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

11th January 2017

Dear Sir / Madam

A Smart, Flexible Energy System – A call for evidence

EA Technology welcomes the opportunity to respond to the Smart, Flexible Energy System call for evidence and applauds the Department for Business, Energy and Industry Strategy and Ofgem for taking a proactive stance in this field at such an exciting and challenging time for our industry.

This consultation response is representative of our company's views – several key influencers in the company have contributed to the content.

We are recognised as a world leader in the field of network innovation and smart solutions through the delivery of leading-edge projects and propositions including:

- **Electric Nation (2016-2019):** The world's largest EV trial, investigating complex charging demand control technologies across a wide range of EV types, also assessing customer acceptance across 500-700 trial participants. The project was conceived, designed and is being led by EA Technology and sponsored by Western Power Distribution.

- **SmartEV Consultation (2016-2017):** This project is consulting with the transport and energy industry to define an Engineering Recommendation or equivalent, a functional specification, and a customer messaging strategy to facilitate customer understanding and buy-in to PIV-network demand response tools.

- **My Electric Avenue (2012-2015):** Multi-partnership project, led by EA Technology, pioneering deployment of demand control technology to understand the issues and mitigate the impact of EV clusters on the local electricity networks (> 200 customers engaged).

- **Thames Valley Vision (2012-2017):** EA Technology were contracted by Scottish and Southern Electricity Networks to developing the bid for this £30 million project and have developed the policy and training outputs from this £25m project.

- **Customer-Led Network Revolution (2010-2014):** The UK's largest smart grid project, we were involved in developing the bid for this trial and subsequently developed specifications for storage, network technologies and control systems as well as

implementing outputs including policies, training, and design tools for Northern Powergrid.

- **Gigha Flow battery (2013-2017):** EA Technology is providing technical and project management expertise for an innovative flow battery project deploying first-in-class technology, developed by a UK SME and ideally suited to supporting renewable generation.

- **Transform Model® (2012-date):** Our Transform Model, based on real data, is a representation of the electricity distribution network and describes the impact that future scenarios may have on the planning and operation of networks. It provides a tool to asses and optimise investment over a range of conventional and 'smart' strategies.

- **Australia's Network Transformation Roadmap (2016):** Electricity networks of the future will involve more actors and complex relationships. This work undertaken at the request of Energy Networks Australia describes the transition and necessary innovations to facilitate the Australian electricity network of the future.

This response concentrates on providing answers to those consultation questions that fall within our fields of expertise. We have therefore not attempted to provide an answer to every question posed by the consultation.

We hope that you find our responses useful and are happy to provide further information to support this document. If you would like clarification of any of the points contained in this response we are happy to be of assistance, for example, by arranging a conference call, or by arranging a face to face meeting in London.

Yours faithfully,

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

Please provide evidence to support your views.

There is a significant body of evidence to support the policy and regulatory barriers identified e.g. [1,2]. There are two areas that could be improved:

- Addition of "Reflection of the system level benefit provided"

  Energy storage can benefit the energy system up-stream of the point of connection (i.e. distribution network connected storage benefits distribution network, transmission network, system operator and energy markets) as identified by the work published alongside this call for evidence. Proven mechanisms exist for storage to be paid services to various actors (i.e. providing system capacity[3], DNO peak shaving[4], TNO peak shaving[5], and system level response[6]). However, mechanisms do not exist for the other benefits outlined in the support materials for this consultation such as enabling more connection of low carbon generation. We welcome the acknowledgment of this point under the connections section, but feel it is a substantial barrier to energy storage uptake.

  More problematically, little success has been achieved in allowing these mechanisms to be delivered by the same energy storage system. Initiatives such as the ENA's Shared Services Working Group[7] hold great promise (at least for DNO/TSO services) but have yet to deliver despite long-term efforts, although bilateral efforts such as UKPN and National Grid's TDI2.0[8] project continue.

  For storage to contract effectively with multiple parties, an economical solution could be to accept that a service may be unavailable due to prior activation of an alternative service (and recompense accordingly). This would be a radical shift from the existing models of exclusive access and high penalties for delivery failure (as used in STOR, FFR, EFR and DNO DSR contracts). However, statistical approaches for capacity and critical network infrastructure are used in ENA ER P2/6 (specifically ETR130/ACE49 as updated by EA Technology for DSR) and ENA ER P27 (for overhead line ratings).

  We do not view it as reasonable to expect that energy storage can deliver the expected benefits cited without a systematic policy framework addressing how the various system benefits monetise for the storage operator.

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[1] ESOF Good Practice Guide on Energy Storage (2014) https://www.eatechnology.com/products-and-services/create-smarter-grids/electrical-energy-storage/energy-storage-operators-forum/esof-good-practice-guide
[2] "An analysis of electricity system flexibility for Great Britain" (2016) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf
[3] Capacity Market 2016
[4] SSEN's Constraint Managed Zone Scheme
[5] TRIAD payments included in Low Carbon's successful EFR tender response
[6] 200MW procured for National Grid's EFR
[7] http://www.energynetworks.org/assets/files/news/consultation-responses/Consultation%20responses%202016/Demand%20Side%20Response%20Concept%20Paper_revised.pdf
[8] https://www.ofgem.gov.uk/network-regulation-riio-model/network-innovation/electricity-network-innovation-competition

- Amendment of regulatory clarity to include “long-term policy”

  We agree that regulatory clarity is critical to allow investment in energy storage whilst it represents relatively high-risk. However, this is separate from the need for a long-term energy policy which enables flexible solutions such as storage to compete. We feel that there is currently no such policy, and this should be recognised through inclusion in the list of challenges.

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

Please provide evidence to support your views.

We agree with the issues presented and view the key common thread as a lack of understanding about how storage will operate. This leads to the challenges highlighted around necessary reinforcement for connection, feasible assumptions under P2/6, and materiality of addition of storage to existing connections.

Significant work has been undertaken by DNOs and distributed generation developers in improving the connections process, reflected in the various ICE submissions during 2016[9,10]; we do not expect the energy storage industry to need to repeat these efforts, rather to focus on specific areas of interest.

We feel that the issue of available capacity for firm connections is shared with all other demand and generation customers and energy storage does not warrant special attention beyond that due to the other customer groups. Furthermore, we do not view firm capacity as a high priority challenge for energy storage, if DNOs can offer timely, economic, and well-defined flexible connections. The availability of flexible connections, considering both generation and demand capacity has not been addressed by innovation projects or the evidence cited. We would advocate this area as key for further policy and innovation work.

4. 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.

We agree, with certain limitations, that network operators can use storage to support their networks. The procurement of flexibility services by SSEN[11], and upcoming (and therefore unpublished) measures by other DNOs suggest that the measures within RIIO have had the desired impact in DNO behaviour. However:

- the licensing arrangements for storage provide a material obstacle to ownership of energy storage by DNOs. If there is a plausible use case (such as a purchaser of last

[9] http://www.enwl.co.uk/docs/default-source/ice/ice-dg-(work-plan).pdf?sfvrsn=0
[10] https://www.westernpower.co.uk/docs/About-us/Stakeholder-information/Connection-Customer-Engagement/ICE-2016/WPD-ICE-2016-submission-looking-forward-and-back-r.aspx
[11] http://www.all-energy.co.uk/RXUK/RXUK_All-Energy/2016/Presentations%202016/Grid%201%20and%202/Grid%202.pdf?v=635993506171935287

resort) then we do not view the generation licensing scheme as an effective regulatory instrument
- no results have been published by SSEN on the Constraint Managed Zone (CMZ) scheme and our confidential work with clients suggests that there are substantial challenges to using these approaches to procure access to third-party installation of storage.

We do not believe there is sufficient evidence to support the stated position that network operators could use storage. No storage has been connected under these schemes, and recent work suggests that a DNO owned model has a better business case then the third-party approach[12].

There are locations which make access to non-DNO services difficult (such as in heavily constrained networks[13]). In this scenario, third-party storage could only be procured if the DNO paid the full system cost plus financing costs and profit for the third party. In this situation we view DNO owned storage as the most efficient approach.

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

- **Balancing services;**
- **Extracting value from the balancing mechanism and wholesale market;**
- **Other market barriers; and**
- **Consumer protection.**

It is EA Technology's view that there will be significantly more actors in the market going forward and the regulatory world needs to change reflect this. Our views on the perceived barriers for other market participants are included in our responses to other consultation questions in this response.

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

We think that there is a need for Government/Ofgem to play a role in supporting smart tariffs and new business models, for example (although not confined to) though supporting a public information programme to raise general awareness of the challenges faced by different actors within the electricity industry and promoting understanding of the need for cost reflective charging. This role should not be confined to encouraging smart tariffs but may be especially helpful in areas such as:

- cross-sector impacts of a tariff or business model may require mediation between different parties in the energy system to limit the potential of tariff structures harming other actors

[12] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/The+business+case+of+Storage.pdf
[13] http://www.all-energy.co.uk/RXUK/RXUK_All-Energy/2016/Presentations%202016%20Day%202/Energy%20Storage/James%20Cross%20FOR%20WEB.pdf?v=635996077082040344

- disagreement occurs between industry participants about the technical means that a solution should be implemented
- the recognition that smart tariffs may be needed for both national *and highly local* constraints in order to accommodate new technologies, such as EVs or heat pumps. These are likely to be different in nature, and need to be articulated and promoted differently – arbitration between the two is also likely to be critical, e.g. to agree which has priority.

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

We consider that underlying network cost drivers are likely to change significantly. For example, when considering the increased uptake of domestic small-scale generation and storage in the home (either through dedicated storage units or potentially via the increased use of electric vehicles as a home energy storage system), the volume of energy flowing through the distribution network and the way in which costs for operating that network are recovered will change significantly.

As costs are recovered via volumetric metering, once such metred units drop off through the uptake of technologies outlined above, then the ability of network operators to maintain the system to the same level will be compromised. Customers will still require a 'network', even if its role in the future is not just to supply energy but to act as a trading platform for the selling of energy that has been locally generated.

In order to ensure that the network is sufficiently robust to cater for these requirements, network operators would need to recover costs commensurate with the expense of maintaining the network. This would likely mean a move to a hybrid of capacity charging and volumetric charging (which may be two-way) as pointed out in the consultation document as an option.

Furthermore, the socialisation of costs across all network users means that 'cost-reflective' pricing does not exist at present. The cost of connecting some customers in more remote areas is significantly higher than those in urban areas as there are greater lengths of circuit required to supply fewer customers. In the future, it may become more economic for a network operator to provide services to such customers via generation and storage rather than maintaining long, expensive asset bases. However, at present there is no incentive on network operators or customers to seek this sort of approach. More cost-reflective pricing would introduce this incentive. However, it must be noted that there also needs to be significant changes to the regulatory framework to enable this as it would result in network operators having reduced traditional asset bases, and therefore they would need to be able to derive value from alternative assets such as generation and storage.

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

It would seem prudent that appropriate use be made of short term and long term price signals, with short term being of more use for managing local issues and potentially facilitating energy trading where the network acts as a market operating platform. We do not have strong views

on the feasibility of this and whether it would be cost effective as against just using DUoS for longer term signalling.

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

As outlined above in the response to Q22, we feel that the transition to DSO will mean distribution networks becoming a facilitator to network trading and will open up the opportunities for networks to provide services in different ways to those historically used. By using cost-reflective pricing, network operators and customers will together be able to establish the best network connection options. In a world where some customers are looking to be more independent, it may be cost-prohibitive to maintain significant asset bases to essentially provide a network of last resort to a customer, whereas having some generation or storage that could be called upon infrequently may be more appropriate.

Adopting this more cost-reflective approach will minimise some of the challenges that are being seen in Australia and New Zealand where customers are increasingly becoming self-sufficient (and hence have very low volumetric metering). These customers are still requiring network companies to provide them with the same level of service, essentially at a cost that is shared equally among other customers who do use the network exclusively (i.e. they have not installed their own generation and storage). This sort of situation is likely to be untenable in the long term and the transition to a capacity (combined with volumetric charge) as well as more cost reflective DUoS that could be facilitated by a DSO transition is likely to be preferable.

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

- **Yes**
- **No (please explain)**

Yes.

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

Smart appliances have only recently begun to be introduced to the market place. Where they have been introduced, they are generally marketed as premium appliances using a Wi-Fi internet connection to allow users to control their appliances remotely, with each manufacturer providing their own application to allow users to communicate with their appliances.

No clear consensus has yet emerged on the level of functionality that will be offered by Smart Appliances. For example, Smart Appliances could comprise any or all of the following features:

- An appliance that can respond automatically to tariff signals sent by a Smart Meter, such that the usage of these appliances is prevented or reduced during high price periods, or rescheduled to coincide with low price periods;
- An appliance that can be remotely disconnected by a third party for a limited period of time;
- An appliance that can schedule its operation to optimise the use of on-site generation;

- An appliance that can automatically detect the changes in the network, for example frequency or voltage changes and respond automatically;

The term could equally describe appliances that provide non-energy related benefits to consumers. For example, appliances that can be remotely controlled by users for added convenience. To avoid confusion for consumers, a standard definition of the functionality offered by a 'smart appliance' is a requirement.

Due to the relative 'newness' of smart appliances, we believe that there is no evidence to demonstrate the impact of different approaches to labelling on smart appliances. However, parallels may be drawn from energy efficiency standards and labelling (EESL) programs. The energy efficiency of appliances and equipment covered by EESL schemes have dramatically improved in efficiency over the past 20 years and are also cheaper to purchase[14]. Therefore, it would seem reasonable to assume labelling and regulation will deliver benefits in terms of flexibility of electricity demand through smart appliances.

However, for these benefits to be achieved, other interventions will be required to address consumer behaviours to ensure that smart appliances are used in a 'smart way'. This could include the implementation of smart tariffs to ensure consumers are financially rewarded for allowing the consumption of their smart appliances to be adapted to meet the constraints on the electricity system. However, there is no single approach that is likely to be the 'best' for implementing DSM interventions[15]. Different approaches will be effective for targeting different problems and reaching different goals.

In terms of the four options (A, B, C or none) presented, it is considered that different approaches would be needed for different appliances. Option C is considered appropriate where the appliance contributes significantly to overall energy consumption, particularly during peak hours. Option B is considered appropriate for other appliances, as it will ensure a standard 'definition' is applied to smart appliances whilst also providing consumer choice. This will provide reassurance to consumers that appliances labelled as 'smart' comply with a (to be defined) minimum standard.

30. Do you have any evidence to support actions focussed on any particular category of appliance? Please select below which category or categories of appliances you would like to submit evidence for.

Responses relate to domestic end use demands.

Where energy end uses account for a significant proportion of energy consumption and/or a significant proportion of the peak load, it is considered that Option C would be the most appropriate route. For example, this could specifically relate to the charging of electric vehicles (which are covered elsewhere in our response).

Water & space heating accounts for a significant proportion of energy use by households (over 80%[16]). The majority of this demand is met by gas. However, heat pumps have the potential to decarbonise the supply of space heating. The widespread electrification of heating via heat

[14] Achievements of Appliance Energy Efficiency Standards and Labelling Programs, A Global Assessment, 4E, Energy Efficient End-use Equipment, International Energy Agency
[15] Did you behave as we designed you to? Monitoring and evaluating behavioural change in Demand side management: from what to why, RM Mourik et al, ECEE Summer Study 2015, Paper 8-393-15
[16] United Kingdom housing energy fact file, 2013, Department of Energy and Climate Change

pumps would add significant pressure on electrical infrastructure, and would lead to an increase in peak demand during the winter evening peak. Various trials and modelling activities have shown direct control of 'smart' heat pumps can lead to significant reduction on peak load demand[17,18]. It is also considered that thought should be given to introducing minimum design Standards for heat pumps in the UK. These Standards could, for example, prohibit the use of heat pumps incorporating an electric flow boiler, or as a minimum ensure that such heat pumps are required to include the provision for remote or automatic on/off control of the flow boiler[19].

For wet appliances, it is considered that Option B would be more appropriate. The energy consumption of these appliances is more diverse and has less impact on peak consumption levels. Avoiding the use of wet appliances (i.e. washing machines, tumble dryers and dishwashers) during peak hours will make a useful and worthwhile contribution towards a flexible energy system[20]. However, some of the flexibility could be delivered through customer behaviour change, without the need for smart controls. Therefore, providing customer choice, with an agreed minimum standard for what constitutes a smart appliance (Option B) would be the preferred route.

For cold appliances, flexibility is much more limited. Whilst work has been done to use the demand of cold appliances to provide frequency response[19], there is very little scope for interrupting demand. Therefore, providing customer choice, with an agreed minimum standard for what constitutes a smart appliance (Option B) would be the preferred route.

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

The introduction of 'smart' technology to domestic appliances to allow their operation to be determined in response to a direct signal will mean that domestic appliances will be increasingly operated when the home is unoccupied or during the night. Operation of appliances at night could cause noise issues in certain cases, such as for those in flats or apartments. Fire services advice to householders to prevent fires includes the recommendation that appliances such as washing machines, dishwashers and tumble driers are not operated overnight or while the home is unoccupied [21,22,23,24,25]. A proportion of the fires associated with appliances are caused by faulty products, therefore, any smart appliance standards should include safety measures to reassure customers that fire risks are controlled to appropriate levels. Heating appliances (including storage heaters and heat pumps) necessarily operate whilst no one is in the home. It is recommended that more data is needed on the causes and relative scale of risk involved for various appliances.

Whilst a move to half-hourly settlement creates the opportunity for energy suppliers to offer time of use tariffs, there is little evidence available to show how consumers would react to these

[17] Customer Led Network Revolution
[18] Assessing demand response with heat pumps for efficient grid operation in smart girds
[19] Delivering the benefits of smart appliances, research report completed for DEFRA by EA Technology, 2011
[20] Micro Demand Response and Energy Saving Products: Requirements and Options for Effective Delivery, Task 19, IEA Implementing Agreement on Demand Side Management, 2010
[21] http://www.cheshirefire.gov.uk/public-safety/home-safety/washing-machine-and-dishwasher-fire-safety
[22] http://www.london-fire.gov.uk/BedtimeRoutine.asp
[23] http://bucksfire.gov.uk/communities/section/leaflets-download/tumble-dryers-washing-machines-and-dishwashers/
[24] https://www.westsussex.gov.uk/news/firefighters-issue-safety-warning-following-dishwasher-fire-in-crawley/
[25] http://www.firesafe.org.uk/fires-in-the-kitchen/

tariffs, and whether they would prove to be popular, or even whether they would be actively promoted by energy suppliers.

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

It is clear from EA Technology's engagement with stakeholders across automotive, utilities (distribution, supply and generation) and consumer that there is a varying level of understanding and /or acceptance of the fundamental drivers and reasons behind the need for smart (managed) charging of ULEVs, and how such system/s would integrate with a smart home energy system, which is coming over as almost universally accepted as the ideal in terms of managing home energy use.

The ready conclusion to be drawn from this is that an engagement exercise that adopts a tiered approach could support effective and robust engagement with EV users, which starts with achieving cross-industry understanding of the need for managed EV charging, for example:

- Stage 1: Communication to industry stakeholders

  Government produces a public communique, endorsed by the cross industry/government EV-Network Group, that outlines the positive attributes of a smart charging system approach – making it clear that smart / managed charging will benefit consumers in that ultimately, they could financially benefit from shifting their demand to use less electricity during peak times and help avoid electricity network reinforcement at a local level because of increasing numbers of ULEVs on UK roads. Smart and managed EV charging should be positioned as being complementary to any smart home energy system; however, we should recognise that EV charging is likely to precede more holistic home energy management systems in the majority of cases. The Smart EV project will look to ensure that any functionality specified will facilitate future upgrades to wider smart functionality in the home as part of a holistic energy management system.

  It would be useful to commission a piece of work to understand the value that could be passed through industry to customers for different levels of charging management as measured by the likely avoidance of network reinforcement (DNOs), the potential for capacity response (SO) and supply TOU variations (supply).

- Stage 2: Communication to EV users

  My Electric Avenue identified that 30% of the one million Low Voltage feeders in GB may need reinforcement by 2050, solely due to the impact of clusters of ultra-low emission vehicles (ULEVs) on the network. There is opportunity to save costs of at least around £2.2bn if we manage this situation. We need car and char manufacturers, charger manufacturers and the energy industry to work together in order to achieve this; communications with customers are key if EV control technologies are to become the standard. We are addressing the need for the automotive and utilities sectors, as well as UK Government and consumer bodies, to work together through the EV Network Group; we also need to bring on board customers. A Customer Messaging

Strategy will be developed under the SSEN Smart EV project[26]. What the Smart EV project does not cover, is the implementation of such a messaging strategy, and how it links with other such strategies that are either already in existence or on the horizon.

Government could use the Customer Messaging Strategy under the Smart EV project as a resource to inform development of a nationwide EV customer messaging campaign through an Implementation Framework. Such a nationwide EV demand response communication campaign would:

- Engage customers in EV demand response
- Empower customers to manage their effect on the electricity network
- Inform future UK Government ULEV policy (through conducting surveys of the next generation driver community)
- Switch customers onto plug-in vehicles

There will be a wealth of customer acceptance data (EV demand control using smart chargers) coming through from the Electric Nation project over the coming 12-24 months, which will help inform such a messaging campaign.

34. 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 electricity consumption during vehicle charging; or**
- **Utilisation of an electric vehicle battery for putting electricity back into homes, businesses or the network?**

(a) We believe that customer propositions are yet to emerge because EVs are not yet commonplace and therefore at present there would be limited commercial payback for an organisation to develop a commercial offering to customers. Otherwise, a significant issue regarding protecting customers from lock-in is the lack of a common framework (both technical and commercial) on which to develop customer propositions. As is, this would tie customers into a relationship with a single organisation as equipment would likely be proprietary. This is one of the barriers we are attempting to resolve in the Smart EV project.

There are also barriers regarding knowledge around customer understanding and acceptance of varying levels of EV demand control; as stated under Q. 33. The Electric Nation project will produce customer data from 500-700 EV users, looking at those customers' acceptance or otherwise of having their EV's charging managed. This publicly available data will support consumer propositions for control or shift of electricity consumption during vehicle charging.

(b) EA Technology has found that there is no V2G technology that is market-ready and available for use in a domestic scenario, that is single phase and G83 or G59 compliant (technical documents used to specify equipment for grid back-feed). There are V2G options for commercial use, however these must be G83 or G59 compliant for use in the UK. V2G is a nascent market; EA Technology is working to source and trial V2G units for trial in a domestic charging setting in its Electric Nation project. We are keen to keep Government informed as to

[26] http://www.smarternetworks.org/Project.aspx?ProjectID=1883

progress on this front. A barrier is that the economic case for V2G is yet to be understood, there have been initial studies that seek to estimate value and ascertain whether this is sufficient to offset the additional equipment costs which cast doubt on the viability[27].

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

In terms of electric vehicles, the point at which they become a top priority in terms of electricity networks is the point at which they start to have an impact on the local electricity network; from My Electric Avenue we know that when EVs reach 40-70% penetration on 32% of low voltage networks, this is when they have an impact that needs some form of, preferably smart, intervention to avoid costly and disruptive reinforcement costs. Consumers need engaging with and informing well ahead of this trigger point though; smart and managed EV charging is one way to avoid this impact, but needs adopting ahead of need.

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

Smart energy technologies usually involve measurement of (and response to) system conditions. Large-scale energy systems are inherently distributed, meaning that smart energy systems are dependent of some form of communication between different devices.

There is currently no such thing as an "unbreakable" communications link or device. Therefore, *any* communications link or device represents a route to the compromise of the energy system.

Traditionally, energy systems have been kept secure using a variety of methods[28], including:

- Simplicity i.e. only including communications links where they are essential
- Physical security i.e. keeping all components behind secure locks
- Redundancy i.e. ensuring that there are alternative routes to supply energy if one route fails
- Separation (or "air gapping") i.e. ensuring there is no communications link between the energy network and the outside world

Smart technologies can undermine these security measures in several ways, such as:

- Complexity may be introduced in a potentially uncontrolled way, with multiple participants adding devices at multiple points on the network e.g. home energy management systems or network automation schemes[29]
- There may be a move away from physical data transport layers towards cheaper radio communications[30]

27 Economics of V2G, Adam Chase, E4Tech, http://www.cenex-lcv.co.uk/2016/assets/downloads/lcv2016-presentations/workshop-dome/day2/adam-chase.pdf

28 http://www.annualreviews.org/doi/pdf/10.1146/annurev.energy.29.062403.102238

29 http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/documents/ld-na-25626-en-n.pdf

30 http://energy.gov/sites/prod/files/gcprod/documents/Smart_Grid_Communications_Requirements_Report_10-05-2010.pdf

- The increased use of "redundant" network capacity to accommodate intermittent generation sources or new loads, thereby reducing network resilience[31]
- Increased interaction with the outside world e.g. responding to customer behaviour, weather events, independent generators etc. may introduce new devices and communication channels that can breach the traditional air gap[32]

If a smart grid is compromised, the infiltrator has several methods to bring harm to the energy system (or its participants) including data theft[33], fraud[34], supply interruptions[35] and even physical damage to the network[36]. It is a common misunderstanding that an attacker must assume "control" of the network to bring about harm. This is not the case; mere manipulation of data from sensors can still cause considerable disruption[37].

Despite the above, all threats can be effectively mitigated if the right measures are in place. In this case, the probability that smart technologies can be used to compromise the energy system can be maintained at an acceptably low level. However, if the issue of cyber security is left unmanaged then there is a high likelihood that smart technologies will be used to compromise the energy system.

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

In our view the primary risks are systematic, rather than technological. Specific vulnerabilities in specific technologies will inevitably emerge and it does not make sense to base policy solely in response to this. Ensuring the security of any complex system requires an integrated approach[38] to ensure that the opportunity for compromise is limited.

The primary behavioural risks that we would highlight include: secrecy[39], hype[40] [41] [42] and hearsay[43]: all of these are potentially dangerous and will undermine attempts to set policy based on clear evidence.

To counter these risks, EA Technology would welcome ongoing research[44] and analysis[45] into the nature of the threat, and the formulation of appropriate policies[46] and strategies[47] in response.

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[31] https://www.iea.org/publications/freepublications/publication/smartgrids_roadmap.pdf
[32] http://www.nrel.gov/esi/assets/pdfs/insecure_field_devices.pdf
[33] http://energy.gov/sites/prod/files/2013/12/f5/IG-0900.pdf
[34] http://www.cl.cam.ac.uk/~rja14/Papers/JSAC-draft.pdf
[35] https://www.blackhat.com/eu-14/briefings.html#lights-off-the-darkness-of-the-smart-meters
[36] https://ics-cert.us-cert.gov/alerts/IR-ALERT-H-16-056-01
[37] https://www.enisa.europa.eu/news/enisa-news/stuxnet-analysis
[38] https://openlibrary.org/books/OL7617491M/Secrets_and_Lies
[39] http://www.theregister.co.uk/2016/05/25/seattle_suehawks/
[40] https://sentinelone.com/blogs/sfg-furtims-parent/
[41] http://www.theregister.co.uk/2016/01/28/israel_power_grid_attack_boring_ransomware/
[42] http://www.theregister.co.uk/2015/07/29/australias_cyber_force_punts_discredited_data/
[43] http://www.theregister.co.uk/2016/10/11/nuke_plant_has_been_hacked_says_atomic_energy_agency_director/
[44] http://energy.gov/sites/prod/files/2016/08/f33/CEDS%20award%20selections%20August2016%20fact%20sheet%20FINAL_1.pdf
[45] https://info.publicintelligence.net/DHS-CyberAttacksEnergySector.pdf
[46] http://energy.gov/oe/downloads/roadmap-achieve-energy-delivery-systems-cybersecurity-2011
[47] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/567242/national_cyber_security_strategy_2016.pdf

Regulators and legislative bodies have an essential role in raising awareness[48], ensuring transparency[49], developing skills[50], driving best practice[51], encouraging cross-sector co-operation[52] [53] [54] and mandating regular stress testing of systems[55].

We have not attempted to provide a quantitative analysis of the likelihood and impact of cyber security breaches on the energy system. However, the referenced evidence of both good and bad practices provides a strong indication of the systematic behaviours that are necessary to minimise both the likelihood and impact of any breach.

Rather than specific technical legislation, EA Technology therefore strongly supports any action to strengthen and enforce beneficial cyber security behaviours, backed with legislation (if necessary) to discourage or prevent the deployment of insecure systems.

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

We agree with the emerging system requirements identified.

44. Do you have any data which illustrates:

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

The Transform Model®, developed at EA Technology and widely used throughout the industry is ideally suited to model current and future costs and savings of the scenario discussed. Both Ofgem and BEIS' predecessor DECC have copies of and licences to use this model.

45. With regard to the need for immediate action:

- **Do you agree with the proposed roles of DSO's and the need for increased coordination between DSOs and the SO and TOs in delivering efficient network planning and local/system-wide use of resource?**
- **How could industry best carry these activities forward? Do you agree the further progress we describe is both necessary and possible over the coming years?**
- **Are these 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.**

[48] http://www.theregister.co.uk/2013/05/23/us_power_grid_cyber_attack_report/
[49] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/526351/2015_16_summary_of_the_srp.pdf
[50] http://www.theregister.co.uk/2013/02/12/uk_cyber_skills_shortage/
[51] http://www.ofwat.gov.uk/regulated-companies/improving-regulation/resilience/
[52] https://www.gov.uk/guidance/resilience-in-society-infrastructure-communities-and-businesses
[53] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/278526/12-519-blackett-review-high-impact-low-probability-risks.pdf
[54] https://www.dhs.gov/national-infrastructure-protection-plan
[55] http://www.theregister.co.uk/2015/11/30/cyber_resilience_analysis/

Having worked on the DNO to DSO transition for Energy Networks Australia, we note that the term 'DSO' can be interpreted as many different things, even within a single market/jurisdiction.

As referred to in Q7 the one likely change we will see over the coming decade(s) is that there will be more actors involved in the management and support of the power system: from generators, to new conventional energy supplier entrants, to aggregators (by technology, by manufacturer, by geography, etc.), to solution providers. It is these external events that will create the need to transition from DNO to DSO. How a DNO interacts with these actors will define how far they are on the DSO spectrum.

By way of example, many markets are trending towards the procurement of services, in place of the traditional purchase and operation of assets. This has been seen this in mobile phone ownership and also vehicle ownership with more people than ever leasing cars. Some power companies have handed over aspects of LV management and fault location to 3rd parties with innovative commercial models. How far the DNO moves in this direction has an impact on how big the 'S' is, in DSO. Those companies with a desire to manage all of these activities themselves, and to have the skills in-house, we would argue, are 'Big **S**', whilst those who outsource the activities to others, are 'little s'. Ownership / shareholder drivers, geography, history (e.g. inherent topology of network) and risk appetite would all influence whether a company adopts a DsO or a D**S**O strategy, and this is likely to be business (if not even licence) specific.

We believe this is a key point, as if services are to be provided by third parties throughout the country, it is essential that a common agreement is reached on what these looks like, how they are procured and how they are delivered. These services don't necessarily need to be regulated, nor developed solely by network operators: indeed the best answer is likely to involve regular dialogue of the increasingly growing body of stakeholders and solutions providers to allow a genuine market to operate.

(a) To the extent that the DSO undertakes a degree of delegated frequency control, we agree that the transition from the DNO to DSO will demand more coordination (including near real time control systems) between DSO, and the transmission SO. As noted in the consultation document, we agree that the efficient planning of the power system can only be achieved if there is dialogue and coordination between the DSO, the SO and the Transmission Network Operators. We also recognise that greater visibility of network planning and use of flexible resources across DSO and TO/SO boundaries is important however it should be recognised that the focus of this visibility should be on why the interventions are proposed or the flexibility is required not just reaching a solution. This would better encourage collaborative working.

(b) We believe the industry can carry these activities forward themselves, however the pace of change is likely to be slow. A catalyst is likely to be needed to encourage faster progress, and this could involve targeted innovation funding, pressure from the regulator or third party involvement. We believe the progress described is necessary. We would suggest that the most important areas for consideration include planning visibility and a framework towards the co-ordinated use of flexible resources between DSO and SO (and potentially other parties). Setting a twelve-month programme to achieve meaningful change is considered ambitious in view of the historical rate of change of the energy networks sector. We consider it is important the final answer is correct rather than a swiftly obtained sub-optimal answer.

As per the introduction narrative above, consideration needs to be given to a broader set of stakeholders beyond the narrow boundaries of network operators. This would include aggregators, service providers, and conventional energy suppliers. We note that GB's Smart Grid Forum was a good vehicle for cross industry dialogue, however this Forum appears to have diminished in recent years. If the Smart Grid Forums roles have been transferred to other bodies, for example the Energy Systems Catapult then better communication with the industry is required.

46. With regard to further future changes to arrangements:

- **Do you consider that further changes to roles and arrangements are likely to be necessary? Please provide reasons. If so, when do you consider they would be needed? Why**
- **What are your views on the different models, including:**
  - **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?**
  - **Which other changes or arrangements might be needed to support the adoption of different models?**
  - **Do you have any initial thoughts on the potential benefits, costs and risks of the models?**

(a) It is our opinion that the most pressing need for reform of the roles between DNOs and SO is regarding the use of flexible resources. At present, DNOs compete with the SO (both in terms of cost and availability) for flexible resources that could help defer expensive network upgrades. Methods have been deployed to allow DNOs to access STOR resources[56] such that the SO are compensated for the unavailability of that resource, however, this arrangement is sub-optimal in a future energy system where DNOs rely more heavily on flexible resources. We would suggest that as a minimum, a process should be developed and tested to provide a technical and commercial framework for flexible resources being led by DNOs, in readiness for when it can be demonstrated that enacting the arrangements are in customers' best interest.

(b) We believe the models presented are an excellent basis for further analysis and scrutiny. Faced with the inherent difficulties of making accurate future predictions, it can be helpful to examine several potential pathways. We would wish to draw your attention to recent work published by Energy Networks Australia which also seeks to do this[57].

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

We believe that the existing electricity network innovation funding options are more geared towards innovations that have a high technology readiness level (TRL) and those that are aligned to the specific needs of the network operator. This, however, does not incentivise innovation funding being targeted at cross-industry projects, for example, where many more

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56 WPD FALCON https://www.westernpowerinnovation.co.uk/Document-library/2014/DSR-Dissemination-Event-190614-Full-Day.aspx

57 ENA Australia: Network Transformation Roadmap Grid Design, Operation, Platform and Telecoms http://www.energynetworks.com.au/sites/default/files/grid_design_operation_platform_and_telecoms.pdf

players in the energy sector (and particularly energy supplier and DNO) could be involved to innovate across their traditional boundaries. This would particularly be the case where innovation topics may detract from the business interests of a party.

We believe that existing innovation funding mechanisms should be amended, or a new mechanism be developed, that seeks to address this issue.

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

Broadly, we believe these are valid areas for innovation funding support, however we believe that innovation should be sought in all areas as long as energy users have the potential to benefit. However, aligned to our response for Q47, we believe the cross-boundary areas have the potential to release more benefit.