# Response to the National Infrastructure Commission Consultation on Electricity interconnection and storage

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**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?

*Market framework*

Historically, the electricity market has balanced supply and demand primarily by adjusting supply through altering the level of flexible electricity generation from fossil fuels, plus some pumped storage and demand response at the margins. In the future, the proportion of fossil fuel generation will decline and its load factor will also reduce due to a combination of increased generation from variable renewable technologies (largely wind, with some solar) and greater variability in demand (across days and seasons due to the greater electrification of heat and transport).

Against this background, incentivising the build of new 'conventional' infrastructure (typically large-scale and capital intensive, with long life-times) now, according to the current paradigm, risks systemic lock-in or stranded assets – leading to unnecessarily high overall costs. An approach which considers the long-term direction of change within the electricity market is therefore needed, while retaining the flexibility to adjust to the details of developments.

For the UK to successfully decarbonise its energy system requires not just new technologies, but new market frameworks and ways of doing business. Improvements in ICT, together with energy market liberalisation, offer the potential for new business models that challenge the incentive to increase profit by increasing energy sales.[1] To enable this, markets need to evolve over the next decade to incentivise the provision of energy services, rather than the consumption of energy, and to consider the whole energy system, recognising heat as a critical component, while meeting the flexibility challenge.

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[1] See for instance Roelich, K. and S. Hall (2015) Local Electricity Supply: Opportunities, archetypes and outcomes. https://research.ncl.ac.uk/ibuild/outputs/local_electricity_supply_report_WEB.pdf

*Measures for increasing flexibility*

The precise role that can be played by different flexibility measures is still uncertain but, on the basis of recent studies, demand side management and energy storage (which can overlap technologically) appear to offer cost-effective ways of ensuring reliability in a low carbon energy system in the medium to longer term. The impact of embedded generation may be positive or negative, depending on its operation.

The current analysis, however, is limited, and there is an urgent need to investigate how new technologies can be integrated within future energy systems both technically and under different market frameworks.

Though the costs of energy storage technologies are expected to continue to fall, and its value to rise, the current commercial case is not strong in the UK. We conclude, therefore, that new mechanisms need to be put in place that recognise its potential role. Two options possible options (not mutually exclusive) are:

- Energy storage could be considered as a regulated asset. This might make sense for network-connected facilities that have public-good characteristics.
- Greater participation within the EMR framework, through the capacity market (with special auctions for new energy storage and demand side response technologies, that go beyond the current short-term transitional arrangements) or contracting flexibility through Feed-in-Tariffs (possibly alongside renewables).

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

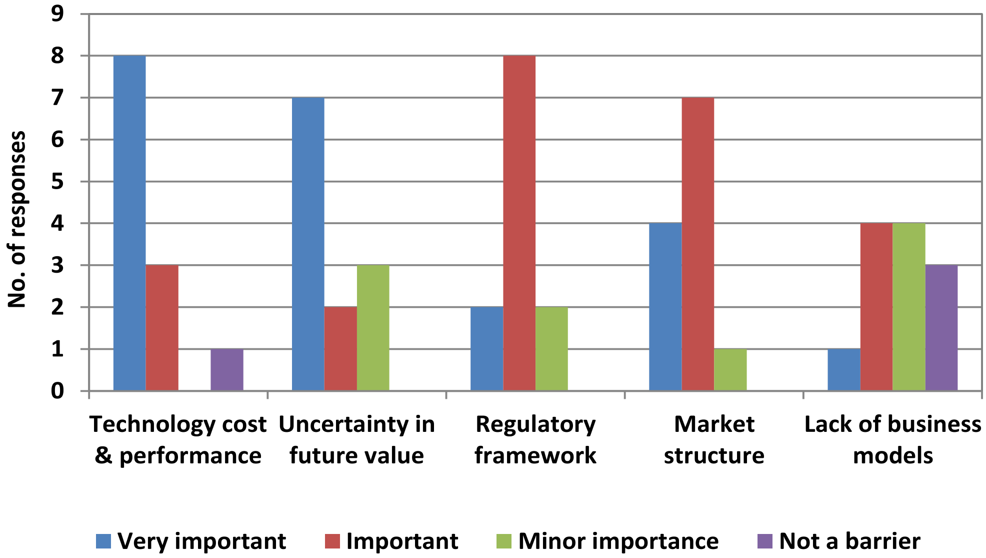
- Are there specific market failures/barriers that prevent investment in energy storage that are not faced by other 'balancing' technologies? How might these be overcome?
- What is the most appropriate scale for future energy storage technologies in the UK? (i.e. transmission network scale, the distributed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

The term energy storage encompasses a wide family of technologies with very different physical, operating and cost characteristics. Due to the different storage technologies available and the varying services that they can offer, it is likely that energy storage can play a role at all scales in the UK and potentially will therefore face different barriers.

We carried out some research during 2014 on these issues to understand the views of key stakeholders on barriers to energy storage and where storage was most likely to be situated on the system.[2] Below is a summary of our results.

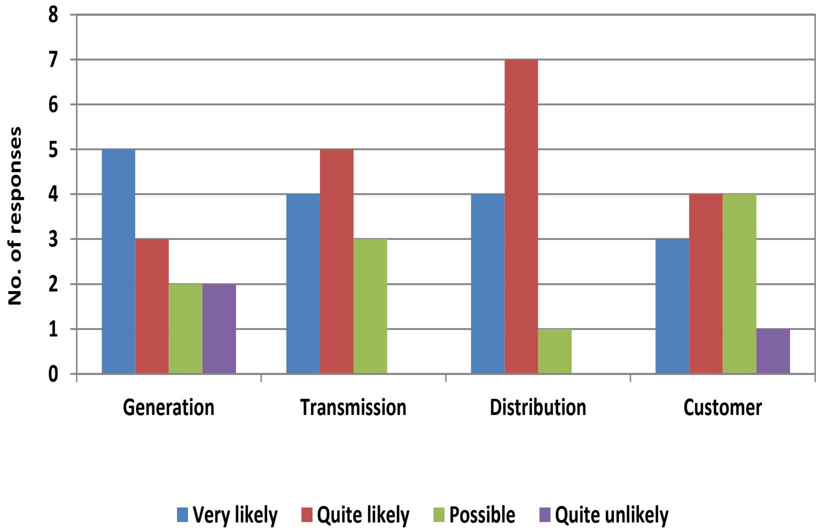
[2] See 'Energy Storage in the UK and Korea: Innovation, investment and co-operation', Appendix A4.2 (2014) Centre for Low Carbon Futures, for full details; available at http://www.lowcarbonfutures.org/energy-storage/korea.

***How important are each of the following barriers to the deployment of energy storage over the next 5-10 years?***




Technology cost and performance was seen as a very important or important barrier by all but one of the stakeholders, with uncertainty of future value also being highlighted as very important by more than half of respondents. A number of specific performance issues were highlighted by stakeholders in response to Question 9. The regulatory and market framework in the UK was also seen to be an important barrier. A number of respondents highlighted in particular uncertainty in the market and regulatory structure as a problem, rather than necessarily any need for further reform. The lack of business models was considered to be less of a barrier, with a number of respondents believing that business models would emerge if the commercial case was strong.

***How likely is additional energy storage to be situated on the following parts of the system?***



Locating storage in the distribution system was seen as very or quite likely by virtually all stakeholders. A number of reasons were given for this including that the small capacity size of some storage technologies were better suited to distribution rather than transmission, that the targets for distribution network operators could be easily realigned to drive storage uptake, that it could address grid constraints and that it was easier to have storage downstream in the value chain. Two-thirds or more also saw generation and transmission as likely or very likely locations for storage. In the case of generation the main role was seen as enabling the integration of variable renewables, such as wind farms. At the transmission level, the reasons given included economies of scale, the value of storage for fast response and dealing with volatility and the market to provide National Grid with system services. Customer-level storage was seen less favourably, but this option was still rated very or quite likely by more than half of respondents. Those in favour often highlighted the role of storage alongside PV systems.

From considering these responses from stakeholders, and other studies[3] we identify six key barriers affecting the deployment of energy storage:

1. Technology cost and performance: the current price of many energy storage technologies is too great to give a business model for deployment, even if the full system value could be extracted. Over time, the technology costs and performance of storage technologies are expected to improve, and the value of storage will rise as renewables are deployed.
2. Uncertainty of value: the value of energy storage is dependent on the energy system mix - uncertainty in deploying renewables could reduce the appetite for investing in options that can address their variability. Further, energy models have so far been limited in their scope and ability to include storage, so estimates of value are still to be refined.
3. Business case: an energy storage technology could access multiple revenue streams in different markets and across timescales of seconds to days. A business model which captures those income streams is currently difficult to establish, as the technology will cut across traditional business boundaries and potentially need to extract value from both regulated and competitive markets.
4. Markets: the current market framework, which now includes a capacity mechanism, does not require the total cost of energy generation to be reflected in the energy price (so called "missing money" problem). This results in lower energy price fluctuations (through lowering peak prices) and so reduces the opportunity for energy storage to provide a service (and extract value) through arbitrage. This might not matter, if there were not also barriers to energy storage participating in the capacity mechanism (see 5) below. More fundamentally, the future long-term value of storage cannot be

[3] Energy Research Partnership (2011) 'The future role for energy storage in the UK' http://erpuk.org/project/energy-storage-in-the-uk/; Centre for Low Carbon Futures (2012) 'Pathways for energy storage in the UK' http://www.lowcarbonfutures.org/energy-storage; Strbac et al (2012) 'Strategic Assessment of the Role and Value of Energy Storage Systems in the UK Low Carbon Energy Future' http://www.carbontrust.com/resources/reports/technology/energy-storage-systems-strategic-assessment-role-and-value; UKERC (May 2011) 'The future of energy storage: stakeholder perspectives and policy implications'

recognized in today's market, with the consequence that other established technologies (i.e. thermal generation) crowd-out the space now, but lock-in future emissions.

5. Regulatory/policy framework: there are restrictions on network operators operating storage technologies on a merchant basis; and high network charges affect storage operators. The EMR process has continued to incentivize the provision of capacity and flexibility by established technologies, without sufficiently recognizing the longer term opportunities from new technologies.
6. Societal: large-scale deployment of energy storage could introduce new technologies at a local level, and larger scale facilities will need planning approval. Wider community acceptance is a pre-requisite if they are to be adopted, but little work has been done in this area.

**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?**

Our work with Korea has demonstrated the value of Governments providing clear signals to the market in terms of expectations and preferred options, rather than taking a laissez-faire approach in which scenarios are merely presented as options and for which the government has no view of the merits or otherwise.

We can also see markets for energy storage emerging in the United States (especially in California where a minimum level has been mandated) and Germany (where incentives were introduced to reduce the cost of installing batteries with small-scale PV).

In recent years public RD&D funding for energy storage has increased significantly – and storage has been identified as one of the Eight Great Technologies. However, while this "technology push" is welcome, there is a distinct lack support to deliver the complementary "market pull". Government should provide greater certainty over what it sees as the role of energy storage in the energy system and consider introducing policies that will encourage investment in the technologies from industry and allow the UK to take a position as a leading innovator.

Without creating the full innovation ecosystem, the UK could see the value from early stage funding being captured elsewhere, as technology development and manufacturing migrate to emerging markets and eventually the UK could end-up in the situation where it needs to import the energy storage technologies for which it funded much of the basic R&D.

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