Plan for A Smart, Flexible Energy System: a call for evidence

This is a collaborative response from staff and students at the EPSRC Centre for Doctoral Training in Energy Storage and its Applications (CDT-ESA) at the Universities of Southampton and Sheffield.

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Removing policy and regulatory barriers - Enabling storage

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?.

- DNOs are generally extremely reluctant to use services provided by third parties to meet their regulatory targets in regard to requirements under the Electrical Safety, Quality and Continuity Regulations and associated standards. Conversely the TNO uses largely contracted services to meet statutory requirements. Allowing storage operators to, for example, control system voltage through either real power generation or supply of VARs could be very beneficial to DNOs provided adequate reliability standards are imposed. [RL]
- Under the EU and GB legislation, energy storage is not considered as a separate asset, but as generation. A generation license is necessary in GB, unless the storage capacity is below 10 MW (or 50 MW). [AG]
- Unbundling requirements: DNOs are not permitted to own and operate storage systems, which need a generation license. This impedes energy storage growth as a way to reinforce or expand the needs of the network. The current exemptions allow DNOs to deploy small scale storage systems. [AG]
- De-minimis restrictions: The total revenues and investments related to energy storage are capped at 2.5% of the overall DNO activity due to the regulations, set by the 1989 Electricity Act. [AG]
- It would be beneficial to energy storage, as it can be very fast acting (<1 sec), to consider operation and pricing in a market with settlement periods (and pricing signals) significantly less than the current 30 minute window. [AC]

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?

- Identifying the most beneficial sites for distributed storage requires more active involvement of DNOs, a willingness to procure constraint management services from third parties and clarity on the required reliability of embedded storage systems.[RL]
- Current experience of the connection request from DNOs is that storage is still treated fundamentally as generation. This needs to be changed and I would welcome greater use of the proposed ENA storage

connection application form to better consider storage connection requests and the services they could offer. [AC]

3. Have we identified and correctly assessed the issues regarding storage and network charging? Do you agree that flexible connection agreements could help to address issues regarding storage and network charging?

- There may be double counting of final consumption levies on storage located behind a single meter if that electricity is subsequently exported. In a situation where a large number of small scale storage systems (such as domestic batteries) are being controlled by an aggregator and perhaps selling services to the DNO, then the control philosophy would likely require export of power to the network that would then be re-consumed at other local properties that do not have storage systems. [RL]

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?

- There are potential issues around how reliably storage systems could deliver the services required by DNOs. It may be that a more sophisticated approach to procurement of services in combination with relaxation of some standards under stress events (such as demonstrated as possible under ENWL's "Customer Voltage & Power Quality Limits" IFI Project) is required. [RL]
- DNOs should be able to own and operate storage within their networks as intrinsically such storage capability will assist with the network operation in terms of control and security. [AC]

5. Do you agree with our assessment of the regulatory approaches available to provide greater clarity for storage?

- It seems appropriate to adopt option (b) as a short term solution to some of the current issues with a view to moving towards (c) or (d). [RL]

6. Do you agree with any of the proposed definitions of storage? If applicable, how would you amend any of these definitions?

- Given that the SO procures demand response services, in the form of reduced demand, it may be appropriate that the definition for storage needs to encompass the delivery of stored energy in an alternative form (most likely heat) rather than simply the conversion back to electrical energy. This is effectively already done with economy 7 heaters, but a greater move to electrical heating through heat pumps and the need for more dynamic 'charging' of the heat store to match peaks in renewable generation, is likely to provide as much opportunity for balancing electrical demand as direct electrical storage and generation. (I.e. supplying heat from a heat store in an electrically heated building is directly equivalent to storing electricity and resupplying it at the time of peak heat demand). [RL]
- It should also be considered that superconducting magnetic energy storage is a method for storing electricity directly without the need for conversion. [GH]
- Would support definition of storage as (d) new activity type to permit subsequent legislation dealing with energy conversion e.g. to/from electrical energy to alternative energy type, and bundling of services I.e. security as well as demand side response. [AC]

Removing policy and regulatory barriers - Aggregators

7. What are the impacts of the perceived barriers for aggregators and other market participants?

- Extracting value from the balancing mechanism and wholesale market - Aggregators need to be able to extract value from providing DNO services as well as SO services; it is not clear how these may be combined. [RL]

- Consumer protection - Consumer protection will be required for small businesses and domestic consumers since it may become possible to compromise consumer activities, lead to loss of value for consumers (e.g. poor control of freezers) or potentially reduce heating to unacceptable levels for vulnerable consumers. [RL}

Do you have evidence of the benefits that could accrue to consumers from removing or reducing them?

- Consumers already face a baffling array of providers, tariffs, comparison and switching services. A service-offerings framework may be required that provides consumers with clearly defined standard products provided by all market participants so that direct like-for-like comparisons can be made. Additional innovate product offerings should also be allowed to encourage further competition. [SJ]

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

- Underlying the electricity market is a basic commodity so the focus for regulators must be on market participants adding value to operators and consumers, not simply choice for its own sake. [SJ]

9. What are your views on the pros and cons of the options outlined in Table 5?

- With system stability being the most important consideration any approach that requires analysis and subsequent redress will likely be ineffective. More active management and response will be required until the role and operation of aggregators are better understood. [SJ]

10. Do you agree with our assessment of the risks to system stability if aggregators' systems are not robust and secure? Do you have views on the tools outlined to mitigate this risk?

- As is being revealed in the field of autonomous vehicles, approaches to control need to be balanced between formal logic, to address critical system operation, and 'learning' to optimise the value and benefit offered to operators and consumers. [SJ]
- Yes: there are clear risks to system stability if aggregator systems are not adequately robust, secure and indeed reliable. There needs to be a consensus approach amongst DNOs as to what level of reliability is required. [SJ]
- In relation to data security it must be acknowledged that a huge amount of information can be inferred from electricity profile data at high resolution and such data could be misused; for example identifying periods when a house is unoccupied leading to theft. The same data does, however, have potential benefits in that it can be used to identify energy savings opportunities. [RL]
- Although rapid simultaneous operation of large amounts of storage would likely cause system stability issues, it is also important to consider that stability issues may arise from poor coordination between storage units e.g. if the same 2 storage units affect the voltage on the same network bus but are not coordinated, it may result in undamped oscillation of output between the 2 stores if inadequate control strategies are employed. It may therefore be important to consider the degree of coordination that is likely to be required to prevent such issues arising [RCJ]

Providing price signals for flexibility - System Value Pricing

14. Can you provide evidence to support changes to market and regulatory arrangements that would allow the efficient use of flexibility and what might be the Government's, Ofgem's, and System Operator's role in making these changes?

- Some of the benefits from the usage of storage will be delivered in a timeframe less than half an hour. Hence a change to a settlement period of significantly less than half an hour should be considered to help extract the maximum benefit of the energy absorption/delivery of an energy store, which may only be for a few seconds, but could contribute greatly to the stability and operation of the network. Half hourly

settlement within such a context is a significant disadvantage. What is the rationale behind the definition of half hourly settlement versus smaller timescales? [AC]

Providing price signals for flexibility - Other Government Policies

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

- It is clear both the RO for wind and the FiT for solar have been hugely successful in terms of incentivising a growing market for wind and solar power respectively, evidenced by the rapid installed capacity base in both technologies. Hence such government interventions have clearly been useful to kick start and develop these technology areas and similar mechanisms could clearly work in the storage sector if deemed necessary. [AC]

A system for the consumer - Smart Appliances

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

- No as "energy consumption" should also reflect the nature of "smart" distributed generation or storage assets. For example, renewable assets at the residential end such as wind or solar micro-generation to the potential utilization of electric vehicles or home batteries as an aggregated grid battery etc. [JM]

A system for the consumer - Ultra-Low Emission Vehicles

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

- The predicted growth in the use of EVs poses significant challenges to the grid system as a whole. These are correctly assumed to be local area network stability issues associated with high power flows to a number of EVs requesting charge within a local, domestic area, and whole network capacity issues associated with un-restrained EV charging patterns. [GH]
- Fresh evidence of the growth of EVs and their associated energy storage capacity is being produced currently by the Advanced Propulsion Centre (APC) and Automotive Council via an update to the energy storage roadmaps. [AC]
- Smart charging has the potential to alleviate the latter through modulating the overall charging patterns of EVs in a similar way to demand side management. This would be enabled by smart tariffs leading EV owners to seek out the cheapest method for charging their EV. It is anticipated that this would occur automatically similarly to the suggested method for smart appliances elsewhere in this document. [GH]
- There is, however, only limited potential for smart charging to alleviate local area issues highlighted in 4.10 without very costly and complex systems in place which would single out specific EVs for charge/discharge on each feeder. The load of a high number of EVs on the local network will be greater than the trough to peak difference currently seen on domestic feeders, as such, switching EV charging to the trough will still lead to exceeding of local network constraints. There is to be a significantly higher level of overall demand following high EV penetration levels and this cannot be avoided through choosing when to charge the EVs. [GH]
- The role of fast and ultra-fast charging for EVs should not be ignored in the smart network. Ubiquitous availability of these charging methods would reduce EV owner's reliance on domestic charging, thus, alleviating local area issues highlighted in 4.10. Pairing these chargers with renewable energy sources and energy storage, within one system, allows for both a greater penetration of renewable energy within a

constrained network and facilitates the use of EVs. Evidence of this will follow with a pending publication by George Hilton and Andrew Cruden, University of Southampton. [GH]

- With regards to the vehicle to grid concept (mentioned in 4.13) it should be noted that a major concern is the negative impact on the lifetime of the electric vehicles' batteries. The associated costs and risks to vehicle owners, although difficult to quantify, should be at least compensated by any payments/deductions to encourage participation. A reduction in the lifetime of electric vehicle batteries also increases the demand for effective battery recycling (or, where possible, second life usage of batteries). [HK]
- It should also be noted that both, smart charging and vehicle to grid are not necessarily limited to pure electric vehicles, but should also be considered for plug-in hybrid electric vehicles. Typically, the battery packs of such vehicles have lower capacities than those of pure electric vehicles, hence reducing the potential benefit per vehicle. However, given that plug-in hybrid electric vehicles are currently more common the combined potential benefit can be significant. [HK]

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:

- It should be noted that a pursuit of electrification is not the only change afoot in the automotive industry. Autonomous drive may radically change the usage patterns of vehicles. This has the potential to prove wrong the assumption stated in 4.11 that EVs will spend the majority of their time stationary and plugged in. The trend for reducing levels of vehicle ownership (particularly in cities) will lead to higher usage of those left in circulation. This is encouraged by the growth of vehicle sharing options such as Uber and the intention of Tesla Motors to turn the personal vehicle into a financial asset, earning income for the owner by acting as an autonomous taxi. These trends should not be ignored when creating policy as single use of vehicles may not be the norm when the smart grid ideal comes to fruition. [GH]
- The role and market access/regulation of aggregators will be critical for the delivery of a V2G system as the benefits of V2G come from aggregation of multiple EVs which would require a 3rd party (or DNO/DSO) aggregator, as individual EV owners will not (or are high likely not to) participate in such a market. [AC]
- For vehicle-to-home this may require consideration under a G83 engineering code, hence would need the ENA to revise this current engineering recommendation to accommodate storage within this role. In essence the issue is the vehicle, possibly having been charged elsewhere to the home, transports and delivers this energy to the home, thereby reducing local network load accordingly. [AC]
- In terms of a vehicle manufacturer it is currently hard enough to convince people to buy an EV due to current perceptions of EVs. Both of the above points add the possibility of inconvenience to the consumer, i.e. if they unexpectedly need their vehicle they may find they do not have enough battery charge to complete their journey, whereas if these charging/V2G controls were not in place they would have enough energy to complete their journey. Although this is likely a very rare event it would add to consumers concerns that the EV will not meet their needs and therefore lower EV sales. Perhaps these charging/V2G controls could be added in the future once EV penetration has increased and consumer's perceptions have changed. [TB]

Innovation

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

- The area of energy storage within the electricity network is a new technology area and hence a new skill set (e.g. increased electrochemistry and power electronic knowledge) is required. Increased personnel numbers undertaking appropriate skills training, at all levels from technician through to PhD level, is required to deliver such an ambitious Smart, flexible energy system. Activities such as the Centre for

Doctoral Training in Energy Storage and its Applications (www.energystorage-cdt.ac.uk) are required to deliver the research leaders for this new sector. [AC]

48. Do you think these are the right areas for innovation funding support?

- Yes, I support the areas for innovation support defined, including the forthcoming KTN led Vehicle-to-Grid scoping workshops e.g. London, 17th Feb 2017. Such events, and future funding calls, will elicit technically innovative projects in this field, in a similar fashion to LCNF Calls developed and led on network use of energy storage. [AC]