EPRI | ELECTRIC POWER RESEARCH INSTITUTE

January 9th, 2017

Electricity Systems Team
Department for Business, Energy and Industrial Strategy
4th Floor
3 Whitehall Place
London, SW1A 2AQ

Subject: Response to 'A Smart, Flexible Energy System' Call for Evidence

Dear Sir / Madam:

We are delighted to respond to this important consultation on the development of smart systems for the UK.

The Electric Power Research Institute, Inc. (EPRI) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organisation, we bring together scientists and engineers as well as experts from academia and the industry to help address challenges in electricity. Our research provides both short- and long-term solutions that enable the transformation of power systems to be more flexible, resilient and connected. Our ultimate goal is to provide society with safe, reliable, affordable and environmentally responsible electricity.

Below we have answered all the questions where we believe we can provide a valuable opinion. Please note that EPRI does not advocate or promote any specific policies or solutions. We focus on the research needs and results. With this in mind, we trust our input based on our technical understanding provides useful information for BEIS and Ofgem in developing the next steps for the development of smart systems. EPRI has considerable knowledge and experience through our extensive research in this area, we will be pleased to follow up on any of the points we have made in this letter and provide further information.

Sincerely,

Mark McGranaghan
Vice President, Distribution and Utilization
mmcgranaghan@epri.com

Neil Hughes
Senior Technical Executive
nhughes@epri.com

Enabling Storage

Q1. *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.*

Q2. *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.*

Q3. *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.*

Q4. *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.*

Q5. *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.*

EPRI does not comment on preferred regulatory approaches other than assessing the technical impacts of different policies. However, a key gap that has been identified with respect to the application of energy storage is the lack of standard models for use in planning tools. These are required to assess storage as an element of the overall distribution network and the impact of storage (and the associated controls) on the distribution network performance, including consideration of storage providing flexibility services for the overall grid. It is also important to note the convergence of planning and operations with respect to requirements for advanced energy storage models and the tools that can incorporate these models.

Q6. *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.*

Energy storage has the potential to be a standard network asset, like transformers, regulators, capacitors and other advanced assets (reactive power controllers, smart breakers, etc.). Smart inverters for distributed resources may also be in this category. In order for this to become a reality, planning tools and models for these advanced technologies will need to advance so that energy storage can be considered as part of normal network planning activities that are designed to evaluate alternative approaches for achieving reliability and system management goals. Use of energy storage as a network asset is not necessarily dependent on the ownership model but approaches for defining value and implementing compensation approaches are definitely required.

EPRI does not comment on preferred regulatory approaches other than assessing the technical impacts of different policies. However, a key gap that has been identified with respect to the application of energy storage is the lack of standard models for use in planning tools. These are required to assess storage as an element of the overall distribution network and the impact of storage (and the associated controls) on the distribution network performance, including consideration of storage providing flexibility services for the overall grid. It is also important to note the convergence of planning and operations with respect to requirements for advanced energy storage models and the tools that can incorporate these models.

The barriers around the deployment of storage are well understood and have been widely documented in a number of reports by leading industry participants and commentators, including EPRI. Some of these barriers are technical (integration requirements, information models, models for planning and operations, control system performance, efficiency), some are based on market characteristics (mechanisms for compensating resources for flexibility services and reliability), some of them are regulatory and policy driven (ownership models, regulatory treatment) and some are purely economic (costs vs value for services that can be provided). The most important barrier in the area of regulatory policy is uncertainty – clarity of policy allows innovative approaches for implementation to be developed and implemented with confidence that regulatory requirements and compensation approaches will be consistent for some time. Given that storage offers great functionality and flexibility to all users of networks, we would recommend that the regulatory barriers (e.g. clarity on ownership and compensation for services) be resolved by Ofgem using an approach that involves cross cutting industry participation. We see no reason for it to have a hard definition of being a source of generation given the other roles it can play. If a definition or classification is required, it should cover all the roles storage can play.

It is likely that storage in a variety of forms (thermal storage, battery storage, electric vehicle storage, storage using innovative approaches like fuel conversion) will be a vital part of the energy system if it is to accommodate considerably more variable generation, reduced system inertia and a more engaged customer community. It is important that ongoing barriers to deployment be addressed as they arise in ways that consider the long term consequences and overall costs and benefits of different approaches.

Since energy storage can be a valuable asset for improving network performance and reliability, it is important the network owners and operators be able to make this technology part of their design and plans for future networks. The simplest way to do this may be to allow network owners and operators to own and operate storage, much like any other network asset. However, other approaches for third parties to provide the energy storage services to network operators are also possible and may provide opportunities for innovation. Given the increasingly complex nature of networks, networks operators are often best placed to be able to identify, assess and deploy storage for the benefit of all network users. In many applications, networks operators are ideally placed to own storage as it fits well with their business model (long term, low risk, regulated asset ownership) whereas new entrants may find it difficult to justify an investment given the energy policy uncertainty and long term nature of returns. These could be resolved by limiting to a competitive market, but possibly to the detriment of deployment if that market does not develop. In that event, networks operators and generators would resort to traditional regulated solutions to meet reliability which may not be the lowest cost or be best placed to meet low carbon targets.

In the event of monopolistic network owners owning storage they should be able to satisfy the regulator that their approach is in the best interests of consumers, providing the most economically advantageous solution to meeting a particular need and in no way distorting a competitive market. Network company costs are open to scrutiny through established channels, therefore we believe that should network ownership of storage have a detrimental effect to other industry participants this would become apparent and remedial action could then be taken. More broadly, many consumers now have a dual role as generator and consumer; in many ways behaving (or having the ability to behave) like a storage device. In the future energy system, it is quite likely that all connections to a network will have storage like characteristics. Therefore the question may not be how to define a ‘storage’ asset or connection, but more to recognize the changing nature of the energy system and the behaviour of its participants.

Any future regulatory model or market design will also need to accommodate the different types of storage. Conventionally we think of storage as electrical to electrical connected to distribution networks, however we would suggest broader technologies are also covered – heat, hydrogen, V2G, microgrids to name a few.

We would like to point out the contrasting approach being taken in California towards the deployment of storage which partly consists of a mandate for the large Investor Owned Utilities (IOUs) to deploy storage within their asset base and for 3rd parties to own and operate storage providing services to those IOUs. Though the market structure in California is different to that in the UK, we believe it shares similar challenges and goals and therefore forms a useful comparator. New York is also considering approaches for storage deployment and is addressing many of the same issues identified here – ownership, service models, cost/benefit assessments, third party role, etc.

Aggregators

Q7. *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?

Q8. *What are your views on these different approaches to dealing with the barriers set out above?*

Q9. *What are your views on the pros and cons of the options outlined in Table 5? Please provide evidence for your answers.*

Q10. *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?*

As the future energy system develops which contains considerably more distributed non-flexible generation sources and more flexible controllable demand we believe aggregators will have an important role to play in accessing these resources and bundling into valuable services for all participants of the energy system.

Many detailed studies have been carried out showing the benefits of managing supply and demand at critical periods to negate the need for expensive generation and network capacity to meet peak periods. We suggest these are reviewed and form the basis of any business case for the adoption of new market changes to enable greater aggregator participation in the sector. It is likely that accessing equipment under control of aggregators will become a critical tool to enable management of system incidents and peak periods.

Aggregator systems will need to be robust and secure if system resiliency is to be maintained. Their systems will become a critical part of the infrastructure and as such should be subject to the same industry standards (particularly for security). Whilst this presents some challenges, we believe that they can be overcome in line with many other critical systems.

We believe aggregator systems should be viewed as an integral part of the functioning whole electricity system. We would also encourage the modelling of the behavior of these systems to fully understand the effect they have in response to commercial and system signals. As more systems become part of the whole system it is imperative that they are modelled and understood to ensure that there are no unintended consequences or vulnerabilities and that they behave in the manner expected.

System Value Pricing

Q11. *What types of enablers do you think could make accessing flexibility, and seeing a benefit from offering it, easier in future?*

Q12. *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?*

Q13. *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?*

Q14. *Can you provide evidence to support any changes to market and regulatory arrangements that you consider necessary to allow the efficient use of flexibility? What might be the Government's, Ofgem's, and System Operator's roles in making these changes?*

Enabling flexibility requires flexible sources to be clearly defined, understood, characterised and a have a clear route to market. The market for flexible resources should be open, transparent and easily accessible for new entrants who may be able to bring novel and innovative solutions to market. In order to ensure that this is achieved we would suggest the government, Ofgem and the system operator directly address any issues with market access identified by service providers.

Some enablers we would suggest:

- Assistance with compliance with regulatory requirements.
- Development of standard interfaces and interoperability for systems and devices.
- Clear characterisation of flexibility resources and services (ramp rates, duration, availability, latency, location).
- Co-ordination across markets where flexibility can be provided.
- Encouragement and incentives to 3rd party owners of devices and assets that cam provide flexibility to make them available.

Encouraging the provision of flexibility could be enhanced by the System Operator and network companies sharing greater information on the their current and future needs for flexibility. In particular highlighting: Where it is needed, when, the ideal characteristics required and likely price points to be competitive against current or default solutions. National Grid's System Operator Framework (SOF) opens this conversation, though naturally focuses on the high voltage system, we would suggest this thought process and development work is carried out by the distribution and end user communities in parallel to ensure whole system impacts are identified and can therefore be addressed. This approach of encouraging "non-wires alternatives (NWA)" for distribution network planning and expansion is being addressed in California, New York and elsewhere. Coordination with these efforts could have substantial value in developing approaches that have common characteristics across the industry.

Smart Tariffs

Q15. *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.*

Q16. *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.*

Q17. *What relevant evidence is there from other countries that we should take into account when considering how to encourage the development of smart tariffs?*

Q18. *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?*

Smart tariffs have the potential to incent consumers to take greater control of their energy usage. Many studies and trials (in the UK and US) have demonstrated some of the benefits that can be obtained. Consumers will need both persuasion and incentives to take up smart tariffs. The supplier community in the UK is one vehicle to achieve this, however as they are commercial entities this may be seen as a blocker by consumer groups. The government/Ofgem is in a unique and impartial position to establish the business case, lead the public engagement and define the market parameters for the launch of smart tariffs in partnership with the supplier community.

As we have seen from the smart meter program, the benefits to the consumer will need to be laid out clearly before there is any 'push' to encourage smart tariff adoption. It will be helpful if the government laid this out along with the enabling technologies to help consumers understand how smart tariffs may (or may not) benefit them. We believe smart meters, dynamic pricing, clear tariffs, smart home technologies, home energy management systems (local or cloud-based) and availability of smart appliances are pre-requisites for consumers to make the most of smart tariffs.

Smart tariffs are likely to be particularly well suited to those domestic consumers who have installed PV and home energy storage. Smart tariffs will allow them to maximise the value of those investments. The government should look to ensure that the messaging around PV and storage is updated to reflect the smart tariff advantage. It is possible, if designed correctly, that smart tariffs will have the effect of promoting PV, storage, and electric vehicle adoption. Greater deployment of PV will lead to greater requirements for flexibility and therefore reinforce the need for smart tariffs. As discussed previously, we would suggest the government, perhaps through the Energy Systems Catapult, models the effects of smart tariffs on the potential for PV, storage, and EV adoption to ensure the system wide effects are understood.

Smart tariffs should be combined with the enablement of aggregators, demand response programs and innovative new business models. These are key enablers to ensure that the system wide benefits of smart tariffs are realised. The DNO community are likely to realise significant network benefits if these come together in concert to deliver flexibility to network operators. The government should ensure appropriate safeguards are put in place to protect the most vulnerable and less well-off consumers who may be disadvantaged by smart tariffs.

Smart Distribution Tariffs

Q19*. 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.*

Q20*. What are the incremental changes that could be made to distribution charges to overcome any barriers you have identified, and to better enable flexibility?*

Q21*. How problematic and urgent are any disparities between the treatment of different types of distribution connected users? An example could be that in the Common Distribution Charging Methodology generators are paid 'charges' which would suggest they add no network cost and only net demand.*

Q22*. 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?*

Q23*. 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?*

Q24*. 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.*

These are complex questions and we would suggest a thorough review of distribution charging is undertaken to reflect the changing nature of power networks. If we see a much more decentralised power system then charges could reflect capacity provision more than energy provision.

A domestic customer with PV and storage may act as both a solution to network constraints and a contributor to network challenges at different times of the day/season. Implementing a charging methodology that reflects that would be challenging and complex. If it could be developed it is likely that a customer would find it confusing and they probably don't have the ability (or real time network knowledge) to be able to change their behaviour. One option could be dynamic smart tariffs building on the prior questions, where the near real-time cost of network capacity, in addition to energy costs are reflected in tariffs. If done on a location basis, this will create significant disparity across the country, if done on a time of day basis it may not have the desired effect. We would suggest detailed modelling and simulation to establish options around changes to distribution charging methodologies in order to achieve the desired effect.

At the domestic level, we believe it would be difficult to implement a charging system specific to each consumer (or address). Given that consumers do not have the ability to change distribution company nor direct distribution companies to make appropriate investments in the local network, it will be difficult for them to influence the cost for distribution access that they bear. This would create a postcode lottery approach for electricity network costs being passed onto consumers. We are seeing growth in peer to peer trading, community energy systems and microgrids, in these models the nature of the distribution network is changing from that of a one-way power network to more of a backbone connecting more sophisticated users. There are probably a number of ways in which the costs of provision of a network in these models can be charged for and one methodology may not suit all scenarios. In some instances, the distribution network may be thought of as energy storage or a standby generator for system emergencies. Both of these raise complex questions about how that type of service provision is charged for.

We would suggest these different models of how the distribution network operates are laid out, modelled and understood in order to develop new charging methodologies that can fairly accommodate the changing requirements of network users.

Other Government Policies

Q25*. Can you provide evidence to show how existing Government policies can help or hinder the transition to a smart energy future?*

Q26. *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?*

Q27*. 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?*

Commitment to and follow through on a clear energy policy is vital to attract investors and encourage innovation in order to meet the challenges of decarbonizing our energy system.

The Future Power Systems Architecture (FPSA) work looking at whole system architecture has been important in helping to understand the new complexities and interdependencies. We believe this work should be continued to the next phase with strong industry and academic input. Similarly, we would point to the EPRI developed 'Integrated Grid' concept which is exploring similar concepts and helping the industry develop system wide integrated solutions. Details can be found at:

http://integratedgrid.com/

As indicated in our response to a number of questions, the system is becoming much more complex and we believe it is important that this is fully modelled and understood to prevent any unintended vulnerabilities and instabilities being introduced. At present there is no 'owner' of the health of the overall power system, it is guided by various regulations, codes, markets, commercial mechanisms and customer behaviors. To date these have all aligned well for the historically stable and predictable power system. New technologies, engaged customers and new business models all place new challenges on the these supporting systems and government should ensure that they are aligned and support the functioning of the physical power system.

Smart Appliances

Q28. *Do you agree with the 4 principles for smart appliances set out above (interoperability, data privacy, grid security, energy consumption)?*

Yes.

Q29. *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)*

Q30. *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)*

Q31. *Are there any other barriers or risks to the uptake of smart appliances in addition to those already identified?*

Q32. *Are there any other options that we should be considering with regards to mitigating potential risks, in particular with relation to vulnerable consumers?*

Perhaps it is more important to address issues of interoperability of smart appliances than actually requiring that every appliance be smart. One approach is to help educate consumers on the benefits of smart appliances to help take advantage of opportunities for services and smart tariffs that would require the technology. In order to take advantage of widespread smart appliances, it will be more important that they can be integrated with the operation of the network in a standard manner. This may mean options for communications and standard functions for the smart appliances. An example of this approach has been implemented to support the integration of smart inverters (IEC 61850-90-7).

Where appliances are branded as 'smart' they should meet defined standards and be labelled as such. In the interests on ensuring choice for customers, we would recommend the UK engages with international bodies developing codes and standards to ensure UK views are incorporated as the principles of full interoperability are adhered to.

We would suggest the addition on Electric Vehicles to this list in addition to battery storage systems as they have different characteristics and potentially offer different types of control and flexibility. Similarly, heat pumps and storage heaters represent the potential for large load flexibility services.

Some consideration can be given to linking heat (gas) networks to that of the power sector to form an integrated energy network. While the UK retains a significant gas based heat network, then should mCHP be deployed, the two networks could be operated in a smarter fashion to optimise loadings, maximise network usage and avoid constraints.
With regard to vulnerable consumers we suggest these possible approaches:

- A comprehensive targeted education system on how smart appliances and time of Use tariffs work.
- Support, perhaps through the Energy Savings Trust, to help consumers set up their contracts.
- A default low cost tariff for those unwilling (or unable) to partake in smart systems.
- Greater safeguards with the provision of broadband to the home which may be critical for some smart appliances to operate. Historically broadband is less reliable than energy, in a smarter world this may become a critical part of the energy system and therefore subject to energy style levels of service, regulation and financial compensation schemes for non-availability. Research on approaches or secure use of customer broadband for smart energy device integration is a very important research area.

Ultra Low Emission Vehicles

***Q33**. How might Government and industry best engage electric vehicle users to promote smart charging for system benefits?*

***Q34**. 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?*

***Q35**. What barriers (regulatory or otherwise) are there to the use of hydrogen water electrolysis as a renewable energy storage medium?*

It will be important that agreed standards for communications and smart control of electric vehicle (and Plug-in Hybrid EVs) are agreed between the electricity industry and the vehicle manufacturers. This is likely to occur at a European or global level and the UK should ensure that it partakes in these discussions. Interoperability will be paramount to ensure that a vehicle can use any charge points and communicate with the relevant systems to ensure the benefits of a smart flexible system are realised. This will also provide a potential revenue stream for vehicle owners and improve the overall economic value proposition.

In order for vehicle owners to make their ‘storage’ available it will need to integrate with a network control system which are not yet developed nor deployed. We will need to see some form of market or service be developed in order that the vehicle owner can realise the monetary value of its storage asset. Business models are varied and we may see more than one develop. In any scenario it will be imperative that that the whole system effects are modelled and understood so that for example any action undertaken by aggregator in response to a national price signal doesn’t create any unintended local network issues. EVs offer the potential to provide energy to homes and communities in the event of a system outage, however there are number of technical issues to be addressed to allow for their safe operation this way.

Similarly, for EV owners to self-manage their vehicle storage for the home (or local community) will require a sophisticated home energy management system, the nature of which is not readily available. This challenge is equally present for the adoption of home energy systems utilizing storage paired with PV.

The impact of widespread adoption of EVs on the energy system could be significant. Both as a valuable resource and as a potential source of system issues. PHEVs typically have a battery size 10kWh to 20kWh with domestic fast chargers rated at 7kW. One million EVs would potentially represent a 7GW load. Assuming half connected at any one time, then 3.5GW offers considerable flexibility.

Consumer Engagement with Demand Side Response

Q36. *Can you provide any evidence demonstrating how large non-domestic consumers currently find out about and provide DSR services?*

Q37. *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?*

Q38. *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?*

Q39. *When does engaging/informing domestic and smaller non-domestic consumers about the transition to a smarter energy system become a top priority and why (i.e. in terms of trigger points)?*

We are approaching the point where broad engagement with the smaller and domestic consumers around smart energy systems is required. The key 'enablers' for this are smart meters, PV (and other home generation technologies such as microCHP), electric vehicles and smart appliances (including heat pumps). Equally important is a robust communications infrastructure to enable the integration of these smart devices. There may be opportunities to build on goals to provide universal broadband as an infrastructure to support smart consumer integration rather than building parallel communication networks that will also require ongoing investment and maintenance. Research on secure use of public broadband for smart technology integration with the power system is underway and very promising.

To date there has been little communication around the integrated benefits of these technologies when operated in concert to provide system wide benefits. Arguably the majority of these benefits will flow to network participants rather than final use customers, however those benefits should ultimately find their way to consumers through reduced (or lower than they would have been) bills. It is important that the overall integrated benefits are fully understood by all consumers.

All domestic properties will have smart gas and electric meters by 2020 (along with associated communications networks) providing the core infrastructure for the deployment of smart systems. The first smart meters have been deployed and we will soon have (if not already), consumers with smart meters, PV, home storage and electric vehicles beginning to consider how to optimise these for their own energy needs. There is currently little by the way of information or standardised products available to help with this.

Consumer Protection and Cyber Security

***Q40**. 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*

Consumers already have to consider these impacts with the purchase of other goods and services, whether it be insurance products or holidays. In some respects, partaking in more sophisticated energy related products and services should be no different. Similarly, all of the consumer protection mechanisms that apply elsewhere should apply here too, for example the Data Protection Act of 1998.

One area we think that government should focus on is vulnerable customers, who in the near to medium term are unlikely to be able to afford smart technologies (white goods, EVs, PV etc) and therefore may not get benefits from time of use or smart tariffs. It is important that this is acknowledged and they are protected from miss-selling.

Q41. *Can you provide evidence demonstrating how smart technologies (domestic or industrial/commercial) could compromise the energy system and how likely this is?*

We believe that attempts will be made to hack into smart energy systems and that the potential exists for widespread disruption if successful. There are have been many research articles studying the potential for this. The one which we would draw attention to is by the University of Michigan and Microsoft in 2016. Details can be found at:

https://iotsecurity.eecs.umich.edu/

Q42. *What risks would you highlight in the context of securing the energy system? Please provide evidence on the current likelihood and impact.*

Existing risks are well understood and mitigated for. New smart systems introduce new risks that need to be understood and managed.

The proliferation of connected devices at consumer level represents a weakness in the system given that they have no central overall control (and may not adhere to most industry standards). For example, should all of the EVs connected to the system stop charging at a particular point in time (perhaps through a targeted cyber-attack or a charger firmware upgrade) this would create voltage and frequency instability which if not arrested could lead to network equipment trips resulting in local or widespread loss of electricity. Similarly, should a large fluctuation in the electricity wholesale price (perhaps in response to a global incident) flow into smart tariffs which then trigger the operation of smart appliances this could have the same effect as above in creating voltage and frequency instability. It will be important that the commercial and economic systems are modelled in parallel with the physical system to ensure these possible situations are avoided.

Roles and Responsibilities

Q43. *Do you agree with the emerging system requirements we have identified (set out in Figure 1)? Are any missing?*

The diagram could more explicitly include data, analytics and connectivity. Low cost sensors, low cost computing power and availability of networks is providing vast quantities of data for energy system users to analyse and act upon. The availability of this data is a driver itself as it enables innovators and third parties to use it in ways not previously envisaged. This creates both opportunity and potential for disruption and concern.

Q44. *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?

We do not have any particular data for the UK system covering these items, however from studies we have carried out elsewhere we believe these to be real and significant and would suggest that the UK undertakes detailed system wide modelling to assess the economic impact. Whist we do believe there are efficiency savings through the more optimal use of system resources we would also highlight the potential impact on resilience if these issues are not correctly addressed from a system wide perspective.

A number of studies on the benefits of integrated distributed energy resources have taken place which we would suggest are used as inputs to develop policy in this area. There are also examples of projects that are in the implementation phase that capitalise on smart system wide benefits (maximising the use of DERs). We would point towards Con Edison's Brooklyn Queens Demand Management program in New York state and Southern California Edison Preferred Resources Pilot in California.

Q45. *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.

We do agree with the need for much more co-ordination between DNOs, the SO and TOs. As systems become more interdependent and integrated this will become a critical activity. We believe there are many benefits from integrated system planning and operations across all voltages (and utilising consumer connected 'behind the meter' equipment). This is an active research area that EPRI are involved with and we would be pleased to share our latest analysis and current industry thinking with you.

Q46. 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

No response

Innovation

***Q47**. Can you give specific examples of types of support that would be most effective in bringing forward innovation in these areas?*

***Q48.** Do you think these are the right areas for innovation funding support? Please state reasons or, if possible, provide evidence to support your answer.*

We support the aims of this section of the document in highlighting the need to support continued innovation in targeted areas. The NIC, NIA and LCNF have delivered a number of valuable learnings through leading edge projects trialing and demonstrating innovative new smart solutions. These funding schemes have naturally focused on network benefits and implications of smart systems.

We believe it would be beneficial if these are expanded to cover integrated networks, that is to further include demand side technologies, commercial arrangements and system operations impacts. Currently there is limited innovation funding for home energy management systems and technologies. The Energy Catalyst and Energy Entrepreneurs Fund are providing stimulus to innovators developing products in this area, however more system wide, integrated innovation would be beneficial, particularly involving the supplier community. As an example, we are not aware of much innovation funding support towards Vehicle to Grid (V2G) solutions which, as this consultation points out, clearly offer considerable system wide benefits.

We would also suggest a review of the incubator and accelerator model that operates successfully in the US to help businesses reach commercialization. We believe this area is under represented in the UK. An example of an energy Incubator Network which EPRI leads can be found at:

https://incubatenergy.org/