A Call for Evidence on the Market Procurement Options for Long Duration Energy Storage (LDES)

27 October 2023

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List of Abbreviations

Abbreviation	Definition
CAES	Compressed Air Energy Storage
CAP23	Climate Action Plan 2023
Capex	Capital Expenditure
CO_2	Carbon Dioxide
CRM	Capacity Remuneration Mechanism
CRU	Commission for Regulation of Utilities
DAERA	Department of Agriculture, Environment and Rural Affairs of Northern Ireland
DBC	Dispatch Balancing Costs
DECC	Department for the Environment, Climate and Communications
DfE	Department for the Economy
DSO	Distribution System Operators
ECP	Enduring Connection Process
EVs	Electric Vehicles
GCS	Generation Capacity Statement
GW	Gigawatt
LDES	Long Duration Energy Storage
Li-ion	Lithium-ion
MIC	Maximum Import Capacity
MO	Market Operator
MtCO2e	Metric Tonnes of Carbon Dioxide Equivalent
MW	Megawatt
NGESO	National Grid ESO
OECD	Organisation for Economic Co-operation and Development
Opex	Operating Expenditure
ORESS	Offshore Renewable Electricity Support Scheme
PCM	Phase Change Materials
PV	Photovoltaics

QTP	Qualification Trial Process
RA	Regulatory Authorities
RES-E	Renewable Energy Sources for Electricity
RESS	Renewable Electricity Support Scheme
SDP	Scheduling & Dispatch
SEM	Single Electricity Market
SNSP	System Non-Synchronous Penetration
SOEF	Shaping Our Electricity Future
TRL	Technology Readiness Level
TSO	Transmission System Operator
UPS	Uninterruptible Power Supplies
VRFB	Vanadium Redox Flow Batteries
ZBFB	Zinc Bromine Flow Batteries

2. Executive Summary

The publication of the update to the Shaping Our Electricity Future (SOEF v1.1[1]) Roadmap in July 2023 captures changes to electricity policy and informs a pathway to achieving energy and climate ambitions and objectives across both jurisdictions. It builds on the previous Roadmap and plans for an electricity system that can deliver up to 80% RES-E by 2030 in both Ireland and Northern Ireland. It also considers how the electricity system in Ireland complies with the requirements set out in the sectoral emissions ceilings for electricity to 2030.

Additionally, an action coming out of the Climate Action Plan 2023 (CAP23) in Ireland was for CRU to undertake a review of the regulatory treatment of storage including licensing, charging and market incentives.

The work carried out as part of the SOEF v1.1 Roadmap outlined a need for Long Duration Energy Storage (LDES) and identified the connection of such as a key facilitator in the integration of additional renewable generation capacity. Additionally, SOEF V1.1 highlighted that the short duration incentives have been successful and that the optimum volume of shorter duration storage has been, or is close to being, acquired.

After undertaking extensive engagement with industry/stakeholders and based on the analysis we have carried out, it appears that there is a remuneration gap for investors looking to develop LDES.

It is important to note that ESB Networks are running a procurement process for demand flexibility in Ireland and the LDES procurement that we discuss as part of this paper is both separate from and in addition to this. It is also important to note that consideration will need to be put into the cumulative requirements for storage at specific locations so as to ensure that the optimum amount of storage is procured.

This call for evidence paper seeks to explore if there is a needs case for Long Duration Energy Storage (LDES), examining the potential barriers to investment, the services provided by storage and the options for providing revenue streams.

Additionally, this paper will set out our view of the potential solutions, a timeline for the implementation of a solution and the next steps to be taken.

The key points set out in this call for evidence paper are:

- Current policy in both Ireland and Northern Ireland have set targets of increased renewable integration between now and the end of the decade. These targets are coupled with

[1] SOEF v1.1

additional requirements such as carbon budgets and/or greenhouse gas emission reduction targets.

- The build of additional renewables will lead to an increase in the amount of surplus renewables that are not fully optimised. LDES would help to enable the delivery of government targets in Ireland and Northern Ireland while increasing flexibility.

- LDES enables a number of benefits such as:

    1. Increasing the penetration of renewables
    2. Reduces Carbon Emissions
    3. Reduces the level of renewables dispatch down
    4. Reduces All Island Generation Cost

- Feedback from participants, who are currently looking to make a business case for investment in Longer Duration Energy Storage, is that they are finding that existing revenue streams still leave them with a 'missing money' element.

- There may be a need for an LDES procurement exercise aimed at awarding contracts for storage assets to connect, at the latest, in 2029 with this being followed by a new iteration of the auction for each subsequent year. The decision to undertake these procurement processes will be subject to decisions and approvals by the Regulatory Authorities.

This call for evidence seeks information to help us understand in more detail:

- Whether the conclusions we have drawn above are correct
- Are there barriers within the current market
- Mechanisms by which these can be addressed
- The risks that can be associated with different mechanisms for supporting LDES

EirGrid and SONI welcome feedback on the questions posed within this paper, which will be used to inform a recommendation paper that will be discussed with the Regulatory Authorities prior to submission to the SEM Committee for its consideration.

An in person industry forum will be facilitated on the 10th November to discuss this call for evidence paper.

Note that proceeding with the resulting procurement process is subject to both approval of the funding arrangements and of the procurement exercise itself by the Regulatory Authorities. The TSOs will look to progress a funding application to continue to support this work.

Responses to the questions set out in this paper should be submitted through either the EirGrid or SONI consultation portal **before 16:00 on 24th November 2023.**

3. Introduction

3.1. EirGrid and SONI

EirGrid and SONI are the Transmission System Operators (TSOs) in Ireland and Northern Ireland, managing the electricity supply and the flow of power from generators to consumers. Electricity is generated from gas, coal, oil, and renewable sources at sites across the island. Our high voltage transmission network then transports electricity to high demand centres, such as cities, towns and industrial sites.

EirGrid and SONI are at the forefront of the mass integration of non-synchronous renewables into transmission systems and play a fundamental role in the implementation of government energy policy.

In line with government ambitions, we have a responsibility to enable increased levels of renewable sources to generate on the power system while continuing to ensure that the system operates securely and efficiently.

3.2. Stakeholder Engagement

The initial phase of our work entailed an extensive level of stakeholder engagement. We felt that it was important to keep all relevant parties informed of the work that we were undertaking, while also allowing them the opportunity to pre-screen elements of our proposals. This stakeholder engagement has involved, but is not limited to:

- Regular interaction with the Department for the Environment, Climate and Communications (DECC)[2] in Ireland.
- A presentation has been given to the Department for the Economy (DfE) in Northern Ireland with feedback provided.
- Engagement with both Regulatory Authorities and Distribution System Operators (DSOs)
- Meeting with Storage Industry representative bodies
- Engagement with peer TSOs who are more advanced in respect of LDES (Australia and Great Britain)

We would like to take this time to thank all of the stakeholders who have engaged with us thus far and state our intention to continue a consistent level of engagement.

[2] The Department for the Environment, Climate and Communications in Ireland has specific targets around storage in its Climate Action Plan. No specific targets are yet in place for Northern Ireland

3.3. Purpose of this Paper

The purpose of this call for evidence paper is to both explore whether an incentivisation gap exists and to then outline the list of potential procurement mechanisms for LDES.

We have divided the process for procurement into four phases, shown in Figure 1 below, with this paper dealing with the 'Procurement Mechanism' phase of the process. We do briefly explore some of the other phases below and welcome views from industry on the questions raised.

Figure 1: Phases of Procurement process

Pre-Procurement: A pipeline of projects will be needed to enable liquidity in respect of any market-based competition. This paper explores if there is currently a missing money gap in relation to incentivising the delivery of long duration storage. We acknowledge that industry need a lead time in order to build a business case, secure project financing, enter a connection process, planning permission, etc.

Prior to any procurement exercise, there may need to be a screening exercise to ensure certain prerequisites are in place. An example of such is a connection agreement.

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?

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

Procurement Mechanism: This is the focus of this call for evidence paper. Any procurement mechanism is key to ensure there is a signal in place to developers and investors to allow them to proceed with 'Pre-Procurement' activities. Developing a procurement mechanism is a complex task and there is no silver bullet solution Any design must balance deliverability with complexity.

Build: This is the phase post procurement of the long duration storage. This is where the developer constructs the asset and ancillary equipment. Depending on the type of connection this may drive reinforcements on the transmission network or a new connection asset.

Operation: Depending on the type of procurement mechanism this may necessitate changes to the TSO and MO systems to allow us to schedule and dispatch the assets across long timeframes. This would be a further enhancement on top of the current changes being made as part of the Scheduling and Dispatch Programme.

We acknowledge that there are a number of considerations that do not fall within the scope of this paper, but we wish to provide comfort that they are being dealt with via other mechanisms or workstreams.

Below we have graphically outlined what we believe to be the relevant topics regarding LDES.

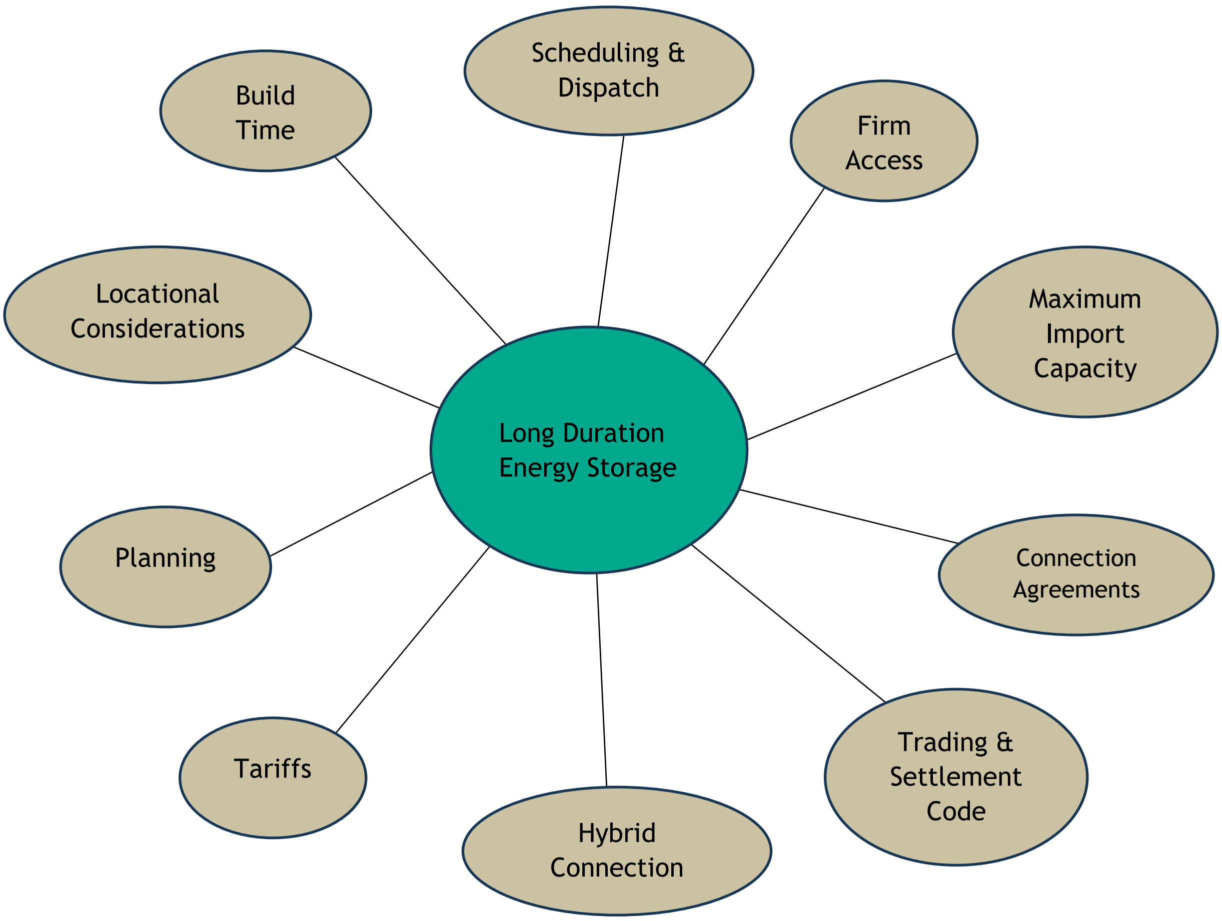


Figure 2: Topics associated with LDES

Topics not considered as part of the procurement process:

1. Scheduling & Dispatch (SDP) – The inflight Scheduling & Dispatch project is implementing a change for Energy Storage Power Stations to allow market participants to enter negative Physical Notifications (PNs) and allow for scheduling and dispatch of same. Monthly workshops are taking place with industry on the details of this. Please refer to www.sem-o.com for further details.

2. Firm Access – In Ireland this is dealt with as part of the Enduring Connection Process (ECP) process. EirGrid has carried out work on an updated Firm Access Methodology and this currently sits with CRU & the SEMC. In Northern Ireland, this is dealt with under the NI Connections Process
3. Maximum Import Capacity (MIC) – This is being looked at by EirGrid & SONI and is being dealt with as part of the ECP & SONI Connections Policy processes.
4. Connection Agreements – Falls under the Enduring Connection Policy (ECP) in Ireland and the SONI Connections Policy in Northern Ireland. The ability of storage assets to obtain a Connection Agreement will be a key element in their facilitation and additional consideration will need to be given to how these assets are included in the ECP and SONI Connections Policy process.
5. Trading & Settlement Code – Changes to the Trading & Settlement Code may have to be looked at. If required, this would be done as part of the procurement process.
6. Hybrid Connections – Hybrid connections are seen as being a key component of the rollout of LDES. There have been 3 recent consultations on topics related to hybrid connections and these are awaiting a final decision from the Regulatory Authorities (RAs.)
7. Network Tariffs – Discussion on the tariffs associated with storage units is not covered in this call for evidence but it may need to be considered prior to any procurement phase.
8. Planning – The ability to obtain planning permission will be a key facilitator for storage assets and EirGrid and SONI are looking to engage with industry groups on how to remove/lower barriers in this respect.
9. Locational Considerations – It is important that Locational Considerations are taken into account. This ties in with EirGrid’s move towards a plan-led development of the Transmission system and Transmission connected assets. This also aligns with the appetite in SONI for a more plan-led approach to efficient development of the Transmission system.
10. Build Time – this will be a post-procurement consideration and topics discussed above such as planning and connection agreements will have an impact on this issue.

Questions are provided for which we request responses **before 16:00 on 24th November 2023.**

As set out in Table 1, a consultation on the contractual arrangements for this procurement exercise will follow, intended to be launched in March 2024.

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

3.4. Procurement Plan

As part of our work, we have sought to develop a suggested timeline for this call for evidence and subsequent work to provide an indication to all stakeholders of when they can expect each step of the process to take place. Due to the lead time associated with delivering complex capital projects, the TSOs would like to have the targeted date for completion of the procurement process and contract award to be January 2025.

The overall procurement plan is provided in Table 1 below.

Description	Start Date	Finish Date
Call for Evidence Paper outlining the options for incentivization of LDES and our recommendations on our emerging preferred option	Q4 2023	Q4 2023
Recommendations paper submitted to SEM Committee for approval	Q4 2023	Q1 2024
Studies to identify the technical and locational requirements for our procurement process	Q1 2024	Q2 2024
Consultation, Recommendation and RA Decision on the contractual arrangements	Q3 2024	Q3 2024
Complete Procurement Process and award Contracts	Q3 2024	Q1 2025
Latest Date for Connection of applicants successful in first iteration of Procurement Process	Q1 2029	Q1 2029

Table 2: Overall procurement process plan

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?

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

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

3.5. Paper Structure

The remaining sections of the call for evidence paper are structured as follows:

Section 4: provides some background information on the issue and what the driving force is for the LDES Project.

Section 5: sets out the needs case for LDES by outlining the benefits resulting from our modelled scenarios.

Section 6: describes the process that we have gone through for firstly evaluating the LDES funding issue and then the options for solving this.

Section 7: provides an overview of next steps and details the call for evidence questions.

4. Background

Through the Climate Action and Low Carbon Development (Amendment) Act 2021[3], Ireland has a long-term commitment to become a climate resilient, biodiversity rich, and climate neutral economy by no later than the end of the year 2050 and achieve a 51% reduction in greenhouse gas emissions by 2030 relative to 2018. In addition, under the Climate Action Plan 2023[4], Ireland has a target to achieve up to 80% electricity from renewable sources by 2030.

The most recent Climate Action Plan publication in Ireland, CAP23, was the first iteration post the introduction of economy-wide carbon budgets and sectoral emissions ceilings. A decarbonised electricity system will form a central component of the solution to decarbonise our broader economy. An action coming out of CAP23 was for CRU to undertake a review of the regulatory treatment of storage including licensing, charging and market incentives.

Under the Climate Change Act (Northern Ireland) 2022[5], Northern Ireland has set a target of at least a 100% reduction in net greenhouse gas emissions by 2050, as well as a commitment to set targets for 2030 and 2040 which are in line with the target for 2050. The Act also includes distinct targets for Carbon Dioxide (100%) and Methane (46%) emissions reductions. In each case, reductions are to be measured against an appropriate baseline, also explicitly defined under the Act. The Act also includes a provision that the Department for the Economy must ensure that at least 80% of electricity consumption is from renewable sources by 2030. Furthermore, the Act provides for a system of carbon budgeting and there is currently a consultation seeking feedback on proposed carbon budgets for 2023-27, 2028-32 and 2033-37 running in Northern Ireland[6].

The Northern Ireland Energy Strategy 'Path to Net Zero Energy'[7] sets out a number of initiatives to ensure that these ambitious emissions reduction and renewable electricity targets are achieved. These include energy efficiency initiatives as well as initiatives to replace fossil fuels with renewable energy and to create a flexible, resilient and integrated energy system. Additionally, the Northern Ireland Energy Strategy Action Plan for 2023[8] includes an action to launch the design of a Renewable Electricity Support Scheme which has commenced.

The practical implementation of these plans for the decarbonisation of the energy industry has manifested itself in a move away from more consistent and dispatchable forms of power generation, such as fossil fuel burning plants, to more intermittent forms of renewable generation, such as wind & solar. While renewable technologies are extremely successful in helping Ireland

[3] https://www.irishstatutebook.ie/eli/2021/act/32/section/15/enacted/en/html
[4] https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/
[5] https://www.legislation.gov.uk/nia/2022/31/contents/enacted
[6] https://www.daera-ni.gov.uk/news/carbon-budget-consultation-launched
[7] https://www.economy-ni.gov.uk/topics/energy/energy-strategy
[8] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Energy-Strategy-Path-Net-Zero-Energy-2023-Action-Plan.pdf

and Northern Ireland to reduce power sector carbon emissions, it is this intermittency that reduces the large potential contribution of these technologies as it can lead to a surplus of renewables at specific times. However, LDES provides a service whereby power system operation can be better optimised and these surplus renewables can be used more efficiently.

The extensive build of renewable generation, and its associated variable output has led us to a scenario whereby we can experience periods of renewables being dispatched down followed by periods of relatively low renewables supply. The former scenario essentially results in renewable generation being a lost opportunity and the latter scenario regularly culminates in flexible backup gas turbines having to run as renewable generation has now become scarce relative to demand.

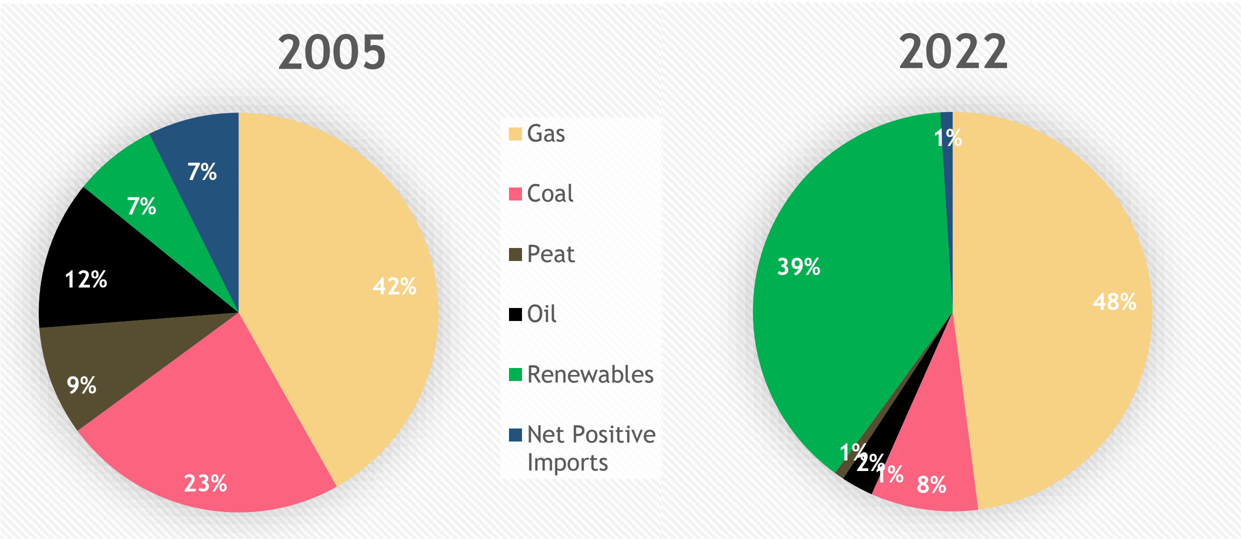


Figure 3: Changes in all-island fuel mix from 2005-2022

As legislation continues to call for, and incentivise, the connection of additional renewable energy it is reasonable to assume that the share of renewables in the fuel mix will increase and thus, without mitigation, we should expect to see higher levels of dispatch down.

4.1. Dispatch Down

Dispatch down of renewable energy refers to the amount of renewable energy that is available but cannot be used by the market or operator of the power system. This is because of either market surplus, broad power system limitations, known as curtailments, or local network limitations, known as constraints[9].

In Ireland and Northern Ireland, renewable energy is predominantly sourced from wind, although solar energy has grown in size and significance in both Ireland and Northern Ireland in recent years. Other sources include hydroelectricity, biomass, biofuel and some forms of waste.

[9] EirGrid Renewable Constraint and Curtailment Report 2022

The dispatch down of renewable energy is driven by three factors:

- **Constraint** – The dispatch-down of wind for network reasons is referred to as a constraint. Constraint of wind and solar can occur for two main reasons:
    - ¤ more wind generation than the localised carrying capacity of the network; or
    - ¤ during outages for maintenance, upgrade works or faults.
- **Curtailment** – refers to the dispatch-down of wind / solar for system-wide reasons. There are different types of system security limits that necessitate curtailment:
    - 1. System stability requirements (synchronous inertia, dynamic and transient stability),
    - 2. Operating reserve requirements, including negative reserve,
    - 3. Voltage control requirements,
    - 4. System Non-Synchronous Penetration (SNSP) limit – this is the sum of non-synchronous generation as a percentage of total demand and exports.
- **Surplus Renewables** – this occurs when there is simply not enough demand for all the renewable electricity that is available. This element applies to Priority Dispatch wind only.

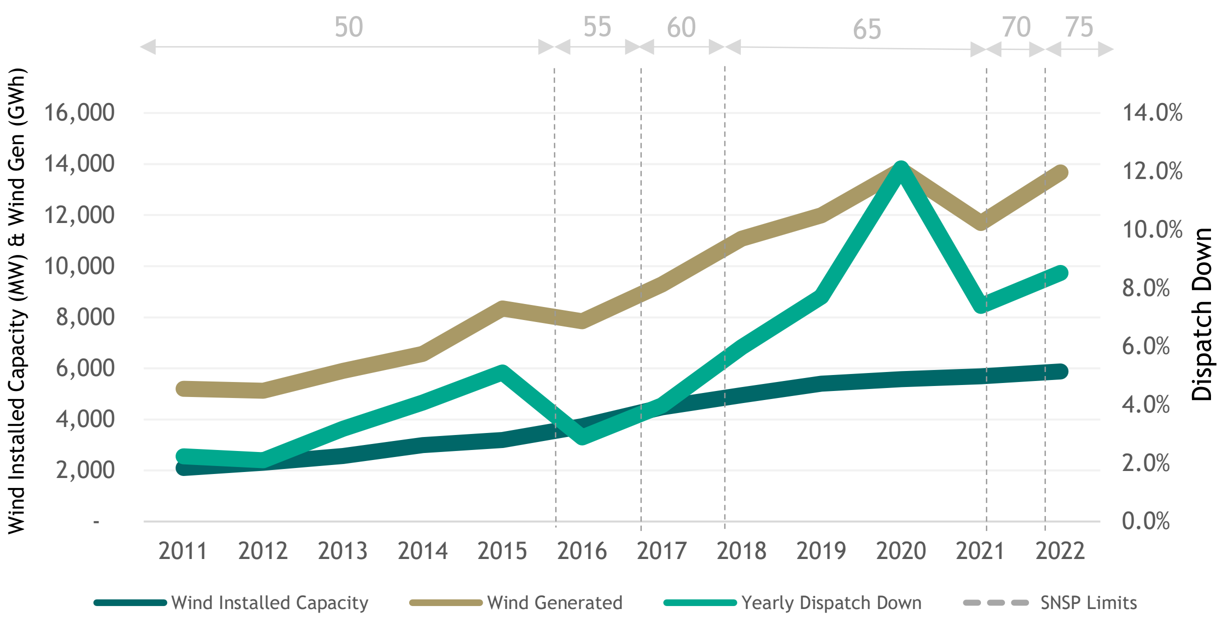


Figure 4: Trends between Wind Installed Capacity (MW), and Yearly Dispatch Down

From Figure 4 above, we can see that there is a positive relationship between the level of dispatch down and the amount of installed wind capacity on the system. There is a plan outlined in Shaping our Electricity Future to reduce a number of curtailment related events through our Operations workstream and to reduce constraints via the Networks workstream. Looking into the future there will however be times when, for operational reasons, the TSOs will need to dispatch down renewables.

In effect these dispatched down renewables constitute generation that cannot be transferred due to network constraints or that are replaced by alternative units due to system curtailment, and is spilled/unused. We tend to see higher levels of dispatch down overnight as dispatch down is a function of demand and interconnector export capacity.

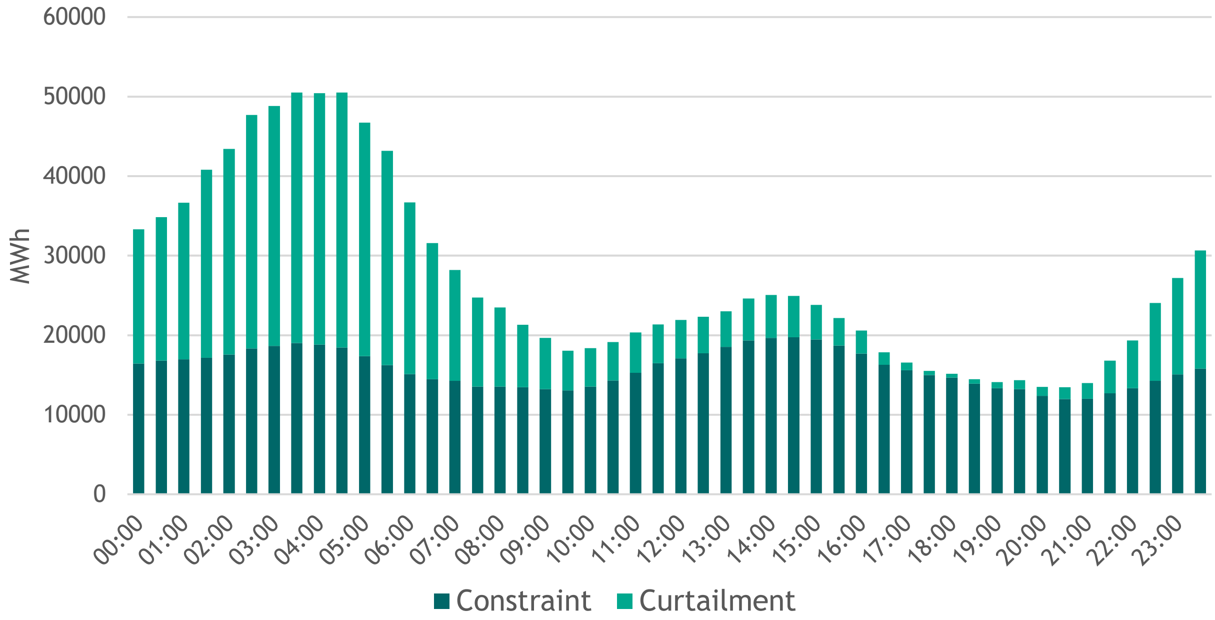


Figure 5: Total hourly dispatch down (2022)

The publication of the 'Climate Action Plan 2023' included a new set of ambitious renewables & flexibility targets which called for a further ramping up of renewable deployment in Ireland. A corresponding increase in renewables deployment is legislated for in Northern Ireland. The aforementioned increase in renewables is expected to result in periods of dispatch down becoming more prevalent.

4.2. Shaping Our Electricity Future

In July 2023 we published the update to the Shaping Our Electricity Future Roadmap, SOEF v1.1, following consultation with stakeholders across society, government, industry, market participants and electricity consumers.

This plan provides an outline of the key developments from a networks, engagement, operations and market perspective needed to support a secure transition to at least 80% renewables on the electricity grid (RES-E) by 2030. It also considers how the electricity system in Ireland complies with the requirements set out in the sectoral emissions ceilings for electricity to 2030. These are important steps on the journey to net zero by 2050. Inherent in this is a secure transition to 2030 whereby we continue to operate, develop and maintain a safe, secure, reliable, economical and efficient electricity transmission system.

A fundamental change that is captured in SOEF v1.1 is the increased targets for the build out of renewables, by 2030, which was published in the Irish Government's Climate Action Plan 2023; additionally, build figures were included for Northern Ireland to help achieve the renewable targets set out in the NI Climate Act.

	Ireland	Northern Ireland
Demand	45.1 TWh (~Median GCS[10] Scenario)	10.2 TWh (~Median GCS Scenario)
Offshore Wind	+5,000 MW	+500 MW
Onshore Wind	+4,500 MW	+1,000 MW
Solar PV	+8,000 MW (including 2,500 MW small scale)	+400 MW (including 100 MW small scale)
Short Duration Storage	+100 MW	+50 MW
Long Duration Storage	+2,400 MW	+350 MW
De-rated Gas Capacity	+2,000 MW	+900 MW

Table 2: Summary of the SOEF v1.1 assumptions for Ireland and Northern Ireland

These updated 2030 renewables targets, allied to carbon emission reduction targets, have led to the requirement for a re-evaluation of the capacity needed to maintain power system reliability while meeting these ambitious targets. The analysis in SOEF v1.1 showed that the power system requires a balanced portfolio of complementary technologies to achieve the many goals set out in CAP 23 and the NI Climate Act.

A key action identified in this roadmap was the need for the connection of LDES in order to contribute to the targets. More detail on the methodology applied and volume of storage included is provided in Section 5.1.

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?

[10] EirGrid/SONI GCS 2022-2031

4.3. Long Duration Energy Storage (LDES)

Although there is no agreed definition of what constitutes LDES, it is generally seen as, and for the purpose of this call for evidence, being storage with a minimum duration of 8 hours.

LDES is globally recognised as being a fundamental part of the push towards the decarbonisation of power systems as it can offer a range of benefits such as:

- **Dispatch Down/Surplus Management**

This constitutes the ability to consume excess renewable energy at times when it would otherwise be dispatched down and not fully optimised. The renewable opportunity cannot be properly utilized as a result of insufficient demand on the system or access to other markets. Thus LDES has the ability to help accommodate additional renewables on the grid. The following example illustrates how storage can help reduce Dispatch Down.

Without Storage	**2am**	**6pm**
Demand	400 MW	400 MW
Available Wind	600 MW	200 MW
Wind Dispatched Down/Unused	200 MW	0 MW
Net thermal Generation	0 MW	200 MW

Table 3: Dispatch Down example without storage

In this scenario, the level of wind, 600MW, at 2am is in excess of the demand, 400MW, on the system and thus the surplus of 200MW is dispatched down and not fully optimised. Later the same day, wind has fallen off to a level below that of demand and thus the System Operator would be required to bring on Thermal units to fill this gap.

With Storage	**2am**	**6pm**
Demand	400 MW	400 MW
Available Wind	600 MW	200 MW
Storage Charging	**200 MW**	**-**
Wind Dispatched Down/Unused	0 MW	0 MW
Storage Discharging	**-**	**200 MW**
Net thermal Generation	0 MW	0 MW

Table 4: Dispatch Down example with storage

The introduction of Storage into the mix changes the steps that need to be taken by the System Operator. Here we can see that rather than dispatch down wind at 2am, the System Operator can now store this wind and use it to reduce/remove the requirement for thermal generation to be run later in the day.

- **Congestion Management - Avoided network upgrade costs and can also add to the security of supply.**

The ability of storage to charge at times of renewable surplus provides the TSO with operational flexibility and thus can help to alleviate the need for network upgrades as there will be less of a need to transport power from these regions or transfer of power can be deferred and the power flow optimised to when there is demand at another time.

In the previous example given, an alternative solution to the 'Without Storage' scenario would be to find a way of moving the dispatched down 200MW to another demand centre, via the build out of additional grid. However, the flexibility in the example shows that Storage can help to reduce this need for grid reinforcement.

One issue that we are seeing arise at the moment is the difficulty with aligning the optimal physical dispatch of storage assets with the optimal market signals. The below example illustrates this as we can clearly see the optimal charging and discharging times from an operation perspective, however, there is not currently a mechanism for the TSO to ensure that the Storage will not be discharged during the period Days 2 – 4 and thus there is the potential for a sub-optimal outcome.

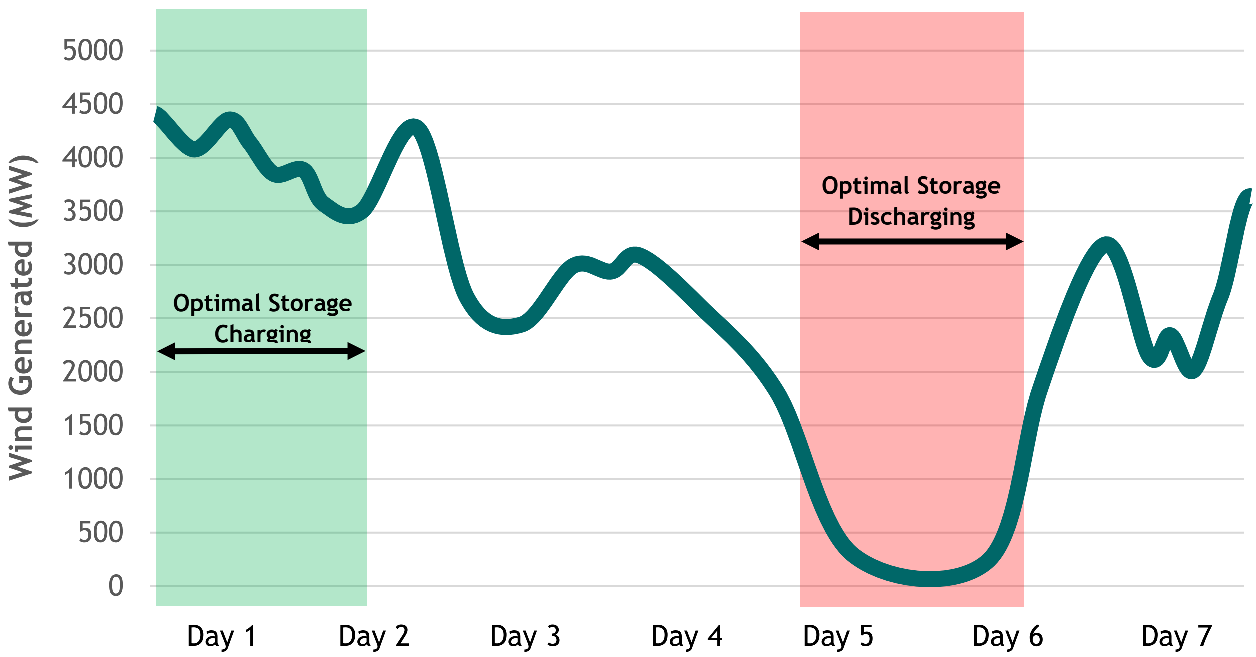


Figure 6: Storage dispatch scenario

Strategic operation of and service provision by storage units offers the potential to maximise renewable integration while also helping to alleviate operational and grid issues.

Although Long Duration Energy Storage provides a desirable 'use-case', we are still not seeing this reflected in applications received or Capacity Market results. At the time of writing, 19 batteries have cleared through the capacity market, totalling approximately 750 MW/ 600 MWh, with the majority of installed battery units having durations of less than two hours.

A common theme that has arisen from discussions with industry and with our counterparts in other jurisdictions is that current market mechanisms do not create an adequate incentive for investment in LDES. We however note moves have been made in both Australia & the Great Britain markets to implement a suite of more targeted incentives for the building of LDES.

We see it as imperative that we look to follow suit and take the necessary policy steps required to implement a similar approach. In Ireland, the Government's willingness to "address any administrative, market or regulatory barriers to the implementation of energy storage projects" has been previously stated in its White Paper on 'Ireland's Transition for a Low Carbon Energy Future'. In Northern Ireland, the Government has committed to supporting the innovation of emerging fields of low carbon technologies, including energy storage. It has also included in its policy framework the implementation of measures on energy storage and committed to developing infrastructure that integrates low carbon sources, as stated in its Energy Strategy – Path to Net Zero Energy.

Question 8: Do you agree with our definition of Long Duration Energy Storage, i.e. storage with a minimum duration of 8 hours?

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

5. Our Needs Case

In this section, we will examine the 'needs case' for the development of LDES. In order to do this, we carried out a suite of model runs using the commercially available Energy Exemplar Plexos modelling software; this is a techno-economic computer software tool that enables us to model the power system and will be familiar to most across the industry.

The results were then analysed under a number of key headings and the results will be broken down as follows:

1. A comparison of a future target year with and without Long Duration Storage
    a. RES-E integration comparison
    b. Carbon Emissions comparison
    c. Change in All Island Generation Cost
    d. Dispatch down comparison

These multi-criterion indicators are widely used within our grid development framework by ENTSOE and by other TSOs.

5.1. Methodology

In order to establish whether there is a needs case for LDES we have carried out a comparison of two model runs:

1. The constrained version of the all-island Plexos SOEF v1.1 model with storage excluded (No New Incremental Storage), and
2. The constrained version of the SOEF v1.1 model with storage included (With New Incremental Storage).

The methodology used is a replica of that used in Shaping our Electricity Future v1.1[11], calling for an additional 2.7GW of 4hr+ storage, with the storage units being located in different zones around the island. Note that the assumptions on volumes and locations in SOEF v1.1 will differ from those that are ultimately successful in the connection process. The assumed volume of storage, based on SOEF v1.1, allocated to each zone is shown in the following table:

[11] SOEF V1.1

Area	Installed Capacity (MW)	Storage Duration Breakdown (MW each duration)			
		2 hr	4 hr	6 hr	8 hr
IE AREA A	200	50	-	-	150
IE AREA B	200	100	-	100	
IE AREA C	450	150	-	200	100
IE AREA D	0	-	-	-	-
IE AREA E	200	50	150	-	-
IE AREA F	0	-	-	-	-
IE AREA G	125	25	-	100	
IE AREA H1	350	50	50	100	150
IE AREA H2	250	-	50	200	-
IE AREA I	400	150	-	250	-
IE AREA J	950	175	75	400	300
IE AREA K	100	50	50	-	-
NI AREA SE	625	250	125	-	250
NI AREA NW	0	-	-	-	-

Table 5: SOEF 1.1 All-island battery allocations by region and capacity

The zones used are shown below:

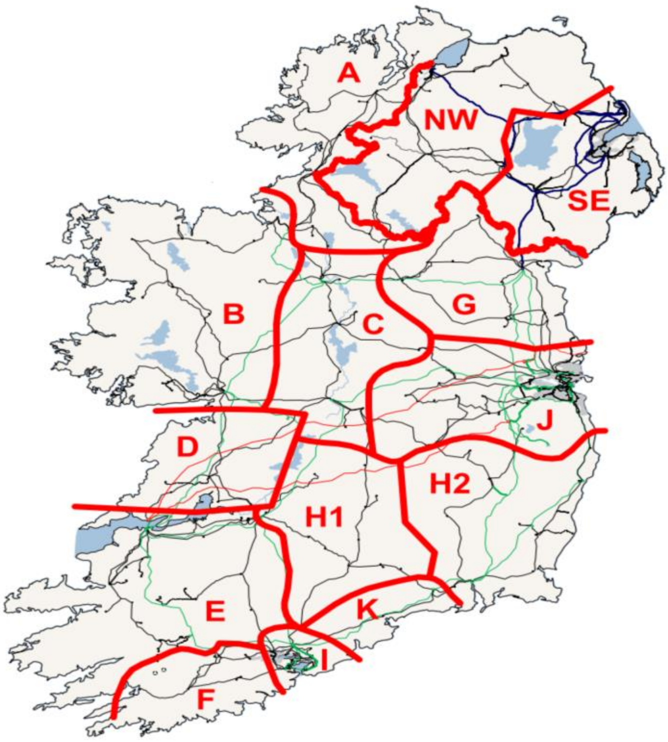


Figure 7: Zones used in storage allocation.

In advance of analysing these results, it is important to note that the model runs that we have analysed assume that all the additional renewables, referenced in Section 4.2, have been built.

Additionally, the work carried out during the SOEF process constituted the running of a high level co-optimised model and part of the next steps will entail more detailed modelling.

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

5.2. Results

The assumptions underpinning the SOEF v1.1. model are included in Section 6.3 of that document (see footnote 11). Below we can see the criteria that we have assessed the impact of storage under and the subsequent results:

Result (All Island)	No New Incremental Storage	With New Incremental Storage
RES-E	circa c.84%	circa c.89%
Carbon Emissions	4.9 MtCO2e	3.35 MtCO2e
Dispatch Down levels	circa c.35%	circa c.27%
All Island Gen Cost	€1.126 billion	€0.754 billion

Table 6: Summary of SOEF 1.1 key results - All Island

Further insight into these key results is added below along with an evaluation of the financial benefits of connecting storage.

5.2.1. RES-E Targets

Over the last two decades, there has been a fundamental shift towards the inclusion of renewables in the fuel mix of both Ireland and Northern Ireland. This has been driven by legislative changes both in the form of financial incentives for the building of renewables but also in the setting of minimum targets for their connection to the grid. The most recent policy on this has directed that 80% of the energy generated on the island should come from renewable sources by 2030.

The below shows us that the inclusion of storage has a positive impact on the integration of renewables and will be a key facilitator allowing surplus renewable energy to be better optimised.

Model Name	% of RES-E
No New Incremental Storage	circa c.84%
With New Incremental Storage	circa c.89%

Table 7: Model results of % RES-E achieved with storage and without storage - All Island

It is important to note here that the 80% target is essentially a step towards a net zero system and only forms part of an initial set of targets. The higher RES-E figures resulting from the inclusion of storage in our model run provides a contingency against unforeseen macro changes such as large demand increases and/or the under-delivery of some of the targeted renewables and/or grid upgrades.

5.2.2. Carbon Emissions

A fundamental change that resulted from the publishing of the Climate Action Plan 2023 was the setting of Carbon Emissions budgets. This is an additional requirement to that of the RES-E targets. To support achieving the legally binding requirements of the carbon budgets, ambitious target capacities of renewable generation have been included in the Climate Action Plan 2023. In order to achieve these targets, the electricity sector in Ireland has been set an emissions ceiling of 3.00 $MtCO_2e$ by 2030[12]. Currently, the Department of Agriculture, Environment and Rural Affairs of Northern Ireland (DAERA) are consulting on carbon budgets in Northern Ireland.

Model Name	Jurisdiction	CO_2 Emissions ($MtCO_2e$)
No New Incremental Storage	Ireland	2.91
	NI	1.99
	All Island	4.9
With New Incremental Storage	Ireland	2.17
	NI	1.18
	All Island	3.35

Table 8: Model results of CO_2 emissions ($MtCO_2e$) with storage and without storage

We have calculated the carbon saving €155 million (carbon price used was €100 per tonne of CO_2) and this is included in the All-Island Generation Cost below. A caveat on this would be that the price used in the model was just one of a number of forecasted prices, with other parties such as the OECD forecasting a price of €120 per tonne, which would increase the savings garnered.

12 Just to note there are two components to the target - the end point in 2030 and the need to only emit 60 $MtCO_2e$ over the period – 40 $MtCO_2e$ in the first 5-year budget and 20Mt in the 2nd 5-year window

5.2.3. All-Island Generation Cost

As part of our analysis, we have looked at the impact of the storage units on the All-Island Total Generation Cost in 2030. This essentially covers the cost of all the inputs required to produce the power required to meet demand.

Model Name	Value in € 000
No New Incremental Storage	1,126,615.33
With New Incremental Storage	754,918.57

Table 9: All-island generation costs with and without storage

The Generation cost approach is an approved method for assessing the Cost Benefit Analysis of a Grid Development Project under ENTSO-E Guidelines[13]

From the above, we can see that the inclusion of storage units in our assessment has led to a reduction of circa €3.7 billion in All-Island Generation costs over 10 years or close to €5.5 billion over 15 years.

5.2.4. Dispatch down

With CAP23 having set ambitious renewables build targets, it is envisaged that we will see an increase in dispatch down, with there being a positive relationship between the two historically. As we can see from Table 10, the build out of storage helps to reduce dispatch down levels by almost 23% in relative terms or 8% in pure terms. This will ensure that more generation is put to optimum use, while also helping to reduce operational Dispatch Balancing Costs (DBCs).

Model Name	% of RES-E
No New Incremental Storage	circa c.35%
With New Incremental Storage	circa c.27%

Table 10: RES-E levels for various model scenarios

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?

[13] ENTSO-E Guideline for CBA of Grid Development Projects

6. Path to a Solution

6.1. Technology - the Current State of Play

The acceleration in the integration of renewables into the global market has led to a corresponding increase in the demand for storage. This has drawn both financial and human capital into energy storage, leading to the industry evolving and advancing at a rapid pace.

It is against this backdrop that we are writing our call for evidence paper and we have endeavoured to remain cognisant of these ongoing developments while keeping sight of what is feasible within the timeframe of our initial proposed auction cycle.

To this end, we have engaged Jacobs Engineering Group to provide us with an assessment of the global storage market, as of May 2023. As part of this piece of work, they have outlined some of the most used forms of energy storage:

1. **Batteries:** Batteries, particularly lithium-ion batteries, are widely used for energy storage in various applications, including portable electronics, electric vehicles (EVs), and grid-scale energy storage. They store energy chemically and can provide power when needed.
2. **Pumped Hydroelectric Storage:** Pumped hydroelectric storage is currently the most widely deployed form of grid-scale energy storage. It involves pumping water from a lower reservoir to an upper reservoir when excess electricity is available, and releasing the water through turbines to generate electricity when demand is high.
3. **Compressed Air Energy Storage (CAES):** CAES systems store energy by compressing air and storing it in underground caverns or tanks. When electricity is needed, the compressed air is heated and expanded to drive a turbine and generate electricity.
4. **Thermal Energy Storage:** Thermal energy storage involves storing heat or cold for later use. It can be achieved through various methods such as storing hot water or molten salts, phase change materials (PCMs), or utilizing ice storage for cooling applications.
5. **Flywheels:** Flywheel energy storage systems store energy in the form of a rotating mass. When excess electricity is available, the flywheel spins faster, storing kinetic energy. When needed, the flywheel's rotation is converted back into electricity.
6. **Supercapacitors:** Supercapacitors, also known as ultracapacitors or electrochemical capacitors, store energy electrostatically. They have high power density and can quickly release energy. They are commonly used in applications where rapid energy storage and release is required, such as regenerative braking in vehicles.

7. **Hydrogen Storage:** Hydrogen can be produced through electrolysis or other methods and stored for later use. It can be utilized in fuel cells to generate electricity or as a fuel for various applications, including transportation and industrial processes.

It is important to acknowledge that there is a diverse range of battery technologies currently being used for the purpose of energy storage, which are included in the categories above. The most commonly deployed battery technologies today are listed below, however, it is important to note that this is not an exhaustive list:

1. **Lithium-ion Batteries:** Lithium-ion (Li-ion) batteries, as mentioned above, are widely used for energy storage in various applications, including portable electronics, electric vehicles (EVs), and grid-scale energy storage. They offer high energy density, long cycle life, and relatively low self-discharge rates.
2. **Lead-acid Batteries:** Lead-acid batteries have been used for energy storage for many years and are commonly found in automotive applications and uninterruptible power supplies (UPS). They are affordable and have a relatively long cycle life, but they have lower energy density compared to lithium-ion batteries.
3. **Flow Batteries:** Flow batteries use liquid electrolytes stored in external tanks to store energy. They are suitable for large-scale energy storage and have the advantage of decoupling power and energy capacity. Common types include Vanadium Redox Flow Batteries (VRFB) and Zinc Bromine Flow Batteries (ZBFB).
4. **Sodium-ion Batteries:** Sodium-ion batteries are an emerging technology that uses sodium ions instead of lithium ions for energy storage. They are being researched as a potentially cheaper and more abundant alternative to lithium-ion batteries.
5. **Solid-state Batteries:** Solid-state batteries are a promising technology that uses solid electrolytes instead of liquid or gel electrolytes found in traditional batteries. They offer advantages such as higher energy density, improved safety, and potentially longer cycle life.
6. **Sodium-sulphur Batteries:** Sodium-sulphur batteries are another type of rechargeable battery that uses liquid sodium and sulphur as active materials. They are primarily used for grid-scale energy storage due to their high energy density, long cycle life, and ability to handle high temperatures.

With such a diverse range of potential technologies, we deemed it necessary to include an independent feasibility assessment of technologies entering the procurement process. This is to ensure the deliverability of these projects.

The scale that they have been assessed upon is the Technology Readiness Scale.

6.2. Technology Readiness Level

Technological maturity plays a major role in differentiating and ultimately deciding between various energy storage technologies. Understanding and assessing a technology's maturity helps mitigate potential risks and pitfalls that are associated with the procurement of new and untested storage solutions. Through the evaluation of factors such as reliability, deliverability, system performance, and compatibility with existing grid infrastructure, we can be confident in maximising investment value and ensuring a successful deployment of storage systems.

1. •Basic principles observed and reported
2. •Technology concept and/or application formulated
3. •Analytical and experimental critical function and/or characteristic proof of concept
4. •Component and/or system validation in laboratory environment
5. •Laboratory-scale, similar system validation in relevant environment
6. •Engineering/pilot-scale, similar (prototypical) system validation in relevant environment
7. •Full-scale, similar (prototypical) system demonstrated in relevant environment
8. •Actual system completed and qualified through test and demonstration
9. •Actual system operated over the full range of expected mission conditions

Figure 8: Detailed Technology Readiness Level (TRL) scale

EirGrid and SONI have liaised with global engineering partner Jacobs to perform analysis on current and emerging storage technologies to determine their respective maturity. Assessing the maturity of energy storage technologies is vital to ensure the future reliability and deliverability of any contracted storage system, thusly maximising the value of the investment.

The method used for this analysis was the Technology Readiness Level (TRL) which scales from one to nine. The purpose of the TRL ranking is to utilize a common scale that indicates and compares various technologies on their progress in the development process. If a technology is placed at TRL 1, only basic principles have been observed and is still at the stage of scientific research. Any technology that is considered TRL 9 has been comprehensively proven in an operational environment. In between the outermost values, there are various milestones to indicate each position on the scale.

As an example, one storage technology that has reached TRL 9 is pumped storage. Pumped storage using reversible hydroelectric turbines has been used since the 1930s and has continued to prove a valuable asset for global TSOs with over 100 GW of pumped storage in use today. Additionally, iron-air batteries are an example of a rapidly developing technology that is climbing the TRL scale. Currently, iron-air batteries are situated at a TRL 7 as the first large-scale commercial demonstration is soon to come online.

Looking forward, we aim to set a minimum TRL level as one of the criteria in the qualification process. The intention here will be that we strike a balance between technological maturity and cutting-edge solutions.

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?

6.3. Demonstration Projects

EirGrid and SONI already have some mechanisms to test new energy products and services such as the Qualification Trial Process (QTP) for new System Service technologies. However, EirGrid and SONI believe that there is also a need to develop an Innovation Trials Sandbox to test novel and emerging technologies (TRL 5 – 7), where it is clearly demonstrated to deliver quantifiable benefits to consumers.

Another option would be to run a scheme similar to the Pathfinders scheme run by National Grid ESO in GB whereby the missing money gap is bridged for emerging technologies.

Any demonstration/trial process would need policy/regulatory approvals.

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

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

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

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

6.4. Missing Money Assessment

To further understand the gap in financial incentivisation for storage developers, we have partnered with AFRY to develop a financial model which provides insight into the missing money element of various storage implementation scenarios. The term 'missing money' quantifies the idea that current market mechanisms and revenue streams do not adequately reflect the value of investment. In the case of LDES which requires large upfront costs, missing money describes the level at which the necessary financial resources to procure the technology outweigh the potential future revenue.

This model takes into account all relevant financial data for various storage scenarios, allowing for the analysis of trends such as installed capacity, storage duration, and contract lengths. Key assumptions used in the model can be seen in the table below.

Assumption	Battery 1-hr	Battery 2-hr	Battery 4-hr	Battery 6-hr	Battery 8-hr
Opex (€/kW$_d$)	17.8	20	26	30	36
Capex (€/kW$_d$)	507.76	635.00	955.02	1275.33	1556.75
Hurdle Rate (%)	9.5%	8.5%	8%	8%	8%
Economic Life (years)	17	17	19	21	22
De-rating Factor	0.5	0.5	0.5	0.5	0.5
Contract Length (years)	10	10	10	10	10
Capacity payment (€/kW$_d$)	83.05	83.05	83.05	83.05	83.05

Table 11: List of assumptions for missing money modelling

By understanding and considering the trends in missing money for various storage scenarios, it becomes possible to balance the necessary incentives required to provide the most value to the transmission network.

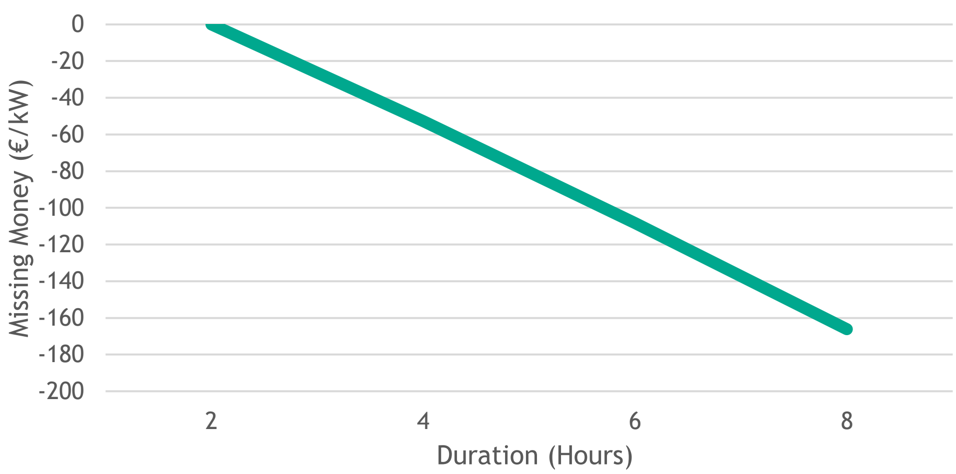


Figure 9: Storage duration and missing money

As shown in Figure 9, as the duration of the storage asset increases, so does the missing money. For this scenario, the missing money increases by 166% when the storage duration rises from 2 hours to 8. It is unclear the extent of how linear the trend is, but it can be reasonably expected to continue as durations extend past 8 hours.

	Storage Duration (hours)			
	2	4	6	8
Missing Money (€/kW)	0	-52.77	-108.38	-166.17
SOEF v1.1 Figures (MW)	1050	500	1350	950
Total Missing Money (€ 000 000)[14]	0	26	146	158

Table 12: Missing money modelling results for various storage durations

Combining the storage values from SOEF v1.1 and the corresponding missing money, an estimate of the total missing money for full procurement can be seen. For the desired 3,850 MW of 2-8 hour storage, the total missing money equates to approx. €330m[15].

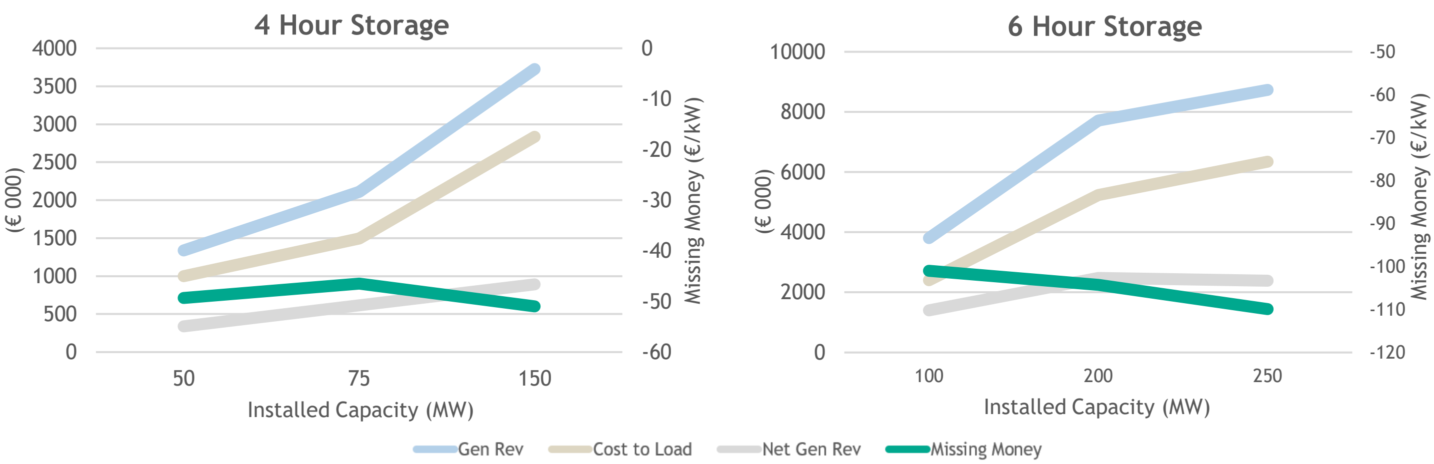


Figure 10: Trends in missing money between 4, and 6-hour duration.

Additionally, it can be seen in the above graphs that through an increase in installed capacity (MW), missing money for the storage system increases. In the case of 6-hour storage, increasing installed capacity from 100 MW to 250 MW translates to missing money increasing by 9%. This is not always a negative, as while storage systems with larger capacities require a more substantial upfront investment, larger capacities allow the asset to bring in more revenue and provide greater benefits to the grid. More analysis into the balance of increased capacity (and missing money) and value to the system will be commenced shortly to ensure the optimal procurement and implementation of storage.

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

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?

[14] The cost to procure each storage duration denoted in SOEF v1.1; *'Total Missing Money (€ 000)' = ('Missing Money (€/kW)' * 1000) * 'SOEF v1.1 Figures (MW)'*

[15] The missing money (€) to build full storage capacity stated in SOEF v1.1. Calculated as the sum of 'Total Missing Money (€ 000)' in Table 11.

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

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

6.5. Options

As part of our analysis, we have looked at a number of schemes to help incentivise the connection of LDES. For the purposes of our paper, we have narrowed these down to four potential options:

1. Status Quo – essentially a 'do nothing' approach
2. Amended current – some refinements within the existing market schemes to improve revenue stacking
3. Storage Support Scheme Auction – a standalone storage auction
4. System Services – the granting of long-term system service contracts

We will now look at these four options in greater detail.

1. **Status Quo**

The 'Status Quo' approach would essentially constitute a 'do nothing' approach whereby LDES would continue to pursue adequate investment signals via the current market mechanisms – the Capacity Remuneration Mechanism, System Service products and Energy Market revenue.

This option relies heavily on a number of developments, including:

- rapid innovation within the storage industry;
- substantial fall in the cost of the components that are required for the building of storage units; and
- a more efficient production process.

If all three of these developments occurred in a similar timeframe we could reasonably expect a large decrease in the per unit cost of different storage technologies.

Some considerations relating to this option are:

- Although it is possible for the three cases outlined above to overlap, it is highly unlikely for that to happen within the tight timelines that we are currently operating under and thus a solution based around this occurring would be high risk.

- The global demand for storage is expected to increase substantially over the next decade and this will in turn drive an increase in demand for both the component parts and the end product. It is therefore unlikely to expect substantial cost savings to manifest unless a substantial supply increase occurs in tandem.
- An incentive approach that is based around both rapid increases in technology and economies of scale has the potential to lead to developers entering speculative bids into future CRM auctions. The policy is essentially a gamble on technology and thus it would be unreasonable not to expect participants to enter into this gamble also.

We believe the speculative nature of this approach provides no hard guarantee to potential developers of storage units and thus is highly unlikely to incentivise investment in the area.

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

2. **Refine Current Mechanisms**

This option would entail carrying out an assessment of the current remuneration mechanisms that are available to potential connections and investigating if a suite of refinements can be made that help target LDES.

The intention here is to maintain an accepted way of attracting investment into the energy sector while using a number of targeted reforms to help send out a stronger investment signal to potential developers of LDES.

Examples of these potential reforms could include:

- Capacity Remuneration Mechanism (CRM)
    - A change to storage duration classes
    - The use of locational scalers
    - Increase in Price Caps
- System Services
    - Targeted products that incentivise the services offered by LDES

Some considerations relating to the option are:

- Changes to derating factors must be based upon a methodology and changing it may have unintended consequences/be subject to challenge. We note that considerable work took place between the RAs and TSOs in the last 12 months on derating factors. The current approach is based on capacity adequacy; however, we are seeking a product for system flexibility and not capacity adequacy. Although capacity adequacy is an indirect benefit of storage for the needs case identified earlier, it is not the primary driver. As noted above this could result in unintended consequences.

- The CRM must be technology agnostic; thus, the inclusion of locational scalers/signals has the potential to lead to a perverse outcome – such as another non-storage technology connecting in a constrained area.
- There is a risk that changes to the current mechanism would not be enough to incentivise LDES and would thus constitute time wasted.
- Has a low likelihood of incentivising investment in LDES Grid reinforcements to allow symmetrical MIC and MEC to enable full utilisation of energy arbitrage.

While this approach looks to make targeted changes to already existing approaches, we propose the small number of changes is unlikely to be sufficient in ensuring a competitive procurement process for LDES. Added to this is the risk of creating perverse incentives in the CRM and thus arriving at a suboptimal outcome.

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

3. <u>Storage Support Scheme Auction</u>

This option would involve the setting up of a stand-alone support scheme for Storage units. This approach looks to mimic the RESS and ORESS schemes that are in place for onshore and offshore renewables respectively in Ireland. It would entail the running of an annual Storage auction with an agreed post-auction delivery window.

Both the RESS & ORESS schemes were successful in attracting investment into their specific sectors and the idea is that a similar approach for storage could lead to a similar result.

Some considerations relating to this option are:

- Successful units would operate in a similar manner to other market participants in the ex-ante energy markets. They would trade out a position and nominate to fulfil that position along with full participation in the balancing market.
- They could also participate in the System Services market.
- There is no guarantee that the procured storage would behave in the way that is optimal for managing grid issues and government targets.

- Issues such as Firm Access and the units MIC would remain.

We propose a properly structured stand-alone storage auction would have a high likelihood of incentivising a competitive procurement process. However, allowing storage units to operate freely in the ex-ante auctions would remove the requirement for them to provide the use case for which they are being procured.

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

4. Fixed Term System Services Contract with Central Control

This option entails the creation and procurement of a new system service, Flexibility. This new system service will be procured via 'Long Term' system service contracts, whereby a contract is offered for the lesser of (a) the lifetime of the storage asset, or (b) a period of 15 years.

The first step that we took when assessing this option was examining whether what we were proposing would fall within the definition of a 'System Service'.

A System Service can be defined as tools that would form an important part of securely integrating high levels of renewable generation into the power systems of Ireland and Northern Ireland. Storage will help to facilitate these additional renewables as it can bulk time shift times of renewable energy surplus to times when the system is short of renewables.

A follow-on question here is whether Storage should fall under the heading of units that contribute towards capacity adequacy. We are of the opinion that the Storage procured under this system service arrangement would not create any additional megawatts that have not already been procured as part of the CRM, with storage instead offering a service(s) that help the TSO to better optimise these already procured MWs. However, this capacity can be considered in the capacity adequacy stack and it can be netted from volume requirement, similar to the net demand approach that is carried out for wind and solar.

Some considerations relating to this option are:

- We propose that this option helps to alleviate a number of the complex issues that arise when connecting & contracting storage assets. Current market & operational issues such as Firm Access and the Maximum Import Capacity (MIC) fall away as the former is essentially a markets issue and the latter will be managed in real-time by the TSO.
- With this option, it is envisaged that units that have been awarded a system services contract will be precluded from participating in other markets, such as that for other

System Service products, Capacity Market and the Ex-ante Energy Markets. Consideration will need to be given as to how we will effect this change. For example, consideration will need to be given to how energy consumed and produced is remunerated.

- Successful parties would receive payments based on their availability and will be obliged to make themselves available for the entirety of their contract. There will be a performance incentive imposed upon units that are not available to provide the services that they have been contracted to provide.
- Upon the signing of the contract, operational dispatch of the unit(s) will become the responsibility of the Transmission System Operator and the unit(s) will be dispatched in a manner that is deemed to be in the best interests of the system as a whole.
- The terms and conditions of the awarded Flexibility contracts will differ from the current System Services Regulated Arrangements contracts and will require a further period of development and consultation.

We propose that the use of Longer-Term System Services contracts has the dual benefit of providing the investment incentive for the developers' business case, while also guaranteeing that the units are available when needed to provide the use case of the TSOs.

Question 26: Do you believe that the 'Fixed Term System Services Contract with 'Central Control' option is a viable option? Please explain your rationale.
Question 27: Are there realistic alternative procurement mechanisms?

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

6.6. Multi-Criteria Assessment

In order to examine the different approaches for the incentivisation of LDES, we have undertaken a high level Multi-Criteria Assessment of the four options, shown in Figure 11 below.

We have scored each of the above criteria on a scale of 1 – 5, with 5 being the most positive and 1 the least.

For the purposes of this exercise, we have divided the criteria into two sections:

- Strategic Fit, and
- Deliverability

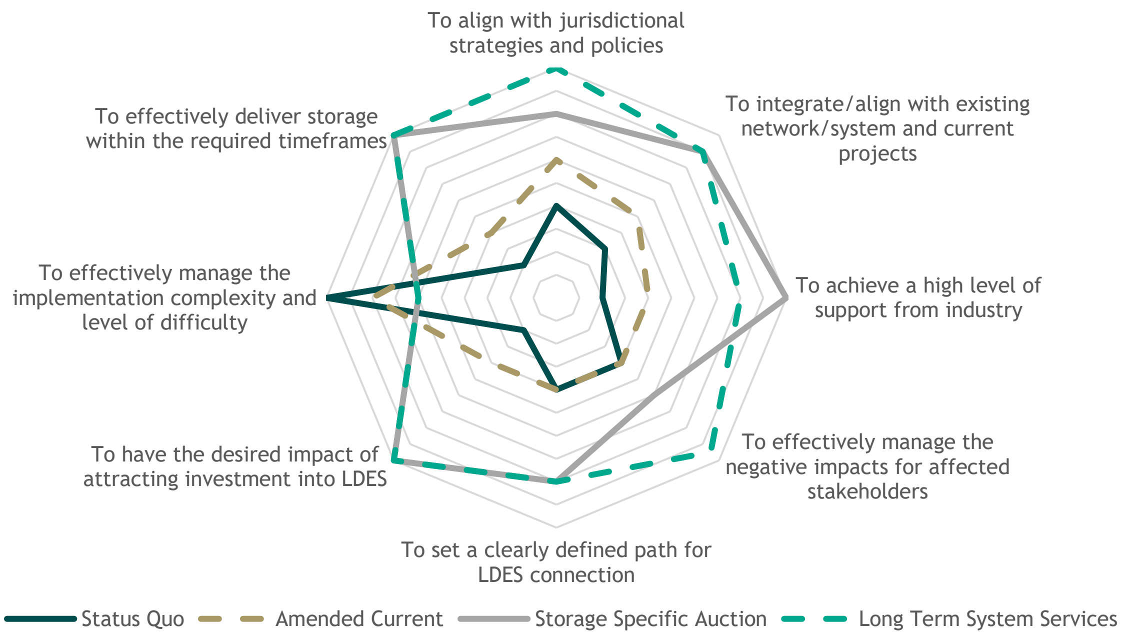


Figure 11: A weighted representation of the four options examined under Strategic Fit & Deliverability

Strategic Fit examines how the options will align with governmental policies and the expectations of both industry and the public. It is assessed by asking will the option:

- Align with jurisdictional strategies and policies
- Integrate/align with existing network/system and current projects
- Achieve a high level of support from industry
- Effectively manage the negative impacts for affected stakeholders

Deliverability examines the ability of the option to provide a coherent and implementable solution for the incentivisation of LDES within the required timelines by asking does the option:

- Set a clearly defined path for LDES connection
- Have the desired impact of attracting investment into LDES
- Effectively manage the implementation complexity and level of difficulty
- Effectively deliver storage within the required timeframes

As we can see from the above, the two 'change' options of a Storage Specific Auction or a Fixed Term System Services contract appear as being the best options, with the latter being the highest scoring option.

Following on from this we then scored these two 'change' options under an additional 12 criteria.

Strategic Fit:

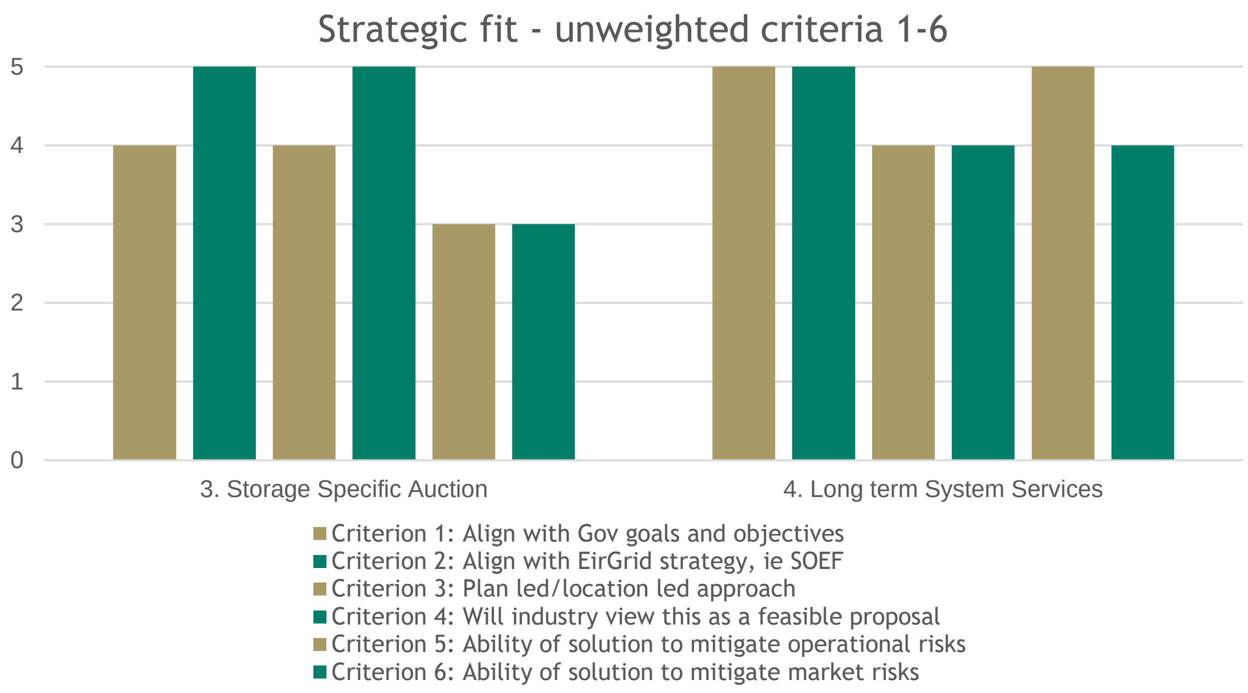
1. Align with Government goals & objectives in Ireland and Northern Ireland

2. Align with EirGrid and SONI roadmap outlined in Shaping our Electricity Future
3. Plan led/location led approach
4. Will industry view this as a feasible proposal
5. Ability of solution to mitigate operational risks
6. Ability of solution to mitigate market risks

Deliverability:

7. Provides coherent process for connection
8. Leads to competitive procurement process
9. Investment certainty is given to industry
10. Level of experience delivering the works
11. Option depends on new/untried technologies
12. Ability to deliver meaningful impact by 2030

The Long Term System Service contract was the preferred option based on the above criteria, mainly due to its ability to better mitigate both operational and market risks (criteria 5 & 6). We have included a graphical representation of these results below.



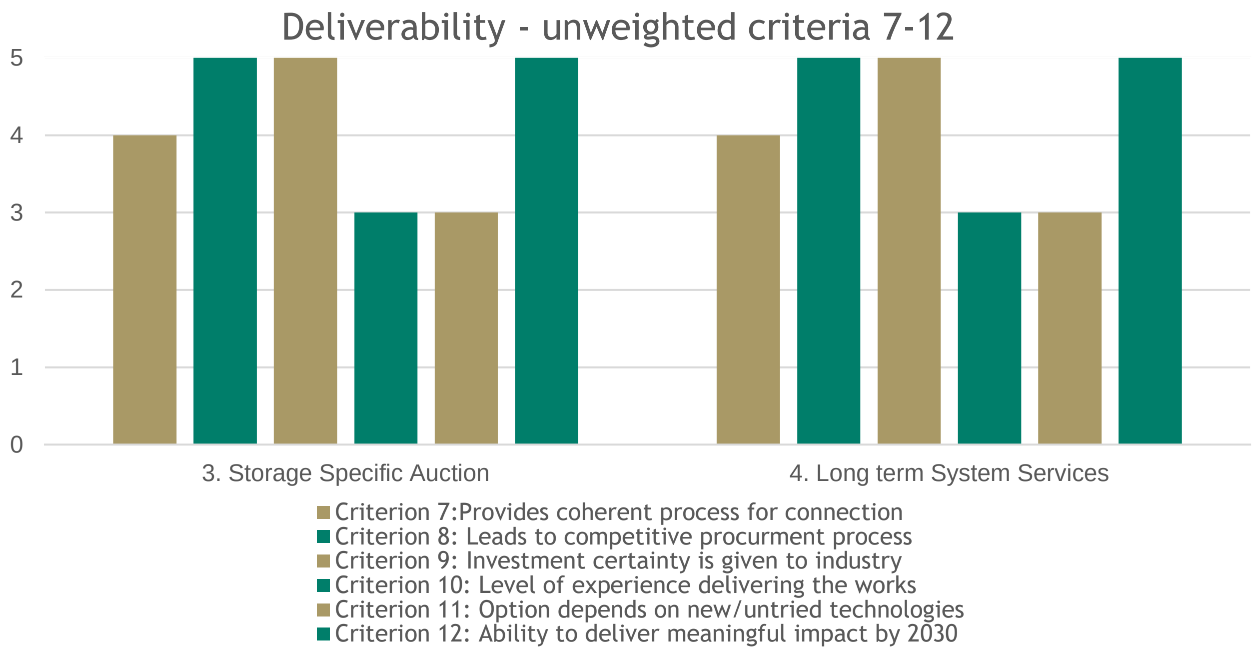


Figure 12: Strategic Fit and Deliverability unweighted criteria results

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

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

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

7. Next Steps

7.1. Summary of Questions

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?

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

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

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?

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

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

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?

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

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

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

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?

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?

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

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

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

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

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

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?

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

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

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

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

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

Question 26: Do you believe that the 'Fixed Term System Services Contract with 'Central Control' option is a viable option? Please explain your rationale.
Question 27: Are there realistic alternative procurement mechanisms?

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

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

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

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

7.2. Responses

EirGrid and SONI welcome feedback on the questions posed within this paper.

Responses should be submitted through either our EirGrid or SONI consultation portals before **before 16:00 on 24th November 2023.**

It would be helpful if answers to the questions include justification, supporting evidence and explanation where submitted. If there are pertinent issues that are not addressed in the questionnaire, these can be addressed at the end of the response.

It would be helpful if responses are not confidential. If you require your response to remain confidential, you should clearly state this on the coversheet of the response. We intend to publish all non-confidential responses.

All Parties confirm and acknowledge that although they may inform (in a notice or statement) EirGrid in writing that specific data submitted under this Call for Evidence Paper may be classified as Confidential Information or commercially sensitive, such information may be subject to disclosure in accordance with the provisions of the Freedom of Information Acts as applicable. All Parties acknowledge that any statement or notification from a Party to EirGrid does not bind EirGrid or guarantee that any such described information in such a notice or statement will not be subject to disclosure under the Freedom of Information Acts.

7.3. Industry Forum

An industry forum will be held on **10th November from 10:00 to 13:00.**

The purpose of this session is to bring you through the key areas of this call for evidence paper and to allow time for questions and clarifications.

If you would like to attend this information session, click here.