Facilitating the deployment of large-scale and long-duration electricity storage

Response from Regen and the Electricity Storage Network

As the call for evidence document rightly highlights, energy storage is an essential source of low carbon flexibility, helping to integrate high volumes of variable renewable generation into the system by balancing supply and demand, maintaining system frequency and exerting a calming effect on volatile energy markets.

The growing UK storage industry has risen to the challenges of decarbonisation and decentralisation, successfully establishing itself in several markets. With multiple technologies that are able to provide a variety of services, storage has the agility to support the transition to net zero in multiple areas. Currently, many of the services are being met by short-duration (i.e. 0.5-2 hours) storage technologies, but the case and potential system need for both large-scale energy storage and long-duration energy storage (LLES) is growing.

LLES is still in its infancy in terms of development and deployment. There are many research projects underway to develop technologies that can provide stored electricity, at a useful capacity, for long periods of time. However, none of these technologies are yet deployed to provide services to the system – at present, there are very few sources of revenue that would reward such long duration. Many of these projects have high capital costs, and it is very difficult to get the investment needed with no realistic prospect of revenue.

The Electricity Storage Network (ESN) has long been calling for a clear plan for long-duration storage, including revenue mechanisms that would fund such projects beyond the research and development phase. The publication of this call for evidence is an important and much-welcomed step towards this.

The recommendations we propose in our response below are as follows:

- **The definition of large-scale, long-duration, long-term storage should not, at this stage, be a rigid definition, particularly with a capacity threshold.**
- **Before funding models can be properly assessed and developed, the ESO should identify the service need and therefore market value of LLES.**
- **BEIS should ensure a wide range of LLES technologies, and the different services they can provide, are recognised and supported.**
- **Tailored markets are needed for the types of service and operational functions that LLES could provide, and that recognise the range of value that storage brings.**
- **Funding models must give consideration to the different component parts of the operating chain of an LLES plant, including the power capacity, the duration it delivers and the length of time for which it stores energy.**

To inform this response, we have conducted interviews with members and other key parties in the sector. To facilitate a full exchange of ideas, in addition to this written response, we would be happy to set up a roundtable meeting between the ESN and BEIS to provide further detail and nuance to our answers.

About Regen and the Electricity Storage Network

Regen is an independent, not-for-profit centre of expertise in sustainable energy with nearly 20 years' experience in transforming the energy system and delivering independent expert advice and market insight on all aspects of sustainable energy delivery. Regen is a membership organisation and manages the Electricity Storage Network (ESN) - the UK industry group formed in 2008 dedicated to electricity storage.

This response is based on our extensive practical experience and input from our membership, which covers a broad range of electricity storage technologies and members, such as electricity storage manufacturers and suppliers, project developers, users, electricity network operators, consultants, academic institutions, and research organisations.

The ESN is committed to creating an environment in which storage can flourish, ensuring that regulations and markets work for all types of storage, for the benefit of the whole system and without favouring one particular technology.

Strategic context: the role and value of LLES in a net zero energy system

1. Do you agree with our definition of LLES as storage technologies that can store and discharge energy for over 4 hours and have a power capacity of at least 100 MW? If not, what alternative definition would be more suitable? Please provide supporting evidence where possible.

Whilst we agree that 4 hours is a reasonable point at which to delineate between short and long duration storage, we question the usefulness of setting such a specific threshold. A rigid parameter may preclude viable technologies from entering the market and providing valuable services to the grid. It is more useful that BEIS work with the ESO to define the system need and allow project durations to emerge in response.

Of particular concern is the 100 MW threshold, which sets an artifical ceiling that will distort project sizes. 'Large scale' and 'long duration', while often complementary features, should not be exclusively defined together – there may be a role for projects of smaller power capacity, but that can provide long duration output (i.e. energy storage capacity). Defining LLES together in this way could artificially target support towards projects that will connect at the transmission network scale and potentially exclude the opportunity for projects at the distribution network scale, where LLES could also be needed. Indeed, multiple smaller, distribtued projects could provide similar services to a singular, large-scale project. Given that BEIS wants to encourage solutions that accelerate net zero, setting a definition that may exclude the opportunity for a wide number of potential projects – including those that would take less time to build – would be counterproductive.

In addition, we believe it would be more appropriate that the defintion use an energy storage capacity target with a MWh figure, rather than an energy power capacity target with a MW figure. The former is what overwhelmingly determines the cost, land use, planning and visual impact of a project, not the latter. A 100 MW project with a 1 hour duration will look very different to a 100 MW project with a 4 hour duration.

It is important that the definition also makes a clearer distinction between long-duration and long-term storage – the difference between the length of time a storage asset can consistently charge or discharge for, versus the length of time it can store energy before discharging. These are two very different components of a storage asset with different possible timescales, market signals and operational implications, but the definition in the call for evidence currently potentially blurs the two.

Long duration, large scale, and long term are all features which may be more helpfully seen in a continuum. In our 2020 paper, 'Electricity Storage: Pathways to a Net Zero Future', we set out storage technologies under such a continuum (see figure 1).

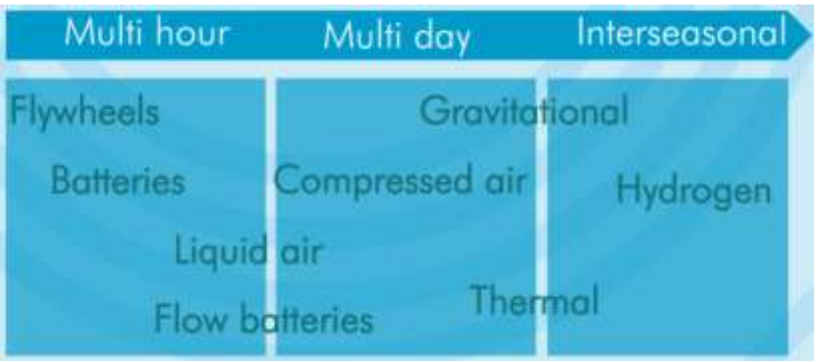

Figure 1: Durations catered for by different energy storage technologies.[1]

[1] Electricity Storage: Pathways to a Net Zero Future, Regen, 2020 https://www.regen.co.uk/wp-content/uploads/ESN-Pathways-to-a-Net-Zero-Future.pdf

Duration, for example, does not fit neatly into specific blocks of time – delineating between them sets artificial boundaries around that service and therefore around projects that will be created to perform that service. 'Long term' also does not benefit from a strict set of timeframes over which it is useful to store energy.

As mentioned above, it may be that multiple assets will provide the service required in a cumulative way – smaller capacity and shorter duration units working sequentially to provide the MW and MWh required. This may also be a useful framing when understanding how to value these types of storage, as addressed later in this response.

Recommendation: the definition of large-scale, long-duration, long-term storage should not, at this stage, be a rigid definition, particularly with a capacity threshold.

2. Do you agree that the electricity system requires, and will benefit from, LLES delivering the services outlined above? Are there any other important services that LLES can provide that are not covered here? Please provide supporting evidence where possible.

We strongly agree that the electricity system requires, and will benefit from, LLES delivering the services outlined in the call for evidence.

In particular, having conducted in depth analysis of the fossil gas peaking plant pipeline as part of Regen's Distribution Future Energy Scenarios for Western Power Distribution and Scottish & Southern Electricity Networks, we are seeing significant positive development activity of fossil fuel projects. Across six distribution network licence areas, c.800 MW of fossil gas peaking plants have either secured planning approval, pre-qualification or been awarded capacity agreements in recent Capacity Market auctions.

The development of a pipeline of new unabated fossil fuel generation is fundamentally at odds with net zero. LLES has the potential to take on some of the roles of system balancing from fossil fuel generation in national and local markets.

In addition to the services mentioned in the call for evidence, we believe that LLES may also be able to provide system contingency and reserve services, such as black start or distributed restart.

As well as helping to balance supply and demand of energy in the physical supply chain, energy storage also exerts an important calming and confidence-building influence within the energy markets. This helps to reduce the volatility of market prices by giving confidence to those traders who are concerned with energy supply and dissuading the action of traders engaged in short term speculation. This system benefit of energy storage seems to have been overlooked by policy makers and regulators and will need some consideration of how this type of service provides value, particularly when considering how to incentivise storage of energy over longer periods. At the moment, there is no way of valuing the length of time a storage asset stores its energy for, which would be a barrier to a business case for interseasonal storage. Therefore, there needs to be consideration given to the different component parts of the operating chain of an LLES plant:

- The potential for high import/export power capacity (large-scale)
- The ability to charge up for longer periods of time (long-duration demand)
- The ability to store energy over longer timeframes (long-term)
- The ability to discharge energy for longer periods of time (long-duration generation)

The recent rise in gas prices has partly been due to the lack of gas storage in GB, with the 'just-in-time' supply model causing shortages and high prices. Gas storage in GB has been reduced in recent years, partly because it has no value in the market and so storage facilities were shut down. While electricity storage and gas storage are very different, there are some lessons that can be learnt for long-duration storage. If the market assigns no value to the holding of energy, then we may find ourselves in a similar position to the GB gas network.

Recommendation: the market, the government, or system operators should assess how the inherent value of storing energy could be recognised.

3. Do you think there will be a need for a range of different LLES technologies, alongside other technologies that may be able to deliver similar system benefits, such as hydrogen production and generation, and carbon capture, usage and storage?

Focusing support on only one technology will restrict our ability to meet our carbon reduction targets and reduces the potential to dilute development risk across more than one technology or subtechnology sector. We therefore strongly agree that supporting a range of different LLES technologies is the most sensible approach; the ESN's membership represents a variety of storage technologies that provide a wide range of benefits which should be supported and rewarded in any future support mechanism.

To help bring a wide variety of technologies to market, we suggest that BEIS consider providing separate support for long-duration, large-scale and long-term storage. The capacity of a storage plant, the duration it delivers and the length of time for which it can store energy are very separate components of a project and so these differences should each be recognised and rewarded in any future support mechanisms.

Recommendation: BEIS should ensure a wide range of LLES technologies, and the different services they can provide, are recognised and supported.

Current market: understanding the storage landscape

4. Please provide details of specific LLES projects that could begin development in the next 5 years. These details should include technology type (including intended use of fuel generated through sector coupling), MW and MWh, the business model or route to market, efficiency and expected development, capital, operational costs and expected lifetime of projects.

True long-duration storage is still in its infancy in terms of deployment. There are many research projects underway to develop LLES technologies, however few of these are deployed to provide services to the system due to the barriers outlined in the following questions – namely high capital costs, poor revenue prospects and absence of direct incentives and tailored market opportunities. Whilst the ESN is aware of a handful of projects in the pipeline, the majority of the opportunities, commercial services and markets are focused on short duration or short to medium scale storage. There is potential for a large number and wide range of LLES projects to begin development, however only with the right regulatory and market reforms and the appropriate support mechanisms will this potential be realised.

Our members will respond with details of individual projects that are currently in development.

Current market: potential barriers to LLES deployment

5. Do you agree that the issues outlined above are barriers to the deployment of LLES? Please comment on any issues that are particularly significant in your view.
6. Are there any other barriers impacting the deployment of LLES?

We agree that the barriers outlined in the call for evidence are the most significant barriers preventing the deployment of storage. These barriers are interdependent – tackling one will help to address or mitigate the impact of the others. In particular, enabling large, accessible, broad and stable revenue for LLES projects will help attract investment, establish a track record, and drive down capital costs through economies of scale.

Lack of market opportunities is also a significant barrier. Flexibility that can provide over 4-6 hours of energy finds little value in the current markets – the Capacity Market is the only route for flexibility of this kind of duration, but it does not provide enough revenue to fully support the business case of a flexible asset. However, it is important to note that the barrier for LLES should be understood less as about lack of signals in existing markets and more a product of the absence of tailored or dedicated markets for the types of service and operational functions that LLES could provide. We must translate the system needs for LLES into a market that LLES can extract value from, and that recognises the range of value that storage brings: the capacity of a storage plant, the duration it delivers and the length of time for which it stores energy.

Recommendation: tailored markets are needed for the types of service and operational functions that LLES could provide, and that recognise the range of value that storage brings: the capacity of a storage plant, the duration it delivers and the length of time for which it stores energy.

In addition to the barriers outlined, there are also a number of policy and regulatory barriers that should be addressed to enable the deployment of LLES:

- **Value of carbon.** Current markets and regulations do not sufficiently value solutions that reduce carbon emissions, such as zero carbon electricity storage. The right signals must be sent through flexibility markets to prevent unabated high carbon assets from participating in flexibility services if we are to keep on course for net zero. A carbon price is unlikely on its own to be an effective way to achieve this; policy makers and regulators must consider market mechanisms that value carbon inherently.
- **Locational signals.** Flexible assets are not currently incentivised to deploy in the right locations. In particular, high Transmission Network Use of System (TNUoS) charges prevent flexible assets being built where they can address constraints, such as the north of England and Scotland. Current reforms to network charges must reflect the investment case for flexible assets and potential benefits to the system of sending the right signals as to where these assets should be located.
- **Regulatory definition of storage.** Storage currently sits, by default, under the electricity generation licence, meaning the fundamental aspects of storage are not recognised separately. The 2017 Smart Systems and Flexibility Plan committed to defining storage as a subset of generation, reiterated in the 2021 Plan, however the storage industry is still waiting for legislative clarity. There is some debate still within the industry as to whether storage should have a separate licence of its own – the longer there is legislative uncertainty, the more this debate continues.
- **Policy certainty.** Whilst it is in a broad sense clear that LLES is a priority for government, policy certainty is needed to mitigate perceived risks about the government changing their minds or losing confidence. This call for evidence, combined with the Long Duration Storage Competition and the tender for a modelling project to look at needs and benefits, will serve to increase confidence and should aim to create a clearer plan about how LLES will grow and integrate into the system. This could evolve quickly to a dedicated LLES energy storage capacity target (i.e. XXX GWh of annual, cyclable LLES capacity by 2030, 2050 etc.)

7. What types of capital are available for LLES and from what types of investors?
8. Do the financing challenges LLES projects face primarily concern raising debt, or also equity?

The financing challenges facing LLES projects concern both raising equity and debt, though debt finance is indeed more of a challenge due to the combination of technology and market risks. As mentioned in response to question 5, revenue uncertainty is a key barrier, and the challenge of stacking multiple revenue streams means it is difficult to raise investor confidence. Once this issue is addressed – through regulatory reforms and providing tailored support mechanisms – both debt and equity financing will be available.

The UK Infrastructure Bank could certainly play a role in providing financing support for LLES projects to reduce capital costs and help attract private investment.

Addressing barriers to the deployment of LLES

9. To what extent will the reforms outlined above support the investability of LLES? Please comment on any specific reforms that, in your view, hold potential to support the investability of LLES significantly.
10. Do you have any views on further reforms that could take place in current markets to improve the investability of LLES?
11. Are you aware of any proposed market changes (and/or system changes) that could make it more difficult to finance LLES within current markets?
12. Considering your answers to questions 9, 10 and 11, do you think further intervention is needed to de-risk investment in LLES?

All the reforms outlined in the call for evidence will support the investability of LLES, however none will provide a strong enough route to market to solve the issue of revenue uncertainty.

Further intervention is needed to de-risk investment in LLES – we outline how such interventions might be structured in response to questions 14-16.

Missing from the list of reforms is the potential for LLES to provide services through local flexibility markets, which are becoming more active, with Distribution Network Operators (DNOs) all running auctions to procure flexibility locally. Whilst the current services being procured are for specific operational needs (such as winter peak demand management, planned maintenance support and unplanned outage recovery), local flex markets could evolve to tackle a broader range of local network needs. There is the potential for LLES to actively participate in these markets and the development of local flex is seen as crucial innovation in the net zero transition as DNOs transition to become Distribution System Operators (DSOs). However, much like national balancing services, these local markets are also currently seeing notable fossil fuel generation participation. The evolution of local flex should also therefore consider how to incentivise low carbon solutions and reward the value that LLES could bring to DSOs.

13. Do you think that it is necessary to try to accelerate the deployment of LLES, even if stronger signals for longer duration storage may not develop until the late 2020s / 2030s?

It is vital that the deployment of LLES is accelerated for a number of reasons:

- The long lead times for LLES projects mean that barriers must be overcome now if the benefits of these technologies are to be harnessed in time to meet our net zero by 2050 target.
- The deployment of renewables on the system is accelerating – we need to ensure the system is prepared with the right technologies, including LLES for the reasons outlined in question 2.

- The uptake of significant numbers of low carbon technologies such as electric vehicles and heat pumps is also largely inevitable. This, coupled with renewable energy deployment, could compound the system need for LLES in the near-to-medium term.
- BEIS should also consider the UK's strategic interest in accelerating the deployment of LLES. As the industry is beginning to attract investment overseas, the UK should press ahead if it wants to take advantage of the export opportunities as the global industry develops. Taking a leading role in developing a British LLES industry and knowledge base will provide an opportunity to create high value, future-proof jobs, as well as to showcase the UK as leading on delivering global net zero promises.

14. Are other reforms needed to markets to ensure long-duration storage assets are providing the maximum value to the system? If yes, please provide detail of what reforms could be needed.
15. Which intervention, in your view, has the most potential to be appropriate for addressing barriers to help bring forward investment in LLES, including novel storage technologies? Are there any other mechanisms which might be appropriate to consider? Please provide evidence to support your response where possible.
16. Please provide suggestions for how the most effective intervention, in your view, could be structured to ensure value for money and affordability.

Funding for a new technology category such as LLES needs stages of supported funding and investment for it to become a developed technology that can support the energy system on a regular basis.

Initially, funding needs to be given for research and development to support and grow the different technologies that can provide large-scale, long-duration and/or long-term storage. This is particularly important in the storage world where there is an abundance of innovative technology types that can provide storage in different ways. The funding under the Net Zero Innovation Portfolio has been a great step forward in providing this stage of support and we welcome the government's efforts to do so.

The next stage of support must provide certainty for investors who may be nervous about putting money into newer technologies that have high Capex costs. We believe the Regulated Asset Base (RAB) or cap and floor models would be the most appropriate to do so and we set out below the opportunities and challenges of each option set out in the document.

The final stage of funding comes from the market – we must have a market that storage can extract value from, that recognises the range of value that storage brings: the capacity of a storage plant, the duration it delivers and the length of time for which it stores energy are very separate components of a project. These differences should each be recognised and fully rewarded in any future support mechanisms.

Several of the funding options outlined in the call for evidence are reliant on that value being recognised in the market and generating revenue – for example the cap and floor model depends on a market price being available against which to provide the floor price.

The current markets, as laid out in question 9, do not currently provide that value, with particular gaps on long duration output and the value of storing electricity over an extended period of time. We believe BEIS and National Grid ESO should identify the system need for LLES and where that value could be recognised through a market mechanism – the ongoing modelling project commissioned by BEIS on the system needs of LLES will go a long way to providing that initial modelling. This could then be built upon by the ESO, for example by combining it with the work currently being undertaken to understand how storage can address constraints. We are also currently responding to the BEIS consultation on the role of the Future System Operator in which we are strongly arguing for an increased system architect role – a function that would help identify LLES flexibility needs and value.

Below, we outline our views on the four proposed interventions:

- **Contracts for Difference (CfD).** A CfD mechanism would not be appropriate to bring forward investment in LLES. As the call for evidence highlights, the CfD works to incentivise generators to maximise their output, with a guaranteed price per MWh produced. It does not reward balancing and ancillary services, and is therefore an inappropriate approach for storage assets, which should be incentivised to deliver value-added services that address system needs.
- **Capacity Market reform.** The Capacity Market is unlikely to be sufficient on its own to incentivise LLES. Currently, the Capacity Market does not facilitate projects with longer lead times than four years, nor does the focus on system stress events acknowledge or reward the additional system benefits that LLES technologies can deliver. In addition, there is a current bias towards high carbon assets being awarded contracts and, due to the current high costs of LLES technologies, it is unlikely they would be able to compete with such assets. BEIS' call for evidence on better aligning the Capacity Market with net zero is welcome and could be a step towards improving the opportunity for LLES to compete. However, we don't believe that changes to the current market will be enough to establish an investment case for LLES. As opposed to the Capacity Market in its current form, the creation of a new market based on the principle of a capacity mechanism that allows larger assets with longer lead times, and retains the de-rating factors for duration, could be an opportunity to incentivise LLES projects to develop. This would still only form a small component of the revenue stack and would therefore need to be complemented with additional dedicated market opportunities and support mechanisms for LLES.
- **RAB.** An RAB model could potentially be well suited to address the lack of revenue certainty by ensuring a guaranteed return on investment and helping to mitigate construction cost risks. This approach may be more appropriate for larger scale storage projects, particularly interseasonal storage, if required.
- **Cap and Floor.** We recognise the potential benefits of a Cap and Floor mechanism in incentivising the optimisation of assets and that this approach has proven successful for interconnectors. However, as mentioned above, we are concerned that it would rely on a market price being available against which to provide the floor price. Current markets do not provide that value, particularly for long duration output and for storing energy over a period of time. A floor price without a cap could be risky if LLES assets take advantage of large swings in market volatility, so we would advise caution against this approach.
- **Essential service provision.** It is important to identify, among the wide variety of LLES technologies and services, which would constitute an essential public utility that would need to provide services in times of system stress, or to calm volatile markets, such as the current gas price increases. Interseasonal storage may be one such example – if a need is identified for such assets, they will be very large infrastructure projects. Black start assets may also come under this category. Such services would be unlikely to be supported in the current market framework, but are nevertheless essential assets that require public investment. Once identified, these essential services could be invested in publicly, or by the system operator. This will be very specific to particular assets, and would need to be funded under strict rules and around highly specified operational need to avoid any competition with the rest of the storage and flexibility industry.

While we believe that the funding models outlined in the consultation are broadly in the right direction, we are concerned that there is still a missing step in terms of identifying the service need and therefore the value that LLES provides to the system. Each of the funding models require the right markets for assets to participate in – these must be identified and outlined alongside the development of these funding models.

We are also concerned that the four suggested interventions fall short in fully rewarding the value of storage assets in their ability to simply store energy to be dispatched at a later point in time.

Recommendation: before funding models can be properly assessed and developed, the ESO should identify the service need and therefore market value of LLES.

Recommendation: funding models must consider how to award value to the ability of assets to store energy over the long term.

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