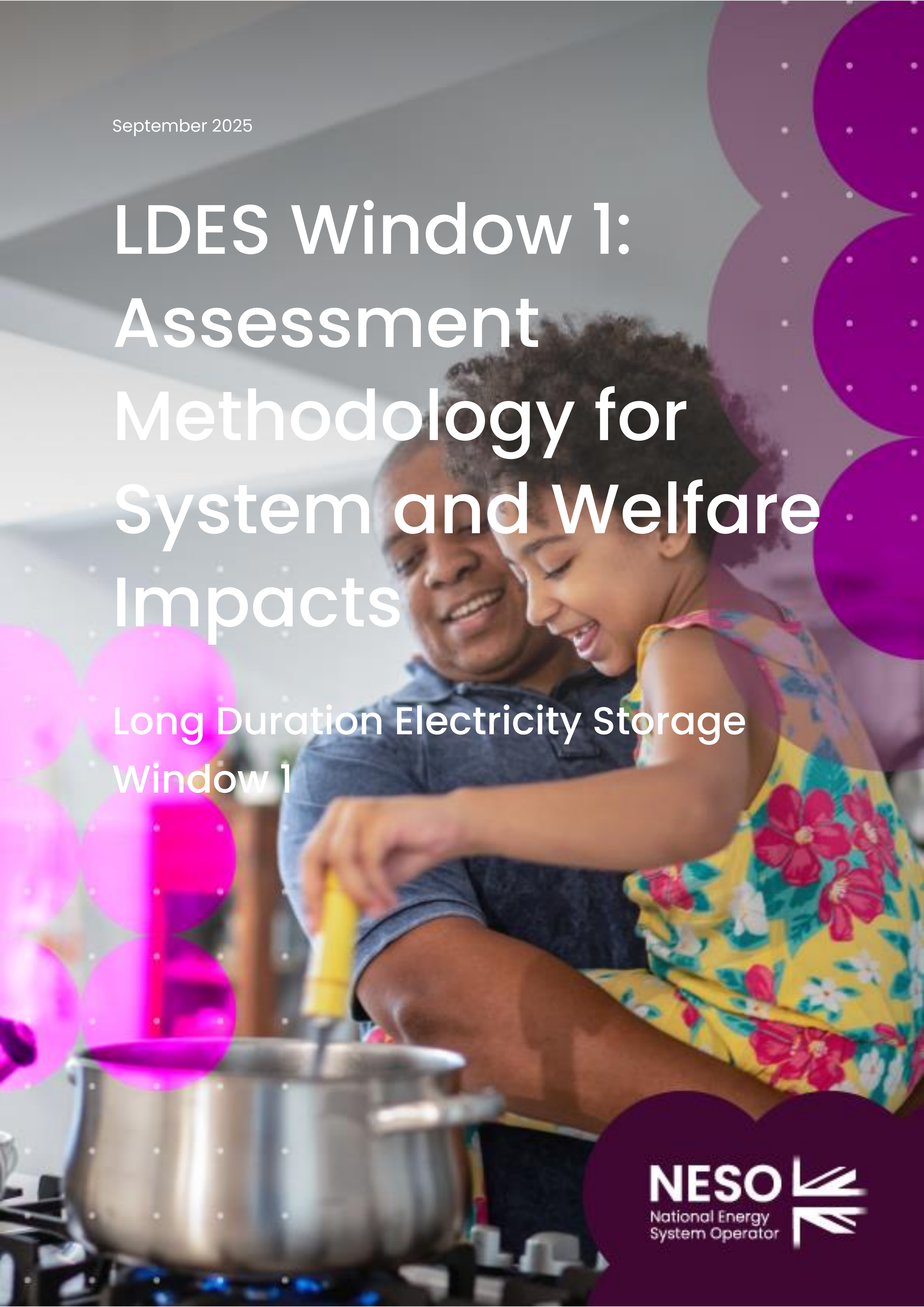

September 2025

LDES Window 1: Assessment Methodology for System and Welfare Impacts

Long Duration Electricity Storage Window 1

NESO
National Energy System Operator

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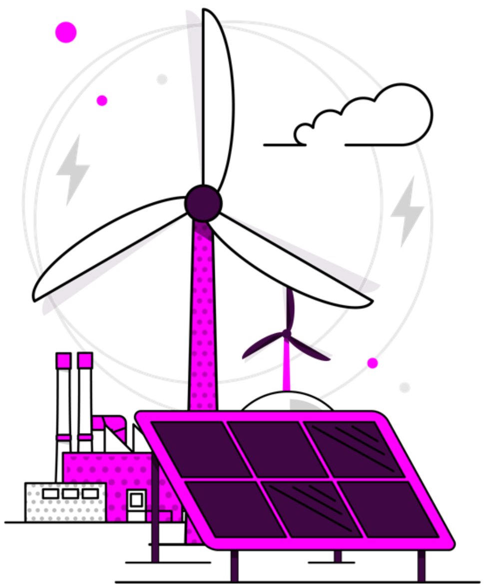

1. Executive Summary

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This document presents the finalised methodology for assessing Long Duration Electricity Storage (LDES) projects under Ofgem's Cap and Floor (C&F) scheme, developed by the National Energy System Operator (NESO). This methodology will serve as the definitive framework for evaluating the system and welfare impacts of Window 1 LDES projects. It reflects both stakeholder feedback and ongoing discussion with Ofgem and will not undergo further revisions.

The C&F scheme is designed to enable investment in LDES technologies, which are critical to achieving a secure, flexible, and decarbonised electricity system. The scheme supports the deployment of storage assets capable of discharging for eight hours or more. This capability is considered essential for balancing intermittent renewable generation and enhancing system resilience.

NESO's Cost-Benefit Analysis (CBA) will quantify the net benefits of each project across a comprehensive set of economic and system metrics. These include:

- Consumer welfare impacts, such as changes in wholesale electricity prices, constraint management costs, and renewable support scheme costs.
- Producer welfare impacts, including generator and storage operator revenues and interconnector congestion rents.
- System benefits, such as improvements to security of supply (measured via Expected Energy Unserved and Value of Lost Load), and avoided renewable curtailment.
- Environmental benefit, specifically the monetised reduction in carbon emissions.
- Qualitative assessments, covering system operability and ancillary service potential.

NESO will also provide support for estimation of ancillary service revenue, which forms an input to the Financial Assessment of LDES C&F. This support will reuse modelled data from the CBA to achieve consistency with the Economic Assessment components outlined above.

A central feature of the methodology is the use of project-specific counterfactuals to evaluate each project's incremental value. For each assessment, the background is created from a Future Energy Scenarios (FES) pathway. A project-specific counterfactual is then created by scaling down non-Final Investment Decision (non-FID) LDES capacity by an amount equal to half the capacity of the project under assessment. The factual scenario is formed by adding the real project into this adjusted background. This approach preserves the realism of the FES pathway and reduces potential bias towards larger projects while allowing the full technical characteristics of each project to be captured.

The methodology also incorporates sensitivity testing, including alternative FES pathways, and extreme weather years, to ensure robustness under varying system conditions.

This final methodology provides a transparent, consistent, and scalable framework for assessing the value of LDES projects. It will underpin Ofgem's decision-making process and support the ranking of projects based on their net contribution to the energy system and society.

1.1 Introduction

This document presents the finalised methodology for the cost-benefit analysis (CBA) component of the Long Duration Electricity Storage (LDES) Cap and Floor (C&F) scheme, as developed by the National Energy System Operator (NESO). Ofgem has tasked NESO with creating a detailed scope of work to quantify the benefits of LDES projects seeking a C&F regime under this scheme. This methodology contributes to the complete MCA framework published by Ofgem alongside this document. The LDES Cap and Floor scheme, introduced by Ofgem under the direction of DESNZ, ensures investors receive a minimum amount of revenue to enable investment in LDES assets. Alongside this, the cap on revenue provides returns to consumers for their support, where LDES assets operate above the cap level. These LDES assets are crucial for achieving the UK's 2030 decarbonisation targets, as indicated in NESO's previous analyses under the Government's Clean Power 2030 (CP30) initiative. The scheme is designed to provide revenue certainty and stimulate investment, particularly for projects facing deployment barriers.

Ofgem's broader project assessment framework for the initial LDES application window employs a multi-criteria assessment (MCA) to evaluate eligible projects. This encompasses both quantitative and qualitative impacts, including socio-economic welfare, system benefits, and strategic value. NESO's CBA is a critical component of this evaluation, alongside additional assessments conducted by Ofgem.

1.2 Scope of document

This document outlines the proposed NESO methodology for conducting the CBA portion of the LDES Cap and Floor Project Assessment. This takes the following structure:

- **Section 2:** Summary of changes since the previous iteration of this document, based on stakeholder feedback, ongoing discussion with Ofgem and internal revision.
- **Section 3**: Description of the core modelling capability used to model the impacts and benefits of the eligible projects.

- **Section 4**: Welfare and cost components considered for analysis, including descriptions of rationale for including or excluding components from the described scope.
- **Section 5**: Detailed modelling methodology including creation of project counterfactuals.
- **Section 6**: Sensitivities to the core analysis which are included within the scope.
- **Annex 1**: Rationale for excluding alternative counterfactual approaches
- **Annex 2**: Stakeholder questions and clarifications

2. Summary of changes following stakeholder feedback

2. Summary of changes Following Stakeholder Feedback

This finalised methodology reflects extensive stakeholder input received during the consultation process. NESO has carefully considered all feedback and made targeted improvements to ensure the assessment framework is robust, fair, and aligned with system needs. Key changes include:

- **Project-specific counterfactuals with partial capacity removal**
  For each project, a dedicated counterfactual is created by scaling down non-Final Investment Decision (non-FID) LDES projects in the background to remove capacity equal to half the project's size, before adding the real project to form the factual scenario. This reduces potential size-biasing, which could have resulted from the previous methodology, which used a single counterfactual to assess each project.

- **Support for estimation of Inertia and Short Circuit Level (SCL) revenue streams**
  In response to requests for better recognition of ancillary services, the methodology now provides data required by the Financial Assessment to estimate potential inertia and SCL revenue streams for each applicant project. This support includes provision of reference rates from NGESO's Stability Pathfinder programme[1], understanding of locational requirements for ancillary services and provision of data on modelled asset availability..

- **Removal of Clustering Requirement**
  Stakeholders expressed concern that clustering could obscure individual project value and introduce bias. NESO has confirmed that no formal grouping or clustering will be applied. All projects will be assessed individually using the Marginal Addition method, ensuring transparency and comparability.

- **Zonal Pricing Scenario Removed**
  Following the UK Government's decision to retain national pricing, the previously proposed zonal pricing sensitivity has been removed. This ensures alignment with current market design.

- **Expanded Scenario Coverage**
  To address concerns about over-reliance on optimistic system assumptions, NESO will now model three Future Energy Scenarios 2025 (FES25) pathways:

  - **Holistic Transition** (will be used as central case)
  - **Electric Engagement** (high electrification and stress conditions)
  - **Falling Behind** (slower decarbonisation and continued gas reliance)

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[1] https://www.neso.energy/industry-information/balancing-services/network-services/stability-network-services

- **Improved Revenue Modelling for LDES Owners**
  Day-Ahead (DA) market revenue will be calculated using the arbitrage positions achieved through the wholesale market. **Balancing Mechanism (BM)** revenue will be calculated by using positions within the BM model, taken at bid and offer prices which are calculated within the BM model. These two revenue sources will be considered additive, for use in project financial assessments. This change reflects stakeholder feedback that BM-oriented strategies and behaviours were previously undervalued.
- **Refurbished and Extended Assets Treatment Clarified**
  The methodology now includes clear procedures for assessing refurbished and extended assets.

These changes collectively strengthen the methodology, ensuring it captures the value of LDES technologies while remaining consistent, scalable, and policy aligned.

3. Model background

3. Model Background

The Long Duration Electricity Storage (LDES) Cap and Floor Cost Benefit Analysis (CBA) will be based on the latest available Future Energy Scenarios (FES) 2025 pathways, published in July 2025 [2]. These scenarios provide the most up-to-date projections for generation, demand, gas and hydrogen use, European market interactions, and flexible demand assumptions. FES2025 also includes assumed background levels of battery storage, pumped hydro, compressed air storage, liquid air storage, and hydrogen storage.

3.1 Scenario Framework

The base assessment will use the **Holistic Transition** pathway as the central scenario.

Security of Supply analysis will be undertaken separately using a single designated reference scenario. This scenario is based on FES pathway information, modified to provide meaningful analysis of security of supply implications.

3.2 Assessment Tracks and Time Horizons

Projects will be assigned to one of two tracks based on their earliest available delivery date:

- **Track 1**: Assessed over 2030–2055
- **Track 2**: Assessed over 2033–2058

The durations indicated are aligned to the C&F regime timescales. The MCA Framework provides alternative formulations which could be considered in the case of longer-lived assets.

All projects within a track will be assessed over the same time horizon, regardless of individual availability dates. Please refer to Ofgem's MCA Framework for an explanation of how actual delivery date will be considered as a non-monetised impact.

As the Plexos energy market model currently simulates only up to 2044, results from the final three modelled years will be averaged and extrapolated to cover the remaining years. This approach is consistent with previous Network Options Assessment (NOA) practices and ensures a proportionate and pragmatic solution.

3.3 Treatment of Background LDES

For this assessment, Long Duration Electricity Storage (LDES) refers to assets capable of discharging at full rated power for eight hours or more. These assets are essential for balancing supply and demand in a high-renewables system and are fully reflected in the background Future Energy Scenarios (FES) pathway. FES pathways contain various LDES projects, including those without Final Investment Decision (FID). These projects are

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[2] https://www.neso.energy/publications/future-energy-scenarios-fes

included based on market analysis but may not have currently achieved full funding certainty.

When evaluating an individual project, the counterfactual is created by scaling down non-FID LDES capacity in the background—limited to projects scheduled up to and including 2035—to remove capacity equal to half the size of the project being assessed. By removing only half the project's capacity from the background, the method reduces potential bias towards larger projects while still enabling a meaningful comparison. This approach maintains the realism of the FES scenario and focuses the analysis on the true marginal contribution of each project within its system context.

3.4 Market Design Assumptions

Following the government's decision to maintain a national electricity pricing framework, the base case for this assessment will continue to use national pricing, consistent with current GB market arrangements.

3.5 Balancing Mechanism Modelling

Plexos will be utilised to perform two consecutive models on each sensitivity. Firstly, a wholesale market model will be applied, which uses an unconstrained network. This provides a view of each generator's position within the day-ahead market. Following this, a balancing mechanism (BM) model is performed. This takes inputs from the wholesale market model, applies constrained boundary conditions, and then looks to reoptimise generation based on minimisation of redispatch action costs.

To accurately reflect system constraints in the BM, boundary capability limits are required. As updated boundary data will not be available in time for this assessment, we will map inputs from the Beyond 2030[3] pathway onto the FES2025 scenario. This approach ensures continuity with previous modelling and allows the assessment to remain on schedule without compromising analytical quality.

3.6 Selection of Future Energy Scenarios for CBA Modelling

To ensure the CBA is robust across a range of plausible system futures, three FES2025 pathways will be selected. These were chosen to reflect diverse decarbonisation pathways, system configurations, and consumer behaviours, while also incorporating stakeholder feedback.

Included FES25 pathways

- **Holistic Transition**
  The central scenario for the CBA. It represents a balanced pathway to net zero with high renewable penetration and strong consumer engagement. It serves as the benchmark for assessing LDES value in a highly decarbonised system.

[3] https://www.neso.energy/publications/beyond-2030

- **Electric Engagement**
  Characterised by the highest peak electricity demand, driven by widespread electrification of heat and transport. It includes high levels of interconnection and dispatchable low-carbon generation, making it ideal for testing LDES under high-stress conditions.

- **Falling Behind**
  Reflects a slower decarbonisation trajectory, with continued use of unabated gas and delayed deployment of low-carbon technologies. While it does not meet net zero by 2050, it is included in response to stakeholder feedback and provides a useful stress test for LDES project valuation in a more conservative system outlook.

Excluded Scenario

- **Hydrogen Evolution**
  Assumes rapid development of a national hydrogen network and widespread hydrogen use in industry, transport, and heating. However, stakeholder feedback indicated limited interest in hydrogen-centric pathways. Given the additional modelling complexity and lower relevance to near-term investment decisions, this scenario has been excluded from the core CBA.

4. Cost and Benefit Components

4. Cost and Benefit Components

This section sets out the components that NESO will assess as part of the Cost Benefit Analysis (CBA) for Long Duration Electricity Storage (LDES) projects. These components will inform Ofgem's Multi-Criteria Analysis (MCA) framework or will be used to estimate project revenues and subsequent expected cap and floor payments within the Financial Assessment.

4.1 Assessment Input Components

All components will be presented as changes relative to the baseline (calculated using the corresponding counterfactual), with positive values indicating benefits and negative values indicating costs.

It is important to note that the generic marginal value of Long Duration Electricity Storage (LDES) reflects a combination of the Future Energy Scenarios (FES) pathways and the specific characteristics of the project being assessed. These values may be positive or negative depending on the scenario context and project configuration. Accordingly, they are primarily used to support the economic assessment by enabling consistent project rankings, rather than to represent the absolute value of system changes attributable to each individual project.

Consumer Welfare: Wholesale market costs

Wholesale market prices and volumes have a crucial impact on consumer welfare. These prices are determined by the interaction of electricity supply and demand. Changes in wholesale market volume-weighted prices directly affect the costs of electricity for consumers. For the LDES cap and floor assessment, we will evaluate how the integration of Long Duration Electricity Storage (LDES) impacts the volume-weighted prices experienced by consumers. This involves analysing overall volume-weighted price changes for GB consumer electricity costs. As an example, reductions in wholesale market prices due to LDES integration at a fixed generation volume could lead to significant cost savings for consumers.

Consumer Welfare: Contract for Difference (CfD) support scheme costs

Contract for Difference (CfD) costs are treated separately to other welfare components within the economic assessment, as described in the MCA Framework document. This is information is provided to achieve a more granular understanding of the effects of system changes on consumers.

The CfD scheme supports renewable and low carbon energy generators by guaranteeing a stable level of revenue through a pre-agreed strike price. If the wholesale market price is below the strike price, consumers top up the generator's revenues to the strike price level. Conversely, if the wholesale market price exceeds the strike price, generators pay back the excess revenues to consumers. The integration of LDES could impact the wholesale market prices and, consequently, the CfD scheme costs.

Consumer Welfare: Constraint management costs

The Balancing Mechanism (BM) costs of resolving network constraints will be calculated. Costs associated with the BM are ultimately borne by consumers. The integration of LDES could influence these costs by providing additional flexibility potentially reducing the need for more expensive balancing actions. The output of this is a monetised value (£).

Producer Welfare: Wholesale market costs

For producers of power in the GB market, revenue is primarily driven by the wholesale market. The integration of Long Duration Electricity Storage (LDES) can influence these prices, impacting the gross margin for energy production. The gross margin is calculated as the revenues from electricity production less the costs of fuel and carbon emissions. If the addition of LDES leads to higher wholesale market prices, producers stand to benefit from increased revenues. Conversely, if LDES results in lower market prices, producers may experience a reduction in their revenues. Therefore, it is crucial to assess how LDES affects wholesale market prices and the subsequent impact on producer revenues, across all types of existing generators and storage (including existing PSH and BESS operators) within the GB market.

Impacts on existing BESS/storage welfare will be calculated using the same methods required for LDES owner welfare, and included within the producer welfare component (see subsequent section for details).

Producer Welfare = Generator Welfare + Storage Welfare

Producer Welfare: Interconnector Congestion Rent

This component captures the impact of LDES on interconnector congestion rents, which represent the economic value derived from electricity price differences between connected international markets. Congestion rents are calculated as the product of interconnector flows and the price differential between the two market zones.

For the purposes of estimating GB welfare impacts, it is assumed that 50% of total congestion rents accrue to GB, which is consistent with previous approaches used in system modelling.

LDES owner Welfare: Wholesale market arbitrage and Balancing Mechanism revenues

Arbitrage revenue will be calculated by post-processing PLEXOS modelling outputs to quantify the cost of charging and the benefit of discharging—typically across periods of significant price differentials. This revenue stream is a core component of LDES profitability, as it captures the value of shifting energy from low-price to high-price periods. These revenues will be captured from the Day-Ahead (DA) position of each asset.

In addition, the Balancing Mechanism (BM) revenue will be calculated, using the BM positions and bid/offer prices of each assessed project. These revenues will be developed from the dedicated BM model. The actions taken within this model are related to management of thermal constraints, rather than re-optimisation of positions due to forecast errors or energy actions. This revenue stream can be assumed additive to the DA revenue described above.

Project capex and opex costs are captured within the economic assessment ranking process. These are provided by asset owners as part of the application process. The use of these costs is outlined further in the MCA Framework document.

System Impacts: Security of supply (cost of EENS using VoLL)

The contribution to security of supply of a technology depends on the expected demand, the weather, and the expected generation portfolio. As such, it is likely to change with time. In the case of LDES it will depend upon maximum power output, total energy stored and, to a lesser extent, round trip efficiency (RTE). The last factor dictates how fast LDES can recharge between two stress periods which are separated by a relatively short period of time.

The Resource Adequacy in the 2030s update [4], published in July 2025, considers a number of scenarios. We expect that one of these scenarios will be chosen to act as a baseline for this analysis, albeit with all future uncommitted LDES/pumped storage removed.

A well-constructed reference scenario can be designed to be representative of typical or critical conditions, thereby ensuring that the assessment captures the essential dynamics of the energy system. By selecting a reference scenario that reflects a range of factors such as demand pattern and renewable energy generation we can ensure that the cost changes calculated are meaningful and applicable to real-world conditions. Using a single reference scenario to calculate cost changes in security of supply metrics is a robust and efficient method for assessing different LDES options. This approach ensures that the analysis is resource-efficient, clear, and focused on the most critical metrics.

The assessment will employ a Marginal Addition Methodology Approach, which evaluates the security of supply with and without individual LDES projects against a background scenario that includes potential LDES projects, providing insight into the marginal impact of each project within a fully integrated energy system. This background will be related to the reference scenario used for security of supply assessments, which may differ to the counterfactuals used within other parts of the CBA methodology. Projects will be grouped based on characteristics such as storage duration and efficiency but not location as our resource adequacy model excludes transmission. Within the group, the welfare value associated with security of supply will be apportioned to each project based on its total capacity.

There are many potential metrics for security of supply, but the one which most easily lends itself to incorporation into an economic evaluation is Expected Energy Unserved (EEU). This is a statistical average over many weather years and unplanned outage simulations within the model. We will calculate these metrics for operational years 2030,

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[4] https://www.neso.energy/about/our-projects/resource-adequacy

2035 and 2040 using the reference scenario. This benefit will then be interpolated and extrapolated to the remaining years. This can be combined with the Value of Lost Load (VoLL). The cost changes between reference and variant cases will represent the overall security of supply value of each project.

The output of this is a monetised value (£).

System Impacts: Avoided renewable curtailment (not monetised)

Renewable curtailment volumes can be calculated from the model. This metric captures the extent to which LDES can help integrate renewable energy sources by reducing the need to curtail excess generation. The output of this category would be a GWh value of curtailment.

We propose to separately monetise unpriced carbon externality cost, and therefore explicit monetisation of avoided renewable curtailment could result in double counting of benefit. This category of welfare will not be combined directly with the other monetary values in this assessment but provides a useful indication of change in system behaviour as a result of LDES project integration. Ofgem will consider this metric as a non-monetised indicator within the economic assessment.

System Impacts: System Operability Qualitative Assessment

System operability and the provision of ancillary services–such as frequency response, reserve, reactive power, and stability–are important considerations in assessing the overall value of LDES technologies. While NESO will not model operability-related benefits in the Cost Benefit Analysis (CBA), we acknowledge that these services may represent a significant revenue stream for some technologies, particularly those with lower round-trip efficiencies that may place less emphasis on arbitrage.

In this context, ancillary service value cannot be discounted from the overall assessment. However, there are major uncertainties in forecasting future ancillary service revenues. These services are procured via competitive tenders, subject to changing technical requirements and pricing structures, and winning contracts depends on market conditions and asset capabilities at the time of delivery. NESO cannot assess or rely on project-specific cost or bid assumptions that may be commercially sensitive or speculative.

To reflect the importance of these services, applicant projects will be expected to provide their own view of potential ancillary service revenues as part of their Project Assessment submissions. These revenue estimates will not be used directly within the assessment but will be used to derive a separate set of assumptions and sense check against projected forecasts within the Financial Assessment.

Additionally, a series of qualitative assessments of contributions to system operability services will be considered. These will be reliant upon submitted technical information from each of the assessed projects, and the subsequent scores against these categories will then be used to adjust the project rankings within the Economic Assessment. Scores will be based on the ability of each eligible project to provide value to an identified system service. Further details on the process for this are outlined in the MCA Framework document.

NESO have supported Ofgem by providing input into the design of the Project Data Submission Excel sheet and will contribute to the qualitative assessment of these submissions–particularly in evaluating technical claims and consistency with current system needs.

Wider economic and social impacts: Unpriced Carbon Externality Cost Adjustment

Emissions will be calculated based on PLEXOS modelling. A societal value of carbon emissions adjustment will be calculated using the differential between the carbon appraisal value and the assumed carbon price used within modelling. This approach ensures that the environmental impact of LDES integration is quantified in terms of CO2 reductions, contributing to the overall assessment of societal benefits. The output of this is a monetised value (£).

4.2 Total System Cost Components

The total system cost calculation will comprise the following components:

Generation Costs

These are calculated based on the short run marginal cost of the plant and the generation output from the plant in each period. The short run marginal cost includes fuel costs, efficiency, and variable operating and maintenance costs.

Carbon Costs

These are the extra carbon costs not included in the market price, calculated from the societal value of carbon emissions from the Green Book central value series.

Interconnector Costs

Interconnector costs need to take account of the cost of power imported, as well as the value of exporting power to other regions. These costs are based on flow and region price, with 50% of the total value assumed to account for variable interconnector ownership and whether power is bought or sold into other markets.

Network costs for connecting Long Duration Electricity Storage (LDES) projects to the grid will not be considered because many projects have not yet completed the full connection application process due to ongoing connection reform. The impact on the need for wider reinforcements will not be explicitly assessed, however the impact on Balancing Mechanism costs will be evaluated.

4.3 Other Revenue

NESO will provide support in estimating additional monetised value streams that fall outside the scope of the welfare-based assessment but may represent significant sources of revenue for certain LDES technologies. This includes indicative valuations for services such as Stability Control (SCL) and inertia. These estimates will be incorporated into the Financial Assessment and may also be considered as qualitative criteria within the Economic Assessment ranking process.

NESO will provide the following information to assist with estimation of system service revenue streams:

- **Modelled availability data**: From Plexos modelling, operational data will be extracted, including active operational periods of each asset (i.e. representation of synchronisation or active charging and discharging). This will be used to scale potential revenue streams of each asset, based on projected participation rates within markets.
- **Reference cost data**: These costs will be used to estimate the potential revenue, based on service volume provided. Figures will be derived from mid-range estimates from NGESO’s Pathfinder programmes.
- **Locational data**: Where relevant for system services, NESO can provide a scaling factor, representative of the locational requirements of each service.

NESO will additionally provide assistance with outlining methodologies for monetisation of revenue streams, based on latest understanding of the relevant markets in each case.

Greater detail on these methodologies is provided within the MCA Framework document.

5. Further details on method for undertaking the assessment

5. Further details on method for undertaking the assessment

In this section, we outline the methodology for conducting the Cost-Benefit Analysis (CBA) for Long Duration Electricity Storage (LDES) projects. Our approach employs a Marginal Addition (MA) method to quantify the benefits of individual LDES projects against a credible background. This method enables detailed analysis of individual project benefits, while maintaining a fair and transparent assessment.

5.1 Technical Parameters required for modelling in Plexos

LDES applicant projects are required to submit detailed technical parameters to enable accurate setup and modelling in Plexos. These parameters must comprehensively represent the LDES plant and will be fully outlined within the Project Data Submission Excel sheet. There are varying requirements for PSH projects and other technologies, due to the different information required to model each project type.

5.2 Marginal Addition (MA) Method

This section describes the methodology for evaluating the impact of Long-Duration Electricity Storage (LDES) projects through the creation of a project-specific factual and counterfactual.

The process begins with a base system model aligned to a selected Future Energy Scenarios (FES) pathway, containing non-Final Investment Decision (non-FID) LDES projects that will be scaled down to remove capacity from the background. For scaling purposes, only non-FID projects scheduled up to and including 2035 are considered.

5.2.1 Formation of Counterfactual

Counterfactuals are created by scaling the non-Final Investment Decision (non-FID) LDES projects in each pathway, to create an initial reduction of LDES capacity. A separate counterfactual is created for each applicant through the following process:

1. **Identify non-FID LDES to be scaled.**
2. **Remove Partial Project Capacity (0.5 × C(x)):**
   Define the capacity of the project being assessed as *C(x)*. Create the counterfactual by scaling down the non-FID LDES until a total of **0.5 × C(x)** is removed:

   $$\text{Counterfactual} = B - 0.5 \times C(x)$$

   where B is the non-FID LDES capacity of the unadjusted base scenario.
   This partial removal reduces the risk of biasing results in favour of larger projects while still creating a meaningful capacity gap for the project to fill in the factual case.

   The scaling described above is applied initially to non-FID LDES projects in the same zone as the assessed project. If the requirement for capacity reduction exceeds the non-FID LDES capacity in this zone, this is followed by uniform scaling across all other non-FID LDES projects in the FES background. If there are no non-FID LDES projects in the same zone as the assessed project, scaling is applied uniformly. This scaling approach is applied irrespective of the notional LDES technology type or commissioning timeline, ensuring a consistent and technology-neutral adjustment across the background.

3. **Preserve All Other System Assumptions:**
   All other generation capacity, demand, interconnection, and network assumptions remain unchanged to ensure the counterfactual is credible and consistent with the selected FES pathway.

5.2.2 Formation of Factual

The factual scenario is constructed by adding the real project into its project-specific counterfactual:

$$\text{Factual} = B - 0.5 \times C(x) + P(x)$$

where P(x) is the actual project with all its technical characteristics modelled in full, including location, duration, efficiency, operating profile, and other relevant parameters.

5.2.3 Key Features

Individualised for Each Project: Each applicant's assessment is based on its own counterfactual, reflecting the partial removal of background LDES equivalent to half the project's size.

Full Technical Representation: The factual scenario incorporates the project's actual technical and locational attributes, enabling an accurate evaluation of system impacts.

Bias Mitigation: Removing only half the project's capacity from the counterfactual reduces the tendency for larger projects to be overstated in value due to larger "capacity holes."

5.2.4 Assessment

The project's contribution is determined by comparing two scenarios:

- **Counterfactual:** FES scenario with scaled-down non-FID LDES projects to remove capacity equal to **0.5 × C(x)**, without the real project present.
- **Factual:** The same scenario with the real project included.

All welfare components and system impacts in Section 4 are calculated for each run, including base case and sensitivities. The marginal benefit of the project is defined as the difference in welfare between the factual and counterfactual results. Discounting of benefits is applied at the social discount rate, aligned with Green Book standards.

5.3 Modelling refurbishment and extension

This section outlines the procedures for managing refurbished assets and extensions.

5.3.1 Refurbished Assets

Where an assessed asset is being refurbished and the counterfactual scenario would have included the refurbished asset, the original asset will be removed from the background. This ensures that any improvements in capacity, efficiency, or other technical parameters are accurately captured in the assessment. To enable this, applicants must clearly identify the asset being replaced in their submission—including the asset name, company, and existing capacity—so it can be reliably identified and removed from the counterfactual.

5.3.2 Extended Assets

For asset extensions, only the incremental (extended) portion will be modelled in the factual scenario. The counterfactual will remain unchanged. Applicants should ensure that all technical parameters provided in the application—such as capacity, duration, and efficiency—relate solely to the extension, rather than the characteristics of the full post-extension asset.

This approach ensures that the Marginal Addition methodology reflects only the net new contribution of the project, maintaining consistency and fairness across all assessments.

5.4 Additional Considerations

In line with Ofgem's Technical Decision Document, several additional considerations are relevant to how LDES projects will be assessed. Ofgem has proposed a twin track approach to manage projects with different delivery timelines: Track 1 for those deliverable by 2030, and Track 2 for those deliverable by 2033. Projects are also categorised into two streams based on technology maturity, with Stream 1 covering fully commercial technologies (TRL 9) and Stream 2 covering emerging or near-commercial technologies (TRL 8). The following considerations expand on how these policy structures are reflected in the assessment methodology.

Assessment Tracks: The Plexos modelling approach is neutral to the twin-track approach, as outlined in Ofgem's TDD. However, the benefit calculation horizon depends on the track (2030 or 2033), as defined in the introduction section.

Technology Readiness Levels (TRL): All projects will be evaluated uniformly, regardless of whether they are at TRL9 (stream 1) or TRL8 (stream 2). The assessment will be determined primarily by the configuration of each LDES plant in Plexos, which will be tailored based on the specific parameters provided for each project. This includes techno-economic parameters and locational information.

Clustering: NESO will not apply a formal clustering approach in the assessment of LDES projects. While clustering could reduce model runtime, it poses challenges for consistency and transparency. All projects will be assessed individually using the Marginal Addition methodology. The minimum eligibility thresholds–100 MW for Stream 1 and 50 MW for Stream 2—are considered sufficient to limit the impact of modelling noise. This ensures that all projects are evaluated fairly, and any material system benefits are captured without the need for artificial grouping.

Co-located Assets: To ensure consistency across assessments, no additional generation or demand assets will be added to represent co-located configurations. Including such assets would compromise the neutrality of the counterfactual and introduce applicant-specific assumptions, undermining comparability. Constraints linking LDES to co-located assets will not be explicitly modelled, as doing so would require detailed, project-specific assumptions that are not consistently available. This ensures a fair, transparent, and scalable assessment framework.

6. Sensitivities

6. Sensitivities

Sensitivities can be used to provide evidence of project benefit under varying conditions. This creates a more robust understanding of the benefit that can be achieved from the LDES projects submitted than using only the base set of conditions for assessment.

The base case will use the Holistic Transition (HT) scenario from the latest iteration of the Future Energy Scenarios (FES25), which presents a balanced view of the UK's energy future aligned with current policies and trends. It serves as a reference scenario, capturing a plausible trajectory for energy supply and demand while accounting for decarbonisation goals, technological progress, and economic growth. This pathway provides a realistic framework to support informed decision-making and strategic planning.

Sensitivity: Two additional Future Energy Scenario (FES) Pathways

Future Energy Scenarios (FES) explore a range of plausible energy system pathways shaped by policy decisions, technological progress, and consumer behaviour. These scenarios provide a valuable basis for assessing how different system futures may influence the value of LDES, particularly under varying levels of decarbonisation ambition and the availability of alternative flexibility solutions.

To capture a broader range of potential outcomes, two additional FES pathways—Electric Engagement and Falling Behind—will be modelled alongside the central case. This will allow the assessment to test the robustness of project benefits under contrasting system conditions.

Sensitivity: Weather Years

NESO's standard dispatch modelling is based on the 2013 weather year, selected for its representative mix of conditions, offering a reasonable stress test across technologies. However, capturing system behaviour under more extreme weather patterns may provide valuable insights into the resilience and performance of LDES under varying renewable output profiles.

We propose modelling two additional weather years —1985 and 2010—on the HT scenario to evaluate LDES benefits under different meteorological extremes:

1985: A Dunkelflaute year, with prolonged periods of low wind and solar generation.

2010: Characterised by a stormy winter and multiple high-wind events.

2013: Serves as the baseline, with a mix of cold spells and milder conditions.

This sensitivity will be assessed relative to the base case.

Additional sensitivities will only be pursued if they are identified as high priority during the assessment process and if sufficient time and resources remain after completing the primary evaluations. This ensures the analysis remains focused, efficient, and aligned with available capacity, while allowing flexibility to address critical emerging issues.

Annex 1: Rationale for Excluding Alternative Counterfactual Approaches

Annex 1: Rationale for Excluding Alternative Counterfactual Approaches

This annex outlines NESO's thoughts on the proposed alternative counterfactual options for use in the LDES Cap and Floor Eligibility Assessment. These were intended to overcome a potential for a perception of size-bias within the original methodology, which used a fixed counterfactual for each assessment.

For C&F Window 1, our plan is to use the approach outlined in section 5 of this document, which creates a project-specific counterfactual for each project by removing non-FID LDES capacity equivalent to half the capacity of the assessed project. The methodology has also accounted for a more realistic geographical distribution of the projects in the assessment background, using FES-specific backgrounds as opposed to the initial uniform distribution proposed in the version of the methodology outlined in the consultation process.

Option 1: Band-based counterfactuals

Description: This method would require splitting projects into groups based on capacity (MW), and defining a fixed counterfactual based for each of those groups whose "notional gap" matches the median/mean size within each band.

Rationale: Even by splitting projects into different "size-bands", there will still be biases between projects in the same band (i.e. comparing the smallest and largest projects within each band). The argument of size bias would therefore remain but would be concentrated on the comparisons within these individual group definitions.

This approach also introduces challenges regarding the appropriate grouping. The extent (i.e. min and max power capacity) of each band would need to be defined, and these decisions may not meet the approval of the stakeholder group.

It may also be challenging to compare benefits of projects which belong to different groupings using this methodology, due to "cliff-edge" effects.

Option 2 – Interpolated MA with Synthetic Counterfactual Adjustment at CBA stage

Description: Project-specific counterfactual system values are synthetically derived, without explicit modelling of a counterfactual for each option. This is achieved by undertaking two PLEXOS runs, using the extreme capacity values to remove the smallest and largest eligible project sizes, and then interpolating all welfare values between these points.

Rationale: This approach requires calculation of "endpoint" counterfactual benefits, which are then used to create a linear interpolation between these extreme cases to match any one project being assessed. However, this relies upon an assumption that benefit varies linearly with the power capacity of storage in the background. This is unlikely to be a realistic assumption, since benefits are often subject to "step-changes", and will also be a function of other variables such as storage duration and location.

It is also possible that this approach will now introduce a bias in favour of larger-scale projects. This is due to the larger amount of capacity being removed from the counterfactual, which creates a greater opportunity for large-scale projects to draw benefit. The approach could also double count capacity of project being assessed, which can't be corrected without further assumptions and corrections.

Option 3 – Bias corrected interpolated MA

Description: This approach builds on option 2 by introducing a correcting factor, aimed at addressing systematic size bias. Instead of using the interpolated values as final, this variant uses modelling evidence to apply adjustment factors to these values. This would use more data point to fit a curve to the interpolated values, rather than using a linear interpolation between the two extreme data points.

Rationale: As a variant of option 2, this shares most of the same drawbacks identified above. It would be simplistic to assume a reliable relationship between storage power present in the model and overall benefit, since this relationship will a) probably contain "step-changes" and non-continuous behaviour and b) depends upon other factors such as location, storage duration and other technical characteristics. The correction applied may over- or under-shoot for projects whose marginal system value deviates from the sample average, since there are multiple factors which we would not be able to consider within this sampling. This therefore falls short of a technology- and location-aware counterfactual.

Option 4 – Dual-Counterfactual Averaging Approach

Description: This approach compares each project against two counterfactuals, with one common counterfactual and one case where the factual case is common across all the projects. For each assessed project, the system costs and welfare components are derived from these two options independently and then averaged. This is intended to create a lower sensitivity to size-related bias, by averaging effects from each end of the spectrum.

Rationale: One of the biggest challenges from this perspective is the extra modelling time required, since this approach would require double the number of total runs to create the "common factual" backgrounds.

There is also a limitation in the "common factual" method that we would not be modelling the actual project characteristics in our common factual scenario. This could therefore misrepresent some welfare benefits which are dependent upon factors such as round-trip efficiency and duration, which will in practice vary between projects.

Option 5 – Standardised Per-Unit Counterfactual Approach

Description: This approach models a fixed capacity (e.g. 100MW) of each project, while still fully representing other technical characteristics (efficiency, duration etc). The intention is to remove size-related bias by only modelling the same marginal portion of the overall system definition in each case. The overall system costs and welfare components are then derived for each project by linearly scaling the modelling outputs by the overall project capacity.

Rationale: This approach would model a fixed unit size for each project and then scale the benefits to match the original project size. This has been considered by NESO as an approach previously, but has the following drawbacks:

- It may not be possible to assume that welfare benefits linearly based on project size, since the behaviour of storage can be highly non-linear. This is particularly true when resolving thermal constraints, which may require a fixed thermal capacity to unlock (thereby introducing "step-changes"). Therefore, the final scaling of the benefits may introduce inaccuracies to the process.
- This approach would also introduce a potential size-bias against the larger projects. If we believe that benefit can be assumed to follow a diminishing returns relationship against total capacity (which, as noted previously, may be a simplistic representation), then larger projects would be disadvantaged by this method, since we would not be modelling their "highest-value" MW of storage, but only their "lowest-value" MW. Scaling this benefit across the whole project capacity could then be considered as introducing a systematic bias.

Option 6 – Capacity Expansion Modelling Approach

Description: This approach would embed all of the applicant projects as options within a full capacity expansion model, which co-optimises generation and storage to meet system requirements at lowest cost. The model would then select which projects from the portfolio to build, based on minimisation of a defined system cost. This would account for diminishing returns, since projects are selected in one process.

Rationale: As shared previously by NESO, there were several disadvantages of this approach which resulted in this being dropped from consideration at an early stage of the methodology development process:

- **Transparency**: Difficult to define welfare and project specific metrics across the board using this approach.
- **Complexity**: Setting up these models would have introduced significant complexity and impacted delivery timelines.
- **Sensitivity to data:** Results would be very sensitive to input data, potentially creating multiple points of contention among stakeholders.

While it may be possible to revisit this for future application windows, NESO feel that significant further testing and calibration would be required before we have full confidence in proceeding with this assessment methodology.

Summary

Storage behaves in non-linear and sometimes unpredictable ways and many of the options proposed rely upon theoretical assumptions about the way storage could behave to create heuristics. However, adopting these heuristics could skew results and open the assessment up to further challenge – by attempting to add complexity to the counterfactual to address one problem, it is possible to create other issues which might require greater levels of assumption. Issues with these approaches include transparency, ease of execution or explanation, linearity and practicality.

The option proposed in this document, using project-specific counterfactuals to reduce size-bias, is considered the most transparent option, with the least unwanted side effects. Feedback relating to geographical distribution of background projects has also been taken on board. We believe that this is the best approach for both delivery and creating a transparent process, which can be clearly understood.

Annex 2: Stakeholder Questions and Clarifications

Annex 2: Stakeholder Questions and Clarifications

This annex presents a comprehensive summary of stakeholder feedback received during the consultation process on the NESO aspects of the methodology. It captures key questions, concerns, and recommendations raised by stakeholders, alongside detailed responses.

The purpose of this annex is to ensure transparency in how stakeholder input has shaped the final methodology. It highlights areas of consensus, addresses points of contention, and clarifies NESO's rationale for methodological decisions. Topics covered include the modelling framework, treatment of ancillary services, counterfactual design, sensitivity analysis, and the integration of system-level benefits.

By documenting this dialogue, this Annex reinforces the robustness and fairness of the assessment framework and aims to provide stakeholders with confidence in the integrity of the evaluation process.

Overall Assessment (MCA)

Stakeholder: Supports the MCA framework in principle but raises concerns that modelling limitations and reliance on unproven flexibility sources may underestimate LDES value and overstate floor support costs, potentially leading to under-procurement of needed capacity.

NESO: We are addressing this concern by considering a range of scenarios in the assessment. The CBA is not reliant on a single optimistic view of alternative flexibility sources. By running multiple scenarios—including different Future Energy Scenarios (FES) and extreme weather years—we mitigate the risk of underestimating LDES benefits or overestimating floor support costs. This comprehensive approach ensures that even if some assumed new technologies under-deliver, the value of LDES is still captured under a range of plausible system conditions.

As an input to the Project Assessment, Ofgem will determine a Window 1 target LDES capacity range (in MW and MWh). This will have been determined using a capacity expansion optimisation approach. The CBA then helps rank projects within that target range based on their benefit. This two-step process ensures that the scheme supports an appropriate level of capacity while selecting the most beneficial projects.

Stakeholder: The consultation's reliance on a Multi-Criteria Assessment (MCA) is questioned due to NESO's lack of current or planned services requiring long-duration storage. This absence suggests low system need and undermines the socio-economic welfare (SEW) justification. Additionally, unresolved REMA reforms—especially zonal pricing—render the Strategic Assessment premature and unreliable.

NESO: The LDES Cap & Floor regime is designed to identify projects that achieve a specified target capacity for Long Duration Energy Storage, determined through a comprehensive modelling approach that incorporates various factors based on the UK's Future Energy Scenarios. Additionally, in July 2025, the Government announced its decision to maintain national pricing rather than transitioning to a zonal pricing regime. Consequently, we believe that the Cap & Floor regime is timely and will provide benefits to UK consumers.

Stakeholder: Supports combining monetary and non-monetary assessments but warns against overreliance on NESO's conservative counterfactual. Requests transparency on how qualitative results will be scored and combined.

NESO: We welcome the support for an in-the-round assessment combining monetised and non-monetised factors. The methodology has been updated to include a greater number of scenarios, featuring different backgrounds of generation and demand which will provide a variety of conditions against which each LDES project is measured. After that, the multi-criteria assessment (MCA) overlay allows us to adjust for strategic and qualitative factors, which ensures that a purely numbers-driven ranking can be refined to reflect real-world importance.

Stakeholder: NESO should quantify currently excluded benefits like re-optimisation and ancillary services. While Ofgem argues these are common across projects, omitting them may lower overall net benefits and reduce the LDES capacity awarded. A flat £/MW benefit for ancillary services could ensure fair recognition without incentivising overstatement by individual projects.

NESO: We acknowledge the importance of capturing re-optimisation and ancillary service benefits. Our final methodology now explicitly includes key ancillary services like inertia and Short Circuit Level (SCL) in the financial evaluation of each project. While the Plexos market model cannot fully simulate simultaneous day-ahead and balancing re-optimisation, we use a two-step process (day-ahead followed by balancing) that captures the majority of balancing-value drivers. This phased approach was chosen because Plexos's built-in interleaving feature would freeze interconnector prices and give unrealistic results for GB's coupled markets. By applying the same robust modelling to all projects, any underestimation of balancing revenues affects all applicants equally, preserving fairness and transparency. Nevertheless, the financial assessment of each project will provide an estimation of rebalancing and optimisation of revenues which can be achieved.

Stakeholder: The current modelling approach using Plexos fails to capture the true revenue potential of LDES assets, particularly those focused on the Balancing Mechanism

(BM). Plexos cannot simulate concurrent WM and BM participation, underestimates BM volumes by omitting energy actions, and lacks functional interleaving. This leads to undervaluation of BM-oriented strategies, misrepresents marginal pricing, and results in lower simulated utilisation and revenues than observed historically. These limitations risk suboptimal policy decisions and understate consumer benefits from BM-active LDES.

NESO: Our modelling approach for market revenues is deliberately structured to capture balancing services as robustly as possible. We run a full day-ahead (wholesale market) optimization followed by a dedicated balancing market simulation, so LDES can take actions in both markets sequentially. This method captures the dominant driver of BM costs (constraint management) which historically accounts for >50% of BM spend and is projected to increase. We avoid Plexos's concurrent interleaving mode because it cannot update interconnector flows mid-step, which would distort cross-border pricing. By using the sequential approach, we maintain realistic price signals and still link the two markets (day-ahead outcomes feed into BM re-dispatch). Every project is evaluated with the same WM+BM setup, so a storage asset focused on BM is not unfairly disadvantaged, with any underestimation of BM-specific value being uniform across all applicants. Nevertheless, the financial assessment of each project will provide an estimation of rebalancing and optimisation of revenues which can be achieved.

Additionally, we separately assess critical ancillary service revenue streams (like inertia and stability) so that these operational values are also included within the assessment decision.

Stakeholder: System benefits like frequency response and restoration services should be monetised where possible. If not, they must be given sufficient weight in the economic or strategic assessments. NESO should also monetise re-optimisation revenues using net imbalance and error forecasting. Failing to do so risks underestimating the value of technologies like PSH.

NESO: We agree these services are important and aim to recognise them appropriately. Where we can robustly monetise contributions—such as inertia and short-circuit level—we now do so explicitly in the financial assessment.
Frequency response and restoration services remain difficult to monetise consistently across technologies and future conditions, so we address them through the qualitative operability assessment in the multi-criteria framework, ensuring they are given due weight in project evaluation.
Re-optimisation revenues from net imbalance management are not separately modelled because doing so reliably would require a fully stochastic real-time simulation, which is not practical or proportionate for this assessment. However, much of this value is already captured indirectly: if a project improves system balance and reduces BM redispatch costs or security-of-supply risks, these savings are monetised and credited to the project. Nevertheless, the financial assessment of each project will provide an estimation of

rebalancing and optimisation of revenues which can be achieved.
This ensures technologies like PSH are properly valued for both their economic and strategic contributions without double-counting or relying on speculative forecasting.

Stakeholder: Excluding re-optimisation and ancillary service revenues risks undervaluing technologies that provide flexibility and system support. Stakeholder acknowledges the complexity of forecasting these revenues but urges Ofgem to attempt inclusion to reflect full economic value.

NESO: We agree that revenue from intra-day re-optimisation and ancillary services is part of an LDES project's value, and we strive to reflect that as much as possible. While our core market model cannot explicitly forecast re-optimisation moves, we do capture the effects in other ways. For example, our linked Balancing Mechanism analysis measures how each project reduces re-dispatch volumes and costs needed to manage constraints. Any reduction in total BM spend is counted as a benefit credited to the project. Additionally, if a project boosts real-time reliability (for instance by providing extra supply in stress hours), this shows up as an improvement in security of supply (lower expected unserved energy), which we will also value in the welfare calculation. Nevertheless, the financial assessment of each project will provide an estimation of rebalancing and optimisation of revenues which can be achieved.

Potential SCL and inertia revenue streams will now be calculated for each project, and other ancillary service contributions are described in the wider MCA framework documentation.

Stakeholder: Ancillary service revenues are difficult to forecast and may overlap with other revenue streams. Stakeholder warns that developers may overstate their performance and recommends more clarity on how NESO will model these services and validate project claims.

NESO: We understand that forecasting ancillary service revenue is difficult and that double counting must be avoided. Our methodology addresses this by explicitly considering some key ancillary contributions in a prudent way. For example, we will assess how projects can support system stability including contributions to inertia and short-circuit level since those can be important for certain storage technologies. These revenue estimations will be based on technical parameters provided by projects, rather than using developer revenue projections.

Stakeholder: Ancillary services and re-optimisation must be better captured. Stakeholder notes limitations in PLEXOS modelling and plans to submit its own nodal model analysis. They argue current modelling underestimates project value.

NESO: We acknowledge that PLEXOS cannot trace every intra-day trading move. Instead, we value re-optimisation indirectly: when a project reduces Balancing-Mechanism (BM) thermal-constraint costs or improves security of supply in stress hours, those savings are considered a benefit in the assessment. This avoids double-counting the same action twice and removes the need for a fully stochastic dispatch model, which would be impractical for assessment of more than 100 applicants. Nevertheless, the financial assessment of each project will provide an estimation of rebalancing and optimisation of revenues which can be achieved.

The ancillary-service treatment has been strengthened, as the methodology now calculates inertia and short-circuit-level (SCL) revenue stream, using Stability Pathfinder benchmarks. These sit alongside our existing BM-constraint and security-of-supply metrics, giving stability-focused projects clear, monetised recognition. Frequency response is not separately priced in the CBA; instead it is acknowledged qualitatively in the operability score within the multi-criteria assessment.

The framework is applied consistently to all applicants—LAES, PSH, batteries, and others—so no technology is advantaged or penalised.

Economic Assessment

Stakeholder: Normalize evaluation metrics (e.g., per MW/MWh) in a way that effectively accounts for technology-specific characteristics, such as degradation and state-of-charge (SoC) for batteries to ensure a level playing field.

NESO: Our evaluation already accounts for technology-specific characteristics without the need to normalize metrics per MW or MWh. Benefits of each project will be assessed by Ofgem using measures such as net present value of benefit cost ratio, which inherently reflects factors like battery degradation, state-of-charge constraints in the project's performance, and relative cost of building each project. A larger project may have higher absolute benefits and higher costs, whereas a smaller project has both benefits and costs scaled down - comparing the full net outcomes ensures a level playing field. By not normalising everything to unit size, we avoid skewing results; instead, each project stands on its own merit based on the submitted parameters. This approach effectively creates fairness, since projects are ranked by their actual contribution to system welfare relative to their costs, which is ultimately what matters for consumers and the system.

Stakeholder: Consider the locational requirements for dispatchable low-carbon technologies and ensure realistic assumptions in the counterfactual on deployment of potential alternatives like Power CCUS and BECCS

NESO: The modelling does consider where new dispatchable low-carbon resources (like power CCUS or BECCS) could be located. We use scenario inputs that include the likely deployment and locations of these alternatives based on FES and network development plans. Therefore, the counterfactual assumes a realistic build-out of alternative technologies in appropriate places. All projects, LDES and potential alternatives, are evaluated within a realistic network context. This means that if an LDES project offers locational benefits that alternatives can't easily provide, our assessment will capture that through contributions within the Balancing Mechanism. In summary, the locational requirements and feasibility of alternatives are built into our assumptions, ensuring LDES projects are compared against a credible backdrop.

Stakeholder: The assumption that LDES projects are revenue neutral in the balancing market undervalues their contribution. Scenario-based stress testing should be used instead.

NESO: We do not assume that LDES projects remain neutral in terms of Balancing Mechanism (BM) revenue. Rather, the CBA explicitly includes balancing market costs for each project. Reduced overall BM actions (resolving constraints) will count as a benefit. By modelling these actions, we capture the contribution of LDES during stress events or volatile periods (when BM prices spike), addressing the concern that a neutrality assumption would undervalue that contribution. Our scenario and sensitivity analysis further ensures that even under extreme conditions, the extra value LDES can provide in the BM is reflected in the results.

Stakeholder: Locational impacts, particularly for PSH projects in constrained zones, must be modelled accurately.

NESO: Locational impacts are modelled, based on validated inputs from both scenarios and grid operators. We use detailed network capability data from the grid operators to represent the best view of transmission constraints and bottlenecks. Thus, a pumped-storage hydro project in a highly constrained zone will show greater system benefits (like reduced curtailment or constraint costs) in our results compared to the same project in an unconstrained area. In essence, the model evaluates where each project is located and how it alleviates local issues. By using the best available network data, we ensure that location-specific advantages are accurately reflected, so technologies like PSH in the right locations get full credit for their impact.

Stakeholder: All relevant revenue streams, especially Balancing Mechanism (BM), must be included

NESO: We have captured a broad range of revenue streams and system benefits in our methodology. The Economic Assessment explicitly includes wholesale market arbitrage, Balancing Mechanism (BM) cost reductions. Ancillary services like inertia and SCL are also captured within the methodology. We also account for security of supply impacts and carbon emissions at the societal cost of carbon. By including these monetised components (and evaluating any remaining operability benefits qualitatively), we ensure that all relevant value streams from LDES are recognized. This comprehensive approach means the assessment is not narrowly focused, as it reflects the multiple ways in which LDES projects provide value to the system.

Stakeholder: Re-optimisation and ancillary services need to be considered appropriately, given their relatively high value as potential revenue streams

NESO: Ancillary services are considered.
• Balancing-mechanism cost reduction: Our DA → BM model run explicitly measures how each project lowers re-dispatch volumes and costs (to satisfy network constraints). Any reduction in total BM spend is monetised as a benefit and attributed to the project.
• Security-of-supply uplift: A project's ability to respond in real time also shows up as improved security of supply (lower expected energy unserved). Available storage from LDES applicant will add to system margins in stress hours, so for example a PSH or battery that steps in at short notice earns welfare credit for preventing supply shortfalls.

"Net imbalance trading" is excluded from our modelling. Forecast errors are highly scenario dependent. Robustly simulating intra-day imbalance opportunities out to 2050 would require a full stochastic dispatch, which isn't computationally tractable for a large number of applicants. There's also a risk of double-counting – treating the same action as both a BM cost saving and a project revenue would inflate total value. Finally, we wanted to maintain consistency across technologies: the current approach rewards any asset that lowers overall BM costs, regardless of technology type. Nevertheless, the financial assessment of each project will provide an estimation of rebalancing and optimisation of revenues which can be achieved.

Stakeholder: The Economic Assessment does not reflect the true value of LDES assets because it fails to simulate the operational realities of the Wholesale Market and Balancing Mechanism. This is especially problematic for assets designed to serve the BM, whose value is tied to real-time flexibility and re-optimisation—factors not captured in the current modelling framework.

NESO: The Economic Assessment is intended to be a fair and consistent estimate of each project's system value, rather than a perfect real-time simulation. We apply the same modelling method to all projects, so if certain real-time optimization opportunities (e.g. rapid re-dispatch in the BM) are not fully represented, this limitation affects all candidates equally and thus preserves a level playing field. Nevertheless, the financial assessment of each project will provide an estimation of rebalancing and optimisation of revenues which can be achieved. Our model does capture the major value streams such as day-ahead arbitrage, balancing cost reductions, carbon savings, and security of supply, which together give a solid approximation of each LDES's impact. Additional services that are hard to monetize can be considered qualitatively in the multi-criteria assessment. In summary, the CBA provides a consistent comparison quantitatively including factors that can be monetised.

Stakeholder: The Economic Assessment does not fully capture second-order effects, particularly the impact of subsidised LDES on short-duration storage. These interactions could distort Capacity Market pricing and undermine the viability of unsubsidised battery assets. The assessment must also address policy uncertainties (e.g. REMA, TNUoS, P462), skip rate assumptions, and provide transparency on modelling methodology to ensure robust, system-wide outcomes.

NESO: Skip rate representation is included in our analysis, and every component of our model is documented transparently. We can report each cost and benefit element for scrutiny, ensuring there are no hidden factors. Moreover, our method and counterfactual approach are applied consistently for all applicants, which means improves robustness of the modelling. We also account for major policy uncertainties by running scenario sensitivities. This consistency and transparency in methodology give us confidence that even second-order effects and market distortions are reasonably captured or at least not unfairly biased against any project. In terms of impact on short-duration storage, this will be captured through our analysis on producer welfare. In cases where LDES projects affects revenues of other producers in the system, this will be reflected in this welfare component, which forms part of the decision-making process.

Stakeholder: Economic Assessment should include residual value and monetise capacity market and ancillary services. Real-time flexibility should be quantified. Ofgem should provide planning assumptions to standardise modelling. Stream 1 and 2 projects should be assessed separately due to non-linear impacts.

NESO: We have considered elements like residual asset value and capacity market revenues, but given the very long timeline and many uncertainties, we did not treat them as fixed monetised inputs. We have determined that modelling the capacity market revenue for each project decades into the future, for example, would be speculative and prone to error, which could skew the results of the assessment. On the positive side, we have strengthened the assessment by modelling key ancillary service revenues such as inertia and SCL support for each project. Stream 1 and Stream 2 projects are effectively assessed on the same basis, which avoids any unintended bias.

Stakeholder: Stakeholder agrees with the broad set of impacts but criticises the exclusion of cap and floor payments from the economic assessment. They also argue for monetising capacity market and curtailment impacts and call for clarity on how different benefit categories are weighted.

NESO: In the Capacity Market, Long Duration Energy Storage (LDES) producers are price takers, and their participation is not expected to have a significant impact on overall consumer welfare. Notably, LDES plays a key role in reducing price volatility, thereby lessening the need for capacity procurement through the market. The primary focus should be on the collective benefits of LDES, rather than on individual project evaluation. Additionally, the LDES Cap & Floor regime seeks to identify projects that meet a predetermined target capacity, determined through a comprehensive modelling approach that considers factors such as curtailment impacts and competing technologies. As a result, there is limited need to assess the economic benefits of curtailment separately. However, its emission reduction benefits are implicitly captured within the monetised emission component of the Multi-Criteria Assessment (MCA) framework.

Stakeholder: A major omission is the lack of consideration for the impact on the existing unsubsidised BESS fleet, which could be financially undermined by subsidised LDES projects. This introduces a new risk factor for investors. Additionally, the inclusion of renewable support scheme costs is criticised as speculative and potentially misleading, given the uncertain origin of stored energy and the flaws in the CfD scheme itself.

NESO: Battery storage (BESS) is explicitly represented in our baseline scenarios, and our welfare-based analysis inherently accounts for impacts on existing assets. In other words, if subsidised LDES projects affect the market for unsubsidised BESS, those effects show up in our model through changes in producer and consumer surplus. Our focus remains on total system welfare, ensuring that any negative impact on one group (e.g. incumbent storage operators) is weighed against gains to consumers and overall reliability. Regarding renewable support scheme costs, we handle these carefully and avoid speculative assumptions. We only incorporate such costs where they are directly tied to LDES operations and can be consistently assessed. Through this approach, the economic assessment stays grounded in evidence and does not mislead stakeholders about uncertain policy-related costs.

Stakeholder: Stakeholder supports the proposed impact categories but argues more should be monetised, including cap and floor payments, capacity market effects, and avoided RES curtailment. They also call for inclusion of community benefits, water resource optimisation (especially for PSH), and long-term benefits beyond 2055. They warn that annualising costs over 25 years may bias against long-lived assets like PSH.

NESO: NESO agrees that additional value streams—such as cap and floor payments, capacity market effects, and avoided curtailment—can be relevant for certain technologies. However, LDES assets typically act as price takers in the Capacity Market, with limited impact on overall consumer welfare. Their contribution to reducing price volatility is already captured in the welfare assessment. Avoided curtailment is implicitly reflected in the system modelling and its associated emission reductions are accounted for in the carbon valuation. Community benefits, are considered, please see the MCA document for further details.

Stakeholder: The right impacts are mostly included, but key ones are not monetised. Stakeholder calls for monetising capacity market and ancillary service impacts, and for modelling project-specific start dates, degradation, and availability. They argue that failing to do so will distort comparisons, particularly disadvantaging shorter-duration and faster-response technologies. They also recommend dropping interconnector modelling to focus on more material differentiators.

NESO: We agree that monetising key services is important. Inertia and Short Circuit Level (SCL) revenues are now monetised using reference values derived from NGESO's Stability Pathfinder contracts. These values are adjusted for asset availability and, in the case of SCL, for locational system need. This ensures fair valuation across technologies and regions.

Capacity Market revenues are not monetised because LDES operators are price takers and their participation does not materially affect consumer welfare.

Degradation is modelled via cycle life and efficiency. Outage availability is not currently included due to data limitations but is recognised as a future improvement area.

Stakeholder: The proposed impact categories are broadly appropriate. Stakeholder recommends ensuring both MW and MWh contributions are captured and that locational benefits are assessed comprehensively. They highlight that southern or midlands-based LDES can provide value by displacing gas generation on the demand side of constraints, not just by absorbing renewables.

NESO: Our modelling effectively captures both the megawatt (MW) and megawatt-hour (MWh) contributions through a simulation of the operation of the GB electricity system. Additionally, the modelling of the Balancing Mechanism accounts for network constraints, thereby evaluating locational benefits. This will highlight clear benefit from locations of projects with respect to constrained boundaries

Stakeholder: Several key characteristics of Li BESS are undervalued. Stakeholder calls for a non-monetised metric for response time, better treatment of degradation-linked costs, and recognition of geographic system value. They also highlight the role of Li BESS in decarbonising sectors like marine and data centres, and argue that NESO's modelling underestimates BESS flexibility due to perfect foresight assumptions.

NESO: Our modelling explicitly accounts for capacity and power degradation. Applicants are also able to include additional degradation-related costs within their fixed and

variable Operation & Maintenance costs, which are integrated into our model.
We incorporate boundary constraints to evaluate the locational benefits of assets and their ability to alleviate constraints. This is measured through redispatch costs, a key monetised welfare component, calculated using bid/offer prices and the volume of energy redispatched. Therefore, if a project results in reduced overall Balancing Market (BM) actions, it is considered beneficial.
Additionally, our modelling assesses the monetised benefits of the emission reduction capabilities of Long-Duration Energy Storage (LDES) assets. This captures each asset's contribution to the decarbonisation of the GB energy sector and other interacting sectors.
We recognise that the assumption of perfect foresight may not be entirely realistic, yet it is a common approach for large and complex models of this nature. This assumption is necessary due to the prohibitively high computational costs and the lack of readily available data associated with modelling imperfect foresight. However, our perfect foresight assumption is applied over a rolling multi-day period, rather than an entire year, to minimise any potential distortions.

Stakeholder: Transmission charges and losses vary significantly by location. These should be reflected in NESO's economic assessment by incorporating TNUoS charges and locational transmission loss factors into the LDES Project Welfare component.

NESO: TNUoS charges and locational loss-factor tariffs are redistributive payments, not real system costs, so we exclude them from the LDES Project Welfare metric. Physical losses and locational effects are already captured in dispatch, and the economic value of location is reflected through Balancing-Mechanism constraint costs: whenever an LDES asset eases a local bottleneck, the reduction in BM re-dispatch spend is monetised as a welfare benefit.

Stakeholder: Argues that key system-level benefits—especially grid reinforcement deferral—are not fully captured in the current framework. Recommends treating this as a distinct, monetised impact and using co-optimisation

NESO: Potential network reinforcement deferral is indirectly accounted for through our modelling of balancing costs. When an LDES project reduces constraint and redispatch costs in the Balancing Mechanism, it in effect lessens the urgency for certain network upgrades. We have not created a separate monetised category for grid deferral, because those benefits will be realised in later network planning processes (outside this CBA). However, by capturing the reduction in BM constraint costs now, we ensure any such deferral value is reflected in the project's contribution. In essence, the model's outcomes for lower BM spend serve as a proxy for the value of deferred reinforcements.

Stakeholder: BM-focused LDES assets deliver significant system-level benefits by increasing competitiveness and reducing consumer costs in the BM. These benefits are not captured by Plexos modelling, which fails to simulate real BM dynamics. Historical backcasting shows direct consumer savings from improved BM price stacks. If the Marginal Additional approach does not reflect these savings, it may indicate a failure to model asset behaviour accurately.

NESO: We recognise the importance of BM-focused LDES assets and agree that they can deliver significant system-level benefits by improving competitiveness and reducing redispatch costs. While the Plexos balancing model used does not simulate real-time BM re-optimisation, it does incorporate key system constraints—such as thermal limits and boundary capabilities—which are critical drivers of BM costs. This allows us to capture a meaningful portion of BM-related value.

Re-optimisation revenues from net imbalance management are not modelled separately, as doing so would require a fully stochastic real-time simulation, which is not practical or proportionate for this assessment. However, much of this value is captured indirectly: if a project improves system balance, reduces redispatch costs, or enhances security of supply, those benefits are monetised and credited to the project through the Marginal Addition approach. Nevertheless, the financial assessment of each project will provide an estimation of rebalancing and optimisation of revenues which can be achieved.

This ensures that technologies like pumped storage and fast-response assets are properly valued for both their economic and strategic contributions—without double-counting or relying on speculative forecasting.

Stakeholder: The Economic Assessment overlooks critical system-level costs, particularly the negative impact of subsidised LDES on short-duration storage. These assets may be crowded out of key markets, leading to revenue erosion or reduced investment. Sensitivity modelling should be used to assess these interactions and ensure a balanced view of LDES deployment that includes both benefits and potential market distortions.

NESO: Short-duration storage already forms part of the background fleet in our market model, so any change in its revenues or utilisation when LDES is added is reflected by the producer-welfare metric, which is produced as part of this assessment. If subsidised LDES were to erode battery margins, that effect would register as a loss in producer surplus and reduce the project's net benefit.
We also test scenarios, giving a balanced picture of how LDES deployment interacts with existing short-duration assets and the wider system.

Stakeholder: The proposed exclusion of real-time flexibility benefits from the economic assessment undervalues battery-based LDES, which offer sub-second response and simultaneous charge/discharge capabilities—advantages not shared by other technologies (PS or CAES). These benefits should be recognised in both, financial and economic assessment.

NESO: We acknowledge that certain fast-response and real-time capabilities of battery-based LDES provide unique benefits. While those sub-second responses or simultaneous charge-discharge features aren't directly given a cash value in the Economic Assessment, they are not ignored. Such operability advantages are considered in the qualitative part of our evaluation. This means that even if economic modelling doesn't monetize a capability like instant response, the final decision-making process will still consider that advantage. The outcome is a balanced view that incorporates both the modelled benefits and the less tangible, yet important, services that advanced LDES technologies offer.

Stakeholder: Several system-level benefits of PSH are not captured in the Economic Assessment. These include inertia, short circuit level (SCL), reactive power, and restoration services. Coire Glas alone could provide 8 GVA.S of inertia (~7% of GB needs). If these benefits are not monetised, they must be given appropriate weight in scoring. Wider network reinforcement costs should also be included, as they vary significantly between projects and affect constraint management outcomes.

NESO: Thank you for highlighting the broader system-level benefits of PSH. The methodology calculates monetised estimates for inertia and short circuit level (SCL), which will be included in the Financial Assessment and may also be considered in the Economic Assessment. Other ancillary service contributions are addressed in more detail within the Multi-Criteria Assessment (MCA).

Any reduction in system constraints due to an LDES project are captured as a lowering of Balancing Mechanism (BM) costs. This serves as a proxy for alleviating network strain, meaning projects that help avoid constraints reflect a benefit comparable to avoiding network reinforcement within our modelling results.

Stakeholder: Avoided network upgrades and job creation are key system-level benefits missing from the Economic Assessment. These should be included as monetised or strategic factors. A robust framework is needed to assess these consistently.

NESO: Avoided network upgrade costs are indeed an important system benefit, and we reflect them indirectly through our balancing cost metrics. In our model, if an LDES project lowers constraint-related BM costs, this indicates an easing of network congestion, which is exactly the factor that often justifies transmission upgrades. Thus, those savings are a proxy for deferred network investment. We will highlight such outcomes in our reporting to make the link clear. Broader socio-economic benefits such as job creation are outside the scope of the CBA's monetised analysis, but they can be considered within the Strategic Assessment (which can consider regional economic benefits and other externalities as part of the qualitative score). We have a consistent framework to ensure that all these factors are considered in a comparable way across projects, even if not every factor translates into a pound value in the assessment.

Stakeholder: Identifies underrepresented BESS benefits: real-time flexibility, voltage support, inertia, market liquidity, and volatility mitigation. Suggests using proxy metrics for consistent assessment.

NESO: We fully recognise the additional system benefits that LDES, including battery-based storage, can provide — such as real-time flexibility, voltage and frequency support, inertia, improved market liquidity, and volatility mitigation. Where robust monetisation is not feasible in the Economic Assessment, these contributions are captured qualitatively within the wider assessment framework. Inertia and SCL revenues are now being quantified explicitly in the assessment to ensure this particular benefit is assigned a monetary value.

Stakeholder: Stakeholder highlights two missing monetised benefits: avoided RES curtailment and capacity market impacts. They argue that reduced RES curtailment lowers the need for new RES build, which should be monetised. They provide modelling evidence showing this omission could lead to negative net benefits for LDES under Ofgem's current approach.

NESO: In the Capacity Market, Long Duration Energy Storage (LDES) producers are price takers, and their participation is not expected to have a significant impact on overall consumer welfare. Notably, LDES plays a key role in reducing price volatility, thereby lessening the need for capacity procurement through the market. The primary focus should be on the collective benefits of LDES, rather than on individual project evaluation. Additionally, the LDES Cap & Floor regime seeks to identify projects that meet a predetermined target capacity, determined through a comprehensive modelling approach that considers factors such as curtailment impacts and competing technologies. As a result, there is limited need to assess the economic benefits of curtailment separately.

Stakeholder: Two key benefits that are underrepresented: (1) reduced RES curtailment lowers the need for new RES build, which should be monetised; and (2) capacity market impacts, where LDES can reduce clearing prices and shift marginal bids. They argue both are quantifiable and should be included in the modelling, especially as they vary by duration and technology.

NESO: Our modelling tracks renewable curtailment levels, and any reduction in curtailment due to an LDES project is reported as part of the results (indicating more renewable energy is utilized). While we don't explicitly credit projects with avoiding future renewables build, Ofgem will take the curtailment reduction into account qualitatively when considering project benefits. Similarly, we observe capacity market and security of supply impacts if a project improves system margins or reduces the need for other peak capacity, that is reflected in our metrics (like lower expected unserved energy and potentially reduced capacity requirements). These factors ensure that each LDES's contribution to supporting renewables and enhancing resource adequacy is recognized consistently across all projects. In the Capacity Market, Long Duration Energy Storage (LDES) producers are price takers, and their participation is not expected to have a significant impact on overall consumer welfare – therefore, no explicit monetisation of the capacity market is proposed for this assessment.

Stakeholder: Stability and inertia services, especially from grid-forming batteries, are not captured but could offset significant system costs. Constraint management modelling is also seen as critical but highly sensitive to assumptions about generation and network build. Stakeholder recommends modelling projects from their actual connection dates and including sensitivities for network delays and outages. They argue the current approach will misrepresent both absolute and relative project value.

NESO: We recognise the importance of incorporating inertia and stability services into our modelling efforts. However, modelling these services presents challenges, particularly when using Plexos, the industry-standard software for electricity market modelling and simulation. Responding to stakeholder feedback, we have revised our methodology to evaluate the monetised revenue streams of Long Duration Energy Storage (LDES) assets in relation to system inertia and fault current.
The aim of this exercise is not to explore network build delays, but to identify the most suitable LDES projects to meet a predetermined target storage level. To ensure consistency, each project is assessed against the same generation, demand, and network build assumptions, based on the latest Future Energy Scenarios (FES). These scenarios are developed through comprehensive modelling and extensive stakeholder engagement. Additionally, we will conduct a sensitivity analysis of the benefits of LDES projects across the various FES scenarios to illustrate how these benefits fluctuate with different generation, demand, and network assumptions.
We use 2030 or 2033 as the modelling start date, not the precise connection date, to enable consistent and transparent project comparisons.

Stakeholder: Resilience during extreme events and whole-system optimisation (e.g. reduced curtailment, eased constraints, higher renewables penetration) are seen as undervalued. Stakeholder recommends scenario-based stress testing and extreme event modelling to better capture these benefits across technologies.

NESO: We recognise the importance of capturing resilience to extreme events and broader system integration effects. To support this, the assessment includes a set of additional scenarios designed to stress-test the decision-making process. These scenarios explore a range of uncertainties, including variations in background storage technologies, differing levels of consumer engagement, slower-than-expected renewable deployment, and extreme weather years. This approach ensures that the resilience and integration benefits of each project are consistently evaluated and remain comparable across all submissions. Additionally, the dedicated security of supply analysis includes multiple weather years, with varying conditions, to give a more robust measure of resilience.

Stakeholder: Several system-level benefits are not captured, including deferral of transmission reinforcement, real-time system services (e.g. inertia, voltage), and long-term resilience. Stakeholder urges Ofgem to model these with greater granularity and include them in the economic assessment.

NESO: The purpose of this assessment is to compare LDES projects consistently against a common system backdrop, not to determine optimal network build timing. All projects are tested against the same FES-based generation, demand, and network assumptions, ensuring a level playing field.
We acknowledge the importance of system services: inertia and short-circuit level revenues are now explicitly monetised; reactive power impacts are captured qualitatively. While we do not separately model long-term reinforcement deferral, any reduction in Balancing Mechanism constraint costs resulting from an LDES project inherently reflects locational congestion relief, providing a proxy for avoided reinforcement where relevant. We also test a range of stress scenarios, helping reveal how LDES improves long-term system resilience under different futures.

Stakeholder: The Marginal Addition (MA) method disadvantages larger, later-delivery projects by assuming a saturated market and undervaluing their marginal contribution. This creates a bias against PSH and Track 2 projects. Ofgem is urged to use a hybrid of First Additional and MA approaches and to appraise Track 1 and Track 2 projects simultaneously using identical counterfactuals. Current assumptions risk favouring less mature projects and introducing a "winner's curse."

NESO: We did evaluate a First Addition (FA) approach but ultimately removed it because it produced a non-credible baseline scenario. An FA counterfactual (where one project is added to an empty system) left the system short of flexibility, leading to unrealistically high benefits for the first-added project and even causing loss-of-load issues before later projects were added. In contrast, the Marginal Addition method gives every applicant the same, well-supplied background, avoiding that bias. However, the Marginal Addition method has been amended to create project-specific counterfactuals which provide a fairer balance of overall storage capacity across a range of project sizes.

Additionally, Track 1 and Track 2 projects are assessed against the same methodology, using different benefit windows. The size of these windows are identical, and so projects in these tracks are assessed on a level-playing field within the economic assessment. The background for each track 1 and track 2 projects follows the principle outlined for project-specific counterfactuals, and is related to the size of the project rather than the "ordering" of projects.

Financial Assessment

Stakeholder: Revenue neutrality following BM actions is unrealistic for BM-focused LDES assets. These assets pursue high-frequency trading strategies to maximise BM margins, not simple day/night arbitrage. The assumption ignores the volatility and unpredictability of BM dispatch patterns. More accurate modelling would show higher utilisation and revenue, challenging the neutrality assumption.

NESO: Our CBA does not rely on a "revenue-neutral" assumption. At system level we measure how each LDES project reduces Balancing-Mechanism system costs (e.g. by displacing expensive offers during volatile periods)

Stakeholder: Strong disagreement with the assumption of revenue neutrality. Stakeholder argues that BM value is highly locational and significant for many projects. Excluding it flattens differences and undermines system value recognition. They recommend using NESO data, third-party tools, and developer inputs to estimate BM value.

NESO: We agree the BM value is highly locational. In our analysis, we do not assume that Long-Duration Energy Storage (LDES) projects remain neutral concerning Balancing Market (BM) revenue. Our modelling approach incorporates boundary constraints to assess the locational advantages offered by assets and their capacity to alleviate constraints. This is quantified through redispatch costs, a principal monetised welfare component, which are determined based on bid/offer prices and the volume of energy redispatches. Consequently, if a project leads to a reduction in overall BM actions, it is considered a benefit. Additionally, based on stakeholder feedback, we have revised our modelling approach to fully capture the incremental revenue accrued by LDES assets for every BM action performed.

Market Modelling

Stakeholder: Stakeholder supports the Marginal Additional method but stresses that when assessing expansions of existing assets, the original asset must be removed from the modelling background to ensure only the net benefit of the expansion is captured. While Ofgem has clarified this intention, it is not clearly reflected in NESO's documentation, which states that refurbishment projects will be assessed like new ones.

NESO: The methodology has been updated with your suggestion.

Stakeholder: Raises concern that the Marginal Additional method may obscure differences between technologies if the notional LDES archetype doesn't reflect real project characteristics. Recommends allowing archetypes to vary by technology class and clarifying how atypical projects will be assessed.

NESO: We have updated the counterfactual design to address this concern directly. The background LDES used in the Marginal Additional method is no longer uniform. Instead, it is now distributed across zones according to the FES pathways. This ensures that the counterfactual reflects where and what type of LDES is most likely to be deployed in practice, improving realism and fairness.

Each applicant is modelled using its actual technical characteristics, including technology type, round-trip efficiency, ramp rates, and operational constraints. This means that atypical or novel technologies are fully captured in the assessment. The counterfactual provides a consistent system backdrop, while the detailed modelling of each project ensures that differences in technology class and performance are reflected in the marginal benefit calculation. This approach balances the need for a transparent and reproducible baseline with the flexibility to assess a wide range of LDES technologies on their own merits.

Stakeholder: The Marginal Additional method may be flawed if applied to the FES HT scenario, which already assumes high flexibility. This risks undervaluing LDES assets in low-flexibility futures. Sensitivities should reflect uncertainty in deployment of emerging technologies. LDES assets offer high value in high-renewables, low-flexibility scenarios and should be assessed accordingly.

NESO: In the latest version of the methodology we are considering more scenarios, which should help to mitigate this issue through consideration of different background technology development timelines.

Stakeholder: The Marginal Additional (MA) method disadvantages large, long-lead-time projects by assuming market saturation and diminishing returns. This contradicts the policy intent of supporting high-CAPEX LDES. The archetype approach also removes locational realism. A hybrid of First Additional (FA) and MA methods is recommended to ensure fair treatment and reflect true system value.

NESO: We tested several counterfactual options. "First-Additional" (adding a single project into an otherwise storage-empty system) was rejected because it created two problems:

-First-in bias. With no other LDES on the system, the lone project appeared to deliver an inflated benefit, overstating its value and automatically downgrading every project assessed afterwards.

-Locational distortion. Until all projects were modelled, the network was artificially unbalanced, so site-specific constraint relief and curtailment reduction were both mis-represented.

The Marginal-Additional (MA) method avoids both of these issues by providing a more realistic baseline and retaining locational realism. However, the approach has been amended to create project-specific counterfactuals. This is intended to remove any size-related bias, which could be created through addition of large projects which might experience diminishing returns.

Additionally, the archetype approach has been changed to reflect a more realistic expectation of LDES development. Instead, background LDES capacity is now distributed across zones based on FES pathways. This ensures that the counterfactual reflects where and what type of LDES is most likely to be deployed in practice, improving realism and fairness.

Stakeholder: The MA method is pragmatic but oversimplified. It removes locational and technological benefits and underestimates PSH's value. Second-order impacts like reduced network reinforcement are not captured. These limitations must be addressed elsewhere in the assessment.

NESO: The updated methodology addresses these concerns through several enhancements. First, the background LDES counterfactual is no longer uniform—it is now distributed across zones and durations based on FES pathways. This ensures that the counterfactual reflects realistic deployment patterns and avoids masking locational or temporal value. Project specific counterfactuals are now derived reducing bias, and improving the quality of the assessment.

Second, each project is modelled using its actual technical parameters, including location, duration, efficiency, and operational constraints. This ensures that the unique characteristics of technologies like PSH are fully captured in the marginal assessment. Project-specific counterfactuals are now included, which attempt to resolve any size-related bias that might have adversely affected larger-scale projects.

Third, while second-order impacts such as deferred network reinforcement are not monetised directly, they are indirectly captured through reductions in Balancing Mechanism (BM) constraint costs. If a project alleviates local congestion, the resulting BM savings are credited to the project. This provides a proxy for avoided reinforcement value without requiring speculative assumptions.

Together, these improvements ensure that the MA method remains robust, transparent, and capable of recognising both direct and indirect system benefits across a diverse range of LDES technologies.

Stakeholder: MA method is simple but flawed. Using notional LDES plants across all zones removes locational realism. Second-order impacts like avoided reinforcement and gas displacement are not captured.

NESO: We've made significant improvements to address these concerns. The counterfactual no longer uses a uniform distribution of background LDES. Instead, background projects are now spatially and temporally based on distribution from the FES pathways. This ensures greater locational realism in the baseline.

Each project is assessed at its actual location, with full network constraints applied. This allows us to capture locational value — such as constraint cost reductions — directly in the welfare metrics.

While second-order impacts like avoided reinforcement and gas displacement are not separately monetised, they are indirectly captured through changes in redispatch costs, carbon emissions, and generation mix. This ensures these effects are reflected in the overall system value without requiring speculative assumptions.

We believe this approach strikes the right balance between realism, consistency, and analytical robustness.

Stakeholder: The method is not seen as suitable for either absolute or relative assessment. The counterfactual includes unrealistic LDES placements (e.g. central London) and ignores key revenue streams, favouring slower, longer-duration technologies. Stakeholder also warns against grouping dissimilar assets and stresses the need to model degradation and availability, especially for BESS and water-dependent assets. Transmission outages must also be reflected to avoid overestimating capacity.

NESO: The updated methodology addresses these concerns through several targeted improvements:

Realistic Counterfactual: The background LDES counterfactual is no longer evenly distributed. It is now spatially distributed, based on the established FES backgrounds. This ensures that background assets are placed in zones where LDES is most likely to be beneficial, avoiding unrealistic placements.

Technology-Specific Modelling: Each project is assessed using its actual technical parameters, including location, duration, efficiency, and operational constraints. This ensures that both fast-response and long-duration technologies are evaluated fairly based on their system contribution.

No Grouping of Dissimilar Assets: All projects are assessed individually using the Marginal Addition method. There is no clustering or grouping by technology type, ensuring that each project's unique characteristics are preserved in the assessment.

Degradation and Availability: The methodology incorporates cycle life and round-trip efficiency to reflect degradation over time. While outage availability is not explicitly modelled due to data limitations, applicants are encouraged to reflect this in their operational parameters. This is recognised as a future enhancement area.

Transmission Constraints: The Plexos model includes boundary capability constraints, which reflect transmission limitations and congestion. This ensures that projects behind constrained boundaries are credited for reducing redispatch costs, indirectly capturing the impact of transmission outages.

Together, these measures ensure that the methodology provides a fair, realistic, and technology-neutral assessment framework.

Stakeholder: The method is criticised for misrepresenting BESS behaviour. Stakeholder argues that BESS does not act like marginal generators and that the method may undervalue their flexibility and revenue potential. They warn that this could lead to inappropriate comparisons with gas peakers and misaligned incentives.

NESO: We clarify that our scenario background already includes a robust mix of BESS and other flexible assets reflecting their expected deployment, so batteries are not treated as absent or undervalued in our modelling. Moreover, in our Marginal Additional approach, a BESS project doesn't need to behave like a conventional generator to be assigned welfare. Asset flexibility can still translate into system cost savings and reliability improvements, which the model records as benefits (e.g. reducing peak prices and providing contingency during sudden outages). If introducing an LDES project (like a large battery) were to significantly lower prices and thus reduce revenues for other producers, our welfare framework would capture that as a transfer from producer surplus to consumer surplus, ensuring we count net benefits correctly. In short, the model is capable of reflecting batteries' unique operating style and will not mistakenly compare them one-for-one with inflexible peaking plants. We continuously refine our PLEXOS settings to ensure the true value of BESS flexibility is recognized in the results.

Stakeholder: The method is pragmatic but fails to capture locational, technological, and long-term benefits. Stakeholder warns that ignoring second-order impacts like avoided peaking or transmission investment could lead to inefficient decisions. These should be addressed elsewhere in the assessment.

NESO: Our assessment accounts for locational and technological factors, as well as long-term system benefits, albeit in a balanced and integrated manner. Locational benefits, for instance, are captured through our network modelling. If a project in a constrained area helps avoid expensive re-dispatch or future transmission upgrades, the reduction in congestion costs and constraint payments will be reflected in the relevant welfare category for that asset. Technological differences (such as provision of inertia) are reflected, ensuring that a project's specific features translate into quantifiable system benefits. Long-term effects like avoiding new peaking generation or deferring network reinforcements are not explicitly a separate output in the Marginal Addition run, but they are indirectly accounted for by improvements in system adequacy and reduced total system costs over the study horizon. Where certain second-order benefits cannot be directly quantified in the model, we make sure to address them qualitatively in the multi-criteria assessment. This way, the decision-makers see a complete picture, and no significant benefit (locational, technological, or long-term) is omitted from our considerations.

Stakeholder: Stakeholder notes that the revised counterfactual—placing notional LDES plants in all 37 zones—may dilute locational differences, potentially overstating benefits of clustering projects in the same region. This could overlook diminishing returns from regional saturation. Ofgem should consider locational and temporal variation in the Strategic Assessment or allow NESO to run additional sensitivities for regionally concentrated applications.

NESO: The updated counterfactual no longer assumes a uniform distribution across all zones for background LDES projects. Instead, it uses a distributed background LDES configuration, based on FES pathways. This ensures that the counterfactual reflects where LDES is most likely to be beneficial, improving locational realism.

Each project is assessed at its actual location, with full network constraints applied. This means that any locational advantage—such as constraint relief or curtailment reduction—is captured directly in the welfare metrics. The model also accounts for diminishing returns through system-wide dispatch optimisation, which reflects saturation effects when multiple projects are concentrated in the same region.

While the Strategic Assessment may consider broader system planning implications, the CBA already includes locational sensitivities through network modelling and constraint cost impacts. If a high volume of regionally clustered applications is received, NESO retains the flexibility to run additional sensitivities to ensure robust evaluation.

Stakeholder: Counterfactual should avoid assuming high LDES saturation, which could understate marginal benefits. Recommends adding sensitivities for high-renewable and high-constraint zones, and testing outcomes across different storage technology mixes.

NESO: We agree that testing multiple scenarios is important. The final CBA will cover a broader range of scenarios and sensitivities, not just a single high-saturation case. By expanding the scenario set, we ensure that any diminishing returns or locational saturation effects are captured. This robust scenario-based approach will better reflect the marginal benefits of LDES under diverse future conditions.

Counterfactuals have also been amended in this methodology, to avoid over-saturation effects. This is outlined in the main document, and consists of reducing the level of LDES capacity present in the background, in line with the capacity of the assessed project.

Stakeholder: Recommends the counterfactual reflect a realistic "no LDES" scenario aligned with UK net zero targets, network plans, and FES demand forecasts. Suggests prioritising sensitivities such as high renewables, gas price volatility, low renewable periods, and interconnector outages to better capture LDES value under stress conditions.

NESO: A full "no-LDES" counterfactual would not be consistent with the UK's net zero trajectory or security-of-supply requirements, as modelled in the Future Energy Scenarios (FES). Such a baseline would create an unrealistic system shortfall and artificially inflate the value of the first project added. Instead, our approach removes non-Final Investment Decision (non-FID) LDES from the FES scenario at the level of half the capacity of the assessed project. This ensures the counterfactual remains technically feasible and policy-aligned, while providing a fair and consistent benchmark for all applicants.

To address the need for stress testing, we model a range of sensitivities, including:

- High and low decarbonisation pathways (e.g. Electric Engagement and Falling Behind)
- Extreme weather years (e.g. Dunkelflaute and high-wind conditions)

These scenarios ensure that the value of LDES is assessed under a broad range of credible system conditions.

Stakeholder: The counterfactual and sensitivities must reflect foreseeable market and regulatory changes. Key sensitivities should include P462, TNUoS reforms, zonal pricing under REMA, gas price volatility, skip rate assumptions, and declining lithium-ion costs. These factors materially affect LDES economics and must be modelled to ensure robust, future-proofed assessments.

NESO: We've considered many of the factors you've highlighted in shaping the methodology. The assessment focuses on system value, and while not all elements are explicitly modelled, several are addressed as follows:

Zonal Pricing (REMA): This was considered during consultation but is not included in the current version due to current policy direction and modelling constraints.

P462 and TNUoS Reform: The potential impacts of P462 are being considered in our background assumptions. TNUoS reform is being monitored, though not currently modelled due to the lack of a confirmed implementation pathway.

Skip Rates: These are incorporated within the Plexos framework to reflect realistic operational behaviour.

Technology Cost Trends: Declining lithium-ion costs are not explicitly modelled. The assessment focuses on system value rather than technology-specific cost projections. Applicants are expected to reflect cost assumptions for their projects within their submissions, which will be considered during evaluation.

Stakeholder: A single static counterfactual is insufficient. A scenario-based, locationally aware, and dynamically maintained set of counterfactuals will better capture the system-critical role of PSH and ensure fair valuation

NESO: We believe our base case scenario provides a meaningful and consistent reference point for assessing all projects. It is now based on a distributed, background LDES fleet aligned with the FES2025 scenario, ensuring realism in both location and duration.

To capture broader system uncertainties and stress conditions, we complement this with a suite of scenario-based sensitivities—including variations in demand, flexibility, weather years, and system configurations. This combined approach ensures robust and fair valuation across a wide range of plausible futures, while maintaining transparency and comparability in the core assessment.

Stakeholder: Stakeholders should be allowed to engage with the chosen FES scenario through workshops. The current modelling horizon (to 2044) is too short for long-lived assets like PSH, which can operate for over 100 years. Limiting the assessment to 25 years risks undervaluing enduring system benefits and strategic contributions.

NESO: We appreciate the long-term perspective of assets like PSH. However, attempting a fully stochastic or ultra-long-term simulation for this assessment would be impractical. Given we must model day-ahead and balancing markets for many applicants, expanding to 100-year horizons or Monte Carlo-style random stress testing isn't computationally feasible. Additionally, modelling over this timeframe would be subject to many uncertainties, such as the network rollout and the development of generation background, which would increase the level of uncertainty for results from this period of time. Value beyond this point is therefore extrapolated, as per the methodology.

We tackle uncertainty through a curated set of scenario sensitivities (including stress weather years and alternative scenarios) and by qualitatively recognizing long-lived benefits. The horizon we've used captures the core economic impacts in line with typical appraisal periods, and any residual value or very long-term strategic benefit can be considered in Ofgem's wider decision framework.

Stakeholder: The FES HT scenario may overstate flexibility and understate LDES value. Stakeholders should be consulted on the chosen scenario. The 25-year modelling horizon is too short for PSH, which can operate for over 100 years. Additional sensitivities (e.g. low DSR, low interconnector capacity) should be included.

NESO: The analysis will incorporate multiple FES scenarios and sensitivity cases to cover uncertainties. For instance, we plan to include scenarios with lower demand-side response, as well as stress-test years (e.g. a Dunkelflaute) to ensure LDES value under extreme conditions is captured. By expanding beyond the core Holistic Transition scenario, we address the risk that optimistic flexibility assumptions could underplay LDES benefits. While our quantitative modelling horizon is out to 2044, value beyond that is extrapoloted as discussed in the methodology, so long-lived projects are not penalised by the truncation.

Stakeholder: Supports using the Holistic Transition scenario but warns that high consumer flexibility assumptions may understate LDES value. Recommends using stress weather years and a low-flexibility counterfactual to better reflect LDES benefits.

NESO: We intend to use the Holistic Transition (HT) scenario as a starting point, but we will also examine other scenarios as variants to account for uncertainty in consumer flexibility. We are also considering extreme weather years (prolonged low renewable periods) to capture LDES benefits under stress conditions. By including these additional cases, we ensure that the assessment does not understate LDES project value just because the core scenario assumes high flexibility.

Stakeholder: Supports counterfactual use but recommends delayed delivery scenarios and sensitivity to lower LDES deployment. Suggests additional sensitivities: wind variability, fuel prices, electrification, and LOLE stress periods.

NESO: We appreciate these suggestions on counterfactual design. Our analysis already explores additional scenarios, including cases with delayed renewables deployment and lower LDES uptake, to test the robustness of results. We also incorporate key sensitivities such as varying wind output (through weather year scenarios). The additional scenarios ensure that fuel price fluctuations, and different levels of electrified demand are considered. This ensures the decision is stress-tested against a range of future conditions, making our method robust and comprehensive.

Stakeholder: Strongly criticises the proposed counterfactual, calling it unoptimised, unrealistic, and unfair to large projects. They recommend calibrating LDES levels, using more realistic locations/durations, and modelling multiple FES scenarios. They also suggest aligning with interconnector CBA precedent.

NESO: We've significantly improved the counterfactual to address these concerns. The distribution of background LDES projects is no longer uniform or arbitrary—instead, it is now based on the distributions within the published FES pathways. This ensures the counterfactual reflects realistic deployment patterns and system needs.

Each project is assessed at its actual location with full network constraints applied, ensuring that locational value and project scale are properly captured in the welfare metrics. This approach avoids bias against larger or regionally concentrated projects.

In line with stakeholder feedback, we also model multiple FES scenarios and stress conditions to ensure robustness. This broader scenario framework captures a wide range of system futures—consistent with the approach used in interconnector CBAs. Additionally, project-specific counterfactuals are now used in this methodology, to account for size-related bias that could have occurred using a single counterfactual representation.

We believe this provides a fair, transparent, and policy-aligned foundation for assessing all LDES projects.

Stakeholder: Calls for an optimised counterfactual to avoid systemic underestimation of SEW and project distortions. They recommend aligning low-carbon generation with FES and optimising other plant types. They also suggest distributing notional LDES in the counterfactual based on expected project characteristics and ensuring the counterfactual leaves space for large projects to be fairly assessed.

NESO: The counterfactual used in the Marginal Addition (MA) method has been updated to reflect a more realistic and policy-aligned system configuration. It is now based on the FES2025 Holistic Transition scenario, which incorporates optimised assumptions for low-carbon generation, demand, and flexibility. This ensures alignment with the UK's net zero trajectory and system planning outlook.

To avoid systemic bias, the counterfactual now uses an LDES background of non-FID LDES, aligned with the published FES pathways. This approach reflects where LDES is most likely to be deployed and avoids the distortions associated with uniform or arbitrary placement.

Project-specific counterfactuals are now used, creating a space based on the size of the project being assessed. This was included to account for the size-related bias that could have resulted from adding larger projects to a single background, which could have resulted in diminishing returns.

This approach provides a robust, transparent, and scalable framework that avoids distortions while capturing the full system value of LDES technologies.

Stakeholder: Two key sensitivities are recommended: (1) project delays and cost overruns, weighted by delivery risk; and (2) delays to network build, which would increase constraint-related benefits for projects behind boundaries. These are seen as essential to fairly assess project value and risk.

NESO: The aim of this exercise is not to explore network build delays, but to identify the most suitable LDES projects to meet a predetermined target storage level. To ensure consistency, each project is assessed against the same generation, demand, and network build assumptions, based on the latest Future Energy Scenarios (FES). These scenarios are developed through comprehensive modelling and extensive stakeholder engagement. Additionally, we will conduct a sensitivity analysis of the benefits of LDES projects across the various FES scenarios to illustrate how these benefits fluctuate with different generation and demand.

Stakeholder: The FES HT scenario assumes high consumer flexibility, which may depress LDES value. Stakeholder recommends using a low-flexibility counterfactual and modelling sensitivities for low interconnector capacity and high gas prices. These would better reflect the value of PSH under stress conditions.

NESO: We agree that high consumer flexibility in the FES HT scenario could understate LDES value. To address this, our assessment includes a range of sensitivities—including an additional scenario with lower consumer flexibility. These scenarios help reveal the resilience and value of PSH and other LDES technologies under a range of conditions, ensuring robust and balanced evaluation across a range of system futures.

Stakeholder: Stakeholder supports the proposed sensitivities but recommends adding low demand-side response and low interconnector capacity scenarios. They also question assumptions in the FES Holistic Transition scenario, especially around consumer flexibility.

NESO: We acknowledge these concerns and are addressing them directly: the "Falling Behind" scenario, which we will include in the assessment, features lower consumer demand-side response and reduced interconnector capacity, providing a robust sensitivity alongside the Holistic Transition case. This ensures that LDES value is tested under less optimistic flexibility and network conditions.