Consultation: Long duration electricity storage: proposals to enable investment

Response from UCL Institute for Sustainable Resources

5th March 2024

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The UCL Institute for Sustainable Resources' mission is to provide evidence, expertise and training to respond to climate change and support sustainable transitions for people and planet.

This is a summary of a response submitted via the online questionnaire on the UK government website. We have chosen to answer the questions where we have specific expertise.

We would be delighted to discuss this response, or any of our other work. Please contact Katherine.page@ucl.ac.uk

1. **Do you agree with the policy objectives that have been identified? Please explain your reasoning.**

Generally, we agree with the policy objectives identified.

However, we have some concern about the "reduce system costs" objective as this suggests a counterfactual or comparator future scenario that would 'cost more'. A better framing may be that the objective is to seek to provide value for money for consumers. There will necessarily be some investment required and costs involved, and an objective to "reduce system costs" is ambiguous.

2. **Are there other factors we should consider in our policy objectives?**

Overall, we would encourage the government to provide an environment within which new forms of truly long duration storage are incentivised. For instance, more funding for research and development into novel and much longer duration storage.

4. **Do you agree with our assessment that a cap and floor is the most appropriate policy option to enable investment and bring forward the required LDES? Please explain your reasoning.**

Having assessed the supporting information, we surmise that the cap and floor on revenues seems like a reasonable option.

5. **Do you agree with our approach to not set an overall scheme capacity?**

It seems reasonable to not set a minimum scheme capacity, as other variables such as location, efficiency, and especially, storage duration are also important and would change the required optimal capacity of storage.

6. **Have we sufficiently identified wider risks and do you agree with the proposed mitigations? Please provide your reasoning.**

As several of the risk control measures rely on how the allocation process will work, special importance should be given to this process. Nonetheless, the risk list presented in the document is comprehensive and covers the most evident potential risks.

7. **Do you agree that only those technologies that meet the electricity storage definition should be eligible for an LDES scheme?**

Storage technologies that deliver energy in the form of heat should not be explicitly excluded from the policy. With the increase of heat electrification, the effect of thermal uses from industry and the residential sectors would strain the electricity grid and increasing their flexible demand in the most cost-effective way is a must. There is no evident reason why a cap and floor mechanism could not operate on heat delivering storage. Especially if this kind of storage has the potential of providing flexibility to the whole system in a most cost effective way.

8. **Do you agree that it is appropriate to exclude technologies that can already be funded under existing market arrangements and/or those that would be eligible for multiple business model support?**

This seems reasonable. If technologies, such as hydrogen, can apply to alternative support options, It is better to leave developers to decide which scheme they would be supported by.

9. **Do you agree with our proposal for a minimum duration of 6 hours? If not, please provide a rationale.**

We acknowledge that there is no clear definition of precisely what duration constitutes “long” duration, however we would argue that the inclusion of storage options with discharge durations as low as 6 hours is puzzling for a number of reasons.

Firstly, previous analysis conducted for BEIS classified long duration storage as having more than 12 hours of discharge duration.[1] Indeed, that study showed that the most cost effective long duration storage (LDS) was hydrogen stored in salt caverns which had a potential discharge duration of up to 720 hours. The findings were corroborated by researchers, including an author of this response, who looked at least cost designs for net-zero compatible power systems for the UK and found that systems with nearly 100% variable renewables (wind and solar) supported by long duration hydrogen storage and batteries, were the most cost-effective designs.[2]

Secondly, another study analysed the parameter space for LDS and found that durations above 100 hours have the greatest positive impact on the system, in terms of cost reductions and the displacement of other firm capacity.[3]

Thirdly, storage of such a short duration (i.e. 6 hours) is likely to function in a mode of operation that is very different from longer duration assets (e.g. days, weeks or months) and as a result experience a markedly different exposure to investment risk. Generally speaking, shorter duration storage can benefit from providing daily supply-demand balancing (as, for example, pumped hydro does today) and a range of ancillary services (e.g. frequency response, operating reserve, etc as, for example, grid scale batteries are used for today) depending on the technology in question. At the same time, longer duration storage, if used to provide a more strategic longer term balancing option (e.g. during multiple days or weeks of very low wind conditions, which will be a critical system challenge going forward) and system reserves, cannot benefit from the aforementioned revenue streams (particularly daily arbitrage). Thus, designing a support mechanism that lumps these storage options together may lead to unwanted outcomes. It would seem prudent to better reflect that longer duration storage options tend to offer a different value proposition to the system while experiencing different investment risk exposure.

[1] https://www.gov.uk/government/publications/benefits-of-long-duration-electricity-storage
[2] https://www.sciencedirect.com/science/article/pii/S0360544222023325
[3] https://www.nature.com/articles/s41560-021-00796-8

10. **Do you believe we should be setting a minimum efficiency criterion? Please provide your reasoning.**

Efficiency alone shouldn't be a criterion. Some technologies or specific projects may be of relatively lower efficiency but could have lower total Levelized Cost of Storage (LCOS) or provide other services that decrease total system costs or provide other local benefits. The suitability of each project should be addressed by looking at all objectives at the same time and not excluding specific solutions based on just one metric.

In addition, for longer term storage (above one week), self-discharge could outweigh charging and discharging efficiency and total cycle efficiency would be difficult to define as it would depend on the cycling of the storage asset.

Having said that, it is important to define minimum efficiency levels during the lifetime of each project. This is important because some storage technologies may decrease their efficiency significantly during their lifespan, at which point, the support should adapt to the new (lower) expected revenue, or the instrument's beneficiary may be required to refurbish its system to keep receiving the benefit.

11. **Do you agree with the proposed approach to splitting the streams by TRL level? Please provide your reasoning. If not, please suggest an alternative approach.**

This seems reasonable. However, it is not clear how the total capacity would be allocated between the two streams. Only accounting for the main objectives could lead to only projects of "Established technologies" being supported, as they present much more certainties. A minimum total support capacity of the second stream may be required, but this could lead to supporting technologies that provide less service to the system.

An alternative, and maybe complementary, approach is to splitting streams by storage duration. As mentioned in the response to question 9, storage of longer duration (above few days or weeks) will likely face different challenges to storage between 8 and 24 hours). Therefore, it may be important to assess and address these specific needs in a separate stream.

12. **Do you agree with the different capacity minima set out for the streams? Please provide your reasoning.**

It is reasonable that less developed technologies could opt to the scheme with lower capacities. Although it is not clear if (or why) the specific proposed figures are the correct ones. Furthermore, establishing minimum capacities without considering the storage duration may hinder the uptake of longer duration storage with slow charge/discharge, which could also provide valuable services to the system.

13. **Do you agree that the identified wider system benefits should be considered when assessing a project?**

Yes, both wider system benefits and impacts should be considered in the assessment of projects. For instance, the material requirements and wider environmental impacts of construction and storage vary from technology to technology, along with the cost of storage.

14. **Would an approach similar to that of the interconnector scheme be appropriate? if not what alternative would you suggest?**

The general proposed approach seems reasonable, especially drawing on the experience of interconnectors. However, the specific details of the design and delivery of the policy will likely dictate its long term level of success.

16. Do you agree with allowing recovery of debt via the floor and recovery of equity via the cap? Please provide your reasoning.

As one of the main reasons for revenue stabilisation mechanisms are to provide cashflow certainty and enable access to finance, it seems reasonable to fix the floor at a level equal to the debt service coverage ratio of the project. However, this would imply that the conditions of the loans (tenor and interest rate) are to be shared with the scheme administrator. It needs to be analysed whether this has the potential to drive up interests and tenors of the loans, especially of the allocation of the scheme support is not going to be competitive.

Similarly, to the case made for the floor, the difference between the cap and the floor should cover for the return on equity investment, but this amount should in theory be different for projects with different fractions covered by equity investment. A project with high fraction of debt finance would have a comparatively higher floor and lower cap (with a relatively narrow band in between), while a project with high fraction of equity financing would be expected to have a lower floor and a higher cap.

A particular case worth analysing is balance sheet finance, where fixing the floor and cap would require knowing the corporate debt structure. Treating these projects as purely equity projects would put big players in an advantageous position, as they could have access to very low cost debt at corporate level.

An alternative would be to calculate the floor assuming 100% debt financing and calculate the cap required at 100% equity financing. However, this will certainly lead to over rewarding revenues and higher cost for final consumers.

18. How do we design the thresholds to be at the appropriate level to balance investment certainty with potential consumer exposure to additional support costs?

Setting the floor at a level to service the debt is a requirement to fulfil the policy's purpose of decreasing risk for investors. However, the way this floor is calculated is relevant, as it should represent the actual level of debt service of the project.

It needs to be noted that a revenue stabilisation mechanism, as the one proposed here, decreases the risk even more than a price stabilisation one (like the CfD for generators), as it almost eliminates the volume risk. Therefore, it would be expected a more stringent cap on revenues as a payback.

20. Do you agree using annual gross margin is a suitable approach to setting the cap and floor thresholds? If not, what alternative would you suggest?

It should also include the operational costs. Otherwise, distortion in the operation may be introduced. Also, all revenues, including those from capacity market and balancing mechanisms should be accounted for.

It has to be noted that some technologies produce excess heat which can constitute an additional revenue stream. It is not clear if this additional revenue streams are to be accounted for, as accounting for them may hinder the adoption of co-generation practices, but not considering them may promote maximising thermal output and decreasing the electric performance of the storage. However, this last point may be avoided if performance rules are imposed to the asset operators.

21. What performance incentive could be used to encourage full operation of assets to prevent dispatch distortions around the cap?

The proposed options seem reasonable in principle, but the detailed design is key and will dictate their effectiveness.

22. What performance incentive could be used to encourage full operation of assets to prevent dispatch distortions relating around the floor?

Same as above

24. Have we identified relevant operational risks associated with creating an LDES investment scheme?

The risks identified in the document are relevant. However, it is difficult to identify all the possible gaming opportunities. Therefore, a close follow of the operation of the assets under the scheme needs to be performed to detect any loopholes, especially in the early years of the scheme. Transparency of information to the scheme administrators should be included in at contract level.

25. Are our proposed mitigations sufficient for mitigating against the operational risks, like gaming? Please provide your reasoning.

They are good options, but as pointed in the previous answer, there need to be a follow up on individual assets operation.

26. Do you agree that the cap and floor scheme should be allocated administratively?

In principle a competitive auction should be better, but it is fair the point made in the document about having a mix of many different technologies and having many technical, economic and social variables to balance for the decision. In that sense, the administrative allocation seems reasonable, but it still needs to follow some clear rules and criteria. An obscure process may damage the perception of the scheme and be seen as an additional risk when financing a project, driving up capital cost.

A possibility is to have more set rules for the more established technologies' stream and more case by case approach for the novel technologies' stream.

27. Do you agree that length of a cap and floor contract should be based on the project length?

Setting the duration of the scheme to the project lifetime could result in over rewarding. If the floor is set to pay the debt service, then it makes sense that it should disappear, or at least, be adjusted down, as soon as the debt is paid.

It also could lead to projects overstating their actual efficient lifetime to keep receiving floor payments for longer. This issue can be addressed by setting performance requirements (proposed in 5.3.1.2) but needs to be studied further. This is especially important in storage, as some technologies present degradation with time and cycling.

28. Do you agree that cap and floor recipients should also be able to participate in other electricity markets, such as the CM? Please provide reasoning.

Yes – interconnectors can already do this. With regards to BM, they also should be allowed to participate, but including or excluding these revenues from the scheme's revenue calculation is a matter for debate, as including them could - under certain circumstances - reduce the incentive for participating in the BM, which is not necessarily optimal for the system.

29. To what extent could finance be needed from UK Infrastructure Bank or elsewhere, alongside the cap and floor scheme, to help address barriers to investment in LDES?

CfDs for renewables have shown that when revenue risk is managed commercial banks are keen to provide finance. In this case, they might be even keener as the scheme is a revenue stabilisation (rather than price

stabilisation), decreasing the risks even more. The involvement of the UK Infrastructure bank may be required more by the less developed technologies' stream, where the risk is not only a financial uncertainty, but a technical one.

34. Do you agree that exceptional event should be considered as part of the review of cap/floor? Please provide your reasoning.

Yes. Macroeconomic shocks and other exogenous effects should be accounted for when adjusting the scheme's operation.

36. Do you agree that target start dates should be set? If not, please explain why.

Target dates should be set but should be based on a fraction of the original estimated time, as some technologies have much longer building times than others (pumped hydro, for instance). This should be also monitored, as the incentive would be to overestimate construction times.

38. What are the important factors for deciding who is the appropriate body to bring forward this scheme?

Storage can happen at different levels of the system from transmission to systems embedded in distribution networks. Technical knowledge of technologies and the grid requirements is very important. This is especially important considering the administrative allocation system will require assessment of different criteria that are far from trivial and arguably would require extensive modelling capabilities.

39. Would either of the delivery routes set out affect the investment case for LDES projects?

We don't see a clear difference for investment based on who delivers the scheme.