Response to the Call for Evidence on Long Duration Energy Storage (LDES)

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1. Table of Contents

2. Introduction

The Call for Evidence on the Market Procurement Options for Long Duration Energy Storage (LDES)[1,2] closed on 1 December 2023. In total, 38 responses were received (35 via the EirGrid portal and 3 responses via the SONI portal). The 32 non-confidential respondents are listed below:

1. Electricity Association of Ireland
2. SSE
3. Energia Group
4. RWE Renewables
5. Form Energy
6. Bord na Móna
7. Wind Energy Ireland
8. Gas Networks Ireland
9. Fluence Energy Ireland Limited
10. Energy Dome
11. ESB GT
12. Energy Storage Ireland
13. ABO Wind
14. Flexible Power Solutions Ltd
15. EDF Renewables
16. FuturEnergy Ireland
17. Aughinish Alumina Ltd
18. Obton Ltd
19. Siga Hydro Ltd
20. Cenergise
21. Corre Energy
22. RedoxBlox
23. Siemens Energy
24. Alan Mulcahy
25. Highview Power Limited
26. Irish Energy Storage Association
27. Mutual Energy
28. Andrew Frew
29. Renewable NI
30. Bord Gáis Energy
31. Elaine Baker
32. EP UK Investments

We were very happy with the response and level of engagement from industry and want to thank everyone who contributed. The insights from respondents have proven to be extremely valuable, and many of the points raised are being taken forward and will help shape the future of this project. Additionally, we would like to thank everyone who attended and participated in the industry forum held in Ballymascanlan as it was a great opportunity to meet and continue the constructive dialogue around energy storage.

This response paper aims to provide a condensed overview of the responses to the Call for Evidence while seeking to present the varying viewpoints and arguments from stakeholders in a concise way. It is important to note that the summaries of each question may not encompass every single point raised by respondents, but rather aim to highlight overarching themes throughout.

[1] EirGrid LDES Call for Evidence
[2] SONI LDES Call for Evidence

3. Responses to Call for Evidence

3.1. Connection Agreements

The following question was asked:

Question 1: Do you believe that a connection agreement needs to be a prerequisite for a procurement exercise? What other prerequisites should be in place?

Summary of consultation responses

The majority of respondents maintained that a connection agreement should not be a prerequisite for a procurement exercise.

- One concern in relation to making connection agreements a prerequisite is that this would restrict competition and reduce liquidity in the procurement mechanism. Further, resources would be used to provide connection agreements to projects that may not be successful in the auction which can be seen as inefficient.
- There is concern that requiring a connection agreement may disadvantage new projects as there may not be enough time to be able to participate any storage procurement exercise.

Some alternatives were suggested such as requiring a connection application or planning permission as a prerequisite instead and issuing connection offers only to successful auction participants. It was also proposed that if the approach was to guarantee connection agreements for successful projects, then in the event that there were delays outside of the market participant's control, the contract date and length should be maintained.

One respondent proposed requiring a land agreement/option for pre-qualification and proof of planning submission for auction bidding. This would allow auctions to be run at the earliest stage possible while helping to mitigate against the risk of project failure. It was expressed that a connection process outside of or in parallel with the Enduring Connection Policy (ECP) will need to be considered to facilitate the participation of projects in the auction process and increase competition. It is important that participants have certainty on connection costs and timelines prior to bidding and so some form of connection assessment may be required for pre-qualified projects. Connection offers can then be made to successful auction participants.

It was also suggested that providing a precise technical definition of what is required from an LDES unit be a prerequisite, including criteria weightings for location, capacity, charge/discharge rates, and round-trip efficiency. Projects that meet these requirements should then be provided with an 'over the fence' connection.

If a connection agreement is not a prerequisite, it may be necessary to provide projects with an indication of accurate connection timelines and costs as well as another way of managing planning risk, such as prioritising planning for projects that are successful in the auction.

Some of the responses supported having a connection agreement as a prerequisite with mechanisms introduced to avoid excessive costs charged to unsuccessful projects. An example would be for the Transmission System Operators (TSOs) to issue Grid Connection Assessment letters to projects with information on the feasibility of the required connection and then issue a grid connection offer if the project is successful.

Respondents also called for an assessment of the environmental impact of projects to be a prerequisite.

3.2. Hybrid Connections

The following question was asked:

Question 2: Do you believe hybrid connections would help expedite the delivery of long duration storage or are other factors driving the critical path?

Summary of consultation responses

Many respondents supported hybrid connections to help expedite the delivery of long duration storage. It would also make more efficient use of grid connections and allow developers to share grid costs between storage and renewable projects. Other benefits listed in responses included innovative technology solutions for the grid, expanded and diversified service offerings and potentially greater capabilities to charge through hybrid sites and thus greater availability of storage units. However, it was noted in the responses that more long duration storage will be required than would be suitable for hybrid connections. It was also suggested that the TSOs should indicate what flexibility an LDES project can have in a hybrid connection and provide a range of technological set-points and expected import/export parameters. Responses highlighted the need to exclude hybrid projects combining any kind of fossil fuel with storage.

Responses called for consideration to be given to the difference between allowing hybrids to utilise existing grid connections and allowing the new build of hybrids. Further, TSOs should consider in a competitive auction that an LDES bidder putting forward a hybrid solution will need to consider availability restrictions for the LDES asset into their bid compared to an LDES bid that is non-hybrid.

There were also references to the need to consider how this may affect RESS contracts in terms of whether support payments would be received for utilising electricity that would otherwise be dispatched down.

Answers to this question also referenced that consideration should also be given to sharing MIC or non-firm MIC.

One respondent stated that it is more important to allow multiple services to be provided from the same grid connection rather than co-location with other assets. Stacking demand and system services through a single connection allows the stacking of credible services and will keep infrastructure available for future demand.

Other factors driving the critical path that were noted include the granting of planning, electromechanical equipment delivery times, more flexible connection rules, and charging allocations for efficient electrification of heat, transportation, hydrogen, and other technologies.

Although hybrid connections would likely speed up the delivery of LDES for electrical power, some respondents suggested that existing demand connections could do this for both electricity and long duration storage of heat which is a bigger demand than electrical power and has a larger seasonal variation.

Additionally, there were concerns regarding how hybrid projects would run under the System Services Central Control procurement option. It is unclear if central control would work for the LDES asset if it is sharing a connection with a wind/solar asset that is independently operated. It was also noted that storage's role as a contra-flow device on the network means their connection should not be driving transmission upgrades and their ability to connect as a flexible asset should mean traditional planning standards do not apply. Other respondents raised questions regarding how such assets would be managed. If such connections were behind the meter, it would need to be ensured that the storage was importing from the generator rather than the network. If the

assets were sharing the connection in front of the meter, mechanisms would be needed to understand whether the storage or generator has priority dispatch. Another respondent made the point that the benefits of hybrid connections will only be achieved if the usage of the connection is complementary, i.e., the usage of the connection by one shared asset is generally at a different time than the usage of the other.

It was highlighted that beyond the benefit of sharing shallow grid connection costs, there is little difference between installing LDES as a stand-alone grid connected asset and installing that asset behind the meter of a renewable project, at an overall system level. They stress that it is more important that LDES assets are located in areas of existing network congestion rather than behind the meter of a wind/solar asset. It was pointed out that some factors may cause developers to pursue standalone storage projects rather than hybrid connections, including the potential for import capacity limitations to restrict storage at some existing renewable sites.

3.3. Additional Topics Related to LDES

The following question was asked:

Question 3: Are there any topics that we have not included above?

Summary of consultation responses

Some responses maintained that the list of topics was comprehensive but required much more detail as it is not clear how or when the listed issues will be addressed via other workstreams. It was made clear by some responses that agreement on the way forward for some of these issues will be necessary before a procurement process can be chosen or carried out, e.g., firmness, hybrid connections, locational issues.

- **Stacking of Services**

  One additional topic from the responses was the stacking of services as some forms of LDES such as liquid air energy storage use synchronous generation and so can provide other services such as inertia, reactive power, reserve, etc. For these types of assets to be able to provide the maximum benefit to the system operator, they need to have the ability to provide those services. If there is no value or recognition for these additional benefits, they will represent a lost opportunity and will not be provided.

  It was also noted the impact of the selected technologies on grid stabilisation during charging, discharging, and wait times and how this could become another important revenue stream for LDES projects.

  Another respondent highlighted that the extent to which a storage asset can participate in system services, and how in doing so it can guarantee availability for its primary purpose, will impact operation and financial viability.

- **Permitting process**

  Responses also called for the need for a permitting process that is much faster than current permitting timeframes for renewable projects and which includes a permitting track should be considered when focusing on how to expedite the delivery of LDES in the most optimum way.

- **Scheduling & Dispatch**

  It was noted that the changes proposed under the Scheduling & Dispatch Program (SDP) in front of the Trading and Settlement Code Modification Committee are specific to batteries but should be technology neutral. Including 'Dispatchable Demand' would allow thermal storage to offer 'GreenSoak' services to better integrate renewable generation.

  Responses highlighted that scheduling & dispatch rules will need to be established to ensure that the level of flexibility a storage operator has is clearly defined and how that can work with the system operator's expectation of availability. Further, it was put forward that it may not be the most economical approach to discharge from the storage asset as soon as possible following a dispatch down event in order to maximise availability for charging.

  Further, concerns were raised regarding how the new scheduling and dispatch objective referenced in this paper of moving energy from Day 1 to Day 4 as a storage dispatch scenario will be included in the SDP project and delivered for Q2 2027. The TSOs must ensure their IT systems can fully utilise the new LDES assets once built rather than trying to catch up after the assets have been energised and investors are financially exposed to IT delays.

- **Market Charges & Network Tariffs**

  One respondent also referenced the need to make market charges and network tariffs dynamic. As it stands, charges and tariffs lock in fossil fuel consumption even when zero carbon indigenous power is being dispatched off. This means the proposed procurement process would need to overcome these charges before any real financial support is received.

  It was noted that tariffs need to be differentiated into charging and discharging measures as storage units should not be subject to grid fees for both import and export.

  Another respondent added that non-energy charges applied to flexible electricity consumers blunt efficient market price signals and that the procurement process needs to be carried out in conjunction with the regulators, their demand side strategy and reform of charging structures.

- **Environmental Considerations**

  Multiple respondents echoed that Environmental considerations relating to the construction of LDES must also be considered. It was stated that a high standard must be set on supply chain integrity and the minimization of environmental impact across the supply chain.

- **Delivering LDES from the demand side**

  One respondent noted that we have yet to consider the potential for delivering LDES from the demand side. For example, if electrified demand can add 8 hours of storage to their side and agree to reduce demand and use the storage on receipt of an LDES instruction it has the same net impact as a generator provider.

- **Locational Considerations**

  Respondents put forward that the tariff structure with guaranteed reliable green power has the potential to incentivise data centres to be built closer to storage facilities.

Also referenced was the importance of locational considerations which will likely depend on the purpose of storage. If its purpose is to reduce dispatch down, then storage will need to be located in the network at a point the generated electricity could reach. If the purpose is to support curtailment events and system services, the location may be less critical.

- **Questions that require additional explanation for bidders**

  The below questions were listed as areas that are still unclear but critical to the success of the procurement process and will impact the viability of projects:

  - Does the storage device need to be capable of charging and discharging at the same rate?
  - What is the minimum required power rating of the storage device?
  - What is the minimum required energy storage capacity?
  - What is the minimum round-trip efficiency?

  One respondent noted that the TSOs will need to specify the required MIC, rate of import, and volume of electricity to be stored.

- **Sector coupling of heat and power sectors**

  Responses referenced how coupling of heat and power sectors can access huge amounts of low cost long duration thermal storage to save carbon, allowing expansion in renewable energy supply with less dependency on expensive storage systems for electricity and reducing costs associated with guaranteeing wind revenues via contracts for difference.

- **Merchant Tail/Contract length**

  Certainty needs to be provided to investors regarding what the connection agreement will be post the LDES contract, regardless of which procurement option is chosen.

  The duration of support was commented on, suggesting that it would be logical for support to be directed towards projects that can provide reliable, long-term lifetime benefits, rather than technologies that provide a shorter term impact.

- **Governance of workstream**

  The policy on storage has still not been published by the governments. In Ireland, DECC consulted on a storage framework at the start of this year but it is unclear how this Call for Evidence interacts with the DECC policy-based consultation or the ESBN procurement process for demand flexibility. Additionally, the DECC policy on compensation for renewable assets will need to be considered as how oversupply is compensated will affect the cost benefit analysis.

  It was also suggested that the TSOs, DSOs, and RAs set up a steering committee to ensure all the issues listed are captured and fully considered.

- **Build Finance**

  Financial support could be considered for successful projects during the build phase similar to emergency generation projects.

- **Separation of Procurement Process**

It was put forward the need to separate the procurement process for up to 2030 and post-2030 in terms of the services and requirements necessary and therefore which procurement option could be the most optimal.

- **Health and Safety Considerations**

  Responses noted that there are important health and safety considerations as project size increases for lithium-ion technology. Some larger facilities are likely to meet minimum thresholds in COMAH and DSEAR legislation and it is therefore imperative that each developer carefully considers the safety implications and gaining necessary permits should be a requirement.

- **Other comments**

  Another respondent noted that the consultation does not seem to consider the differing techno-economic characteristics of bidding projects. They also highlight the importance of the procurement process to differentiate between the holistic system value of technologies with varying MEC, efficiency, costs, etc. The process should also ensure the solution consumers are paying for is not more expensive than the problem it is solving.

  One response suggested that performance, lifespan, and round-trip efficiency could be considered in a procurement process to incentivise high performance, mature, and lasting LDES solutions. This could be in the form of scalars. Maximum Export Capacity (MEC) was also mentioned as a topic to be included as a relevant topic due to transmission constraints.

  Other important topics to include, according to responses, are interaction with the future system services market as well as interaction with CRM and rationale for why the CRM is not suitable for this as well degradation rates of technologies. Availability and O&M are listed as topics to be considered.

  It was also noted that a route to market may be needed for storage durations above 2 hours and below 8 hours, assuming long-duration storage is considered as having durations above 8 hours.

3.4. Procurement Timelines

The following question was asked:

Question 4: If a procurement exercise is run in January 2025 will there be sufficient liquidity, i.e. projects which have connection agreements, planning, etc. in place?

Summary of consultation responses

A majority of respondents were in agreement that there would not be sufficient liquidity if a connection agreement were a prerequisite. Many other respondents were not able to give a definitive answer as more information regarding the procurement process (especially the prerequisites) was needed.

As mentioned above, the predominant issue identified to have the largest effect on liquidity was the potential prerequisites for procurement. By having a connection agreement as a prerequisite for a procurement exercise that is a year away, the TSOs may be severely limiting the technologies and storage durations that would be able to apply. Additionally, with the current timelines, it

could be unlikely that any projects that are not already in the process of receiving a connection agreement would be able to apply. Lowering prerequisites and allowing projects with, for example, planning applications and secured land would significantly increase the number of viable projects in the initial procurement process.

It was also stressed that the earlier the TSOs release more concrete information regarding the procurement process, including perquisites and relevant parameters, the more likely sufficient liquidity will be present.

The following questions were asked:

Question 5: Is the timeline from contacts to connections here realistic?

Question 6: What, if any, are the main blockers to achieving these timelines?

Summary of consultation responses

Most respondents were in agreement that the stated four-year timeline for procurement is quite optimistic and the ability to connect within that timeline will depend greatly on the storage technology.

Respondents made it clear that the ability to connect within the stated four years will depend on the type of storage that is procured. This timeline may favour technologies that are commonly used now such as lithium-ion batteries, while proving to be very challenging for emerging technologies or labour-intensive solutions such as pumped storage. While more time may be needed generally, multiple respondents expressed their desire for contracts to reward projects that may deliver early.

There were many respondents who identified the connections process as a major risk in their ability to confidently deliver on time. Additionally, a major blocker at the moment is a lack of clarity around the procurement process details.

3.5. A Need for Storage

The following question was asked:

Question 7: We believe that SOEF v1.1 outlines a clear need for the procurement of additional long duration storage, do you agree that there is a need for long duration storage for Ireland and Northern Ireland? Can you provide evidence to support your opinion?

Summary of consultation responses

30 of 34 respondents to this question agreed with the assessment in the Call for Evidence that there is a need for LDES in the power system of the future. Respondents highlighted the impact of LDES in helping issues such as renewable surplus, grid constraint, and the reduction of generation costs. It was agreed upon that the implementation of LDES can be a major facilitator in reaching our decarbonization goals.

Although important, it was emphasized that the installation of LDES should not be a substitute for additional network reinforcement and upgrades.

A few respondents believed that more analysis must be done to fully understand the impact of longer duration storage as at the moment their procurement is a substantial risk. Additionally, respondents wanted more information about the specific problems LDES will be solving.

One respondent believes that at the moment there is no clear evidence that LDES is the only or best provider of surplus generation management. They recommend looking at large scale district heating as a solution as it will provide benefits to individual households. It was stated that only in future decades as we approach net zero will energy storage be required.

The following question was asked:

Question 8: Do you agree with our definition of Long Duration Energy Storage?

Summary of consultation responses

Among respondents, there was not a strong consensus regarding the Call for Evidence's definition of LDES having a minimum duration of 8 hours. While more than a third of the respondents either agreed with the definition or did not object to it, many provided input on ways to improve the clarity and focus of the definition.

A chunk of respondents emphasized the continued importance of storage with 2–6-hour durations and the missing financial incentivisation and investment signals in this range. Storage within the 2-6-hour range is not yet saturated in Ireland and Northern Ireland and has the potential to provide substantial value in relation to the costs of current storage solutions of 8 or more hours.

Multiple respondents suggested that there should not be any fixed definition of LDES as potential projects should be weighed on their ability to provide the most value to the system for the least cost. Not all 8-hour storage projects may provide the same value to the system as system characteristics and discharge capabilities can vary greatly between technologies and projects. Additionally, it is stated that defining LDES as a minimum of 8 hours may unnecessarily rule out various technologies.

Two respondents believe that defining LDES as a minimum of 8 hours is unrealistic at the moment due to current financial spreads and the general feasibility of the technology for the stated procurement timelines.

Other respondents were hoping for the TSOs to provide more clarity and analysis on the desired outcome of a procurement process. As modelling in the Call for Evidence explored the figures stated in Shaping our Electricity Future v1.1 (only 2,4,6,8-hour storage), respondents believe more modelling into the impact of longer duration storage is necessary to justify the definition of an 8-hour minimum duration. It is also suggested that there must be more clarity on what is going to be procured, and the services that those units will target.

The following question was asked:

Question 9: Are there any services provided by LDES that we have excluded above?

Summary of consultation responses

Respondents were unanimous in that LDES has the potential to bring a wide range of services to the grid. The benefits listed ranged from system-wide benefits such as frequency regulation to local benefits like voltage phase angle management, among others. Multiple respondents made the argument that due to these potential benefits, the selected procurement mechanism should

ensure developers have the ability to revenue stack and implement as many services as possible in order to maximise value to the system and to help secure a return on investment.

The most common excluded services are below:

- Black Start
- Inertia Services (potential for synthetic or synchronous)
- Voltage, Ramping, Frequency Support
- Renewable Surplus, Carbon Abatement, Dispatch Down and Congestion Management
- Capacity Adequacy
- Network Reinforcement Deferral

The following question was asked:

Question 10: What do you view as being realistic procurement targets (both volumes and durations) achievable by 2030?

Summary of consultation responses

The prevailing sentiment among respondents is that without additional information on the potential procurement process, it is very difficult to determine what volumes and durations will be achievable by 2030. One major factor determining the number of projects available for 2030 will be the amount of advance notice developers receive on procurement details such as the prerequisites and locational scalers. Multiple respondents noted that as seen in the past, industry can respond quickly when the appropriate signals and procurement approach are in place. Additionally, multiple respondents emphasised that the connection process will play a major role in the deliverability of procurement targets.

Many respondents expressed their desire for multiple phases of procurement. It is argued that utilizing multiple phases of procurement will allow projects that can be delivered by 2030 to be contracted, but also give a long-term investment signal which will enable a continuous stream of projects to be delivered throughout the 2030s. This would also allow the TSOs to iterate and learn from the early procurement rounds.

One respondent was concerned with duration-based procurement as it may rule out technologies or projects that provide greater value to the system. Another respondent recommended the prioritisation of storage around 4 hours in duration as the technology is mature and has a higher chance of delivery before 2030.

The ability to procure the volume of storage set out in SOEF v1.1 and the Call for Evidence will depend to a large degree on the policy and regulatory environment in which the procurement takes place, according to one respondent. This risk will need to be navigated to ensure deliveries before 2030.

Four respondents did believe it would be realistic to procure at least 1 GW of 8+ hour storage if the best-case timelines set forth in the Call for Evidence were adhered to.

3.6. Storage Modelling

The following questions were asked:

Question 11: Do you agree with the modelling assumptions and the modelling results that we have used for assessing the impact of storage?

Question 12: Are there additional criteria that we should consider?

Summary of consultation responses

A common viewpoint shared by a large group of respondents was that there was not enough information about the model details to replicate or validate the information shown, but the fundamental results showing the general benefits of storage were as expected. A key recommendation was for the TSOs to release the models, input data, and assumptions used in the Call for Evidence.

A recurring theme among responses was the desire for the creation of more detailed and expansive models. The model in the Call for Evidence only looked at one scenario for 2030 with a maximum duration of 8-hour storage placed in possibly suboptimal locations. Some of the suggested improvements to the model are listed below:

- **Multiple Years** – Investigate the impact of storage past 2030
- **Multiple Scenarios** – There is no guarantee the grid will look the way it is expected in SOEF v1.1
- **Longer Durations** – The current model only explores up to 8-hour storage, while the procurement mechanism aims for 8+ hours
- **Diversify Technology Used** – Technologies other than lithium-ion batteries should be considered as procurement is technology agnostic. This should include exploring other solutions such as electro-boilers and thermal storage
- **Storage Locations** – Locations shown in the model may not be the most optimised
- **Revenue Stacking** – Modelling additional system benefits could increase the value of storage
- **Rare Weather Events** – Models should take into account rare weather events which may increase the effectiveness of storage
- **Include Maintenance Outages** – This may add another use case for storage
- **Carbon Abatement** – Factor in the long-term impact of carbon savings and the effects on our carbon budgets

Multiple respondents believe that more detailed modelling will find the benefits of storage far exceed the numbers shown in the Call for Evidence.

3.7. Project Evaluation

The following questions were asked:

Question 13: Do you think using the TRL as a way of assessing a project's probability of delivery is reasonable?

Question 14: Is there additional criteria that we should consider using?

Summary of consultation responses

A majority of respondents believe that the Technology Readiness Level (TRL) should only be one aspect in the assessment of a project's probability of delivery. It is argued that having a high TRL may reflect a general technology's readiness but does not reflect the readiness of individual projects. Additionally, it is believed that TRL levels are unambiguously defined and can be susceptible to challenge if there is not a publicised process to assess and approve new technologies. Despite these blockers, it is generally viewed that TRL can play one part in the evaluation process if the TSOs can develop a publicly available method to determine the TRL of perspective technologies.

Multiple respondents recommended that a better way to reduce deliverability risk is to implement security measures such as adequately sized bid bonds or add performance bonds into the contract. These would move the risk of deliverability onto the developer and help prevent more speculative projects from entering the procurement process.

Other factors should also be considered which focus more on the progress of the individual project rather than the technology itself as it could give a better window into its potential deliverability timeline. Another respondent recommended the Technology Performance Level (TPL) scale be used as it considers more of the economic side of various technologies and could be a better indicator of deliverability.

Around one-third of respondents have no objections to TRL being used as the primary method to determine a technologies viability. Many of these respondents believe that setting the bar to qualify for the procurement mechanism at a TRL of 7 or 8 was reasonable.

One respondent stated that it was premature to apply any criteria to the deliverability of potential projects as it has not yet been justified why LDES would need to be procured outside the existing market mechanism in the CRM.

A list of additional criteria that respondents think should be used to determine a project's probability of delivery is below:

- Commercial Readiness Index (CRI)
- Levelized cost of storage (LCoS) for extended period
- Grid Compatibility
- Manufacturing Readiness Level (MRL)
- Performance characteristics
- Technology Performance Level (TPL)
- Environmental impact
- Technology suitability
- Technology development
- Supply chain capacity
- Volume limitations
- Corporate involvement

3.8. Innovation Trials Sandbox

The following question was asked:

Question 15: What level of interest (low, moderate, or high interest) would you have in participating in such an Innovation trails Sandbox?

Summary of consultation responses

15 of 27 respondents to Question 26 had a high interest in participating in an Innovation Trials Sandbox. It was mentioned that demonstration projects are a crucial aspect of developing and

bringing new technology to market. While highly interested in this prospective sandbox, multiple respondents said that their participation would be reliant on more clarity around the supports of the mechanism.

11 respondents reported that they have a moderate interest in participating in an Innovation Trails Sandbox. The largest concern among these respondents is that the development of the Sandbox would take time and resources away from the main procurement mechanism. It was made clear that this should be a completely separate workstream from the main procurement mechanism to ensure delivery is not prolonged. It was also mentioned that it is critical to ensure that all data and learnings from the sandbox be made available to maximise the value of the exercise.

A few respondents noted the potentially significant level of funding that would be needed to run the sandbox as many of the technologies targeted for such a scheme are not commercially viable.

One respondent suggested that the sandbox should facilitate the use of existing connections (i.e. hybrid connections) as it could further drive learning and development.

The following question was asked:

Question 16: What opportunities do you foresee with an Innovation Trials Sandbox?

Summary of consultation responses

The main opportunity reported by respondents is the ability for innovative technologies to have the platform to test and improve in their route to commercialisation. This exercise can also give the developer, the TSOs, and regulators confidence in the viability of the technology and reduce future risk. Additionally, it allows time for all parties to gain familiarity with the emerging technologies and their operation within the market.

One respondent stated that the Innovation Trials Sandbox could position the SEM at the leading edge of innovative technology and advance Ireland and Northern Ireland's position as a leader in renewable generation.

The following question was asked:

Question 17: What risks or challenges do you foresee with an Innovations Trials Sandbox

Summary of consultation responses

A majority of respondents believe that the largest risk with the Innovations Trials Sandbox is the possibility of delay with the primary procurement mechanism if the development of the two isn't done in parallel. The volumes of LDES needed to reach our 2030 targets will likely only come from the main procurement mechanism, so it is important it is prioritised. A risk of the Sandbox is the low volumes of LDES that would be procured, which makes it a more costly investment in the short term when compared to more mature technologies.

Another common risk reported by respondents was the process in which projects would be picked to participate. It was stated that a strong set of selection criteria should be developed with stakeholders to reduce the risk associated with picking technologies that may not be viable solutions in the future. There are substantial costs associated with pilot projects, so it is vital that money be allocated wisely. Due to these high costs, other respondents stated that contracts given by the Innovations Trials Sandbox should compensate most, or all costs as there should be minimal risk for developers.

Multiple respondents warned that participation in the sandbox would be limited if it precluded developers from the main procurement process. The option to enter both procurement processes is critical to the sandbox's success.

Coming from the contractual side, multiple respondents gave suggestions on various factors that may lead to more success in the exercise. One of these was the need for pilot projects to not be penalised for tripping, or outages for repair and upgrades as it may hinder the success of the trial. Additionally, there should be certainty for developers in their business case post-trial. Another respondent stated it will be important that issues pertaining to intellectual property be well defined in advance.

The following question was asked:

Question 18: How would you like an Innovation Trails Sandbox to operate?

Summary of consultation responses

Respondents emphasized the importance of providing less mature technologies an opportunity to demonstrate their viability in a real grid environment. Ideally, this would be operated as a technology agnostic process with close alignment and cooperation with the government, TSOs, regulators, and the selected industry partner. Multiple respondents also added that this could be a great opportunity to partner with third-level institutions to add a research aspect to the Sandbox.

One Respondent recommended that to garner sufficient interest in the Sandbox, projects should be allowed to expand and fully develop post-completion of the trial period. This would help minimize losses after the trial period and be an efficient use of the grid connection. It was also suggested that projects should be able to operate in the market which would act as a first route to funding and an opportunity to better prove the project.

Two respondents stated that the Sandbox should be aimed at relatively more mature technologies that may have the ability to be brought onto the grid around 2030-2035. These technologies would have the ability to deploy at larger volumes which will be crucial to support incoming renewable generation. While more mature than some technologies, many of the same blockers are present due to investment risk, legacy barriers, and lack of information. Other respondents prefer for eligible technologies to be in the TRL range 6-7 or 5-7 and implemented in a variety of sizes.

3.9. Missing Money Modelling

The following questions was asked:

Question 19: Do you agree with the assumptions that have been used in these calculations?

Summary of consultation responses

The prevailing sentiment among respondents was that the Call for Evidence did not provide sufficient detail into the assumptions that went into the model. Without the wider context, it is difficult to come to any conclusions about the accuracy of the results. It was suggested that the model used and the rationale behind the assumptions be released so that industry can gain a better understanding of the findings. While the accuracy of the results can be questioned, many

respondents agreed with the general findings of the model which show a missing money issue for longer-duration storage assets.

Within the assumptions stated, many respondents pointed out that using a set derating factor of 0.5 among all storage durations does not align with the current approach in the capacity market. A flat derating factor for all durations may lead to an underestimation of the missing money issue at hand. A few respondents also highlighted other assumptions such as contract lengths, hurdle rates, capacity payments, and the use of additional revenue streams as points where future modelling should more closely align with the current landscape.

Respondents also recommended that additional technologies and durations be looked at in the modelling process. With the procurement process looking at 8-hour storage and above, the modelling should follow suit and expand in that area. Additionally, differing technologies will all have different combinations of Capital Expenditure (CAPEX), Operational Expenditure (OPEX), efficiencies, asset lives, etc., and should be considered as procurement will be technology agnostic.

The following question was asked:

Question 20: The analysis has identified that there is a missing money issue with regard to new entrants looking to develop storage projects. Do you agree with this assessment?

Summary of consultation responses

Of 31 respondents to this question, 26 believe that there is a missing money issue regarding the development of new energy storage projects. The current lack of revenue through existing markets and a general lack of certainty have led to a shortfall of LDES deployment across Ireland and Northern Ireland. Although most respondents agreed with the idea of a missing money gap, many noted that due to the lack of information regarding the model assumptions and usage, the specific numbers reported in the Call for Evidence cannot be validated. Furthermore, it was stated that there is still a clear need to more accurately assess and quantify the missing money gap and justify the development of an additional procurement mechanism.

One respondent noted that the missing money issue should also not be ignored for lower duration assets (4 hours and below) as they can still provide substantial value to the system and in many cases are not financially viable.

Respondents that did not agree with the missing money sentiment largely wanted more clarity around the modelling in the Call for Evidence and expressed the need for a more accurate and in-depth analysis to be done before coming to any specific conclusion. One respondent suggested that any missing money that is found should be addressed through the CRM and the System Services Future Arrangements.

The following question was asked:

Question 21: Do you think it would be possible for a long duration energy storage asset to construct a business case centred around energy market arbitrage? Can you provide support for your position?

Summary of consultation responses

24 of 28 respondents to this question are in agreement that building a business case centred around arbitrage would either be not possible or extremely difficult. Market volatility provides too much revenue uncertainty to be able to be able to get adequate financial backing with the raised CAPEX

and OPEX of longer duration storage options. It was noted that stacking revenues from multiple markets can help in building a business case but likely remains not enough to get sufficient financing. Additionally, as more storage capacity enters the market, arbitrage margins may be decreased due to the flattening of price curves from storage.

One respondent believes that it is possible to business case based on existing SEM revenue streams. A few minor changes may be required to existing markets, but the changes would be more straightforward than the creation of a new procurement method. Some of the changes that could help create a business case in the existing markets include the setting of appropriate derating factors for LDES, eliminating the risk of double charging via transmission charges, strike price alteration, and incentivisation through the System Services of Future Arrangements.

It was also voiced that the ability of future LDES projects to construct a business case centred around arbitrage may depend on changes to firm access policy, and whether fossil fuels are considered in future price signals.

The following question was asked:

Question 22: Do you have any comments on the above analysis.

Summary of consultation responses

A majority of respondents reiterated their desire for additional modelling and analysis to be conducted on the missing money issue. Ensuring the model inputs and assumptions (derating factors, OPEX, CAPEX, etc.) closer reflects real market conditions can vastly improve the accuracy of results. Alternative technologies and solutions should also be looked at such as coupling the electricity and heat sectors as technology to tackle renewable surplus is available that would not have a volume limit or be constrained by export capacity. One respondent suggested that an alternative consultancy conduct a second analysis and update the results twice a year to provide a dynamic value for missing money as it could possibly be used as a reference in early iterations of procurement. It was also noted there is a desire for the TSO to release both the model and assumptions used for full transparency.

Another respondent wanted to emphasize that market design is a big issue going forward. There needs to be a path to hybridization, optimization of grid connection points, and a market mechanism for capacity to help enable the transition to long duration storage.

It was also suggested that due to battery storage only currently being viable for durations at, or below 4 hours, an incremental approach to the durations of batteries that are procured should be taken to optimise value to the end consumer.

3.10. Procurement Options

The following question was asked:

Question 23: Do you believe that the ‘Status Quo’ option is a viable option? Please explain your rationale.

Summary of consultation responses

All 29 respondents to this question were unanimous in believing that the ‘Status Quo’ approach is not a viable option and would not provide the right signals to spur LDES investment. It was stated

that in existing market arrangements there are no signals for LDES and that without a new support or regulatory push, there likely won't be any LDES being built in the near future. Current markets don't recognise the true value of LDES being implemented into the grid; this can be seen through the lack of LDES assets coming through these markets.

Multiple respondents believe that waiting for technological advancement and economies of scale to provide a sufficient signal for LDES development will take a long time if it ever happens. Given the future global demand for storage, it is unlikely prices will decrease enough to resolve the current missing money problem. Waiting and going the 'status quo' route would be extremely risky and would put our climate targets in jeopardy.

Other respondents argue that continuing via the 'Status Quo' will lead to a highly inefficient overall power system that will lead to higher overall costs for grid operation and a net negative for the economy. It was argued it may not be sustainable to continue with RESS for wind and solar when a similar mechanism isn't in place to help accommodate that power onto the grid.

The following question was asked:

Question 24: Do you believe that the 'Refine Current Markets' option is a viable option. Please explain your rationale.

Summary of consultation responses

19 of 29 respondents to this question were of the opinion that refining current market arrangements is not a viable option and would not deliver the required incentives for long duration storage. It is argued that the scale of changes needed to make LDES competitive would take a significant amount of time and may have other unintended consequences. A path forward for LDES is needed in the short term and there is no guarantee these changes would be able to be implemented in that timeframe with an impact comparable to other options. As seen with current examples such as the changes to the system services market, changing existing markets is not always straightforward and may take significant time.

Another argument made by multiple respondents is that the CRM is mainly focused on adequacy and was not designed to compensate for flexibility and constraint management. Significant redesign would have to take place for the CRM to properly value the benefits that LDES brings to the system. As mentioned above, changing markets to incentivise something that they were not initially designed to would risk adverse impacts in other areas of the market. Only implementing incremental changes in the CRM will likely prove insufficient in providing the revenue certainty needed to get financing. Additionally, the CRM operating as technology agnostic adds another layer of difficulty in pinpointing storage solutions.

One respondent suggests that before progressing with any solution, a thorough review of the current markets and their potential issues needs to be performed. The analysis provided for this option in the Call for Evidence was not enough to determine its viability. It is argued that making changes through existing markets may take some time to process but would not be as disruptive or complex as creating a new procurement process. A few changes suggested for the capacity market by respondents include reconsidering de-rating methodology, and firm access policy, phasing out payments to fossil fuel infrastructure, and Reliability Option penalties.

Two respondents stated sufficient support for LDES can be created through modifications of the current markets. It is suggested that a new DS3 product to support surplus generation management is implemented in addition to methodologies around SNSP-following market and network charges.

Additionally, it was stated the creation of a separate asset class for energy storage would help target LDES.

One respondent believes that the 'Refine Current Markets' option is the only viable option that was put forth in the Call for Evidence. It is suggested that more time be devoted to accessing this option to better understand and model the interactions of various revenue streams. Only minor changes would be needed such as a review of de-rating factors, creation of a new system service product, and/or a review of the impact of strike price on energy market revenue. These changes may be considerably more straightforward, cost effective, and timelier to implement than any of the other options in the Call for Evidence.

The following question was asked:

Question 25: Do you believe that the 'Storage Support Scheme Auction' option is a viable option. Please explain your rationale.

Summary of consultation responses

21 of 31 respondents to question 25 believe that a Storage Support Scheme Auction is a viable option and would provide the required signals to drive LDES investment. Many cited the ability to revenue stack and operate in different markets as a key benefit that would provide developers with more flexibility, transparency, and confidence. This would allow asset owners to manage risk themselves by appropriately responding to market signals. Although this is the preferred procurement mechanism for many, multiple respondents expressed their desire for this to be developed in parallel to reforms in the CRM.

One respondent referenced the success of the current auction support scheme in New South Wales, Australia which specifically targeted a volume of energy storage. It was stated that this regime has given confidence to developers to progress other projects and to participate in future auctions.

Firm access was pointed out in the Call for Evidence as an issue that could reduce the effectiveness of the support scheme. One respondent believes that the concept of flexible or non-firm connections for Maximum Export Capacity (MEC) or Maximum Import Capacity (MIC) should be considered as applying traditional planning standards to storage assets is not appropriate and may lead to unnecessary grid buildout. As storage tends to act against the normal flows of power on the grid, they do not need 24/7 access to their full MEC/MIC. Restricting MEC or MIC of new projects may constrain the development of storage assets and not allow them to provide their full value to the grid.

Many respondents emphasized the importance of the auction design, specifically on how units will get compensated for their operation in the market. A carefully designed mechanism should incentivise the operation of storage in a way that is optimal for alleviating grid issues and providing the services they were contracted for. One idea is for penalties to be implemented to disincentivize behaviour that is not in the best interest of the system. Another respondent suggested that the TSO could publish an expected dispatch signal and storage assets would only receive payments if the signal were followed.

Three respondents pushed back at the idea put forth in the Call for Evidence that 'there is no guarantee that the procured storage would behave in the way that is optimal for managing grid issues and government targets'. It is viewed that this issue is the purpose of the Balancing Market and should be addressed in the ongoing reforms to the market and balancing market systems. It is also argued that efficient energy arbitrage by asset owners may have the greatest impact in flattening wholesale energy prices and therefore shouldn't be limited in their operation.

Of the 30 respondents, 3 believe that the Storage Support Scheme Auction is not a viable option. A major concern is the timetable that was put forward in the Call for Evidence as lengthy processes such as EU State Aid approval and design consultations would likely have to take place, among others. Additionally, if the auction scheme is not implemented correctly there is a potential to distort competition in the CRM auctions while conceivably not addressing the merchant risk from markets that are going through considerable change.

Another argument against this option is that creating another procurement mechanism will further segment the market. It is believed that we need to avoid any further segmentation and focus on modifying the current capacity market to provide the signals that are desired. Furthermore, ignoring the CRM and implementing this new support scheme may be irresponsible given the risk of delays and cost to consumers associated with implementing such a scheme.

Other respondents felt that more information is needed before any conclusion can be reached about the viability of this option. More details regarding the level of support that would be present, contractual arrangements, and mechanism implementation are needed as they may be key factors that could determine the effectiveness of the support scheme.

The following question was asked:

Question 26: Do you believe that the 'Fix Term System Services Contract with Central Control' option is a viable option. Please explain your rationale.

Summary of consultation responses

A large majority of respondents had a variety of concerns with the 'Fix Term System Services Contract with Central Control' option. The largest concern with this option is the potential for market distortion. It was argued that if the TSOs have control of large quantities of storage, it could have an impact on market prices and create an increasingly unforecastable market which will lead to heightened risk for future projects. Additionally, the TSOs having full visibility on all market participant's commercial offer data and having the ability to submit offer data themselves presents a major conflict of interest. More consideration must be put into how units will be dispatched and interact with various markets.

Another major concern is the legality of central control of storage by the TSOs. It is stated that this option may be legally very complex and would likely lead to legal challenges that could delay the project significantly. Specifically, one respondent believes that this option may be in breach of the general principles of European Union law (EU Electricity Directive 2019/944, EU Aid – Article 107 TFEU), EirGrid TSO Licence (Condition 10,16,19), SONI TSO License (Condition 12,13, Articles 8(1)(a) or (c), Section 14(1)(a),(b),(c) or (d)), CRU duties, and UREGNI duties (Section 12). Respondents suggested that issues around the legality of central control be further addressed before progressing with this option.

The usage of storage assets by the TSOs was also a point of concern among respondents. Firstly, it is believed that preventing LDES assets from being operated and freely optimised in the market to deliver a wide range of services for the grid would likely lead to suboptimal usage. One example presented was a trial conducted in Italy by the IRERA which concluded after a 5-year period that TSO dispatch of utility-scale storage was not as efficient and provided less value than units operated by market players. On top of potential inefficiencies, TSO dispatch may lead to the increased degradation of storage from improper cycling and use. Developers may need to plan for worst case degradation over the asset's lifetime which would lead to higher prices. Additionally,

TSO dispatch would complicate hybrid sites with shared MEC as developers would not be able to optimise all the assets behind the primary connection point.

8 of 31 respondents stated that they believe this is a viable option for LDES procurement, with this being the preferred option for two respondents. This route to market provides revenue certainty to developers which lowers risk and can help them benefit from low-cost capital. Central control also can help circumnavigate current market issues around MIC and firm access which can allow for optimal use of units. Continuing with this point, multiple respondents emphasised while this procurement mechanism can alleviate some market issues for storage assets, it should not stop these changes from being implemented in the wider markets.

The following question was asked:

Question 27: Are there realistic alternative procurement mechanisms?

Summary of consultation responses

A handful of respondents suggested a variety of alternative procurement mechanisms that were aimed at incentivising storage and ultimately providing maximum value to the consumer. A few are listed below:

- **Cap and Floor Mechanism** – Multiple respondents stated that a cap and floor mechanism, similar to the potential approach in the UK, could be viable for Ireland and Northern Ireland. The main benefits from this come from the ability to provide sufficient downside protection to investors while also incentivising efficient use of the asset in the market with a shared upside. This can ensure that the cost to end consumers is minimised.
- **Flexibility Option** – Storage assets can be procured via an auction with the TSOs having the option to operate the asset under a specific set of circumstances. The option over the assets would have to be exercised before the day-ahead auction. When the option is not exercised, it would allow the asset to be free to participate in other markets which may reduce the risk of asset underutilisation.
- **Demand Turn Up** – A service to pay participants to utilise excess energy that has been generated from renewable sources. This payment could help bridge the missing money gap for storage assets and would allow for revenue stacking from other markets.
- **Other Options -** Other options for procurement reported by respondents include the use of fixed profiles, and a Regulated Asset Value Type mechanism. It was also suggested that the TSOs consider a blend of mechanisms described in the Call for Evidence. Another idea is to consider the use of longer-term contracts (upwards of 30 years).
- **General Principles of Procurement** – Any procurement method that goes forward should follow a general set of principles:
    - Technology agnostic and support investment from a variety of technologies and capabilities
    - Maximise long term certainty for a floor revenue for winning technologies
    - Procurement based on overall system value vs cost and take into account locational benefits. The process should recognise the hedging value of storage

- Selection process should be based on a transparent full system & network model that bidders can understand and replicate

The following question was asked:

Question 28: Do you believe that an all-island or a jurisdictional approach is the best method? Please explain your justification.

Out of the respondents, there were mixed beliefs over whether an all-island or jurisdictional approach should be taken about LDES. There were 3 who sided with a jurisdictional approach and 7 with all-island among other respondents who had some consideration of both. Broadly, there seems to be a consideration that it is not prudent to assume that it could be simply one or the other, and many participants noted that there is an ideal and a practical element at play here, which both need to be considered.

Of all the respondents who prefer the all-island option, the most appealing aspect of it appears to be the unity that it provides. The benefits included involve one grid in place and the ISEM having access to the European markets, while it would also reduce administration, duplicity, and bureaucracy. Other respondents note that the all-island approach would be preferable with some changes, including making sure the storage is located where it maximises the benefit to the system. Respondents don't want a two-tiered procurement mechanism as this would risk an imbalance of information within the system.

Of the 3 respondents who opted towards the jurisdictional approach, what seems to be a significant driver of this preference is that it would make the implementation and achieving approval easier for the LDES projects. This is noted in relation to RESS contracts, where both jurisdiction's approval isn't required, which takes time and could be hindered by different policies and approaches. The jurisdictional approach also allows for the tailoring of the appropriate supports. Another note was that the jurisdictional approach allows for more expedient implementation of MDES and LDES due to the lower approval barrier.

Of the respondents who had mixed feedback, the main takeback seems to be that they are preferential to one side or have an ideal view, while also retaining that that may not be practically a possibility under consideration. There is a desire for future storage projects to be developed within a market that isn't restricted by geography. They recognise that the jurisdictional project by project approach would be the most suitable while also taking into consideration who will be funding these projects and the limitations that may bring. The more storage options available the more flexible the system, while anything that requires state clearance needs jurisdictional approval. A large concern of respondents is that the two jurisdictions should be able to work in parallel and in alignment with one another, while ensuring that one does not act as a brake holding the other back. The all-island approach may be an ideal, but the jurisdictional approach may be the most efficient given the operational requirements of the different jurisdictions.

Other respondents raised concerns related to highlighting the necessity for alignment between SEMC/RAs/TSOs/DSOs on the need and role of LDES and its participation in the market are optimised. These respondents hold that further insights and justifications are required on these options but believe that should the jurisdictional approach be integrated well into the market that it should be able to move the liquidity required.

3.11. Multi-Criteria Assessment

The following question was asked:

Question 29: Are the criteria we have used for assessing each option appropriate?

Summary of consultation responses

Among 20 respondents to this question, we have a variety of opinions. There were 6 who agreed with the criteria used, 3 who didn't, and a further 11 who didn't come to one particular conclusion.

Of the respondents who thought that these criteria were sufficient, it was noted that these criteria cover the policy obligations, while also meeting the expectations of industry and the public and addressing the need for market signals for timely LDES investment. However, it was suggested future assessments should consider implementing weighted criteria based on critical need as it may lead to a more accurate outcome. Respondents think a review like that applied to the CRM would have been a good starting point. Key principles to focus on include preventing undue distortions to efficient market functioning and preserving market operations and pricing to risk. Criteria to consider as per the CRM assessment are functioning of the internal electricity market, security of supply, competition, equity, environmental concerns, adaptive, stability, efficiency, and practicality.

Those who responded that the criteria were not appropriate said they needed further elaboration, while also being unconvinced of the accuracy of the considerations in aspects such as pricing and the cost to the System Operator. Concerns were raised over the weighting of costs to the System Operator not reflecting the procurement options. Criteria 8 refers to the cost competitiveness but not the total cost incurred. Under "Fixed term service contract" option 4 it is required that the total cost of assets be paid for by the System Operator, but in option 3 only some support will be granted by the System Operator and the rest will be made from market optimization, reducing the cost to the system operator. Other points noted were the need to include interaction with existing markets as a criterion, in addition to the potential for market distortion. Further analysis is required to uncover and mitigate market distortion risk. Overall, there is a lack of in-depth information about the criteria used, making it difficult to assess if fit for purpose. Unintended consequences are not considered. There is more regard needed towards the TSOs ability to deliver for successful auctions regulatory, SEMC, and EU approvals that may be required, and time delays.

Respondents with a mixed view on the criteria considered them to be insufficiently elaborated upon and not leaving sufficient scope for innovation in the industry. They think the scoring should have been carried out by industry, particularly questioning how the investment certainty could be scored if not by industry, then noting it would be useful if financial institutions were to carry out an assessment and feedback on the bankability of options 3 and 4. It was noted that the criteria don't consider risks and benefits to energy consumers of the LDES procurement option, for this reason, the options should have an assessment of the costs of the benefit of each option included. "Fixed Term System Services" excludes the provider from markets, consideration should be given to whether this increases the cost. Several respondents note that the storage-specific and Long-Term System Services options should be progressed further for more detail to compare, monitor, and incorporate evolving criteria from the LDES procurement options. A respondent also noted the need to include carbon budgets/targets, to account for future network and current reinforcement plans, and to clarify market interactions and how they are managed. Consider a technology agnostic approach and the clearing mechanism proposed so that the most "efficient" storage can be delivered.

There is a need noted by the respondents to clarify certain areas of the criteria. One raised the question of why option 3 is less aligned with government goals than option 4, and then why option 4 mitigates market risk better. It was noted that was no clarity given as to how discharged energy wouldn't impact the wholesale market and balancing market.

The following question was asked:

Question 30: How would you augment the criteria used for assessing each option?

Summary of consultation responses

Respondents noted a lack of depth in the criteria and suggested more elaboration and room for innovation. Issues surrounding the detail provided in the assessment and detail around the construction and assessment of the criteria were noted. One noted and suggested the criteria were too high-level and subjective, suggesting "Alignment with European goals and objective and in particular, alignment with the TEN-E regulation and the Commission recommendations on how to exploit the potential of energy storage" as an additional criterion.

Issues surrounding the weighting in the assessment were raised. One respondent suggested carrying out an assessment in terms of €/MWh or €/t CO2 for costs for the level of benefit of the criteria. Another noted that the inclusion of Operations and Maintenance costs within the criteria would increase the clarity on associated costs for financial institutions involved. Multiple respondents noted that the key component and highest weighted component should be the incentivisation of a low carbon generation portfolio at the lowest cost to the consumer, while one respondent considered that there should be carbon budgets included in "Align with jurisdictional strategies and policies". There were then some issues with how the different criteria were measured and their components weighed against each other. New weighted considerations were suggested, such as: scalability of solution, overall system value delivery, comparative assessments across technologies and durations, grid capacity utilization maximization, net zero industry act criteria, and whether it encourages a range of market participants to increase competition. Using weightings, these can be used to assess risk and their ability to deliver. The options that utilise more storage options should be weighted higher, keeping a score of how well the options utilise the storage services.

Multiple respondents gave feedback including different considerations that the criteria could take. These involve legal risks, such as the risk of the untried technology involved. Also included is a recommendation for the solution to be within a capacity mechanism that applies to all non-wind, non-solar units and where a low/net-zero carbon compatible CONE and demand curve applies. There is a need for more detail in the criteria, on the ability of the unit to demonstrate efficient dispatch and investment signals as well as feasibility and practicality of options delivering required volumes of LDES for decarbonisation, while maintaining security of supply. One respondent stated that the options considered should have been based in existing market frameworks, due to the benefits associated with having a straightforward timeline, transparency with market participants, and being cost effective to the consumer. This would have been a more efficient use of the TSOs resources than options 3 or 4, which should only have been considered after every and any other market solution was ruled out. As such, the options should be procured through existing measures, such as the CRM, with options 1 and 2 as the focus. Respondents also gave key considerations that should be taken such as ESG dimension considerations and environmental impact across the supply chain. The diversity of technologies is essential. Some respondents wish to consider the duration of support contracts and look to long-term technologies, lasting around 30 years, rather than the Li-ion batteries which would need replaced 2-3 times in that period.

One respondent stated that the relative benefit of the options for energy consumers should be considered. Appraisal of the options should be carried out by an independent party, avoiding bias. The criteria for assessing goals should be defined. In the paper, the initial assessment of options is undefined, while the detailed assessment of supporting mechanism scoring systems is highly subjective. Another respondent noted that the assessment for each option should include needs case for LDES, market impacts, realistic deliverability in terms of the timeline and developers' criteria. High-level design and detailed design require more consideration before any consultation on a contractual framework.

The following question was asked:

Question 31: Do you agree with our assessment of each option?

Summary of consultation responses

A consensus among respondents was the need for more detail to be given regarding how the scoring for the multi-criteria assessment was carried out, and further elaboration on the criteria used. Many respondents did not agree with option three getting scored lower than option four and felt that the scores were quite subjective. Going forward, it was emphasised the need for further engagement with industry and an additional high-level design consultation before coming to any conclusions. It was also suggested that future multi-criteria assessments have additional, more detailed criteria that is weighted to better compare options.

Three respondents firmly disagreed with our assessment of each of the options. It was argued there was a significant issue associated with the weighting and scoring of the options given, potentially coming from unintentional unconscious bias and the aggressive timeframes given. There may be a desire to side-step market problems rather than to resolve them, leading to the System Services option being scored higher. One respondent suggested that the high score of the system services option may also be the result of the un-tested, high-level assumption that the TSO will operate storage assets more efficiently than independent operators. It is again emphasized that criteria for the scoring of the options should be included and expanded upon as there was little justification for the conclusions reached. Another respondent questioned the validity of the assessment based on the lack of transparency and time provided to review, and questioned whether this is a valid consultation exercise in accordance with public law.

4. Appendix I

4.1. Glossary of Terms

Abbreviation	Definition
CAPEX	Capital Expenditure
COMAH	Control of Major Accident Hazards
CONE	Net Cost of New Entry
CRM	Capacity Remuneration Mechanism
CRU	Commission for Regulation of Utilities
DECC	Department of the Environment, Climate and Communications
DS3	Delivering a Secure, Sustainable Electricity System
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations 2002
DSO	Distribution System Operator
ECP	Enduring Connection Policy
ESG	Environmental, Social, and Governance
GW	Gigawatt
ISEM	Integrated Single Electricity Market
LCos	Levelized Cost of Storage
LDES	Long Duration Energy Storage
MEC	Maximum Export Capacity
MIC	Maximum Import Capacity
MRL	Manufacturing Readiness Level
MW	Megawatt
MWh	Megawatt hour
O&M	Operations and Maintenance
OPEX	Operating Expenditure
RAs	Regulatory Authorities

RESS	Renewable Electricity Support Scheme
SDP	Scheduling & Dispatch Programme
SEM	Single Electricity Market
SEMC	Single Electricity Market Committee
SNSP	System Non-Synchronous Penetration
SOEF	Shaping Our Electricity Future
TEN-E	Trans-European Networks for Energy
TFEU	Treaty on the Functioning of the European Union
TPL	Technology Performance Level
TRL	Technology Readiness Level
TSO	Transmission System Operator
UREGNI	Utility Regulator Northern Ireland