Non-technical issues relevant to the deployment of Distributed Energy Storage

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Summary

The EPSRC funded C-MADEnS project has been researching a range of non-technical issues relevant to the deployment of distributed energy storage (DES), with a particular focus on batteries in households. Interim results from this ongoing work have shown:

- Under current market arrangements and with traditional business models, there is little financial benefit to householders from installing DES, even if they have PV installed.
- Changes to the regulatory system, combined with a range of innovative business models that allow householders to access new sources of revenue, would provide greater incentives for the uptake of DES. These developments could also result in an increased number of prosumers.
- Local authorities can play an important role as enablers in the development and deployment of DES to help meet local policy objectives. This is due to their powers in planning and procurement and their relationships with key actors, such as electricity and gas distribution companies.
- The general public is not currently well informed about DES. Both local and central government are seen as playing an important role in delivering credible information and practical support to help householders adopt the technology. Yet, at the same time, a lack of trust in public institutions may present a significant barrier.

Background

There is increasing interest in the role that distributed energy (electricity and heat) storage (DES) might play in a future energy system. The drivers for the increased uptake of DES include:

- carbon targets (local and national)
- rapid uptake of renewable technologies and the concomitant need for flexibility services;
- increased localisation of electricity generation (e.g. photovoltaics and combined heat and power);
- introduction of more district heating networks;
- falling costs of energy storage technologies;
- new sources of revenue that can be captured by innovative business models.

There are also broader policy priorities that may be relevant including improving air quality within city/regional boundaries, reducing energy poverty, improving housing provision, meeting industrial energy demands for economic growth, and developing new clean-technology industries – all of which implicitly require action on the energy system.

This policy brief highlights a number of issues that are relevant to the scale-up of DES deployment based on research undertaken by the EPSRC SUPERGEN Energy Storage Challenge project *Consortium for Modelling and Analysis of Decentralised Energy Storage* (www.c-madens.org).

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Regulatory environment

There is currently limited financial benefit to householders from installing DES. The value of DES comes from engaging in arbitrage (i.e. storing electricity when it is cheap and using it when electricity is expensive) and from selling services to the ancillary services market (which supports the operation of the transmission and distribution system). At the moment the vast majority of domestic consumers pay a flat tariff for their electricity and, even when a household has PV installed, the revenues from arbitrage are likely to be small.[2] The value of providing ancillary services may be greater but, at the moment, few consumers have direct access to this market.

However, the overall value of DES to the energy system is likely to increase as renewable technology deployment continues, and there may be wider societal benefits (i.e. positive externalities) that are not easily captured through the market. Policy and regulatory frameworks therefore need to evolve to prepare markets for these future developments and remove unnecessary barriers so that the economic value of DES can be realised in the future.

Work to date has focused on the role of local authorities in enabling the deployment of DES. With the potential to lower costs, improve the reliability of energy supplies and reduce emissions from fossil fuels, DES could help meet local policy objectives by playing a role in local energy system transformation. Local Authorities already have powers in planning and procurement, as well as relationships with key stakeholders including regulated gas/electric distribution network companies and some are teaming up with energy supply companies. The gradual devolution of powers from Westminster may provide additional tools enabling them to take an increasingly active role in responding to the energy needs of their communities. Conversely, greater local energy autonomy could conflict with national policies and market frameworks. There clearly needs to be more dialogue between national and local/regional scales to establish parameters for energy policy and regulation.

There may also be a case for the development and/or demonstration of DES to show that a city/region is encouraging energy innovation in order to attract investment. However, this risks leading to a fragmented national innovation system, and competition between regions to attract innovation may dilute the UK's overall strengths.

When we consider DES, it is important to recognise that it can cover a wide range of technology options (heat/power, energy/power scales, supply/demand/network-connected) providing different services; and there are different models for ownership/operation (see below). Technological R&D is already being undertaken in universities across the country (e.g. the Birmingham Centre for Energy Storage[3], the Swan Centre at Newcastle University[4], and through the Faraday Institute[5]), and demonstrated at scale in various locations (e.g. a 2.1 MWh battery is being installed in Nottingham[6], and a 15MWh liquid air energy storage system has been built in Bury[7]). It is not clear what criteria are being used to inform the distribution of R&D funding. There is a risk that decisions to support initiatives may be taken based on limited knowledge of the options and of the wider implications.

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[2] Households with PV can use a battery to store the "free" electricity generated by the PV system during the day for use to meet peak demand in the evening, thus reducing their overall purchase of electricity from the grid.

[3] https://www.birmingham.ac.uk/bces

[4] http://www.ncl.ac.uk/energy/research/

[5] http://www.faraday.ac.uk/

[6] http://www.nottingham.ac.uk/news/pressreleases/2018/january/europes-largest-community-battery-installed-at-trent-basin.aspx

[7] https://www.businessgreen.com/bg/news/3014913/highview-wins-gbp15m-funding-for-new-hybrid-liquid-air-energy-storage-system

Future research by the C-MADEnS project team will address this knowledge gap by assessing a wide variety of storage options using multi-criteria decision analysis based on wide stakeholder engagement and energy systems analysis. It will then identify the mechanisms that local authorities have at their disposal to influence the deployment of DES, and how these could be enhanced, together with the associated risks.

Business models

Drawing on a review of the literature, a framework consisting of three layers has been developed to categorise the different types of business model that are relevant to city-scale energy. The first layer consists of traditional business models for the purchase and storage of electricity, which are largely dictated by the degree to which a consumer is connected to the grid (i.e. on-grid, off-grid or private wire). The second layer outlines the 'core' business models which provide innovative city-level solutions to local customers (e.g. those that support prosumers, third party aggregators, community groups, and municipal suppliers). The third layer contains the business models that augment the core layer by delivering specialised ancillary services, such as those that help enable industry code compliance. These business models can help enable actors, such as households, companies and local authorities, to create a profitable case for energy storage.

Modelling work was undertaken to explore the potential number of prosumers in a hypothetical energy system. The results suggest that if prosumers with storage (and without aggregation) are able to optimise self-consumption (relative to buying and selling electricity from and to the grid), then this is the most beneficial outcome and increases the expected number of prosumers. This in turn leads to fewer power exchanges with the grid, thus decreasing the grid's total variable costs. Under these circumstances, traditional consumers contribute more to grid financing through their electricity bill than prosumers because the fixed cost of the grid is recovered through the price of each unit of electricity sold (and traditional consumers buy more grid electricity than the equivalent prosumer). In contrast, the picture becomes more complex when aggregation is allowed in the model, so that prosumers can provide capacity services to the grid. Not surprisingly, the expected level of prosumers increases with the price paid for ancillary services, however this level can only be reached if network costs exceed the cost of importing from the grid. The additional network costs are covered by prosumers as payment for accessing aggregated ancillary services. Therefore, the distributional effects on traditional consumers may be alleviated due to prosumers providing ancillary services.

A 2 kWh home battery

Source: www.moixa.com/media-resources

A review of the practical experience with energy storage highlighted a number of important lessons. For example, community storage has been successfully deployed in the British Isles and Germany to help support local renewable generation and create self-sustainable micro-grids. On the other hand, batteries trialled by prosumers in the UK have exhibited limited potential savings, specifically when used for back-up power and increased self-consumption of solar-PV. However, more innovative business models that stack additional revenue (such as aggregation, peer-to-peer trading etc.) have not yet been trialled in the UK.

Further evidence is available from the initial capacity auctions and the enhanced frequency response tender. These show that: 1) storage currently requires a high price (and long contracts) for capacity services and a lower price for EFR; 2) economies of scale are crucial; 3) price competition in the EFR tender was fierce; 4) incumbent firms entered the EFR tender potentially to gain a foothold in the ancillary markets; and 5) aggregators are competing in the EFR market.

Public perceptions

Some initial insights into public perceptions of DES have been gained from the findings of two focus groups, one with the general public and the other with tenants of Leeds City Council, who live in housing with solar panels. The topics discussed included household energy use, knowledge of DES technologies, and views on energy shortage scenarios. The analysis identified a number of factors that could enhance or limit the adoption of DES technologies.

Topics that reoccur frequently in people's discussions about DES include their expectations about who should be responsible for helping them adopt the technology and what benefits it would need to deliver for them to be interested. Both national and local government are seen as key actors in delivering information and support in this regard, but with different roles. Yet, at the same time, a lack of trust in public institutions, often based on previous experience, can be a significant barrier.

As a whole, people expect that the national government will provide credible information on DES, guarantee their rights and deliver sufficient direct funding or other financial support to make DES, such as batteries, attractive to households. Specifically in situations where energy supply could be compromised, the government should be ready to cope with this without it affecting households. People also consider that the government has an important role in encouraging of behaviour change in respective to practices, such as battery adoption, that could have beneficial impact on energy supply and use. Despite this, people are sceptical about whether the Government is willing to provide the support that they would want.

In general, people see the local council as having an important role in the practical aspects of adopting a battery. Nevertheless, previous poor experiences with previous schemes of different types can negatively impact people's willingness to be involved. In cases where people would be willing to adopt a battery, then they believe that "ideally" the council should be involved. In this regard, participants hoped that the process will be fair (as perceived by them) in as much as it should take into account their individual views and needs. The right kind of information provision is essential both in terms of quantity and quality for assuring this. People have difficulties in identifying the benefits of DES; therefore any information should help to clarify these benefits. In quality terms, information should be precise and credible. It also needs to be provided in a way that the recipient finds useful. This means providing the content tailored to the user's personal needs and recognising the limitations of their technical knowledge – perhaps through a home visit during which the householder can ask questions. Hence, those involved in the DES sector need to recognise potential user's lack of knowledge and concerns when they are producing information about the technologies.