Department for
Business, Energy
& Industrial Strategy

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

Government Response

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Introduction

A smart and flexible energy system is essential for integrating high volumes of low carbon power, heat, and transport. The importance of flexibility for our energy security to ensure that we can efficiently match supply and demand and minimise waste was recognised in the British Energy Security Strategy. We anticipate that at least 30GW of low carbon flexible assets, which includes electricity storage, may be needed by 2030 to maintain energy security and cost-effectively integrate high levels of renewable generation.[1]

From deploying sources of low carbon flexibility, such as short-duration electricity storage, flexible demand and interconnectors, analysis has indicated that there could be significant savings to the electricity system of up to £10 billion per year by 2050 and between £30-70 billion between 2020-2050.[2] Electricity storage can enable us to use energy more flexibly and de-carbonise our energy system cost-effectively. For example, by helping to balance the system at lower cost, maximising the usable output from intermittent low carbon generation (e.g., solar and wind), and deferring or avoiding the need for costly network upgrades and new generation capacity. Storage over longer periods of time, for example across days, weeks and months, can help to manage variation in generation and demand, such as extended periods of low wind or cold weather events.

Electricity storage covers a range of technologies that can deploy at different scales and provide output for different durations. This includes lithium-ion battery storage and pumped hydro storage as well as emerging technologies including liquid air energy storage and flow batteries. The Government is committed to removing barriers to the deployment of electricity storage at all scales as outlined in the 2021 Smart Systems and Flexibility Plan.[3] For example, we awarded £6.7million of government funding to projects across the UK to support the development of new energy storage technologies as part of the Long Duration Energy Storage Demonstration (LODES) competition.[4]

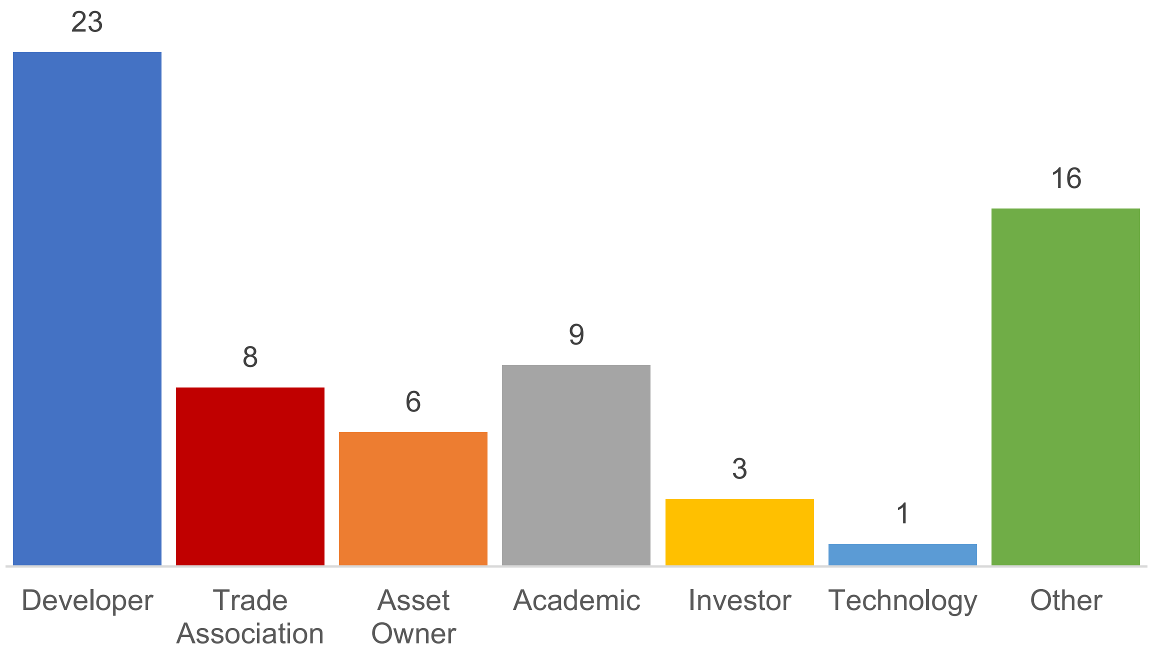
In July 2021, we published a Call for Evidence on **large-scale, long-duration electricity storage** (LLES). We invited views and evidence on the role of this type of storage in the future electricity system, the barriers these technologies face, what intervention might be suitable to address these barriers as well as the risks associated with intervening.[5] This document is our government response followed by a summary of responses. Each chapter begins with a short

[1] https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021
[2] https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021
[3] https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021
[4] https://www.gov.uk/government/publications/longer-duration-energy-storage-demonstration-programme-successful-projects
[5] https://www.gov.uk/government/consultations/facilitating-the-deployment-of-large-scale-and-long-duration-electricity-storage-call-for-evidence

introduction to the policy area and an outline of the questions asked, followed by a summary of responses received.

Overall, we received 66 responses from a range of stakeholders. Figure 1 shows the number of responses by type and the respondents are listed in Annex 2.

Figure 1. Respondents to the LLES Call for Evidence



Government Response

Since launching the Call for Evidence on facilitating the deployment of large-scale, long-duration electricity storage (LLES), the Government has set out its plans regarding the future of our energy system in the British Energy Security Strategy.[6] These plans will shape requirements in the short, medium, and long term. It includes a commitment to fully decarbonise the power sector by 2035, subject to security of supply. We expect these announcements to increase the need for flexibility of all types on the system.

Alongside our Call for Evidence, we commissioned external analysis from AFRY to understand the role that long-duration electricity storage could play in the system, how much may be required over periods of time, and the benefits of different technologies. This analysis was undertaken in 2021 and a report published.[7] The recent energy system announcements have reinforced the need for a more detailed assessment of the role for large-scale, long-duration electricity storage so these changes can be accurately reflected in the policy development process.

From our review of the responses to the Call for Evidence and the externally commissioned analysis, while taking into account the changing context, we have concluded that LLES:

- has an important role to play in achieving net zero, helping to integrate renewables, maximising their use, contributing to security of supply, and helping manage constraints in certain areas;
- provides low carbon flexibility, replacing some unabated gas generation;
- diversifies our technology mix and provides optionality for meeting our ambitious 2035 power sector decarbonisation targets; and
- faces significant barriers to deployment under the current market framework due to their high upfront costs and a lack of forecastable revenue streams.

Considering these conclusions and as outlined in the British Energy Security Strategy, **we will ensure the deployment of sufficient LLES to balance the overall system by developing appropriate policy to enable investment by 2024**.

Next steps

Most respondents to our Call for Evidence identified a Cap and Floor type mechanism as the most suitable for LLES. We recognise that a Cap and Floor mechanism may be suitable in principle, but detailed design work is needed to assess the benefits and interactions of such a scheme with the energy system.

To meet our commitment in the British Energy Security Strategy, we will:

[6] https://www.gov.uk/government/publications/british-energy-security-strategy
[7] https://www.gov.uk/government/publications/benefits-of-long-duration-electricity-storage

- carry out further analysis on the costs and benefits of intervention in the market for LLES, including its contribution to energy security and possible market distortions;
- consider options including a Cap and Floor, and an optimised Capacity Market in addition to wider flexibility operational signal sharpening being considered under the Review of Electricity Market Arrangements (REMA);[8] and
- work with Ofgem to develop an appropriate policy to enable investment in LLES.

We anticipate further consultation with stakeholders on the design of a mechanism to enable investment in LLES and will set out further details in due course.

[8] https://www.gov.uk/government/consultations/review-of-electricity-market-arrangements

Summary of responses

Strategic context: the role and value of large-scale and long-duration electricity storage in a net zero energy system

The UK currently has around 3GW of large-scale, long-duration electricity storage (LLES). This is all pumped hydro storage, built before the privatisation of the electricity system. A range of technologies could provide large-scale, long-duration electricity storage, including, but not limited to: gravitational storage, redox flow batteries, novel batteries such as copper and zinc, compressed or liquid air energy storage, pumped hydro storage, and power-X-power technologies.

In the Call for Evidence, we described LLES as being able to:

- replace fossil-fuelled sources of flexibility including gas turbines and reciprocating engines and reduce the need for additional peaking generation by shifting excess supply from peak to off-peak, as well as managing periods when demand is lower than low carbon supply;
- reduce the need for additional low carbon generation by better utilising existing sources of renewable generation;
- support network constraint management, and reduce the volume and cost of network reinforcements by shifting supply from congested to uncongested periods;
- provide storage over different durations – intraday, inter-day and inter-seasonal, e.g., helping to balance the system across longer periods of lower generation (e.g., periods of low wind) or higher demand (e.g., colder periods when heating demand rises); and
- provide stability services, including inertia, frequency response and voltage.

In this section, we sought views on an appropriate LLES definition. We then looked to understand the different capabilities of LLES, whether a range of LLES technologies is needed, and the current pipeline of LLES projects.

Question 1: Do you agree with our definition of LLES as storage technologies that can store and discharge energy 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.

Summary of Stakeholder Responses

This question received 59 responses. A large majority of respondents (83% of those who responded) disagreed with the proposed definition. Many respondents opposed either the duration of energy discharge, or the capacity suggestion, rather than both. Some respondents suggested the definition use different requirements.

Almost all the respondents who disagreed with the duration of energy discharge thought it should be extended. Respondents variously suggested above 5 hours, above 6 hours, above 8 hours and above 24 hours. One respondent suggested that it should be shorter as no ancillary service provided by a 4-hour discharge duration cannot also be provided by a 2-hour discharge duration. Some of the reasons given for a longer duration of energy discharge were:

- 4 hours could risk battery projects operating in a non-optimal manner to gain support;
- 4 hours is likely to mean operating inter-day, which batteries can do more cheaply;
- 5 hours to align with the Capacity Market or Short Term Operating Reserve service contracted by National Grid ESO; and
- 6 hours to displace some of the gas generation and be able to meet the duration of peak periods.

Most of the respondents who disagreed with the capacity suggestions thought that there should be a smaller capacity requirement, or no capacity requirement. Some of the reasons given were:

- multiple projects operating in a coordinated manner could deliver the same or superior service and should not be excluded;
- this could modify the behaviour of assets to qualify as LLES;
- smaller potential pumped hydro sites could be lost;
- requiring a ‘large-scale’ component could disincentivise new technologies because such a scale carries more risk; and
- it would exclude distribution projects.

A few respondents suggested a larger capacity requirement because the scale of storage required means that transmission connected assets should be prioritised. As the cost of connection to the grid is high this would create economies of scale for bigger projects.

A number of respondents suggested different metrics:

- distinguishing between synchronous and asynchronous technologies because they viewed provision of inertia as important;
- accounting for the number of cycles;
- transmission connected or distribution connected;
- energy/generation requirement rather using power/capacity requirement (MWh vs MW) to better reflect the energy need;
- import capacity to better understand the asset’s usefulness to the grid; and
- cost intensity (cost/MWh).

Some respondents suggested any definition could create distortions whilst others thought that there should be more distinction (short, medium, and long duration) within the definition to account for the difference between LLES technologies. Some respondents thought that a definition should be determined based on the system need.

Finally, a few respondents thought that the definition should be broadened to energy storage to support sector coupling flexibility.

Question 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.

Summary of Stakeholder Responses

This question received 52 responses.

A large majority of respondents (96% of those who responded) agreed that the electricity system requires, and benefits from, LLES delivering the services outlined in the Call for Evidence. Although different respondents emphasised different benefits. A couple of respondents disagreed that these benefits were LLES specific and said that other forms of flexibility were equally capable of providing these benefits.

A number of respondents said that LLES could provide additional benefits. These included reducing the cost of balancing the system, stabilising electricity prices by reducing the peaks and avoiding prices going negative, an opportunity for sector coupling with hydrogen, and providing additional system services not mentioned in the Call for Evidence, such as Black Start, Short Circuit Level, and Reserve.

Question 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?

Summary of Stakeholder Responses

This question received 49 responses. A large majority of respondents (92% of those who responded) agreed that there will be a need for a range of different LLES technologies. The reasons most cited were the need to reduce risk in delivering net zero, that different storage technologies are better suited to different storage needs, and that geographical requirements limit the quantity deployable of certain LLES technologies.

Very few respondents disagreed with this need for a range of LLES technologies. Where they did so, it was on the need to ensure there is a level playing field between technologies.

Question 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 capacity, the business model or route to market, efficiency and expected development, capital, operational costs and expected lifetime of projects.

Summary of Stakeholder Responses

This question received 37 responses. Respondents provided details on a range of projects from large pumped hydro storage to flow batteries.

Current market: Potential barriers to LLES deployment

Our aim is for all storage technologies to be able to compete fairly with each other, and with low carbon generation. Evidence suggests this is currently not the case, with large-scale and long-duration electricity storage (LLES) technologies facing a financing barrier that limits deployment.

The Call for Evidence outlined the key barriers contributing to the overall financing barrier faced by LLES specifically, including:

- high upfront capital costs and long lead times;
- lack of track record;
- lack of revenue certainty; and
- lack of market signals.

We looked to understand whether these were the correct barriers and whether other barriers existed for deployment of LLES. We then sought more detail on the financing barrier that LLES faces.

Question 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.

Summary of Stakeholder Responses

This question received 41 responses.

An overwhelming majority of respondents (98% of those who responded) agreed with the barriers identified. Some respondents thought that these barriers were the same for all types of storage technologies, and one respondent mentioned that these barriers were also present for refurbishing LLES.

A few respondents pointed to additional barriers faced by LLES, specifically:

- network charging / Transmission Network Use of System (TNUoS) regime treating storage unfairly;
- connection times, there are long wait times for LLES to connect to the grid which hinders its deployment;
- linked to the lack of track record, the scale of manufacturing for novel technologies is not big enough to bring down the costs of some LLES technologies; and
- support for interconnectors (through their dedicated Cap and Floor) distorts the market for flexibility, including LLES.

Question 6: Are there any other barriers impacting the deployment of LLES?

Summary of Stakeholder Responses

This question received 42 responses. Respondents provided information on a range of barriers. The most regularly cited where:

- the network charging regime, including high TNUoS charges, hinders the deployment of LLES, particularly in Scotland, where it acts as a disincentive to deploy storage (16 times);
- the general uncertainty about the future of the electricity system, the policies for storage, future network charging, future market landscape, and future regulatory framework (10 times);
- the lack of carbon signals in electricity markets (7 times);
- the inability to obtain grid connections in a timely manner (5 times); and
- the lack of market for LLES to monetise all the benefits that it can bring to the electricity system (e.g., being a very long-lasting asset, the ability to provide multiple system services at once) (5 times).

Other barriers that were mentioned include: the lack of regulatory definition for storage, that increased deployment of flexibility reduces the revenues for each new storage system, existing support mechanisms distort price signals, lack of government policy requiring a mandated energy reserve, the planning process for storage projects being onerous, the lack of governance structure able to coherently allow infrastructure investment to be provided in advance of need, lack of policy to support investment, and the current electricity market structure is too complicated.

Question 7: What types of capital are available for LLES and from what types of investors?

Summary of Stakeholder Responses

This question received 24 responses. Responses to this question were mostly high level and hypothetical. A recurring comment was that having more security in long-term revenues would encourage investor interest in LLES.

Some respondents answered that private equity funding and private debt could be available, and slightly fewer respondents said that public equity funding and public debt could be available.

In terms of type of investors, large/strategic corporates (e.g., utility firms and oil & gas companies), and private infrastructure equity funds were cited by the largest number of respondents.

Question 8: Do the financing challenges LLES projects face primarily concern raising debt, or also equity?

Summary of Stakeholder Responses

This question received 27 responses. Most respondents responded that debt (89%) or equity (85%) was a challenge, many respondents cited both, and explained that lack of revenue certainty for LLES is the main reason for these challenges.

Other explanations for these challenges were the lack of investment in manufacturing for LLES, and the lack of regulatory certainty and policy. For debt specifically, respondents noted the risk associated with being the first few LLES projects to deploy. For equity specifically, respondents noted that the equity available is very expensive, small scale and difficult to obtain, and that short-duration storage is easier to fund.

Addressing barriers to the deployment of LLES

Market reforms: Current routes to market and potential reforms

LLES currently participates in a number of energy markets, and largely, developers need to stack several revenue streams to build a viable investment case. These markets are undergoing reforms that could benefit LLES.

In the Call for Evidence, we referred to the following reforms:

- Stability Pathfinders and other ESO services offering multi-year contract, for which storage is eligible;

- establishment of a UK Infrastructure Bank which will support net zero, and could include LLES projects,
- Capacity Market reforms, that could include allowing longer construction times, and having a low carbon auction to align better with net zero;
- enabling Network Competition through legislation to allow private ownership of onshore electricity network assets, that could include storage;
- changes to network charging, Ofgem is reviewing how demand and generation charges should be applied where storage is acting in a way that benefits the system; and
- clarifications to the transmission Constraint Licence Condition and how it applies to storage.

Engagement leading up to the Call for Evidence suggested that any of these new opportunities would need to be stacked along with other revenue streams, rather than providing a new route to market on its own.

We looked to gather more detail on the impact of these reforms on LLES, whether there were other reforms that might help the investability of LLES, any that might hurt the investability of LLES, and whether additional intervention may be required.

Question 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.

Summary of Stakeholder Responses

This question received 42 responses.

Most respondents (60% of those who responded) thought that these reforms were not sufficient to enable the deployment of LLES.

Some respondents raised the challenges not addressed by these changes, including contracting for system services separately rather than bundling, short delivery timeframes for Pathfinder contracts, the Capacity Market not accounting for carbon and high TNUoS (Transmission Network Use of System) charges, particularly in Scotland.

Question 10: Do you have any views on further reforms that could take place in current markets to improve the investability of LLES?

Summary of Stakeholder Responses

This question received 34 responses. Respondents suggested a wide variety of reforms, the three most suggested reforms were:

- better accounting of carbon in electricity markets, including the Capacity Market, Pathfinders and the Balancing Mechanism; some respondents suggested this could be done by creating separate pots or adjusting bid prices (9 responses);

- supporting LLES through a de-risking mechanism (9 responses); and
- reducing network charges, in particular reducing TNUoS (7 responses).

Other reforms suggested included facilitating revenue stacking for storage operators, the creation of a strategic reserve, reforming ancillary services markets, reforming the balancing mechanism, and creating an energy storage service to manage constraints.

Question 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?

Summary of Stakeholder Responses

This question received 25 responses. About half of the respondents thought some proposed market changes could make it more difficult to finance LLES. The most cited proposed market change making it more difficult to finance LLES was government support for other technologies, including hydrogen, CCUS and interconnectors. Other respondents cited shortening the contract length for ancillary services to 30 min and the market saturation by short-duration assets making it more difficult for financing LLES.

Question 12: Considering your answers to questions 9, 10 and 11, do you think further intervention is needed to de-risk investment in LLES?

Summary of Stakeholder Responses

This question received 42 responses. A large majority of respondents (90% of those who responded) agreed that there was a need for further intervention to de-risk investment for LLES. Respondents who disagreed argued against an LLES specific intervention as short-duration storage could provide the same benefits and they were opposed to market intervention from the government.

Some respondents suggested reforms to de-risk investment. These included developing a Cap and Floor (and versions of the mechanism), a strategic reserve, supporting research and development, changing the Capacity Market (low carbon auctions, barring fossil fuel generators), and better locational signals.

Rationale for further intervention to de-risk LLES, and potential approaches

At present, the challenges LLES faces in attracting the investment it needs to deploy could prevent storage at this scale from being built in the short-term. This means that it may not be an option for tackling the flexibility shortfall required by the reduction in gas generation and significant increase in variable renewable generation expected by the mid-2030s.

The Call for Evidence looked to test whether we should accelerate the deployment of LLES, and whether other reforms might be needed to maximise the value LLES brings to the system.

This section also looked at the different mechanisms that could help bring forward investment in LLES, while ensuring that storage is incentivised to respond to varying price signals and provide flexibility when it is needed. The main options considered in the Call for Evidence were:

- a Regulated Asset Base (RAB) mechanism;
- a Cap and Floor mechanism;
- a Contract for Difference (CfD) framework; and
- a Reformed Capacity Market.

We sought evidence on which intervention might be best suited, whether other interventions should be considered, and how such an intervention might be designed to provide value for money and affordability. We also looked to gather information on whether power-hydrogen-power projects that provide LLES face the same barriers as those outlined earlier, and what type of mechanism might be suited to overcome these.

Question 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?

Summary of Stakeholder Responses

This question received 47 responses.

A large majority of respondents (96% of those who responded) agreed it was necessary to accelerate the deployment of LLES. Respondents cited the need to meet climate targets, the long lead time of LLES projects, the network need for this type of storage, the time needed for supply chains to develop, and the possibility for the UK to position itself as the global industry develops, amongst others.

The respondents who disagreed said that signals for long-duration storage will come throughout the 2020s and therefore accelerating the deployment risks impacting the deployment of short-duration storage, especially as there was not yet a clear requirement of what type of LLES is needed, and how much.

Question 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.

Summary of Stakeholder Responses

This question received 35 responses. A large majority of respondents (91% of those who responded) thought that there was a need for other reforms to ensure LLES assets provide the maximum value to the system. The reforms suggested included reforms to:

- Transmission Network Use of System (TNUoS) charges;
- markets to value LLES;
- create a strategic reserve;
- create a mechanism to provide revenue certainty;
- create a market for constraint management;
- ancillary service markets; and
- align markets with net zero.

Those that disagreed suggested that LLES is not mature enough to be proposing new market reforms.

Question 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.

Summary of Stakeholder Responses

This question received 43 responses.

Just over half of respondents thought that some form of Cap and Floor was the most appropriate to help bring forward investment in LLES. Some respondents chose a Cap and Floor as described in the Call for Evidence. Others suggested that a floor with no cap would be better suited to ensure that LLES assets participate in line with market signals, explaining that if a cap is in place, there is no incentive to use (and wear down) your asset if you do not get any revenues. A similar amount of respondents suggested that a floor and a soft cap, where revenues above the cap are split between consumers and asset owners, might be best suited to compensate consumers for de-risking investment and ensuring assets continue to act in line with market signals.

Some respondents thought that creating a ‘strategic reserve’ would be the most appropriate way of bringing forward investment in LLES. This proposed intervention would provide payments for storage assets to not participate in other markets so that they could be called upon in times of system stress.

Other respondents suggested that changes to the Capacity Market, as set out in the Capacity Market Call for Evidence would be the most appropriate way of bringing forward investment in LLES.[9] The changes suggested included low carbon auctions and extended delivery years for technologies that cannot be built in the current timeframe.

Respondents suggested interventions which might have the potential to help bring forward investment in LLES. These included research and development support; regulated asset base model for LLES; Contracts for Difference for storage co-located with renewables; removing policy and regulatory barriers for LLES participation in existing markets; and a carbon tax.

Question 16: Please provide suggestions for how the most effective intervention, in your view, could be structured to ensure value for money and affordability.

Summary of Stakeholder Responses

This question received 30 responses.

Respondents provided a range of ways to ensure that a Cap and Floor could be structured to ensure value for money and affordability, including:

- removing the cap, or having a soft cap because the cap limits the potential up-side returns to investors who will respond by requiring a higher minimum return and therefore raising the floor, it negates the market signals above an arbitrary point, it can disincentivise return enhancing improvements to the asset, and it is difficult to police and administer;
- ensuring the scheme is technology agnostic and competitive by deriving the income floor level through commercial tender or auction to ensure the most economic projects proceed;
- requiring projects submit a positive cost-benefit assessment to ensure projects provide positive system impacts and limit the risk of having stranded assets and negative impact on other flexibility providers;
- introducing an incentive mechanism to make sure that assets trade and operate efficiently, as is done in the interconnector regime;
- initially delivering contracts through an administrative process before moving to a competitive process to reduce costs during the learning period and allow markets to develop; and
- limiting the volume of storage supported over time, to minimise the risk of over procuring LLES or locking out potential new technologies.

[9] https://www.gov.uk/government/consultations/capacity-market-2021-call-for-evidence-on-early-action-to-align-with-net-zero

Respondents that favoured the Capacity Market for supporting the deployment of LLES thought that it was important to have a competitive process. They suggested the potential to create different pots within the Capacity Market to meet different needs to provide value for money and affordability.

Question 17: Do you think that hydrogen storage that will provide flexibility could face the same financing barriers discussed in relation to LLES above? Please provide evidence where possible.

Summary of Stakeholder Responses

This question received 36 responses. The responses to this question were mixed.

For the respondents that thought hydrogen storage would face the same financing barriers (44% of those who answered) the reasons given were:

- there is currently a missing market for storing energy for a long time which also affects hydrogen storage;
- investment in hydrogen storage is not happening, and the investment dynamics are similar in principle: the high capex and long investment horizons make it difficult to secure debt financing without a form of government support to mitigate revenue risk, securing equity funding is equally challenging as there are other more attractive, lower risk investment options available.

For the respondents that thought hydrogen storage may not face the same financing barriers (25% of those who answered), some of the reasons given included:

- hydrogen storage is significantly less efficient than other LLES technologies;
- the issue for hydrogen storage is the availability of low-cost green electricity, and actually supporting LLES would be able to bring down these costs for electrolysers;
- hydrogen already receives support through different schemes;
- hydrogen storage might be better suited to innovation support as it’s not a mature technology;
- hydrogen storage is needed for inter-seasonal storage and will probably require a different support mechanism; and
- hydrogen faces a lack of demand for hydrogen fuel in the existing power system.

Some respondents voiced that hydrogen storage behaving as LLES should be supported if LLES is to be supported.

Question 18: Do you agree that it is not yet appropriate for a Cap & Floor mechanism to be considered for hydrogen storage? If so, what other approaches might be appropriate to consider?

Summary of Stakeholder Responses

This question received 30 responses. The majority of respondents (67% of those who responded) agreed that a Cap and Floor was not yet appropriate for hydrogen storage. Their rationale was that there was not yet a demand for hydrogen, that it is too expensive and not yet demonstrated at scale, and hydrogen can also be stored for other sectors.

The respondents who thought that a Cap and Floor for hydrogen storage would be appropriate (10% of those who responded) said that such a mechanism could support the creation of a hydrogen market and that when hydrogen storage behaved as LLES it would be appropriate.

Other respondents suggested other forms of support for this technology might be better suited such as a capacity or availability payment; or that hydrogen storage should be viewed as part of the whole hydrogen value chain and production subsidies could flow to support investment in hydrogen storage.

Understanding risks

Any market intervention carries a risk of introducing new distortions, and adding to a wider risk that the variety of government interventions active at once will exacerbate complexity. This section sought evidence on the risks of intervention, and on how to minimise any distortions.

Question 19: What are the key risks in intervening to support LLES, and what risks might arise from a Cap & Floor specifically?

Summary of Stakeholder Responses

This question received 32 responses.

Responses on the high-level risks of intervening to support LLES included:

- creating an uneven playing field for storage technologies which could also hinder the development of new storage technologies as well as slowing the deployment of storage generally;
- cannibalising potential revenues for technologies, such as CCUS and hydrogen generation;
- increasing prices for consumers by stepping in rather than allowing the market to determine the best way to provide the required services;
- over procuring LLES which could lock consumers out of the benefit of future reduction in development costs, or cheaper technologies, and crowd out other storage technologies;

- comparing different LLES technologies is difficult which may make it difficult to make them compete; and
- increasing market complexity.

Responses on the risks to delivering a Cap and Floor included:

- assets not responding to market signals because of a cap;
- assets behaving sub-optimally if there are not sufficient requirements to receive the floor payments;
- difficulty in setting the right floor level and the right cap level;
- delivery of a complex scheme and the time it will take to develop; and
- market distortions for existing LLES to the detriment of the consumers.

Question 20: How might a cap & floor mechanism distort the market for short-duration flexibility and nascent technologies? Please provide evidence where possible.

Summary of Stakeholder Responses

This question received 25 responses.

Respondents provided a number of ways in which a Cap and Floor may distort the market for short-duration flexibility and nascent technologies, including:

- crowding out short-duration technologies and nascent technologies depending on the amount of LLES procured;
- placing a cap could inhibit innovation by limiting the upside of investing in new technologies;
- LLES technologies may modify their bids to compete with short-duration technologies;
- reducing the deployment of short-duration technologies; and
- supported LLES will be able to bid at lower prices than unsupported LLES.

A number of respondents answered that a Cap and Floor for LLES would not create market distortions for these technologies as these usually compete in different markets. However, when they do compete in the same markets, they should be competing to drive down prices, which the Cap and Floor will help LLES do.

Question 21: How could any intervention, such as a Cap & Floor mechanism, be designed and implemented to enable the benefits to outweigh risks?

Summary of Stakeholder Responses

This question received 25 responses. A number of suggestions were made to design and implement an intervention to enable the benefits to outweigh the risks. Some of these are similar to the suggestions made in Question 16. The suggestions included having:

- a soft cap or no cap;
- a positive cost-benefit analysis to ensure the project brings value to the system;
- a competitive process;
- a technology neutral process;
- an appropriate level of financing bonding to limit speculative participation;
- a periodic review of assets;
- an accurate definition of LLES (potentially splitting between medium and long duration);
- a consultation on the design mechanism;
- an exposure to market signals; and
- incentives on developers to deliver projects on time.

Annex 1: Summary of questions

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.

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.

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?

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.

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?

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?

Addressing barriers to the deployment of LLES

Market reforms: Current routes to market and potential reforms

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?

Rationale for further intervention to de-risk LLES: Considering approaches

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?

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.

17. Do you think that hydrogen storage that will provide flexibility could face the same financing barriers discussed in relation to LLES above? Please provide evidence where possible.

18. Do you agree that it is not yet appropriate for a Cap & Floor mechanism to be considered for hydrogen storage? If so, what other approaches might be appropriate to consider?

Understanding risks

19. What are the key risks in intervening to support LLES, and what risks might arise from a Cap & Floor specifically?

20. How might a Cap & Floor mechanism distort the market for short-duration flexibility and nascent technologies? Please provide evidence where possible.

21. How could any intervention, such as a Cap & Floor mechanism, be designed and implemented to enable the benefits to outweigh risks?

Annex 2: Respondents[10]

Storelectric	Regen and Electricity Storage Network	Royal Society
Cumulus Energy Storage	Energy Systems Catapult	Engie
Renewable Energy Systems (RES)	Energy Research Accelerator	Highlands and Islands Enterprise
InterGen	Highview Power	Banks Renewables
Enstore	Copenhagen Infrastructure Partners	Intelligent Land Investments Group
Tidal Range Alliance	REA (Association for Renewable Energy and Clean Technology	Scottish Government
Roulstone, Zachary, Cosgrove	Associated British Ports	RenewableUK
Gilkes Energy	Invinity Energy Systems	Energy UK
Susgen	Durdle	Shell
Uniper	Wang University of Warwick	Scottish Power
National Grid ESO	Waterson University of Warwick	Orsted
ESS Inc	Madley Manchester Met University	Dorothea Pumped Hydro
Flow Batteries Europe	Cadent Gas Ltd	UK Power Networks
Energy Nest	Jacobs UK	Fluence
Mutual Energy	CellCube and Calloch Energy	SSE Renewables
Drax	Octopus Energy and Form Energy	EDF
Meridiam	British Geological Survey	Greenpeace
Sembcorp UK	TotalEnergies	Quarry Battery

[10] Excluding those that requested to be kept confidential

UK Pumped Hydro Working Group (Scottish Renewables)	EscoVale Consultancy	Zenobe Energy
Statkraft	Mott Macdonald	Swanbarton
Solar Energy UK	Roulstone	Conrad Energy

This publication is available from: www.gov.uk/government/consultations/facilitating-the-deployment-of-large-scale-and-long-duration-electricity-storage-call-for-evidence

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