Response from

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Electricity interconnection and storage

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In line with the published terms of reference, the Commission is seeking evidence on how changes to existing market frameworks, increased interconnection and new technologies in demand-side management and energy storage can better balance supply and demand.

1. What changes may need to be made to the electricity market to ensure that supply and demand are balanced, whilst minimising cost to consumers, over the long-term?

- *What role can changes to the market framework play to incentivise this outcome:*
  - *Is there a need for an independent system operator (SO)? How could the incentives faced by the SO be set to minimise long-run balancing costs?*
  - *Is there a need to further reform the "balancing market" and which market participants are responsible for imbalances?*
- *To what extent can demand-side management measures and embedded generation be used to increase the flexibility of the electricity system?*

A first step, in responding to this question, is to clarify the meaning of 'demand' (www.demand.ac.uk). In many discussions, demand is equated with current levels of consumption. This is the benchmark and the point of reference in terms of which strategies of 'supply' are arranged. In this context, demand side management techniques represent a means of ensuring those current, taken-for-granted levels of consumption can be delivered.

Although very widespread, these assumptions overlook the longer histories both of provision and of consumption (Hughes, 1993 [1983]; Nye, 1999; Forty, 1986). In effect they assume that demand, in the sense of a 'need' for electricity is simply there: waiting to be met: hence the challenge is one of meeting need – whilst minimising cost to the consumer and meeting carbon emissions targets.

In fact, demand and the use of electricity is in large part an *outcome* of systems, technologies and institutions of provision and supply. As is widely known, but also routinely forgotten, current levels of consumption (and their timing) reflect concerted and systematic efforts to build demand in ways that suit the 'needs' of generation – for profit, to cover the cost of past investment, to operate efficiently, and to cater for domestic and industrial markets. Classic accounts of this refer to the role of electricity companies in selling home appliances to help build demand during the day, or of promoting night storage heaters as a method of peak load management. These are not just historical curiosities. Demand, in this sense, is continually reproduced and 'built' in just the same way today.

If we think of demand in this more fundamental sense – not equating it with current levels of consumption, but taking it to be an expression of what electricity is used for in society (Shove and Walker, 2014), of the social practices that have become 'electrified', and of how these develop and change over time, we would come up with a very different 'reading' of the question outlined above, and would provide correspondingly different answers.

From this point of view, the 'flexibility' in the energy system is inextricably tied into the 'flexibility' (or not) of the social, spatial and temporal ordering of practices that have come to depend on electric power. Peak loads are thus an outcome of what is called 'societal synchronisation' (Shove, 2009): these being points in the day, the week or the year when many people are engaged in similar energy demanding practices at the same time. The likely outcome of initiatives like real time pricing are consequently filtered through a mesh of social/institutional arrangements which define and determine the scope for shifting 'demand' (i.e. energy consumption) in space and time.

A further obvious point is to notice that the scale of the challenge of balancing supply and 'demand' in the sense of current consumption, relates to the overall scale of demand itself. If total consumption was less, if it occurred at different places and times, the task of meeting it would be different. Again it is critical to recognise that demand – in this more fundamental sense - is itself dynamic. It should be recognised that new investment in electricity infrastructures means making decisions about building the future of demand as well as of supply.

2. What are the barriers to the deployment of energy storage capacity?

- *Are there specific market failures/barriers that prevent investment in energy storage that are not faced by other 'balancing' technologies? How might these be overcome?*
- *What is the most appropriate scale for future energy storage technologies in the UK? (i.e. transmission network scale, the distributed network or the domestic scale.)*

In thinking about this question, it is important to realise that people do not use 'energy' as such: they use the services it provides. These take different form, and it is this which matters for the temporal relationship between generation, 'storage' and use, broadly defined. If we were to think about keeping warm at home, as a service, it is apparent that this can be configured in different ways, and with an array of technologies some of which arguably 'store' energy: e.g. the fabric of the home itself. Again the question posed above would be interpreted and responded to very differently if we accepted that buildings, and potentially clothing, were included in the energy system (Walt Patterson, http://www.waltpatterson.org/mewfinal.pdf), being also implicated in delivering energy services.

A second unorthodox issue to consider is again the relation between the timing of generation and consumption. Large scale policies of storage, especially relating to renewables, suppose that whilst the timing of generation/supply is unpredictable, and fluid, the timing of demand is not. Again this has not always been the case. For example, there may be scope to move the timing of significantly energy-demanding activities to periods when renewable energy is in good supply, thus avoiding the need for storage. In the

Netherlands, only millers were allowed to work on Sundays, an exception that was made to allow them to grind grain whenever the wind happened to blow. See: http://www.lowtechmagazine.com/2009/10/history-of-industrial-windmills.html.

There are modern equivalents to this strategy that could and perhaps should be developed further.

Third, and again illustrating the complex relation between timing, practice and energy demand, the potential for using EVs as storage systems for domestic power depends on related temporal and spatial patterns of mobility and on the scheduling of activities which structure the when and the where of energy consumption. The key point here is that space and location are as important as time and timing. Further, the organisation of 'storage' which can be of resources (fuels), as well as of power is closely linked to systems of provision and to the supply chains involved. More decentralised systems imply different distributions of storage as is evident in quite unrelated cases, such as the use of wood-fuel (Jalas and Rinkinen, 2013).

3. What level of electricity interconnection is likely to be in the best interests of consumers?

- *Is there a case for building interconnection out to a greater capacity or more rapidly than the current 'cap and floor' regime would allow beyond 2020? If so, why do you think the current arrangements are not sufficient to incentivise this investment?*
- *Are there specific market failures/barriers that prevent investment in electricity interconnection that are not faced by other 'balancing' technologies? How might these be overcome?*

Responding to this question depends, above all, on how one interprets 'the best interests' of consumers, in the UK and elsewhere, now and in the future. Concepts of 'the consumer' and of 'their interests' are necessary, but also necessarily abstract, figures in such discussions. At a minimum, it is important that any response to the seemingly technical question of markets/interconnection etc., is explicit and reflective about the idea or image of 'the consumer' on which they depend.

4. What can the UK learn from international best practice in terms of dealing with changes in energy technology when planning to balance supply and demand?

The UK is not alone in building energy demand, and in organising related systems of provision. Rather than supposing models of predict-and-provide, it would be useful to learn from planned or unintended situations of decline (e.g. in some parts of France), in which the entire electricity system is 'shrinking'. There are other parallels in the water sector, e.g. in Berlin (Moss, 2009; Moss, 2000). Networked systems – also including gas – are often predicated on delivering certain levels of supply. It is rather unclear how these systems might work, technically, financially or institutionally, should demand decrease substantially, or in specific parts of the system. Issues of scale (both of demand and supply) are critical also in more 'decentralised' systems (van Vliet et al., 2005).

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