will only be fully realised with the installation of home energy management systems such as HESG. ToU tariffs would allow consumers to reduce energy costs but would need to be introduced in such a way as to prevent the teething problems seen in other energy markets e.g. New South Wales. When ToU pricing was introduced in New South Wales in 2011[6], there were insufficient consumer safeguards. This led to customers continuing to use electricity at peak times and racking up very high bills which lead to the suspension of the pricing mechanism.

39. Cost reflective pricing could lead to very high charges for consuming energy at the time of the peak. While it would be unacceptable to expose end customers to these charges directly, suppliers could be. In this world, suppliers would offer to manage their customers' non-time critical demands to minimise the aggregate cost of supplying their portfolio in accordance with cost reflective pricing. Suppliers who successfully managed their portfolio, through trading and through utilising technology such as smart home energy management systems and combining this with home energy storage, would be able to offer more attractive deals to customers, giving them a competitive advantage. Such an approach could capture the benefits of cost reflective pricing without exposing small customers to severe penalties for consuming at the time of peak. The issue of recovery of the capital costs from customers of proving home energy management systems and/or storage would need to be addressed: the ownership of assets could remain with the energy supplier installing those assets in the event that the customer switched to another provider for its energy supply.

[6] Taylor M, Forster C: *Privatisation of Electricity Networks, New South Wales, Australia (July 2014)*

Providing price signals for flexibility: *Smart Distribution Tariffs - Incremental Change* (Questions 19 – 21)

40. For energy supply in general, reductions in energy use and the smoothing of demand peaks offer very effective means of improving energy security. In electricity, where energy security is more critical than for gas, coal, oil, etc., because it cannot be easily stored and because of its unique characteristics, demand side reduction/response will become more important. Large-scale demand reduction/response will continue to have a key role but aggregated domestic demand reduction/response will become increasingly important as smart metering and associated systems, such as HESG, are introduced.

41. In the longer-term, energy vectors will become increasingly interconnected, such as through gas boilers hybridised with electric heat pumps, petrol engines hybridised with batteries for vehicle motive power, multiple energy conversion assets in heat network energy centres, etc. At times of electrical system stress, it should be possible to switch gas/electricity hybrid heat pumps to operate on gas, thus creating electrical demand reduction. Without hybrid solutions, the demand for electricity will become both larger and more volatile.

42. We believe that **distribution charges are currently acting as a barrier** to the development of a more flexible system. Customers generating their own power do not pay their fair share of the costs of using the system. As the largely fixed DNO charges are recovered on a per unit basis, a customer generating its own power pays significantly less than a customer buying from the grid, but there is no immediate, corresponding benefit to the DNO. To address this, Distribution Use of System (DUoS) charges could be recovered more on a capacity basis than on a usage (kWh) basis, though a hybrid of both would avoid "free-riding" and still provide signals to use the network at appropriate times.

43. We believe that it is appropriate for generators that are reducing network capacity headroom due to the level of exported power flows, whether or not they are netting off local demand, to incur positive, rather than negative DUoS charges. However, distributed generators, as with energy storage, can improve network capacity and security or reduce network capacity headroom for other network users. Technology can enable distributed generation to connect more cheaply and more quickly in exchange for flexible connections that allow for curtailment of generation output if necessary. Generation can also provide ancillary services to defer the need for network reinforcement and is rewarded through lower connection costs or payments for ancillary services (availability and utilisation payments). However, an alternative approach could be for DUoS charges (or payments) to be structured to reflect the conferred benefits of flexibility or network support services.

Providing price signals for flexibility: *Smart Distribution Tariffs - Fundamental Change* (Questions 22 – 24)

44. Customers generating their own power do not currently pay their fair share of the costs of using the energy network. As the largely fixed DNO charges are recovered on per

unit basis, a customer generating its own power pays significantly less than a customer buying from the grid, but there is no immediate, corresponding benefit to the DNOs.

45. Network costs can be broken down into charges for building/maintaining the physical network assets and charges for balancing the system (ensuring a match between supply/demand etc). The charging for assets can then be sub-divided according to the extent that the assets are dedicated to a particular customer, or are shared by multiple customers. For example, Network Costs could be recovered along the following lines:

    - *Dedicated Assets:* For Low Voltage (LV) customers, these could be all assets operating at LV or 11kV. The customer would pay according to the kW of supply available on a monthly basis, regardless of usage.
    - *Shared Assets:* For LV customers, this could be all assets operating at 33kV or above. Customers would pay according to their usage at times of high demand in a similar way to "triad charging" for transmission.
    - *Balancing Costs:* these could be charged according to the kW of supply available on a monthly basis regardless of usage.

Providing price signals for flexibility: *Other Government Policies* (Questions 25 – 27)

46. We believe that that a whole-system, consumer-centric market which drives the trade of energy through evidence-based decisions will drive investment in future technology mix decisions. We believe this is more important than focusing on the challenges of single technology areas. This type of market-structure, where industry is presented with portfolio carbon thresholds, akin to the automotive sector, would drive the responsibility and risk to the most appropriate sector of the market where such actors have the relationships with end consumers to enable them to discover what the consumer is willing to pay.

A system for the consumer: *Smart Appliances* (Questions 28 – 32)

47. The ESC agrees with the 4 principles for smart appliances (interoperability, data privacy, grid security, energy consumption) set out on pages 60 – 61 of the *CfE*. The ESC does not yet have any evidence in favour of or against any of the options set out on pages 60 – 61. The operation of smart appliances, and their interaction with the HESG to provide demand side response, could be trialled as part of the SSH Phase 2 Demonstration, although this has not yet been decided.

48. We would support government action to promote smart appliances and address barriers to their deployment (including consumer protection concerns), at an early stage. It is debatable how much control the UK has over interoperability – the development of equipment standards may be driven by international standards organisations. We believe that it is important that the UK takes an active role in helping to develop these standards.

A system for the consumer: *Ultra Low Emission Vehicles* (Questions 33 – 35)

49. In order **to engage EV users**, it will be important to recognise and manage the tensions between what the customer wants (e.g. high vehicle range and rapid charging) with what suits the electricity system (low charging currents and avoiding the peak). Failing to balance these issues could lead to a need to limit deployment of EV on the one hand, or huge expenditure for relatively modest carbon savings on the other, if we build a fleet of gas fired generation to allow charging of EVs at the time of peak demand.

50. In the long-term, customers could opt out by agreeing to pay for the necessary network upgrading costs. However, customers cannot be allowed to opt out in the short term as this will increase the impact on other customers and/or prevent the network operator from being able to manage the load on their network. Rules would need to be agreed to ensure fairness. For example, if the EV charging load cannot be met in full, should all customers scaled back equally, or is a cap on the maximum level of charge introduced? Advance-warning of problems would allow users to plan and arrange to car-share, use public transport, fuel a Plug-In Hybrid etc.

51. In terms of **barriers for vehicle and electricity system participants**, a major barrier will be providing an affordable charging infrastructure for households without access to off-street parking. In addition, new monitoring and control facilities will be needed by the network operator. Managed EV charging could also be used to provide other benefits to the system. For example, EV chargers could be made frequency sensitive and provide frequency response, thus reducing the need for this to be purchased from generators. Alternatively, EVs could be used to boost demand at times of surplus low carbon generation on the system. In order to achieve these system benefits, the customer must be appropriately remunerated.

A system for the consumer: *Consumer Engagement with DSR* (Questions 36 – 39)

52. The ESC recognises the barriers identified on page 66 to **large non-domestic customers providing DSR**. We do not have any evidence on additional barriers.

53. The ESC, through its SSH Programme, is interested in domestic and small non-domestic consumer behaviour relating to smart systems. The SSH demonstration will work with local authorities, service providers and network operators to investigate how customers use energy and explore business models and value propositions that may be attractive to them. These may include business models that incorporate Time of Use pricing.

54. We believe that engaging/informing domestic and smaller non-domestic consumers about the transition to a smarter energy system needs to become a top priority in good time before business models that offer ToU pricing/DSR start to become widely available. The SSH demonstration will start to trial these business models in around 2018 and the results from this can be used to develop an engagement strategy. The

involvement of local authorities, as trusted third parties, could be important in winning customers' trust before business models are introduced from the early 2020's.

A system for the consumer: *Consumer Protection and Cyber Security* (Questions 40 – 42)

55. We agree that some consumers may be less able to fully realise the benefits from smart energy tariffs. These consumers can be protected through offering tailored tariffs for "vulnerable" consumers or by automatic switching (with consumers' agreement) of load away from peak periods. Energy Service Providers (ESPs) could work directly with customers to help them choose the most appropriate tariff to their needs, or work in conjunction with local authorities and/or groups such as Age Concern and National Energy Action who would act as intermediaries. This should help to reduce any concerns around unintended social impact and data privacy.

56. From a consumer's perspective, the following points are worth noting:

- There is a huge variation in the timing and magnitude of energy consumption.
- Some domestic and non-domestic consumers are more flexible than others and/or have better capability to benefit from this flexibility (it may be more difficult for vulnerable customers to engage with smart products and services and they may require additional support).
- Accessing this flexibility in ways that benefit the energy system will require a blend of approaches, including offers that appeal to consumers with different levels of flexibility and protection for those unable to adjust their demand.
- Cybersecurity[7] is a key risk factor for consumers: equipment standards should contain requirements and protocols to safeguard users.

57. A Code of Conduct could be developed by independent Aggregators and Third Party Intermediaries to protect customers – this would be backed by appropriate regulatory oversight such as the Misleading Marketing Regulations.

The roles of different parties in the system and network operation (Questions 43 – 46)

58. We are pleased that the *CfE* recognises the need for whole system thinking, both within the electricity system and in the way its operation impacts other energy vectors. Reference is made to the "*Future Power System Architecture*"[8] report that was commissioned by Government and delivered jointly by the IET and the Energy Systems Catapult. This report identifies 35 new or significantly modified power system functions that are required to meet 2030 power system objectives. Many of these functions relate directly to delivering a smart, flexible energy system and we would

[7] Bruce Schneier described how smart building devices can be compromised in the following article: https://www.schneier.com/crypto-gram/archives/2016/1115.html#4
[8] http://www.theiet.org/sectors/energy/resources/fpsa-project.cfm?origin=reportdocs

recommend that BEIS and Ofgem consider the report's findings as part of this *CfE* process.

59. In addition to the emerging system risks in Figure 1 (page 73) we would add two drivers for change:

    - ***Data Management*** - the sheer amount of data that can be generated and easily communicated by a multitude of users will drive change.
    - ***Security of supply*** – this includes security of supply in terms of a continual provision of electricity but also the quality of that supply in terms of frequency and voltage variations. As our dependence on electricity increases as it displaces other fuels for heating and transport, there needs to be clarity about the future supply characteristics required and how the responsibilities for delivering these are shared between customers, network owners/operators and device manufacturers.

60. The ESC does not have any data that illustrates current scale and cost of the system impacts described in table 7 (page 74 of the *CfE*), and how these might change in the future, or potential efficiency savings which could be achieved, now and in the future, through a more co-ordinated approach to managing these impacts.

61. We believe that more clarity is required on the future **roles of the Distribution Systems Operators (DSOs) and the interactions with the System Operator (SO) and the Transmission Owners/Operators (TOs).** We believe that the description of a DSO's role in Section 5.2 (p. 75 of the *CfE*) needs more detail and clarity. This could include more information on whether changes to the current electricity distribution licence might be required to create a DSO from an existing DNO? The roles of the DSO need to be clarified to decide whether, or in what circumstances, it might be appropriate for the DSO to own or operate storage.

62. We agree that there needs to be much better co-ordination and co-operation between the DNOs, SO and TOs, but consider that licence changes may be required to ensure that this happens. There also needs to be more consideration of the changes that will be required to the Grid and Distribution Codes and feel that there needs to be more co-ordination between this *CfE* and the recent Ofgem consultation on *Industry Code Governance: Initial consultation on implementing the Competition and Markets Authority's recommendations,* published on 9th November 2016.

63. In terms of **barriers to immediate action**, there does appear to be a barrier in respect of network development schemes that have costs and impacts across the TO/DNO boundary. For instance, the most efficient solution to a problem on the transmission network might be to invest in the distribution network. There does not appear to an established way of deciding how such a solution should be agreed and funded if it was not allowed for in the network company's business plan – this needs to be addressed as a matter of urgency.

64. The approach set out in the *CfE* is essentially evolutionary and industry-led. We are concerned that there are significant risks in taking this approach, in particular that the new functionalities identified in the "*Future Power System Architecture*" report will be

delivered in a timely way. We would support a more "hands on" approach by BEIS/Ofgem to ensure that market-based solutions are developed to meet the many challenges identified in the *CfE* and elsewhere. The pace of change in the energy markets require coherent plans in place to prepare for these challenges and to respond to them once they occur. We would expect BEIS/Ofgem, working with industry stakeholders, to ensure that such plans are in place. In the near-term, we consider that licence changes may be required to ensure that whole system approaches become business-as-usual.

65. We believe that the models for further changes to the market arrangements as presented in Figure, p. 80 of the *CfE*, need further work as they do not currently reflect the true complexity of the relationships between all the parties involved in the electricity supply chain. Potential future models have been considered by the IET[9], and in work on the development of the Smart Grid Architecture Model (SGAM)[10] – these could be used as a starting point to think about future roles and responsibilities for market participants. Future operating models should be capable of implementing and discharging the functionality identified in FPSA. As such it seems likely that models with a strong local management capability will be the most successful.

Innovation (Questions 47 – 48)

66. A key element of the SSH programme is the demonstration of new technology such as the Home Energy Systems Gateway (HESG) which will allow the smart operation of domestic heating and other applications, and the trialling of new business models and value propositions. The SSH demonstration will start around 2018 and the results from this can be used to develop an engagement strategy with customers on how they use and pay for energy, including how they might provide DSR. So, these demonstrations potentially offer an important means of testing the commercialisation of new DSR approaches.

67. We think that Section 6 of the consultation paper correctly identifies many of the areas that need to be developed. We also believe that much intellectual energy is expended on thinking about how to make ideas work in the current market structure. Setting out a clear, whole-system vision of the energy infrastructure we need is the most important role for Government. Support should be targeted at removing barriers to delivering this vision.

ESC: 11th January 2017

[9] IET: *Britain's power system (the case for a system architect)* http://www.theiet.org/factfiles/energy/brit-power-page.cfm

[10] SGAM's approach provides connections between the physical assets of the power system to the business and regulatory frameworks via communications, information and functional operations layers.https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf

Attachment

List of Detailed Questions for the Call for Evidence: *A Smart, Flexible Energy System*

No	Section	Question
1	Removing policy and regulatory barriers *Enabling Storage*	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? Please provide evidence to support your views.
2	Removing policy and regulatory barriers Enabling Storage	Have we identified and correctly assessed the issues regarding network connections for storage? Have we identified the correct areas where more progress is required? Please provide evidence to support your views.
3	Removing policy and regulatory barriers Enabling Storage	Have we identified and correctly assessed the issues regarding storage and network charging? Do you agree that flexible connection agreements could help to address issues regarding storage and network charging? Please provide evidence to support your views, in particular on the impact of network charging on the competitiveness of storage compared to other providers of flexibility.
4	Removing policy and regulatory barriers Enabling Storage	Do you agree with our assessment that network operators could use storage to support their networks? Are there sufficient existing safeguards to enable the development of a competitive market for storage? Are there any circumstances in which network companies should own storage? Please provide evidence to support your views.
5	Removing policy and regulatory barriers Enabling Storage	Do you agree with our assessment of the regulatory approaches available to provide greater clarity for storage? Please provide evidence to support your views, including any alternative regulatory approaches that you believe we should consider, and your views on how the capacity of a storage installation should be assessed for planning purposes.

6	Removing policy and regulatory barriers Enabling Storage	Do you agree with any of the proposed definitions of storage? If applicable, how would you amend any of these definitions? Please provide evidence to support your views.
7	Removing policy and regulatory barriers Aggregators	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?
8	Removing policy and regulatory barriers Aggregators	What are your views on these different approaches to dealing with the barriers set out above?
9	Removing policy and regulatory barriers Aggregators	What are your views on the pros and cons of the options outlined in Table 5? Please provide evidence for your answers.
10	Removing policy and regulatory barriers Aggregators	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?
11	Providing price signals for flexibility *System Value Pricing*	What types of enablers do you think could make accessing flexibility, and seeing a benefit from offering it, easier in future?
12	Providing price signals for flexibility *System Value Pricing*	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?
13	Providing price signals for flexibility *System Value Pricing*	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?

14	Providing price signals for flexibility *System Value Pricing*	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?
15	Providing price signals for flexibility *Smart Tariffs*	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.
16	Providing price signals for flexibility *Smart Tariffs*	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.
17	Providing price signals for flexibility *Smart Tariffs*	What relevant evidence is there from other countries that we should take into account when considering how to encourage the development of smart tariffs?
18	Providing price signals for flexibility *Smart Tariffs*	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?
19	Providing price signals for flexibility *Smart Distribution Tariffs - Incremental Change*	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.
20	Providing price signals for flexibility *Smart Distribution Tariffs - Incremental Change*	What are the incremental changes that could be made to distribution charges to overcome any barriers you have identified, and to better enable flexibility?
21	Providing price signals for flexibility *Smart Distribution Tariffs - Incremental Change*	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.
22	Providing price signals for flexibility *Smart Distribution Tariffs – Fundamental Change*	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?

23	Providing price signals for flexibility *Smart Distribution Tariffs – Fundamental Change*	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?
24	Providing price signals for flexibility *Smart Distribution Tariffs – Fundamental Change*	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.
25	Providing price signals for flexibility *Other Government Policies*	Can you provide evidence to show how existing Government policies can help or hinder the transition to a smart energy future?
26	Providing price signals for flexibility *Other Government Policies*	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?
27	Providing price signals for flexibility *Other Government Policies*	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?
28	A system for the consumer *Smart Appliances*	Do you agree with the 4 principles for smart appliances set out above (interoperability, data privacy, grid security, energy consumption)? □ Yes □ No (please explain)
29	A system for the consumer *Smart Appliances*	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)

30	A system for the consumer *Smart Appliances*	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)
31	A system for the consumer *Smart Appliances*	Are there any other barriers or risks to the uptake of smart appliances in addition to those already identified?
32	A system for the consumer *Smart Appliances*	Are there any other options that we should be considering with regards to mitigating potential risks, in particular with relation to vulnerable consumers?
33	A system for the consumer *Ultra-Low Emission Vehicles*	How might Government and industry best engage electric vehicle users to promote smart charging for system benefit?
34	A system for the consumer *Ultra-Low Emission Vehicles*	What barriers are there for vehicle and electricity system participants (e.g. vehicle manufacturers, aggregators, energy suppliers, network 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?
35	A system for the consumer *Ultra-Low Emission Vehicles*	What barriers (regulatory or otherwise) are there to the use of hydrogen water electrolysis as a renewable energy storage medium?
36	A system for the consumer *Consumer Engagement with DSR*	Can you provide any evidence demonstrating how large non-domestic consumers currently find out about and provide DSR services?
37	A system for the consumer *Consumer Engagement with DSR*	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?
38	A system for the consumer *Consumer Engagement with DSR*	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?

39	A system for the consumer *Consumer Engagement with DSR*	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)?
40	A system for the consumer *Consumer Protection and Cyber Security*	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
41	A system for the consumer *Consumer Protection and Cyber Security*	Can you provide evidence demonstrating how smart technologies (domestic or industrial/commercial) could compromise the energy system and how likely this is?
42	A system for the consumer *Consumer Protection and Cyber Security*	What risks would you highlight in the context of securing the energy system? Please provide evidence on the current likelihood and impact.
43	The roles of different parties in the system and network operation	Do you agree with the emerging system requirements we have identified (set out in Figure 1)? Are any missing?
44	The roles of different parties in the system and network operation	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?
45	The roles of different parties in the system and network operation	With regard to the need for immediate action: a) 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? b) 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? c) 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.

46	The roles of different parties in the system and network operation	With regard to further future changes to arrangements: a) 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? b) 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? ii. which other changes or arrangements might be needed to support the adoption of different models? iii. do you have any initial thoughts on the potential benefits, costs and risks of the models?
47	Innovation	Can you give specific examples of types of support that would be most effective in bringing forward innovation in these areas?
48	Innovation	Do you think these are the right areas for innovation funding support? Please state reasons or, if possible, provide evidence to support your answer.