The Institution of **Engineering and Technology**
Michael Faraday House
Six Hills Way, Stevenage
Hertfordshire, SG1 2AY
United Kingdom
T +44 (0) 1438 313311
F +44 (0) 1438 765526
www.theiet.org

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

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Re: Call for evidence a smart, flexible energy system

Please find attached the Institution of Engineering and Technology's written response submision to the above consultation.

About the IET

The IET is one of the world's leading professional societies for the engineering and technology community, with more than 167,000 members in 150 countries and offices in Europe, North America and Asia-Pacific. The IET provides a global knowledge network to facilitate the exchange of ideas and promote the positive role of science, engineering and technology in the world.

This submission has been approved on behalf of the IET's Board of Trustees, and takes into account the views of IET Members under the guidance of the IET's Energy Policy Panel and should not be taken as representing in any way the individual views of the organisations for which the panel members work.

The IET is happy to discuss these points with the Ministers or Officials.

Yours sincerely,

Gordon Attenborough

Head of Stratigic Engagment & Partnerships

Tel: 01438 765630

Email: Policy@theiet.org

1. Introduction

We welcome this Call for Evidence (CfE) which addresses a number of important issues relating to the challenge of making our electricity supply system operate more flexibly and more efficiently. We have responded to the questions posed but felt that additional comments were required and these are provided here.

The broader picture

We particularly welcome the recognition that the flexibility challenge requires whole system responses, which is a message that the IET has provided evidence for in a series of reports[1], the most recent of which is the Future Power System Architecture[2] report of July 2016.

However, we have a concern that a whole system, co-ordinated approach is not actually being applied in our national thinking. The CfE lacks reference to the potential interactions between the many (good) initiatives that are described, and it can be read as a series of incremental options to be selected as desired. It is our view that a much more radical restructuring of the way parties in the electricity supply chain interact will be needed, including how they are regulated. We feel that the challenge of enabling significant innovation and change over a sustained period of time with a wide agenda that spans the whole system, is not fully recognised in the CfE. The challenge of *enabling* the changes is a material task in its own right, and will require a strategic approach alongside the specific interventions.

We have read this CfE in the context set by several other Government and Ofgem activities. These include Ofgem's consultation on industry code governance[3], Ofgem's 'Innovation Link' initiative[4] and the Department for Transport's (DfT) recent ultra- low emission vehicles consultation[5]. Our strong impression is that these activities, and the thinking behind them, show little evidence of the joined-up approach that will be necessary for a successful outcome.

A simple demonstration of this point is that this CfE makes no reference to the industry code governance consultation even though a whole section of the CfE focuses on roles and responsibilities. This is concerning. The 'Innovation Link' initiative is designed to help new entrants with new propositions to overcome regulatory barriers. These new entrants could well cause disruptive change, particularly those operating beyond the meter, but this does not appear to be given consideration in the CfE. We also see a different approach from the DfT, where it appears that they recognise the disruptive power of battery electric vehicles and accept that they will need to take a regulatory lead to address this. In contrast, while recognizing the need for regulation, BEIS and Ofgem seem much more reticent and less inclined to lead.

Future Power System Architecture

The FPSA joint IET/Energy Systems Catapult report was commissioned by Government. It highlights the growing complexity of the electricity sector and identifies the new and enhanced functionality

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[1] "Handling a shock to the system" - http://www.theiet.org/factfiles/energy/elec-shock-page.cfm & "The case for a system architect" - http://www.theiet.org/factfiles/energy/brit-power-page.cfm

[2] http://www.theiet.org/sectors/energy/resources/fpsa-project.cfm?origin=reportdocs

[3] https://www.ofgem.gov.uk/publications-and-updates/industry-code-governance-initial-consultation-implementing-competition-and-markets-authority-s-recommendations

[4] https://www.ofgem.gov.uk/about-us/how-we-engage/innovation-link

[5] https://www.gov.uk/government/consultations/proposed-ulev-measures-for-inclusion-in-the-modern-transport-bill

that will be required in the near future to facilitate the low carbon transformation. Importantly, this functionality crosses existing boundaries of stakeholder responsibility and therefore requires new levels of cooperation to deliver whole system solutions.

The FPSA report is referenced briefly in the CfE but we are concerned that its recommendations have not been taken on board. We see a need for an integrating influence to ensure that the required functionality is delivered in a timely way. This is why we believe there to be a need for much closer linkage between actions to deliver flexibility and the drivers for change in industry mechanisms such as standards and codes.

We suggest that delivering the functionality recommended by the FPSA report offers a very good test case for the plans that will be published in the spring, particularly in relation to roles and responsibilities. We would expect these plans to propose changes to existing roles and responsibilities so that there is the appropriate leadership and co-operation necessary to deliver the FPSA functionality in a timely way.

Beyond the meter

The CfE addresses important issues relating to the consumer in the section, "A System for the Consumer". We believe that actions by consumers are likely to be one of the most disruptive drivers for change over the next decade. We have already seen how the take-up of solar PV confounded all the forecasts of just a few years ago, albeit mostly due to solar PV farms. The same could happen with EVs and this could have a much more dramatic impact on the power system than solar PV. The launch of the Innovation Link shows that Ofgem recognises the likelihood of disruptive change but this is not as apparent in the CfE. Its tone is that incremental change will be sufficient. The evidence from the FPSA work is contrary.

We also note that there are few references to community energy schemes. This is just one of many non-traditional business models that might flourish in the future, encouraged by the Innovation Link. The FPSA analysis revealed that Community Energy is likely to be one of the most disruptive developments for the sector.

The companion PA report on Aggregators references the important concern that demand side action could interfere with the energy balancing position of suppliers, with not only imbalance cost consequences, but also undermining one of the core design principles of the wholesale and balancing market arrangements. The PA report (p5 and para 3.7.1) references this and notes the challenges but it is omitted from the Ofgem/BEIS main document. In our view this is an important matter to address and bring to the fore.

We believe that there is likely to be a case for making changes to legal and regulatory designs to recognise and ensure the integrity of important functions that cross the metering boundary and potentially have impact for the power system as a whole, both technically and commercially. This may require compliance of those parts of systems beyond the meter; it will certainly require close understanding of stakeholder wishes and behaviours and concerted facilitative action by the established parties who operate on the 'system' side of the meter.

Implementation

It would be helpful if the implementation challenges gained their own profile and wider exposure to all parties. The ability to respond to ongoing change (for example through ensuring scalability of solutions, interoperability of data, and harmonised technical and commercial systems) would be

enabled by the introduction of far more agile change processes in the sector. This is an important topic in its own right. In particular, we would welcome the spring 2017 plan stating clearly who will ensure that the actions of stakeholders across the system, including consumers, are integrated in a coherent way and in line with a transparent strategic plan for managing on-going transformative change.

2. Storage & Aggregators

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.*

Storage has the potential to have a significant positive impact on the operation of the power system in a number of ways. We have accepted material system capacity inefficiencies in the electricity supply chain in the past because of the cost and technology constraints that applied to storage. There now seems to be a genuine prospect of storage becoming widely deployed, potentially at all voltage levels. The value that demand-side storage could bring is particularly enticing as it can impact the entire supply chain.

We are pleased to see that it is now recognised that there are regulatory barriers to the deployment of storage. The CfE provides a good summary of them and we welcome all initiatives that are designed to address these barriers. However, we remain concerned that, in the short term, the owner/operator of a storage facility may not be able, in practice, to access and monetise all the benefits that it can deliver. Ofgem and BEIS should take all necessary actions to ensure that existing market distortions (eg Renewable Obligation Certificates and Contracts for Difference) do not act against the business case for storage. We would strongly encourage Ofgem and BEIS to continue to work closely with the storage community to ensure that this is the case. The need for a level and less complex playing field for storage is urgent.

We would stress the importance of taking a whole system perspective when developing policy and regulatory measures for storage. The optimisation of power system storage requires multiple effects to be taken account of across the supply chain, both technically and commercially. It provides one of the most compelling arguments for whole system approaches. We believe that it might also build a case for a more radical restructuring of the way the electricity supply chain functions, technically and commercially, and how it is regulated. While we would support short term incremental changes that can be shown to bring benefits, we also feel that more radical actions are likely to be needed in the medium term. The plans to be published in the spring should set out distinct proposals for immediate action and for action in the medium term.

***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.*

Networks can only connect sources or sinks of electricity. A generator is a source, and a demand is a sink. Storage is capable of doing both, but not at the same time. Many industrial customers with on-site generation present similar conditions to the network. There is therefore nothing novel about storage. It does present challenges of forecasting likely flows, possibly more so than pure demand or pure generation customers, but still not outside any envelop of normality. The connection design process for a storage facility may be more complex than for demand or generation and a storage operator will have to decide what operating 'envelope' is required before a connection design and offer can be agreed.

Storage currently has to be treated as generation when connected to a distribution network; Regulation 22 of the ESQCR (2002) uses the phrase "source of energy". This is the same phrase as was introduced in the Electricity Supply Regulations (ESR – 1988), and the Department of Energy inspectors who wrote the ESR explained at a public meeting at the IEE Savoy Place in November 1988 that they had used the phrase deliberately so that any future storage technology would be treated as conventional generation.

There is a fundamental difference in the industry arrangements between generation and demand. This might have been appropriate in the 1980s, but it is now time to question whether the distinction between demand and generation needs to be drawn so divisively in the GB arrangements. Both give rise to flows on the network, and should be accommodated and charged on a completely identical/neutral basis.

We would expect Ofgem to address any connection issues directly with the developers of storage projects. We would also expect the ENA's Distributed Generation Fora to embrace connection issues for storage.

***Q3**. Have we identified and correctly assessed the issues regarding storage and network charging?*

Network charging is probably not fit for purpose in its present form. In theory, generation on the 11kV network is credited or charged depending on its notional contribution to security. However, the analysis is generic and does not take account of local effect and costs, and may even credit generation that is driving network investment costs.

Designing a fit for purpose charging regime is surely a key objective here, recognizing that customers are likely to be prosumers, and the CfE states, it is not appropriate to recover network costs on a per kWh basis. A charging regime that was based solely on usage and flows would provide a simple basis for charging storage on a completely level playing field with all other users.

If resolving the challenge of network charging is likely to be protracted (the Common Distribution Charging Methodology probably took about 10 years to introduce) then quicker change processes are likely to be needed.

Do you agree that flexible connection agreements could help to address issues regarding storage and network charging?

There are already good examples of connection arrangements/agreements that allow more efficient use of available network capacity. It seems self-evident that this should be developed further. It is likely that there will be new opportunities to do this for storage as it can often be complementary to a generation connection rather than competitive with it. Close liaison with the Distribution Network Operator (DNO) should enable any potential constraints to be identified, which might require automated curtailment. Equally, opportunities to provide network security support through being able to offer a response to an unexpected network outage could have the impact of freeing up network capacity. Flexible arrangements should be offered to all customers on the same basis.

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.

We agree that network charges should represent a cost reflective and fair recovery of network costs We are not sure that the example in paragraph 12 on page 29 explores this point helpfully. Storage should pay network charges that reflect its use of the network at times of peak demand. We can see that a charging model that is primarily driven by network use at peak demand may not be fit for purpose in a more complex and flexible world.

We would hope that, as there are now a significant number of storage projects either operational or underway, the developers should be able to provide quantitative evidence of the impacts of current network charging methodologies.

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.

We agree that network operators could use storage to support their networks. They are certainly best placed to identify network needs where storage could be the best solution. However, if they are to own and operate storage installations, appropriate safeguards must be in place to address any potential competition issues that will arise. Perhaps the problem needs to be further broken down into 'ownership of the storage equipment', 'operation of the storage equipment' and 'trading and ownership of the stored energy'.

Procurement rules will be needed from the outset to ensure that DNOs are transparently buying system operation services, including from their own storage.

One benefit of network operators owning storage is that they would be able to install a facility of the optimum size and at the optimum location to offset or avoid traditional network reinforcement. UK Power Networks' Smarter Network Storage facility at Leighton Buzzard is an example of electrical energy storage being used in this way. Although it might currently be a more expensive option than traditional reinforcement in some cases, costs of Li Ion and alternative competitor technologies are falling significantly. Moreover, storage could simultaneously provide network support and various upstream ancillary and market services, whereas a conventional network reinforcement solution could not.

If a DNO is prevented from installing energy storage as a network asset then the DNO will be dependent on the market to recognise the potential. If the market fails to respond, then the DNO will be left with no alternative than to apply a solution which may be less cost-beneficial from a whole system perspective. A further consideration in favour of storage being permitted as a regulated network asset, is that DNOs have access to a lower cost of capital and the cost to consumers would be recovered over the regulatory depreciation period of 45 years. It should also be recognised that the operation of grid-scale electrical energy storage requires careful technical integration with the overall operational management of the network. A DNO is best placed to ensure grid-scale storage is able to make the maximum contribution to the system as a whole.

We would suggest that the first priority should be to try to create a commercial and regulatory framework that would allow non-DNO parties to access all the whole system value streams that a storage facility should benefit from. The aim would be to put non-DNO parties in a broadly similar investment position as a DNO. In the event that this is not achievable, for whatever reasons, the option of DNO ownership, in particular circumstances, could be considered subject to agreed safeguards. It is important that the complexities of storage business models are not allowed to unduly impede the development of cost-effective storage solutions.

We would also encourage Ofgem to engage fully in the European debate about the regulation of storage, including the ownership issue.

***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.

We would propose that the alternative regulatory approaches (eg paragraph 38) are properly tested against the outcomes that you are trying to achieve. These outcomes will have technical, commercial and regulatory dimensions. As proposed above, this assessment process should be most productive if it is carried out with the storage developer/owner community in an open, transparent way.

We would highlight that there are technologies under development which can store energy, import and export electrical energy, and import and export heat. Electrical energy may be used to "charge up" the storage but the export could be as electricity or as heat. Also, ULEVs with vehicle-to-grid (V2G) capability may charge and discharge at different points on the system. There is therefore a risk that any definition agreed today could cause anomalies in the near future.

We believe that considerations of storage as either intermittent or non-intermittent generation are of limited value as neither fully characterises the way that storage behaves. As a point of principle, we would question why demand and generation are treated differently both legally and in regulation. Removing this differential treatment could bring simplicity and clarity to a number of the issues discussed in the CfE.

***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.

The debate about the need to define storage has been running for years. The lack of a definition is not a barrier in itself. We consider that, as the measures are developed to address the barriers to storage, it will become clear whether a formal definition is required and at what level. So, agreeing a definition should be an output of regulatory reform, not an input. We do believe however that the current position of classifying electrical energy storage as generation is unsatisfactory and potentially constrains options for ownership and operation. The argument against storage being classified as generation is that it is simply recycling electrical energy that has already been generated. As such, it clearly does not contribute to GB's electricity (ie energy) production capability. It can however play an increasingly vital role in maximising the utilisation of low carbon generation and hence reducing the need for fossil-fuelled generation. Its ability to readily provide enhanced frequency response also makes it superior to some low carbon generation technologies. In summary, we believe that storage, and electrical energy storage in particular, is a key electricity system infrastructure asset that may justify specific recognition of some kind to encourage its use. This needs to be explored further.

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?

We strongly believe that there is a growing role for aggregators in the electricity market. There are already good examples of aggregators providing valuable services to the system operator. We would expect to see an open and thorough engagement between Ofgem, BEIS and the aggregator community so that policy, regulatory and market measures to release the full value of aggregation are developed in a timely way and win the support of all key stakeholders.

However, we find it difficult to respond to the points raised here when there is uncertainty about the structure of the market envisaged. Is it time to review the structure of the GB market and determine if the right roles and responsibilities have been assigned to the right parties? The structure we have now was put in place when a very centralized industry was privatized in 1990. It has been modified substantially (eg the introduction of NETA and BETTA) but fundamentally it is still set up for a centralised unidirectional system. We would welcome an approach that recognises that customers' needs from an energy system in the middle of the 21st century are very different from those in 1989. A good place to start would be the work of the IET and the Energy Systems Catapult, who in the FPSA project identified 35 key functions that the future electricity system (and recognising customers as an integral part of the system; arguably the dominant part of the system) needs to implement. A legal and market framework allied to the required functions would doubtless have its own imperfections, but it seems that designing such a framework might be a better long term strategy than continually working on the barriers of the inherited framework from 1989.

A new legal and market framework would recognize the local nature of production and consumption, the opportunities and efficiencies arising from local operational management (eg of constraints) as well as the opportunities to balance the system overall drawing on a wider range of distributed resources. It might not be sensible or appropriate to institute an immediate change, or at any point in the future, to a new regime. However, having a well understood and well communicated vision in place would enable transition over the medium term.

It will also be timely to review issues of consumer protection and to clarify how the protection regime for energy consumers works with other consumer protection arrangements (excepting the specific sector protections for vulnerable customers).

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

We recognise that providing services, such as reserve generation, can have the effect of putting other trading parties (in particular, Suppliers) out of commercial balance, as the actions of aggregators are not reconciled in settlement. One way of addressing this is for aggregators to be allowed, or required, to participate in the Balancing Mechanism. The case for making this a licensable activity would need to be explored. This could be an important first step in addressing current anomalies arising from interactions between reserve services dispatched by aggregators and balancing actions based on bids and offers from licensed parties.

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

The issue of mass market inclusion in a flexibility market is crucial: it is not clear that the existing NETA/BETTA model is appropriate, or capable of amendment, to achieve the desired ends. It seems appropriate to expect to see more detail of how different approaches could work. The current GB

structure of the industry was laid down in 1990. How confident are we that the roles that evolved in the industry since then, especially Suppliers, are still appropriate to the future and the desired flexibility?

For example, relevant questions might include: What is the point of licences? Why should an aggregator be licensed? And why should a 99MW generator be licence exempt? It is probably appropriate to undertake a thorough review of the roles and responsibilities of parties in the sector, rather than persist to adapt the 1990 ex CEGB/Area board model.

As such it would seem most appropriate for a BEIS, rather than Ofgem, led review.

We do not believe a 'watching brief' is appropriate. Requiring aggregators to become signatories to the BSC and become Balancing Responsible Parties is an attractive option but an option could be to make this a requirement above a de-minimis level so as not to create an inappropriate barrier to local community schemes or start-up energy service providers.

***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?*

We are encouraged that this risk to system stability is recognised. However, the CfE provides little detail on the tools to mitigate it. This is another good example of a risk that requires a whole system approach to understand and address it.

The increasing susceptibility of the electricity system to loading shocks (including DG with limited ride-through capability) means that conventional measures to arrest frequency collapse or rapid acceleration will be increasingly challenged. Given the increasing dependence on distributed energy resources for system balancing and frequency response to manage a system with declining system strength, it is essential that mechanisms to dispatch such resources are sufficiently protected to prevent unauthorised access and 'herding' effects that might cause over-compensation. This includes protection against hacking into communications systems that are used to dispatch demand-side response (DSR), storage, and distributed generation (DG).

The IET's report, "Handling a shock to the system"[6], explains how the number of active devices in the power system will expand by several orders of magnitude over the next 10-20 years. Aggregators have the potential to despatch a very large portfolio of active devices which can deliver 'shocks to the system'. There needs to be a coherent overall plan to ensure that millions of active devices from kW scale to multi-MW scale can operate in a way that does not threaten system security. Developing such a plan requires clear leadership. At present no single party provides this leadership although National Grid's System Operability Framework has provided valuable commentary on the wider operational risks that it can see. There needs to be greater clarity about who will be responsible for managing these system-wide risks into the future.

3. Providing Price Signals for Flexibility

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?*

The three fundamental requirements are that the flexibility services that the system needs to function securely and efficiently must be: a) accessible to those parties that are able to supply them; b) priced to properly reflect their value; and c) settled half-hourly. Following on from this, existing and new entrant parties should be able to access the market so that genuine competition can develop, building customer confidence and engagement. We do not underestimate the challenges that this brings. We are convinced that customers, particularly retail (ie domestic and SME)

[6] http://www.theiet.org/factfiles/energy/elec-shock-page.cfm

customers, will need to be offered simple propositions that are as transparent as possible. We realise that a degree of complexity is unavoidable and that this is somewhat at odds with the 'simpler, clearer' philosophy. However, we are confident that, given the opportunity, new entrants will constructively disrupt the current market and customers will engage.

***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?*

We have not responded to this question.

***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?*

We have not responded to this question.

***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?*

Please see our response to Q7.

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.*

Currently, Government is acting as the de facto architect of the electricity system. In particular, Government took the initiative to roll out smart meters and decided how they should be delivered. One of the key benefits of smart meters is that they are an enabler of a smarter overall system. It therefore seems logical that Government should play its part in promoting smart tariffs, maintaining its leadership role, preferably with a light touch.

However, smart tariffs alone are unlikely to be sufficient to entice the majority of domestic customers and SMEs to significantly change their usage behaviour. Low Carbon Network Fund (LCNF) trials such as Customer Led Revolution and Low Carbon London have shown some encouraging signs of the potential to exploit the inherent flexibility of some domestic appliances, but in the absence of Home Energy Management Systems and/or smart appliances, the scope is limited.

This is an area where commercial innovation and fresh thinking could be fruitful. Innovative non-conventional business models should be encouraged, as should consideration of reviewing concepts such as the Supplier Hub principle. For example DSOs might in future see an attractive option in investing in assets 'beyond the meter' if such investment might defer or avoid network reinforcement. One attraction would be that DNOs could depreciate such investment (as part of the regulated asset base) over 45 years meaning that the financial impact on consumers would be significantly softened. This ability to recover the costs over 45 years (and at a relatively low cost of capital) contrasts noticeably with 'beyond the meter' investment being funded through the Energy Company Obligation on Suppliers.

It is not yet clear how suppliers will respond to a world where demand might be less predictable than it is today. A role which Government and Ofgem can play is to make adjustments to wholesale

markets if necessary to create opportunities for suppliers to better manage their wholesale costs through the use of smart tariffs.

***Q16**. If deemed appropriate, when would it be most sensible for Government/Ofgem to take any further action to drive the market (ie what are the relevant trigger points for determining whether to take action)? Please provide a rationale for your answer.*

We have not responded to this question.

***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?*

We have not responded to this question.

***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?*

We believe that home energy management systems and/or smart appliances are a prerequisite for most domestic customers to engage with smart tariffs. Such systems/appliances could pave the way to dynamic (rather than fixed period) time of use tariffs which would be particularly suited to a future increasingly dependent on intermittent (variable) generation. Home energy storage would be of particular value as an enabler of domestic demand flexibility.

However, all these solutions require capital investment to some degree which might be off-putting for consumers, even if some form of grant is available. A consideration here is whether it might be considered appropriate for energy service providers to invest in HEMS and battery storage in exchange for a commitment to remain contracted to that provider over a period of time. An alternative might be for an asset transfer agreement which would take effect in the event of the consumer wishing to switch supplier. Another option might be for DNOs to make the investment where the case can be made in terms of avoided network reinforcement.

Smart Distribution Tariffs – Incremental change

***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.*

The consultation paper correctly outlines the challenges and conflicts associated with charging.

Whilst it is feasible for smarter distribution tariffs to be developed, for example time-of use tariffs reflecting marginal cost of peak demand driven investment at a granular network level, there are potential barriers to consider. One is that the strength of any network price signal will generally be weak compared with an energy price signal (although transmission Triad charges have changed behaviour amongst large users); another is that nodal charging will lead to perceptions by consumers of a post-code lottery. The latter perception is enhanced by the fact that, hitherto, the cost of maintaining adequate network capacity has been shared by all consumers. Consumers faced with higher distribution charges in a given locality due to limited capacity headroom might therefore question why the marginal cost of network capacity shouldn't continue to be socialised, given that their local network has not benefitted from their previous contributions to general network reinforcement.

***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?*

Incremental changes are likely to add to complexity. It is probably time to start again from scratch and design an overall network charging structure that recognizes market system operation by both

transmission and distribution companies, whilst recognizing other policy imperatives (such as transparency and stability) as explained in the consultation.

However, a move to greater weighting of variable connection charges for peak time loads (so called 'red band' charges) would create greater opportunity for obtaining financial benefit from flexibility, particularly if this was supplemented by dynamically notified charges at particularly challenging times.

***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.*

This example is a good one, and highlights the deficiencies of the current arrangements. Such generators are probably already in a position to cope with an appropriate and small increase in complexity that a modern system operator charging structure would impose – so there would be no drawback in looking to implement a new regime quickly, recognizing that technology development/penetration would be needed before all customers could be progressively moved to such arrangements (recognizing the challenge of differential treatment during a protracted transition period).

Generators which are taking up network capacity – ie due to the level of exported power flows reducing network capacity headroom, whether or not they are netting off local demand, should logically incur positive, rather than negative Distribution Use-of-System (DUoS) charges.

However, as with energy storage, the mode of operation of distributed generation determines whether generators contribute to network capacity / security or reduce network capacity headroom for other customers. UK Power Networks' Flexible Plug & Play Networks LCNF project has demonstrated how technology can enable DG to connect more cheaply and more quickly in exchange for flexible connections which allow for curtailment of generation output if necessary. Other projects, including UK Power Networks' Low Carbon London project have shown how generation can provide ancillary services to defer the need for network reinforcement. In these cases, the generator's contributions are rewarded through lower connections costs or payments for ancillary services (availability and utilisation payments). However, it is conceivable that DUoS charges (or payments) could instead be tailored to reflect the conferred benefits of flexibility or network support services.

A further anomaly that will require resolution is the treatment of network charges for communities engaged in peer-to-peer trading – ie between either customer (consumers, prosumers and generators) within a spatially defined community or between adjacent communities. Under peer-to-peer arrangements, the public distribution network is acting as a virtual private network. Communities might argue that they are making little if any use of the higher voltages of the distribution system, and no use of the transmission system. On that basis they may claim to have grounds for paying lower DUoS charges. On the other hand, they might require insurance in the form of top-up and standby, for example if a local community generator had to go off line unexpectedly. In such cases it would be appropriate to levy network charges for such capacity that had to be reserved to provide such services if required.

Overall, where peer-to-peer arrangements have been established, then a change of approach towards capacity (rather than unit) based network charges might be more reflective of the nature of their usage of the distribution system.

Smart Distribution Tariffs – Fundamental Change

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?*

Historically, the primary cost drivers for the capacity of the electricity system have been peak demand and supply continuity (ie the need for spare generation and network capacity to deliver adequate supply continuity). These drivers will continue to be important. However, if the growth of distributed generation and flexible demand continues, other drivers might become increasingly important. It is certainly possible that more consumers and communities of consumers will become largely self-sufficient in energy supply and so the services they would require from the main grid system will change. DUoS charges include a component linked to peak capacity, albeit not at a nodal level. It follows that charging methodologies will need to be revisited if other cost drivers do become material. In any event, opportunities should be explored to use DUoS charges to reduce the need for network expansion caused by increasing energy demand.

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?*

It is quite possible that one signal might swamp the other. This is a key question, but without more analysis it is hard to answer. It seems that some high level options for charging design could be worked up and illustrated with DNOs and TOs own long term projections – such as those that were required out to 2031 from DNOs for the RIIO ED1 submissions. However, a longer timescale might be appropriate for this purpose. Reconciling short and long run marginal costs is a non-trivial task that will need academic input.

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.*

We have commented on the Chapter 5 models in our response to Q46.

Distribution and transmission charges should be based on the costs of the infrastructure and system operations in place to support customers' (ie those paying network charges) needs, whether actual needs as expressed in clear contractual terms, or assumed needs as part of recognized approaches to system planning and sizing. If such an approach can be found that achieves the above, and other necessary features such as transparency, predictability and stability, then the choice of model should be fairly irrelevant to charging.

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?*

Government leadership and the clarity of its energy policies is vital. Its decision to commission the FPSA project demonstrated leadership and we hope to see this continue. We also hope that the FPSA recommendations are taken on board in the further development of Government policy.

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?*

We have not responded to this question.

***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?*

We have not responded to this question.

4. A System for the Consumer

Smart Appliances

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

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

These would be better described as performance requirements than principles but we agree that they are important and necessary.

We would highlight that the UK, in reality, has little control over interoperability. This will be primarily driven by European and International standards organisations. Many feel that we have been under-represented in these organisations for some time and we would recommend that consideration is given to allocating more resource in this area if we want to have influence over the outcomes.

***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)*

As noted above, it is likely that developments outside the UK will provide the major drivers on appliance manufacturers. The UK should take all necessary steps to engage with and influence these developments. We fully expect that all three options will be used to greater or lesser extent.

There does seem to be a key role for government to ensure that development of flexibility is supported by the global supply chain for mass market products.

The IET and ESC's Future Power System Architecture project is exploring this area, and will doubtless provide sensible suggestions for GB; however progressing its recommendations will probably be mainly for government to do.

***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)*

No specific evidence; all of the above are candidates and will all be important (and EVs of course). The following observations might be helpful.

- Wet appliances - Probably the most flexible of domestic appliances – but rarely used at time of peak demand so limiting their flexibility value for peak demand reduction. However, potentially useful to 'mop up' excess renewable generation and take advantage of low spot prices (or home-generated solar PV output).
- Cold appliances - Good for dynamic frequency response because they are 'always on' (subject to thermostatic control) and therefore available to respond instantly if equipped with a simple, cheap frequency transducer.
- Heating, ventilation and air conditioning – Flexibility dependent on the technology used, thermal inertia/insulation of the application and customer needs. Can be relatively price-inelastic. Hybrid heat pumps that can use gas to meet peak demands do provide flexibility.
- Battery storage systems - Very flexible – able to limit both import and export (of solar PV power) but currently expensive (long / uncertain pay-back)
- Others – EVs have a high degree of flexibility in terms of the time of day they are recharged, which will be important to exploit through 'time of use' incentives and/or smart charging systems.

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

No, provided the question includes all of the network charging aspects covered in Chapter 2.

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

While energy is probably fairly well regulated internet provision is much less so from a customer protection point of view. It is likely that some services will rely on the internet, possibly at the point of use. There is nothing like the customer protection for poor service from ISPs that exists for energy. If ISP provision is part of future energy delivery reliability it should be regulated in the same way.

ULEV

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

Through the manufacturers and distributors. This is a sector used to extremely intrusive regulation. Government should be taking action now, as suggested in the recent ULEV consultation, to build appropriate standards into vehicle regulations. However, the requirements and specifications are clearly still to be developed by the emergence of flexible smart networks.

We expect that this is another area where UK regulations will have to take second place to international or at least European regulations. To achieve interoperability throughout Europe (such as taking an electric car on holiday) will need compliance with EU standards.

***Q34**. What barriers are there for vehicle and electricity system participants (eg 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?*

The biggest barrier is that DSR and flexibility arrangements are not yet mature, so the participants cannot develop propositions with confidence. The CfE process is a welcome step to providing greater clarity.

One challenge relating to bullet point two (V2G) is the integrity of the despatching system that requests regeneration to the grid. If we simply make battery chargers frequency-dependent, there is no need for a despatching system but a sudden drop in frequency could cause overcurrent in the distribution network, particularly LV feeders. Similarly, if V2G is only used to reduce to zero the demand from one consumer or a group of consumers, it would not have any dangerous failure modes. However, if V2G is requested from a central balancing system (via the smart meter network?) a widespread false "regenerate now" signal could cause serious problems - possibly also defeating some network protection. We are aware that these and other related issues have been raised in the DfT's consultation on proposed ULEV measures for inclusion in the Modern Transport Bill. We would encourage close working between BEIS and DfT to ensure that coherent proposals are brought forward recognising the vital linkages between the needs of electric transportation and the electricity system.

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

We have not responded to this question.

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?*

We have not responded to this question.

***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?*

We have not responded to this question.

***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?*

We have not responded to this question.

***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 (ie in terms of trigger points)?*

At the latest it should be when they are on the point of acquiring potentially disruptive, or alternatively high DSR value, appliances such as EVs or heat pumps etc. But a more holistic long term campaign possibly, all though not definitely) associated with smart metering might be appropriate.

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*

To some degree the social impacts will be self-limiting. The biggest opportunity for DSR comes with new appliances, such as heat pumps and EVs, and to a lesser extent new white goods. In many cases, although certainly not all, the use of such appliances by vulnerable customers will not be inherently different to that of other customers, so no particular disadvantage will accrue. It will be necessary, however, to ensure that vulnerable customers have sufficient support where necessary to understand the implications of engaging with smart products and services.

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

In our view, it is highly likely that certain parties will attempt, and sometimes succeed, in hacking into smart systems to compromise the electricity system.

Cybersecurity researchers at the Weizmann Institute in Israel have recently demonstrated how to take control of smart lightbulbs and reprogram their firmware to control their behaviour at will. They were able to do this with an entire building on the Weizmann campus when driving by in a car, also by means of a drone which they flew near the building. The technical paper is at http://www.wisdom.weizmann.ac.il/%7Eeyalro/iotworm/iotworm.pdf . The compromised devices were made by an established European high-tech company and they used an industry standard ZigBee protocol.

It is unlikely that this is a one-off. Cybersecurity expert Bruce Schneier has pointed out in a recent article which originally appeared in the Washington Post how the characteristics of this attack generalise to other populations of "smart" building devices https://www.schneier.com/crypto-gram/archives/2016/1115.html#4

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

We would highlight the risk that large areas of heavy variegated electricity use (eg, large clusters of buildings, say in a city centre; rather than large industrial plants) can be commanded at will by external entities, who could thereby cause uncontrolled and uncontrollable fluctuations in electricity demand sufficient to cause large-scale outage in, or even damage, the parts of the grid system and devices connected to it.

We would also point out that, currently, the manufacturers of the devices that may be attacked bear no responsibility for the impacts of the attack. There is therefore a reduced incentive to make these devices and the systems that control them secure against such attacks.

Once again, this is not a UK specific challenge. It will only be addressed successfully by engagement internationally.

5. The roles of different parties in system and network operation

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

We welcome the fact that the CfE acknowledges the growing need for whole system thinking, both within the electricity system and in the way its operation impacts other energy vectors. We are pleased to see reference to the "Future Power System Architecture"[7] report that was commissioned by Government and delivered jointly by the IET and the Energy Systems Catapult. This report

[7] http://www.theiet.org/sectors/energy/resources/fpsa-project.cfm?origin=reportdocs

identified thirty-five new or significantly modified power system functions that are required to meet 2030 power system objectives. Many of these functions relate directly to delivering a smart, flexible energy system and we would recommend that BEIS and Ofgem consider the report's findings as part of this CfE process.

We would suggest that two important drivers for change should be added. The first can be captured under the heading of 'big data'. Near universal access to the internet and the ability of data to be generated and communicated so easily are in themselves drivers for change. Secondly, there is the issue of quality of supply. This is more than simple continuity of supply. It also embraces voltage variations and harmonic distortion of the AC waveform. As we grow ever more dependent on electricity there needs to be clarity about the quality of supply we require and how the responsibilities for delivering this are shared between customers, network owners/operators and device manufacturers.

These two drivers feed through to the list of emerging system requirements. There is a clear requirement for the total system to include and/or interface with the communications systems that it will depend on. Data and cyber security are obvious system requirements. We would emphasise that "system" as used here includes everything on the customer side of the meter. Regarding quality of supply, there needs to be a clear understanding of the future supply characteristics that we will require.

***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 data but we would suggest that the Transform model, developed by the Smart Grid Forum, might still be the best tool for estimating potential savings, provided that its capabilities are properly understood.

***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?

We consider that the description of a DSO's role in 5.2 lacks detail and clarity. Part a) represents the status quo and part b) simply says, "…an increased role in delivering an efficient, co-ordinated and economical wider system." There needs to be a much better description of what this increased role might be. In particular, is there any intention to make changes to the current electricity distribution licence to reinvent a DNO as a DSO? This feeds back to the discussion in section 2 regarding the operation and ownership of storage.

We agree that there needs to be much better co-operation between the DNOs, SO and TOs but consider that licence changes may well be required to ensure that this happens. We are surprised that this is not discussed in the CfE. We are also concerned that there does not appear to be a clear linkage between the ideas in the CfE and the Ofgem consultation on industry code governance published on 9 November. In fact, there are very few references to the Grid and Distribution Codes in the CfE.

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?

We agree that further progress is needed. We believe that we are just starting the journey to the realisation of a smart system and that the number and scale of the challenges will increase in the next few years, particularly if we reach particular tipping points. For example, we think it quite likely that EVs could 'take off' by the end of this decade (ie more quickly than assumed in the RIIO ED1 business plans) and we are concerned that the DNOs' regulatory settlements, based on assumed lower levels of take-up of EVs, might act as a barrier to investing in the development of smart charging systems. It will be important to ensure that the most efficient network solutions are consistently deployed across GB.

We understand that under RIIO efficient, innovative solutions should be brought forward by the network companies without regulatory intervention. However, it is not clear that RIIO properly incentivises solutions that cut across the customer/distribution/transmission boundaries. There is a general recognition that whole system approaches are now essential. Ofgem should therefore consider whether the RIIO mechanisms need adjustment to ensure that beneficial whole system solutions are delivered and not disincentivised due to the benefits being conferred to parts of the system which are not part of the DNO's regulatory asset base (for example the transmission system) or conferred to users of the system in terms of lower connection charges.

c) Are there any legal or regulatory barriers (eg including appropriate incentives), to the immediate actions we identify as necessary? If so, please state and prioritise them.

There does appear to be a barrier in respect of network development schemes that have costs and impacts across the TO/DNO boundary. So, the most efficient solution to a TO/SO problem might be to invest in the DNO network. We understand that there is no established way of deciding how such a solution should be agreed and funded if it wasn't allowed for in the network company's business plan. If our understanding is correct this does need addressing with urgency.

The CfE says that BEIS/Ofgem believe that there are market-based solutions to many of the challenges identified but that the onus is on the industry to deliver them. The only positive action proposed is to carry out a progress review at the end of 2017. We consider such a 'hands off' approach to be very risky. We have already highlighted the risk that demand-side tipping points might occur in the near-term. We would expect there to be coherent plans in place to prepare for such events and to respond to them once they occur. On behalf of customers we would expect BEIS/Ofgem to make sure that such plans are in place.

As suggested in our response to Q45, we consider that licence changes may be required to ensure that whole system approaches become business-as-usual in the near-term.

***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?

Yes. We have already referred to the "Future Power System Architecture" report in our response to Q43. The approach set out in the CfE is essentially evolutionary and industry led. We consider their to be significant risks in taking this approach, in particular that the new functionalities identified in the "Future Power System Architecture" report will be delivered in a timely way.

b) What are your views on the different models, including:

i. whether the models presented illustrate the right range of potential arrangements to act as a basis for further thinking and analysis? Are there any other models/trials we should be aware of?

ii. which other changes or arrangements might be needed to support the adoption of different models?

iii. do you have any initial thoughts on the potential benefits, costs and risks of the models?

The models presented in Figure 2 of the CfE are very simplistic and therefore do not reflect the complexity of the relationships between all the parties involved in the electricity supply chain. We would commend to you the IET's report, "Britain's power system (the case for a system architect)"[8], which explored the potential future models in some detail. We would also draw attention to the Smart Grid Architecture Model (SGAM)[9] which provides a very useful aid to thinking about roles and responsibilities. Its approach provides connections between the physical assets of the power system to the business and regulatory frameworks via communications, information and functional operations layers. Future operating models should be capable of implementing and discharging the functionality identified in FPSA. As such it seems likely that models with a strong local management capability will be the most successful.

In short, the ideas set out in the CfE need significant further work, involving all stakeholders, to develop a model that is fit for purpose going forward, enables and encourages innovative approaches to system flexibility and has wide support amongst stakeholders.

The IET is continuing to work with the Energy Systems Catapult to extend the thinking and ideas captured in the "Future Power System Architecture" report and will be very pleased to work with BEIS and Ofgem to help shape the development of the power system.

6. Innovation

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

Setting out a clear, whole-system vision of the energy infrastructure we need is the most important role for Government. Support should be targeted at removing barriers to delivering this vision.

We think that Section 6 of the consultation paper correctly identifies many of the areas that need to be developed. We also believe that much intellectual energy is expended on thinking about how to make ideas work in the current market structure.

We are not aware that much development work has been done in the practical implementation of home energy management systems, and the developments of standards for the interoperability of home appliances, including EVs, with each other, with HEMS and with the wider power system. Cleary the expectations of the smart metering system are known in this context, but this is likely to be only part of the functionality that customers will actually want. More development of appropriate open standards in this area would be a good investment.

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.*

Innovation is required in each of the four areas identified. We believe that Government funding should primarily be directed towards challenges that it can take action to address. Government's most important role is to set a clear vision and direction of travel for the energy industry and then enable other parties, particularly new entrants, to bring forward ideas that help deliver it.

We believe that the funding landscape in the energy sector could be made easier to navigate, again, especially for smaller players. We offer comments on each of the four areas.

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[8] http://www.theiet.org/factfiles/energy/brit-power-page.cfm
[9] https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf

Automatic DSR – the CfE acknowledges that considerable work has already been done in this area, including trials. We would suggest that if further trials are to be funded they should be clearly focused on addressing the barriers that are preventing suppliers from bringing forward products and services that will expand the DSR market. A first step would be to consolidate the learning from all the trials that have already taken place, perhaps going back to the Ofgem Electricity Demand Research Project[10].

Flexibility trading/optimisation platforms – we agree that this is a priority area for further research. Also, this is not an area where individual stakeholders can make progress unilaterally. It is therefore an area that needs leadership across the stakeholder community, a role that BEIS and Ofgem should take.

Storage costs – it is not clear to us that large scale demonstration projects will necessarily drive down costs. Cost reduction of storage is more closely connected to the performance of the technologies employed, materials costs and manufacturing processes as mentioned in the CfE. We are aware that the EPSRC's Supergen programme is already funding an energy storage research hub (aka The Energy Superstore[11]). We would strongly encourage a joined up approach to research funding for storage taking account of international activity as well as UK programmes.

Vehicle to grid demonstrations – we would expect there to be considerable appetite in the commercial sector to pursue V2G demonstrations – this is off international interest of course. Our comments about DSR above apply equally well here.

[10] https://www.ofgem.gov.uk/gas/retail-market/metering/transition-smart-meters/energy-demand-research-project
[11] http://energysuperstore.org/