Bird & Bird

Energy Storage to 2020 and beyond

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Contents

Introduction

There is an increasing amount of published information on energy storage highlighting the need to integrate technology into the national electricity network.

This paper is not focused on economic or financial arguments but it is noteworthy that the consensus view is effective deployment of energy storage technologies has the potential to reduce operational system costs and the cost of electricity for end consumers dramatically.

The recently dissolved Energy and Climate Change Committee estimated that if current regulatory barriers to storage were removed, annual savings to consumers could be as high as £7bn[1]. There does not seem to be the same level of consensus in terms of what storage is and what its role in the market should be.

The views expressed in this paper are based on a number of reports dating back to 2011 and the work done by those involved in the industry and certain groups exploring the potential deployment of storage. It seems clear that the majority view is that the categorisation of storage as "generation" must change to allow the potential of storage to be realised. The provision of storage as a multiple service provider is less unilaterally accepted. This potentially stems from the current regulatory structure around storage and the historic use of storage as a single service facility. The primary focus of this paper is on battery based electrical storage.

The view put forward in this paper is that storage is not generation but is the provision of a service using a physical asset to compliment and provide efficiencies in an electricity system. At its core is the ability to make electricity available instantaneously and to transfer the usage of electricity across time periods to maximise efficiency in the networks and to manage the deployment and consumption of generated electricity. At the same time, its ability to both discharge to the grid and absorb excess power in almost real-time provides a highly valuable grid management tool.

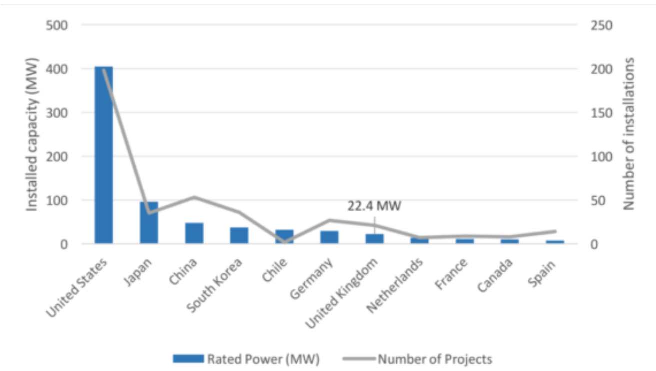
[1] https://www.parliament.uk/business/committees/committees-a-z/commons-select/energy-and-climate-change-committee/news-parliament-2015/energy-revolution-report-published-16-17/

The Where and the How

It seems that there are storage solutions available and being developed at domestic, business, industrial, network and grid scales. There has been some development at all levels and as efficiency and cost viability of storage technology develops, the deployment of storage at all levels continues to progress.

In the McKinsey Global Institute paper from 2013[2] storage is assessed as having one of the highest impacts in the energy sector by 2025. McKinsey considered the primary definition of storage as the storage of electricity for later use on demand (i.e. the deferment of usage of electricity rather than generation). The paper emphasises the need to grow storage capacities and capabilities to meet the now binding reduction of emissions targets. The main barriers are identified as a lack of policy understanding and regulatory change relating to storage technologies alongside the absence of targeted incentives. Surmounting these obstacles will empower the industry to move beyond single use applications and into multiple aggregate services which will in turn increase the viability and financial return on investment on storage projects.

The papers produced by the Electricity Storage Network[3] [4] (also in 2014) identified many similar policy and regulatory issues and the lack of economic and financial incentives as barriers to growth and development of energy storage and note targeted measures taken in other jurisdictions to address equivalent barriers. The Electricity Storage Network's objective was to illustrate ways to remove barriers and create a supportive market approach with a focus on network operator level issues. The suggestions included approaching storage as a multiple service provider with no mutual exclusion among the services provided. Moving to multiple services storage contracts will require specific contractual and regulatory arrangements to build investment confidence through increased contract length and removing constraints on the provision of multiple services. Two years after the papers were first written by the Electricity Storage Network, we are still trying to come to terms with what has to be done to allow the storage services market in the United Kingdom to prosper and we lag behind other international markets as demonstrated in the below graphic.[5]



The Electricity Storage Network's suggested approach is laudable but much depends on policy driving the required changes forward at a pace that allows the rapid integration of storage into the UK's energy industry.

The recent report[6] and statements[7] from the Energy and Climate Change Committee, and the increasing space given to electricity storage in the mainstream media suggest things might be changing. We set out below the potential regulatory changes required and postulate the services, and basic models for integration of storage services into the electricity networks beyond 2020. We base our premise primarily on the availability of battery storage at economic levels – with or without incentive subsidies but with increasing technology capability and cost savings as have been seen in other parts of the sector.

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[2] Disruptive technologies: Advances that will transform life, business, and the global economy, McKinsey Global Institute, May 2013

[3] http://www.electricitystorage.co.uk/files/7814/1641/4529/140509_ESN_Elec_Storage_in_the_National_Interest_Report_final_web.pdf

[4] https://www.ofgem.gov.uk/sites/default/files/docs/2014/05/esn_role_of_storage_in_the_smart_grid.pdf

[5] http://cleantechnica.com/2016/05/12/market-opportunity-energy-storage-uk/

[6] http://www.publications.parliament.uk/pa/cm201617/cmselect/cmenergy/705/705.pdf?utm_source=705&utm_medium=module&utm_campaign=modulereports

[7] http://www.bbc.co.uk/news/uk-37664880

Section 1 – Current UK deployment

The UK has approximately 30 battery energy storage projects in operation, but only a handful of them are larger than 1 megawatt (MW)[8]*.*

Deployment of storage technologies is predicted to grow in 2017 as the price of base technology begins to fall and new market openings such as the National Grid's Enhanced Frequency Response (see Box 3) contracts begin to take effect, making battery storage more commercially viable than it has ever been before. It has been predicted that by 2020 total installed capacity may exceed 1.6GW[9].

Behind the Meter Storage

The use of on-site storage facilities presents a current opportunity as it potentially avoids regulatory and other issues that are seen as barriers to storage in other contexts. See box 1 for an example of this in action in the UK.

[10]Gigha Battery Project.

1

The Isle of Gigha is situated approximately 60 miles from Glasgow and has 4 community owned wind turbines installed as part of a community energy project. Grid constraints restrict the output of the 4th turbine to 225kW rather than its designed 330kW output, which equates to a 3 GWh loss over the planned 25-year asset life. A DECC funded Vanadium Redox battery has recently been installed behind the meter to allow the 4th turbine to generate to its full capacity and the islanders to store excess generation for when needed.

Grid storage

One key area of development is likely to be the deployment of grid scale storage to be used by National Grid and DNOs holding the Transmission and Distribution licences respectively. This process has already begun (see box 2 and box 4) and provides a valuable tool for operators in balancing the power and stability of their systems. For example, approximately 14MW of electricity storage is currently operated by DNOs. In addition, Enhanced Frequency Response (see box 3) is a new service that is being developed by National Grid to assist it in fulfilling its licence conditions to maintain transmission system frequency at close to 50Hz. This forms parts of the balancing and frequency response tools National Grid has at its disposal and is particularly suited to battery storage technologies that are able to discharge power almost instantaneously based on automated signalling. National Grid are also trialling a number of other similar services such as enhanced frequency control capability (EFCC) which aims to provide sub second proportional responses and seems tailor made for the characteristics of storage technologies. This points towards an increasing use of storage by grid operators in managing their networks in the future.

8 http://cleantechnica.com/2016/05/12/market-opportunity-energy-storage-uk/
9 http://www.businessgreen.com/bg/analysis/2442158/uk-energy-storage-tipped-to-exceed-16gw-by-2020
10 http://www.communityenergyscotland.org.uk/gigha-battery-overview.asp

Renewable Energy Systems (RES) to supply battery storage solutions to the UK National Grid Energy Systems [11]

2

RES in collaboration with National Grid have created a 20MW battery system able to provide sub-second frequency response services to the Grid. The service will aid the Grid by balancing it when demand for energy is high. National Grid have stated:

"This innovative technology will enable us to respond to frequency issues in under a second, helping to maintain the integrity of the grid."

The parties hope that this will demonstrate the potential of storage to act as a grid service and accelerate legislative and regulatory actions to remove barriers to wider deployment.

National Grid - Enhanced Frequency Response [12] [13]

3

Enhanced Frequency Response (EFR) is defined as a service that achieves 100% active power output within 1 second of registering a frequency deviation. The rapidity of response assists National Grid to manage grid fluctuation before any faults have occurred and it is anticipated that the service could reduce system costs by an estimated £200million through increased efficiencies. It is therefore a highly valuable tool sitting alongside other frequency response services which typically have response time of between 10-30 seconds. This is a service directly aimed at taking advantage of the technological benefits battery storage provides. This is borne out by the first set of contracts awarded.

In total the auction process secured 20Mw of capacity and of 64 unique sites taking part, 61 are for battery assets.

Each participant can apply for a minimum of 1MW up to a maximum aggregated amount of 50MW, thereby avoiding being classed as generation by virtue of the class exemptions. The assets must be capable of operating at maximum charge or discharge for a continuous period of 30 minutes. While dual service is restricted, different services are allowed outside of the specified times of the EFR tender.

The contracts provided are for a 4 year period which is longer than other services National Grid offers thus providing a more long term basis for investment, albeit not as long as investors in the energy market may typically look for in terms of payback for CAPEX of storage assets.

Innovative Services

There are numerous services that storage can provide in different parts of the system (see our indicative structures in Appendix 2) and this seems likely to increase as innovative approaches are developed in line with the increasing deployment of storage across the system (an example is set out in box 5). A non-exhaustive list of currently possible storage services is set out below – further definitions of the below are set out in Appendix 1:

- Network stabilisation services.
- New area electrification (for example battery storage in a remote unconnected community where interconnectivity may be intermittent).
- Frequency regulation.
- Peak local shifting and management.
- Infrastructure deferral/avoidance.
- Reduced carbon/harmful emissions.
- Increased electric vehicle capability and facilities.
- Deferral of reinforcement of grid/network.
- Active network management.
- Post fault management.
- Reactive power and voltage stabilisation.
- Demand side response services.
- Short term operating reserves.
- Fast reserves.
- Frequency response.
- Black start services.
- Triad management services.
- Cost management and energy service company integration.
- Imbalance management services.
- Constraint management services.
- Demand side services.

[11] http://www.pv-magazine.com/news/details/beitrag/res-to-supply-battery-storage-solutions-to-the-uk-grid_100024721/#axzz4NY1gANzl
[12] http://www2.nationalgrid.com/Enhanced-Frequency-Response.aspx
[13] http://media.nationalgrid.com/press-releases/uk-press-releases/corporate-news/national-grid-brings-forward-new-technology-with-enhanced-frequency-response-contracts/

DNO Grid Storage [14] [15] [16]

UKPN Smarter Network Storage Facility – Leighton Buzzard

4

Leighton Buzzard is currently the location of the largest battery storage trial in Britain; the 6MW facility is based at a UK Power Networks substation. Leighton Buzzard was regularly affected by power outages before the storage facility opened and the facility has provided power to the local network on over 100 occasions (for more than 1700 hours) during its first year in operation. The project also utilises third party service providers (SmartestEnergy and Kiwi Power) to manage the storage facility in order to take advantage of the multiple revenue streams available for storage at this scale.

The project has been made viable because operating generation under 50MW is exempt from the licencing regime and therefore potentially viable for Distribution Network Operators (DNOs). In addition to the 50MW class exemption limit, DNOs are limited in the amount of storage on their networks by de minimis restrictions (limiting their investment in non-distribution activities to around 2.5% of DNO turnover, consolidated reserves or share capital). UK Power Networks analysis suggests they would only be able to develop around 15 projects the size of Leighton Buzzard before reaching their de minimis restrictions.

UKPN's **Smarter Network Storage Project**, funded through Ofgem's Low Carbon Networks Fund, is looking to address the obstacles preventing the adoption of energy storage across distribution networks. UKPN's view is that storage used for a single application, such as network support does not allow the maximum efficiency of storage assets, however, business models for multiple applications are challenging to implement and the regulatory framework needs to better support adoption of storage by DNOs. To this end the project is set to explore the deployment of storage on the distribution network to trial and develop multi-purpose applications, optimisation and control systems, and the commercial arrangements for shared use of energy storage.

Northern Powergrid - Darlington

NEC Energy Solutions in 2014 completed the installation of a 5.7mWh energy storage facility for the UK's Northern Powergrid. The installation is across 6 sites and creates around 2.9MW of power; the Darlington site is the largest providing 2.5MW. The project is for a period of three years and is funded by Ofgem through the Low Carbon Networks Fund. The storage capacity will help integrate renewable generation into the electricity network as part of the Customer-Led Network Revolution initiative which aims to develop smart grid infrastructure.

Nissan Vehicle to grid storage [17]

5

Owners of Nissan's LEAF vehicles will be able to sell back power stored in their vehicles to the National Grid at peak times. Nissan has also unveiled 'xStorage' – a domestic energy storage system of 4.2kWh that allows homeowners to store energy generated at their homes to use at a later time, alternatively they could also store energy from the grid when it is cheap and sell it back when demand, and the price, is higher. Nissan believes this could provide an annual income of £600 for an average user.

Nissan have also revealed that they are working on developing a system for commercial buildings, and hope to include storage technology in all of their European headquarters by the end of 2017.

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[14] https://www.ukpowernetworks.co.uk/internet/en/news-and-press/press-releases/Pioneering-energy-storage-project-shaping-energy-networks-of-the-future.html

[15] http://www.connectedhomeworld.com/content/nec-adds-57mwh-energy-storage-uk-power-grid

[16] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/Project-Documents/SDRC+9.7+Successful+Demonstrations+of+Storage+Value+Streams+LoRes+v1.pdf & http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/

[17] http://www.businessgreen.com/bg/analysis/2457630/nissan-launches-domestic-energy-storage-system-in-vehicle-to-grid-push

Section 2 – UK Policy and Market Developments

As is the case with all new entrant and emerging technologies, commercial viability and attracting investment are key drivers of market growth.

On one hand, policy changes and market design can provide business opportunities or remove barriers, while key market players can also lead growth by incentivising and integrating the deployment of storage on their own systems.

Convincing investors relies on creating confidence in the technology and its revenue streams. Storage is a fast developing market and accessibility to multiple revenue streams is vital for financing especially for the purposes of enticing funding for larger scale projects. It therefore seems likely that financing structures will have to remain flexible in order to react to new opportunities while maintaining certainty on investment returns currently available. National Grid's Enhanced Frequency Response (Box 3) is a good example of creating a bankable market for investors in storage, with understood revenue streams and contract durations. Although the contract period is not long enough to fully repay investment costs, the initial procurement round was oversubscribed and pointed towards investors and developers willing to take a risk on the future development of the storage market.

Government Policy

Market rules will drive the opportunities for storage and the structure of policy driven contract terms informs the risk profile of energy storage projects. This is evident in how renewable generation projects have gone through rapid periods of expansion in recent years based on various policy based incentive schemes such as the RO, FITs and CfDs. While none of these mechanisms expressly exclude renewable energy generation from integrating storage, there are regulatory uncertainties which have prevented any significant deployment to date. Policy should be less constraining and enable industry to develop structures which enhance the capabilities in the sector. As an example, allowing solar generation and storage to be co-located would provide the possibility of forming a base load capability.

DECC (now part of the Department for Business, Energy & Industrial Strategy (BEIS)) recently consulted on how the CfD regime can be modified to allow the integration of storage to generation assets (box 12). This seeks to clarify the metering rules to ensure the value of electricity from the generation facility is metered and calculated at the time of generation and storage is included as a separate metered unit and therefore is excluded from the metered volume used to calculate CfD payments. Further, and perhaps more fundamentally, the same consultation also proposed a new definition of "storage facility" which may mark a move away from storage being classified as generation. It is worth noting that the Energy Storage Network has created a separate definition of Electricity Storage: *"in the electricity system is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy."*[18].

Metering arrangements are also key in the context of other renewables schemes such as the RO and FIT-supported projects. While changes to current project metering arrangements are possible on a case-by case basis, legislative certainty would assist in the deployment of storage making it an investible and bankable proposition leading to expedited deployment at scale.

[18] http://www.electricitystorage.co.uk/

Other mechanisms such as the capacity market which has in the past been criticised for supporting fossil fuel electricity generation are also starting to open up to the possibility of storage playing a part (Box 13).

There are a number of current government reports (Boxes 6 and 7) that recognise the role that storage can play and have advocated the regulatory changes we encourage in this report to ensure that storage is integrated and its benefits maximised in the UK.

National Infrastructure Commission Report[19]

6

The **National Infrastructure Commission Report** on Smarter Energy recommended a regulatory overhaul of the market to develop the role of electricity storage. This includes combatting how storage is defined to avoid storage operators being charged twice for using the electricity network (as generators and consumers). The report states, in relation to the status quo:

"This approach ignores the benefits that storage can play in the electricity system and creates barriers to investment in storage assets. For example, it increases costs for storage asset owners by requiring storage to be charged twice for using the electricity network – once as a generator when exporting electricity and again as a consumer when electricity is being taken from the network to be stored. Whilst storage technologies are clearly making use of the network both as a consumer and producer, charging in this way takes no account of the fact that storage assets are likely to be exporting power at times of peak load, and drawing power at times of peak generation, reducing the stresses faced by the network rather than increasing them."

The report suggests it would be better to charge on the basis of the electricity actually used, reflecting that no storage technology is 100% efficient. This would create a more level playing field with other technologies, and incentivise more efficient storage.

Energy and Climate Change Select Committee Report - The energy revolution and future challenges for UK energy and climate change policy [20]

7

The Energy and Climate Change Select Committee's recent report recognised the current barriers to storage deployment in the UK, with a particular emphasis on the problematic classification and double charging of storage assets. It also focused on the unsuitability of the capacity market and CfD mechanism for storage deployment.

The report urges government to act urgently to ensure the UK can benefit from the huge financial savings storage can bring through system efficiency and can capitalise on the global growth of storage by placing itself as a market leader in the technology – concluding that:

"there must be a clear definition for storage, double-charging must come to an end, and a separate asset class for grid-level electricity storage should be established as a matter of urgency. The Government must also review the outdated Capacity Market rules and regulations in relation to storage, including considering increasing the contract length and addressing restrictions around stacking of revenues for storage projects. We further recommend that Government sets out a high-level public commitment to making the UK a world-leader in storage and sets a storage procurement target for 2020. The Government should also consider a possible subsidy framework for energy storage to accelerate deployment given the importance of storage to unlocking the full potential of renewable energy."

[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/505218/IC_Energy_Report_web.pdff
[20] http://www.publications.parliament.uk/pa/cm201617/cmselect/cmenergy/705/705.pdf

Legislative Change

In our view there is a legislative change needed through secondary (or perhaps primary) legislation which achieves the following:

- Removes storage from the classification of generation. There should be a single definition of storage as far as possible to avoid uncertainties as to how it should be treated at different level of the system.
- Allows any "competent" body to be licenced to operate an electricity storage facility without limitation unnecessarily imposed on services offered.
- Allows a "storage services" operator to provide all or any of the services provided in the schedule to the legislation or others as may be applied for under a licence application. (This may be necessary for future services which are currently unforeseen as being provided by storage services operator).
- Ofgem or another authority should be given the responsibility for ensuring that licences are issued for storage services operators. (This should facilitate licencing whether or not the particular project has merit or not in the eyes of the licensor and the market should be able to determine the investment ratio for each project).
- Limitations on who can be a storage services operator should be relaxed to allow grid, network, industrial and domestic level services to be provided by licenced operators.
- There should be stratification of services into applicable appropriate classes for operator licensing and subsidy receipts/consensus.
- There should be a requirement of storage operators to maintain detailed electronic metering records of all transactions undertaken by them and to interlink with any network/grid operator/electricity generator operating for a purchase agreement for the purpose of integrated services to customers and consumers.
- Storage services should be allowed to operate behind or in front of the meter for any particular operator.
- Grid and metering codes should be amended to allow storage to operate without being double charged (as they are as present) as conventional generators and consumers on discharge and charging respectively
- Storage facilities should benefit from any carbon reduction incentives and payments based on a restructured omissions control payment regime.
- Consequential amendments to other legislation and regulations to allow electricity markets to open up to storage should be incorporated in this legislative amendment.
- Regulations should create a transparent and accountable process for eligible tax concessions and incentive payments as appropriate linked to the relevant parallel legislation.

Section 3 - International Examples

We set out below a number of examples of the ways storage has been integrated and encouraged to grow in other markets.

The key is for the UK to adapt its own energy markets to effectively allow storage to prosper and lessons learned from other countries may prove valuable learning to this end.

Italy [21] [22]

8

Legislative Decree no. 28/2011 allows the TSO and DNOs to develop and manage distributed storage facilities and storage systems in order to increase the dispatch of intermittent generation.

Terna the TSO has developed an investment plan of more than EUR 200 million, on the basis of such legislation. Italy also has installed or planned storage of up to 6,667 MWh which would make it the largest storage market in Europe at present.

Germany [23]

9

Germany appears to be taking a leading role in the growing EU electricity storage market, as it did with feed-in-tariffs in relation to solar generation. An example of this is the solar storage subsidy program, which currently covers up to 22% (repayment bonus) of the cost of residential storage equipment when added to a new PV system (nevertheless, the funding programme no. 275 of the German KfW has been stopped until end of 2016 as of September 2016, due to exhausted subsidies, and it will be continued as of January 2017 again).

Historically energy storage has been considered as a category of technology with no particular connection with energy supply chain categories (generation, transportation, distribution, consumption). This meant that the regulatory framework treated (and still treats) energy storage as an ordinary type of consumption of energy, which led in many cases to grid charges being applied twice for storage facilities. Recent regulatory changes to the EEG in summer 2016 have sought to remove or at least reduce this double charging (although it is not yet clear if this is sufficient to provide a viable economic basis to deploy storage facilities). There are also moves to integrate storage as part of the transmission and distribution systems - however, considering both the European and German regulatory framework (in particular the unbundling regime) - and alongside existing facilities. Storage looks set to become an integrated part of the German electricity system in the coming years, provided that the operation of such storage facilities will become more economic from a technological point of view too.

Japan [24]

10

Japan is one of the leading nations (along with S. Korea) in the production of batteries for storage and it is not surprising that there are a number of notable projects, for example:

- Tohoku Electric Power Company's Nishi-Sendai Substation operates a 40-MW lithium-ion battery system for frequency regulation services; and
- Hokkaido Electric Power Co operates a 60MWh vanadium redox flow for frequency regulation linked to solar generation.

In a residential setting Government subsidies are available for homeowners and companies to install batteries along with solar panels, paying for up to two thirds of the purchase price.

[21] http://www.lexology.com/library/detail.aspx?g=4bf3dda1-44ba-47c3-a860-af76ca74cbe4
[22] http://www.energystorageupdate.com/europe/pdf/TopMarkets.pdf?utm_campaign=4362%
[23] http://www.electricitystorage.co.uk/files/7814/1641/4529/140509_ESN_Elec_Storage_in_the_National_Interest_Report_final_web.pdf
[24] https://www.greentechmedia.com/articles/read/a-look-at-the-biggest-energy-storage-projects-built-around-the-world-in-the

USA

The US power grid has similar challenges to the UK in providing reliable power, as an increasing proportion of the generation is coming from renewable sources. President Obama set a 20% renewable energy generation target and pledged to cut emissions to 26-28% below 2005 levels by 2025 [25]. Favourable regulation and forward-thinking grid operators have encouraged a number of developments in storage. Several states have passed energy storage procurement goals to meet the demands that will be placed on grid in the future. [26] Installed storage capacity roughly doubled in 2015 demonstrating the current speed of change as technology and deployment costs are falling dramatically.

These developments are underpinned by an increasingly storage friendly regulatory and governmental backdrop (see Box 11). The White House has convened the Summit on Scaling Renewable Energy and Storage with Smart Markets and swift executive actions have resulted in a number of committees being formed and legislative changes to promote the growth of energy storage.

In addition tax guidance on storage and regulatory treatment of storage systems is being reviewed. Such comprehensive action driven by central government sends a clear message to the market that storage should play an increasing role in electricity systems, and perhaps more importantly gives a clear message of this plan to investors.

Storage friendly regulation [27] [28] [29] [30]

11

Several states have set procurement goals for storage aimed at meeting differing challenges, for example:

- California is seeking to install 1.325GW of energy storage for both behind and in front of the meter applications by 2020 to meet forecast capacity shortages.
- New Jersey is seeking to install storage to increase system reliability to reduce disruptions to consumers when grid outages occur. This includes storage linked to domestic solar generation for backup power.
- In New York storage is being installed to defer system upgrade costs.

Regulatory treatment

One fundamental difference in the US is that in wholesale markets storage is designated as an 'Exempt Wholesale Generator' by FERC –meaning that it can provide capacity, energy and ancillary services in ISO/RTO markets. However, when energy storage is interconnected in wholesale markets it is defined as a generator constraining the system's potential to perform specified functions and contribute to certain markets, and can limit which entities are allowed to own and operate storage systems on the grid. Similarly to the planning tools used in the UK. Within utility resource planning, energy storage is markedly undervalued by current methodologies and modelling and therefore often not even considered alongside other options.

Nuances exist throughout the US, with differing federal, state and local policies and regulations governing the energy industry and the examples set out below demonstrate a sampling of the regulation in place in the US which are seen as more friendly towards storage:

- **FERC Order 755** – mandates that grid operators must pay fast responding frequency resources based on their performance in following the frequency regulation dispatch signal and separate payments must be made for capacity and actual performance.
- **FERC Order 784** – requires transmission providers to consider speed and accuracy when contracting frequency regulation providers.
- **FERC Order 792** – added energy storage to the category of resources eligible to interconnect with the electric grid, thus allowing storage to receive rates, terms and conditions for interconnection with public utilities that are just and reasonable.

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[25] https://www.whitehouse.gov/the-press-office/2015/03/31/fact-sheet-us-reports-its-2025-emissions-target-unfccc
[26] The state of play in US solar and storage, Solar Finance and Investment
[27] The state of play in US solar and storage, Solar Finance and Investment,
[28] http://www.pv-tech.org/features/the-rise-and-rise-of-us-storage
[29] https://www.greentechmedia.com/articles/read/FERCs-Energy-Storage-Ruling-Could-Jump-Start-Big-Batteries
[30] http://energystorage.org/resources/ferc-order-792

Conclusion

This report sets out a number of recommendations in order to develop the UK's energy storage market. Storage has the potential to provide a number of key benefits in addressing the challenges the UK's electricity system faces: changing demand and generation profiles; an ageing infrastructure; fundamental shifts in the way grids operate; and an increased focus on security of supply as a capacity surplus decreases. Storage can help to maximise system efficiencies and through that address each of these challenges.

However, at present there are a number of obstacles that are preventing the deployment of storage and the UK market risks falling behind other countries and losing ground in what is set to be a rapidly growing market internationally. If the UK can position itself as a world leader in storage technology and deployment over the next few years, there is the potential for UK companies to sell their services to the world. While there are some moves to address regulatory and market design barriers, for example in relation to contracts for difference and the capacity market (see Boxes 12 and 13), this essentially represents a bottom up approach whereby specific changes are made within an overall legislative and regulatory structure that does not fundamentally provide for storage. We believe a better alternative would be for a top down re-evaluation of how storage is treated in the markets with central government driven targets and legislative changes.

We understand that BEIS and Ofgem will soon be launching a consultation focussed on how to best integrate storage and other responsive technologies (such as demand side response) into the market. We anticipate that this will cover regulatory barriers including: (i) how best to define storage; (ii) what kind of licencing regime is appropriate for storage; (iii) how the issues around network changes, double charging and end user levies can be resolved; and (iv) how to integrate storage with current facilities benefitting from financial incentives (such as FiTs and ROCs).

In this paper we have put forward some views on what regulatory changes should achieve and we would be interested to hear the opinion of those active in the industry.

CFD [31]

12

UK Contracts for Difference Consultation

A recent government consultation has suggested that to maximise the commercial benefits of storage, it should be in a different BM Unit to the generation assets. CfD payments would therefore be calculated on the metered volumes of the BM Unit relating to the generation assets, and therefore on the wholesale price at the time of generation, rather than the time of sale.

Their first proposed change is to clarify within the CfD that the BM Unit Metered Volume used to calculate CfD payments should only include the output of generating units of the Facility Generation Technology.

Secondly, to give CfD generators confidence that storage can be installed on a CfD site and that it should be in a separate BM Unit, they propose defining storage within the CfD and stating that it should be in a separate BM Unit to the Facility.

Thirdly, there is a proposal to define storage facilities as 'A means of converting imported electricity into a form of energy which can be stored, and of storing the energy which has been so converted and a generating unit which is wholly or mainly used to reconvert the stored energy into electrical energy.'

[31] https://www.gov.uk/government/consultations/consultation-on-amending-the-cfd-contract-and-regulations

Capacity Market[32]

13

Recent changes have been made to the capacity market to lower the minimum load reduction DSR units to 500 kW. This should provide storage projects with more opportunity to participate in the mechanism.

At the same time, stronger penalties for not delivering capacity may improve the mechanism's attractiveness for storage project which are able to respond rapidly and flexibly. Conversely, the penalties may deter battery storage projects from participating, as the potential open ended generating requirement could restrict participation in other markets with higher revenue potential. It also means that storage tenderers may have to account for the risks that their facility runs out of stored power and that electricity would have to be directly imported to avoid penalties for not meeting their contracted output level.

32 http://smartestenergy.com/info-hub/the-informer/capacity-market-changes-could-boost-storage/

Appendix 1 – Glossary of services to be provided by storage operators

- Network stabilisation services: a service that helps to stabilise the frequency of the network in the event that generation and demand are out of sync across the system. This could help address generation outages and power surges as well as demand peaks and grid outages caused by adverse weather.
- New area electrification (for example battery storage in a remote unconnected community where interconnectivity may be intermittent): providing security of supply to remote areas or areas with intermittent access to electricity, often in support of intermittent renewable generation.
- Frequency regulation: stabilising the frequency of an interconnected grid to ensure that the frequency stays stable across the grid. The frequency can be affected by a gap between power generation and demand which causes the frequency to move away from its stable value. An example is through frequency response services.
- Peak local shifting and management: allows for the time shifting of electricity usage so that the electricity can be stored at a time when there is an excess of generation to be used when there is an excess of demand, thereby maximising system efficiency. Effectively this means adjusting or controlling the load rather than the power station output.
- Infrastructure replacement and reinforcement deferral/avoidance: storage can be used to defer or avoid costly upgrades to the network infrastructure if the increased capacity the upgrade would provide is only minimal or only necessary during a small proportion of the year (through the use of peak shifting for example)
- Reduced carbon/harmful emissions: reducing the amount of greenhouse gases produced to support human activities. Storage is able to do this because it lowers the amount of generated electricity that is wasted due to a lack of demand as that excess electricity can be retained and used at a later date when the demand is present.
- Increased electric vehicle capability and facilities: storage could be used through electric vehicles communicating with the grid, either providing electricity back to the grid (in peak hours) or receiving electricity from it (in off-peak hours). An owner of an electric vehicle could therefore charge their vehicle during cheap off-peak hours and sell the electricity back to the grid for a profit during peak hours.
- Active network management: control systems that manage generation and load for specific purposes. This is usually done to keep system parameters such as frequency within predetermined limits.
- Post fault management: storage can help following a fault in providing system stability while the network systems detect, isolate and resolve the problems.
- Reactive power and voltage stabilisation: reactive power supports the voltage that must be controlled for system stability.
- Demand side response services: services that enable businesses and consumers to turn up, turn down or shift demand in real-time, helping the grid deal with peaks in demand.
- Short term operating reserves: a service for the provision of additional active power to the network from generation, demand reduction, and potentially from storage.

- Fast reserves: is an energy balancing service that provides rapid delivery of active power usually through an increased output from generation or a reduction in consumption from demand sources. Storage has the ability to provide this service as it is able to discharge almost instantaneously.
- Frequency response: Frequency response manages the second by second changes on the system and will balance the system if triggered at a defined frequency deviation. Storage's close to real-time response capabilities provide a real benefit in relation to frequency response services.
- Black start services: the process of restoring part of an electric grid to operation without relying on the external transmission network normally from an on-site auxiliary generator. Storage is able to provide the initial power or act to provide system start-up stability in case of power surges or loss.
- Triad management services: Triads are half hour periods of peak demand on the electricity transmission network used to distribute higher charges between electricity suppliers. Storage can be used to avoid the associated higher charges for energy consumers by switching to battery power rather than relying on the grid during triad periods.
- Cost management and energy service company integration: Energy Service companies (ESCos), help consumers manage and reduce their energy costs. Energy storage integrated into buildings or facilities represents one of the tools ESCos may use.
- Imbalance management services: helping to ensure a greater correlation between what a generator has forecast they are going to do with the actual volumes of electricity they generate. If the forecasts are inaccurate the grid will become imbalanced and the costs associated with balancing the system again have to be paid by users of the electricity system. Storage can help fill any shortfall in predicted generation at short notice.
- Constraint management services: required where the electricity transmission system is unable to transmit the power supplied to the location of demand due to congestion at one or more parts of the network. In this situation National Grid will take actions in the market to increase and decrease the amount of electricity at different locations on the network. Storage can assist by providing power instantaneously to address any constraints.
- Demand side services: Storage can be used by consumers to come off-grid relying on battery power so as to offer Demand Side Response services to the grid.

Appendix 2 – Potential generic deployment structures

Diagram 1

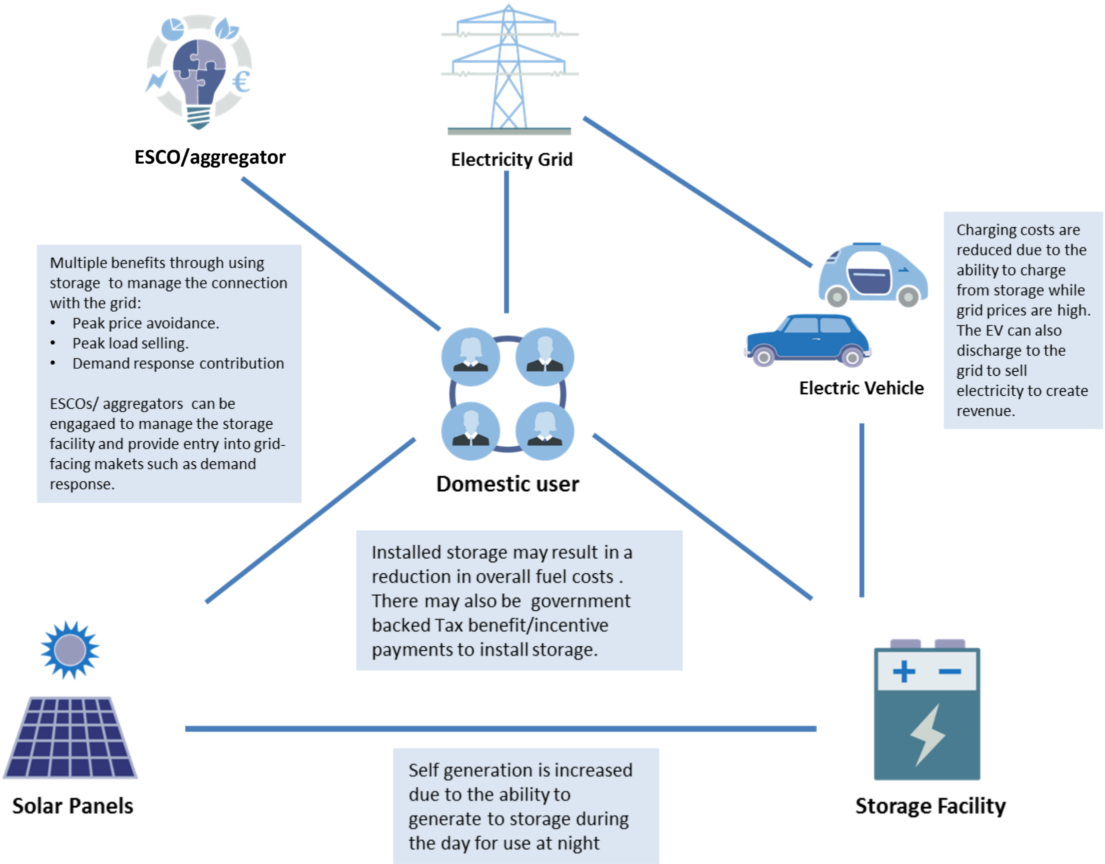


Diagram 2

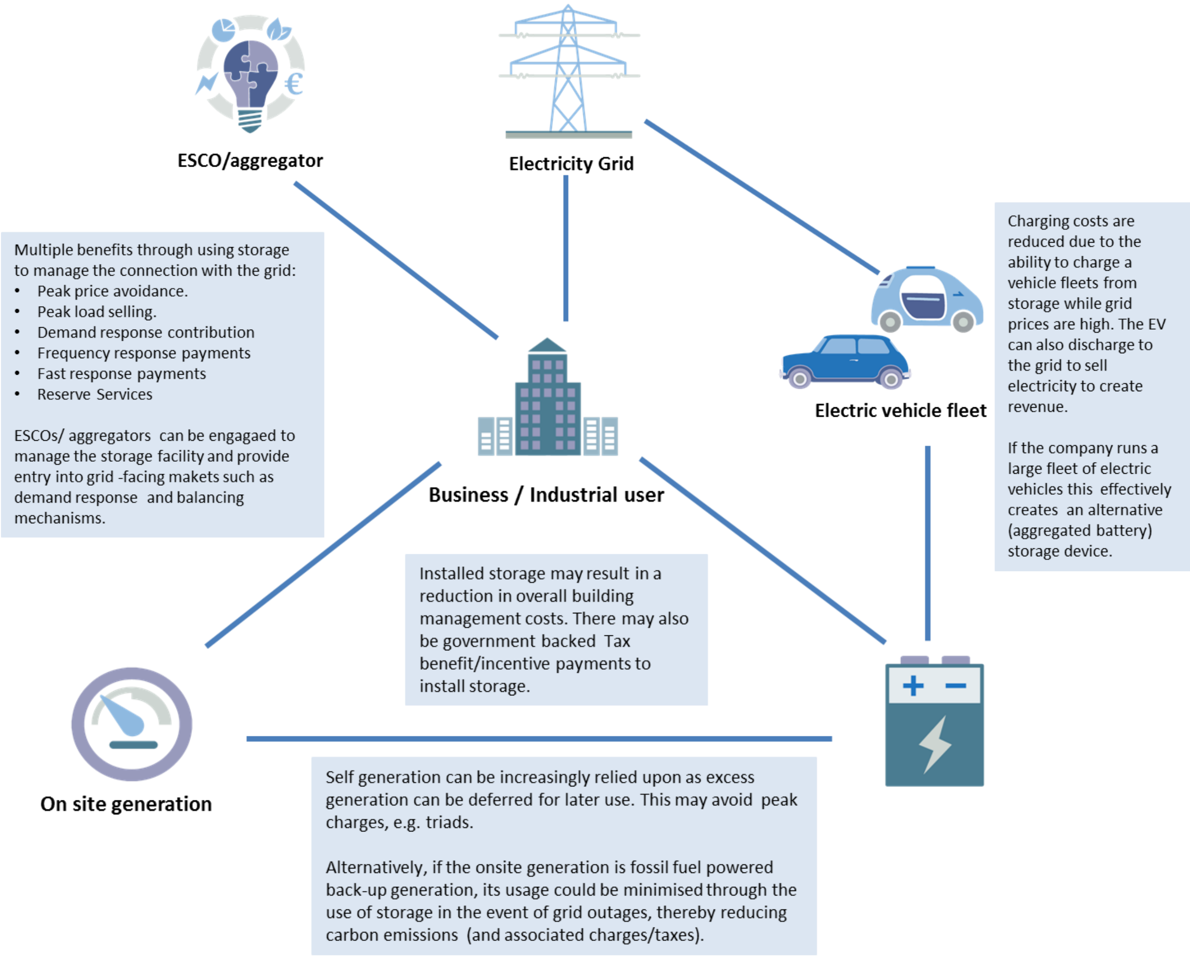
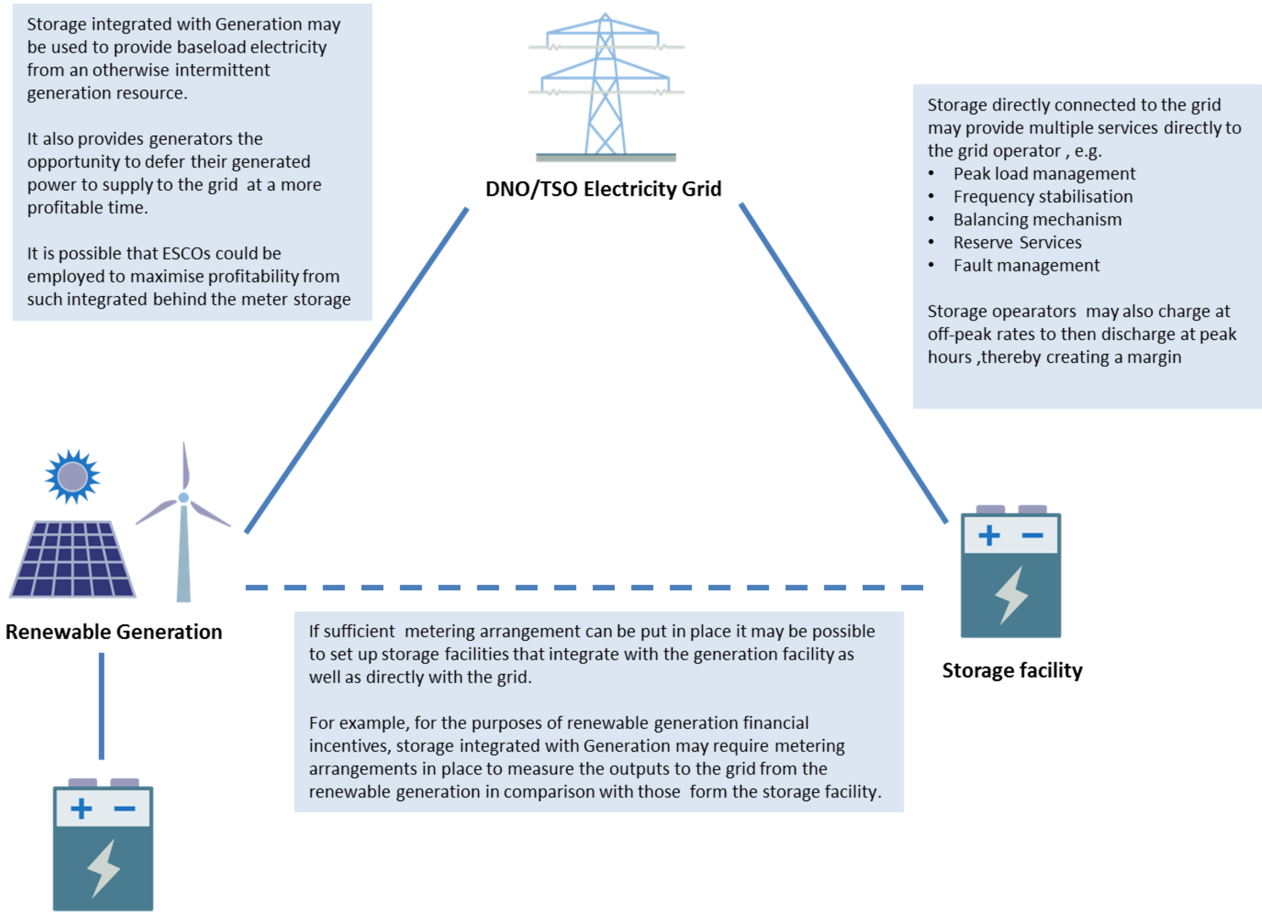

ESCO/aggregator
Electricity Grid
Multiple benefits through using storage to manage the connection with the grid:
• Peak price avoidance.
• Peak load selling.
• Demand response contribution
• Frequency response payments
• Fast response payments
• Reserve Services
ESCOs/ aggregators can be engagaed to manage the storage facility and provide entry into grid -facing makets such as demand response and balancing mechanisms.
Business / Industrial user
Electric vehicle fleet
Charging costs are reduced due to the ability to charge a vehicle fleets from storage while grid prices are high. The EV can also discharge to the grid to sell electricity to create revenue.
If the company runs a large fleet of electric vehicles this effectively creates an alternative (aggregated battery) storage device.
Installed storage may result in a reduction in overall building management costs. There may also be government backed Tax benefit/incentive payments to install storage.
On site generation
Self generation can be increasingly relied upon as excess generation can be deferred for later use. This may avoid peak charges, e.g. triads.
Alternatively, if the onsite generation is fossil fuel powered back-up generation, its usage could be minimised through the use of storage in the event of grid outages, thereby reducing carbon emissions (and associated charges/taxes).

Diagram 3


Storage integrated with Generation may be used to provide baseload electricity from an otherwise intermittent generation resource.
It also provides generators the opportunity to defer their generated power to supply to the grid at a more profitable time.
It is possible that ESCOs could be employed to maximise profitability from such integrated behind the meter storage
DNO/TSO Electricity Grid
Storage directly connected to the grid may provide multiple services directly to the grid operator , e.g.
• Peak load management
• Frequency stabilisation
• Balancing mechanism
• Reserve Services
• Fault management
Storage opearators may also charge at off-peak rates to then discharge at peak hours ,thereby creating a margin
Renewable Generation
If sufficient metering arrangement can be put in place it may be possible to set up storage facilities that integrate with the generation facility as well as directly with the grid.
For example, for the purposes of renewable generation financial incentives, storage integrated with Generation may require metering arrangements in place to measure the outputs to the grid from the renewable generation in comparison with those form the storage facility.
Storage facility

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