A Cost Benefit Analysis of the BiTraDER Innovation Project

A report to SP Electricity North West

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Executive Summary

The BiTraDER project has undertaken the design, build and trialling of a brand new and highly innovative market allowing flexible resources connected to the distribution network to trade their curtailment obligations bilaterally.

Since the submission of the original business case in 2021, the need for the deployment of flexibility to mitigate distribution network congestion has increased alongside the continued decarbonisation of the power system. There is widespread agreement that new forms of distribution connected demand and generation will trigger a need for substantial and expensive network capacity upgrades. However, the flexibility inherent in these distributed energy resources could deliver substantial cost savings and wider benefits to connected customers.

During the period since the original business case submission there has been an increasing focus on local flexible services; including:

- Increased need to understand local constraints through stakeholder engagement for the development of the RIIO price controls and Distribution Future Electricity Scenarios (DFES), including use of the Common Evaluation Methodology (CEM) to identify the need for flexibility; and
- Further development and coordination of flexibility products led by the ENA, alongside the launch of the Flexibility Market Asset Registration (FMAR) system to reduce administrative burden of multiple registration.

These changes have increased the importance of flexibility markets, such as BiTraDER.

The BiTraDER project has developed a sophisticated market platform to allow market participants the opportunity to manage their curtailment at the time of a constraint. The BiTraDER project team, working alongside market participants (through Stakeholder Engagement) have optimised the market platform and underlying market rules through detailed discussions and hands-on trials. This report provides a review the outcomes from the BiTraDER project. This includes a qualitative assessment supported by a quantitative assessment (where possible) recognising that a robust process will be vital in satisfying Ofgem's requirements for the evaluation.

This assessment is based on Ofgem best practice and has been designed to be robust and credible whilst also ensuring that it is both proportional and practicable given the information available.

Qualitative Assessment

The qualitative assessment draws on the stakeholder feedback and discussions across the development of the project. The learnings from the design of the trading rules and the outcomes of the trials identify no clear insurmountable barrier to entry for all participant types. The trial identified initial trades between curtailable RES and non-curtailable carbon intensive participants enabling the continued operation of RES assets, thereby reducing the level of RES curtailment and overall emissions.

Specifically, the results from the trials identified a strong interest in the market from participants. And the changes made to the trading rules (e.g. pricing options, timings of bid/offer submissions etc.) and platform functionality, as a result of the Stakeholder Engagement, led to an improved experience for participants, and we would expect further learning to be identified as the market moves to Business-As-Usual (BAU).

However, the main concerns for the participants remain the transparency of prices in the market and the likely level of liquidity. During the trials this led to gaps between the prices submitted by buyers and sellers in the market. This reflected very different strategies and priorities of the participant types active in this trial based on the different demand / generation technologies (e.g. between renewable generators and carbon intensive assets). However, we believe this is partly due to the limited scale of the trials, and should be overcome with greater participation over time.

Quantitative Assessment

The results of the quantitative analysis show a strong net financial benefit from the introduction of the BiTraDER market. Based on the assumptions discussed in Section 5 a net benefit of £32 million is estimated for the SP ENW region and £544 million when scaled for all the GB distribution networks. These benefits accrue primarily from the reduced need to curtail RES generation and, as a result of the more optimised use of existing generation capacity, savings from avoided generation investment.

Further to the financial benefits associated with reduced RES curtailment, the BiTraDER market also results in strong carbon savings as output from conventional generation (e.g. CCGTs etc.) is replaced by allowing RES generation the ability to continue to generate.

Conclusions

This project had shown that BiTraDER can be part of the solution to mitigate distribution network congestion and optimise RES generation by allowing customers the opportunity to trade their curtailment obligations bilaterally.

The assessment has identified a business case that warranted the development of the innovation project and the funding it received as part of the Network innovation Competition and potential for it to be a success in BAU operation.

1 Introduction

The BiTraDER project has undertaken the design, building and trialling of a brand new and highly innovative market allowing flexible resources connected to the distribution network to trade their curtailment obligations bilaterally. BiTraDER has assessed both current and future customers' appetite for bilateral trading, examining existing techniques that could facilitate such a market, and determining the data requirements to support operation of the market, and the interfaces needed to present all necessary information to a suitable market trading platform, with the appropriate cyber security considerations.

Through the development of detailed market rules and a sophisticated platform for trading, BiTraDER has explored the market's ability to operate in near real-time and determined the functionality required to return the output of the market to the DNO systems for execution in real time.

To help understand the learnings from the project this report provides a Cost Benefit Analysis (CBA) assessing both qualitative and quantitative outcomes. The CBA attempts to understand the extent to which the aims of the BiTraDER project have been met and the potential for it to be a success within BAU operations.

The report is structured as follows:

- **Section 2**: Provides an overview of existing Flexibility Markets available for participants in the SP ENW region
- **Section 3**: Provides a description of the approach to the CBA assessment, including assessment criteria and the evaluation framework
- **Section 4**: Provides the Qualitative Assessment drawing out the leanings from the Trials and Stakeholder Engagement
- **Section 5**: Provides the Quantitative Assessment outlining the expected financial and carbon benefits resulting from the deployment of BiTraDER in BAU
- **Section 6**: Provides a summary of the Conclusion from the CBA
- **Annex A**: Review the Trading rules focussing on the rules that where refined and discussed during the Trials

2 Flexibility Markets in the SP ENW Region

To support the findings of the BiTraDER 'Trials' within the context of the CBA we have considered the potential barriers to participation. Specifically focussing on the impact of price discovery between different participants with different asset types.

To understand why trade matching has proved difficult we have undertaken a review of the existing flexibility markets available to stakeholders. This review assesses the requirements of the different markets to understand the scale of participation and the prices set within these markets.

The aim of this review is to identify (where possible) the different prices across the flexibility markets. This will provide an indication of how different technologies interact with the markets. Through this review we will seek to identify learnings that can transferred into the BiTraDER market or used to infer improvements and provide mitigations to any potential gaps in order to improve the functioning of the market.

2.1 Overview of available flexibility markets and their purpose

The SP Electricity North West's region is served by a suite of flexibility markets at both the national level (run by NESO) and the distribution level (run by SP ENW). These markets aim to balance supply and demand, manage grid frequency, provide reserve power, and relieve network constraints.

This provides participants with the opportunity to choose their exposure to multiple markets based on value opportunities, contract terms, and operational capabilities. Each market comes with trade-offs. Some markets offer daily or even intraday opportunities with no long-term commitment, while others provide revenue certainty through availability payments or longer contracts. Providers will gravitate toward the combination of markets that maximizes their revenue and fits their operational profile. As participants optimise where to offer their services, their choices can influence overall market liquidity and pricing, and in turn opportunity costs of non-participation.

The sections below review the key flexibility markets available to participants in the SP ENW region, focusing on how the structure of each offering (e.g.

auction frequency, contract duration, payment type) impacts its attractiveness to market participants.

2.1.1 Wholesale Day-Ahead & Intraday Markets

The wholesale electricity market (day-ahead auction and intraday continuous trading) is the primary port of call for most generators and flexibility providers. It involves no commitment beyond the delivery period – participants can freely choose volumes day by day or hour by hour. If prices are attractive, a provider sells energy; if not, they can hold back and potentially use that flexibility in another market. There are no availability payments in wholesale; revenue comes purely from energy sold, so participants bear price risk but retain full operational freedom. Notably, being on a non-firm (curtailable) connection does not restrict wholesale participation, beyond having to manage the risk of curtailment during peak times.

Participation is open to any licensed market participant, with no minimum size – smaller assets typically aggregate under intermediaries. Most wholesale participants also engage in other flexibility markets.

2.1.2 Balancing Mechanism

The Balancing Mechanism (BM) offers flexible assets an opportunity to capture high prices during periods of system stress. There are no upfront availability contracts – providers submit offers and bids and are only paid if called upon. Prices in the BM can be extremely volatile, ranging from deeply negative (when excess generation must be cut) to several thousand pounds per MWh during scarcity events. These dynamics create substantial revenue opportunities for flexible assets, particularly those capable of rapid response (e.g. batteries and Gas Turbines). However, to reliably earn BM revenue, an asset must ensure it is not committed elsewhere at the same time.

Participants must meet technical requirements for telemetry and dispatchability, and many distribution-connected assets now participate through aggregators. While the BM handles less total energy than the wholesale market, its financial significance is considerable.

2.1.3 Frequency Response Services

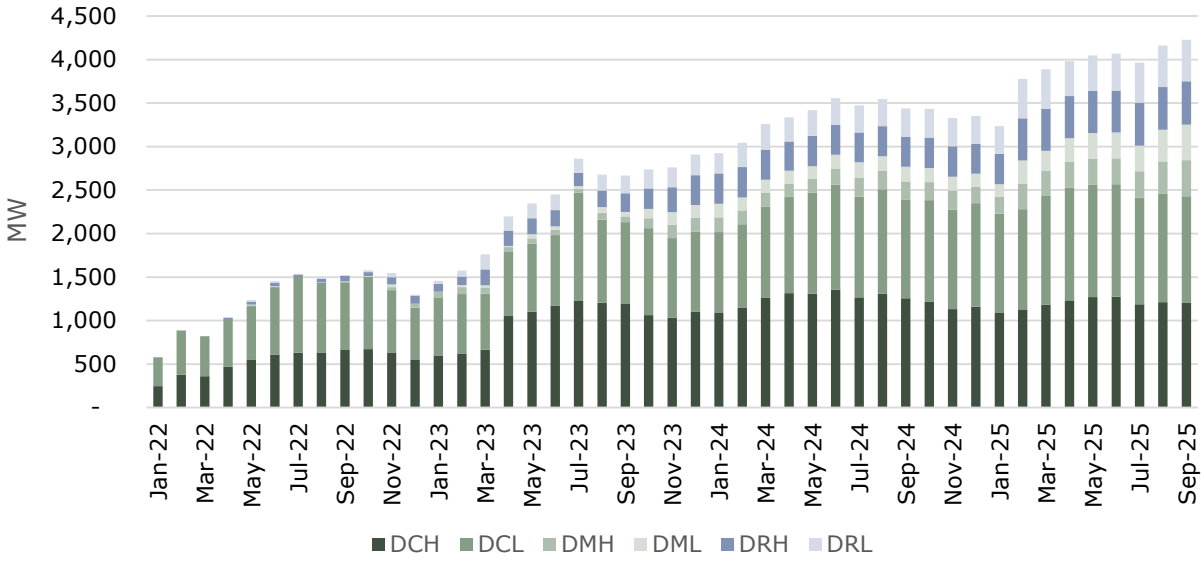
Frequency response services provide rapid, automated adjustments in power output or demand to maintain grid frequency at 50 Hz. Historically, this was handled through Mandatory Frequency Response (MFR) obligations on large generators and through Firm Frequency Response (FFR) tenders, which allowed smaller or aggregated assets to provide either dynamic or static response. However, both frameworks have been phased out, or are being retired.

In their place, NESO has introduced three dynamic services: Dynamic Containment (DC), Dynamic Moderation (DM), and Dynamic Regulation (DR). All three service mitigate overly high (H) or low (L) frequencies. They are procured via daily auctions and are designed to deliver faster, more granular control. DC provides post-fault response within one second, typically from

batteries, and is sized to cover the largest credible system loss (~1 GW). DM offers pre-fault damping for moderate deviations, while DR delivers continuous fine-tuning for minor frequency fluctuations. All three services are co-optimised with reserve products in NESO's Single Market Platform[1].

The transition to daily auctions has made frequency response a flexible opportunity for providers, avoiding long-term lock-in. A participant can decide each day whether to commit capacity to frequency response, and if it doesn't clear or prices are too low, it can use that capacity elsewhere.

Exhibit 2.1 – Average monthly procured volume for dynamic products (MW)



As procured volumes of these services have risen, prices have declined with increasing competition. The amount of average monthly participants has risen from 7 in 2021 to 24 in 2025. Early DC auctions at times cleared above £20/MW/h, but recent prices have settled around £4/MW/h. Despite this, frequency response remains a valuable revenue stream for fast-acting assets, particularly batteries, which dominate participation due to their speed and controllability.

In practice, assets often stack frequency response with other services. A battery might allocate part of its capacity to DC during peak hours and reserve the remainder for wholesale trading or reserve markets. While static response still exists, it is rarely called upon, and NESO is reviewing its integration into the broader dynamic suite.

2.1.4 Reserve Services

Reserve services provide the system with additional generation or demand reduction to manage energy shortfalls that exceed the scope or duration of

[1] More details on the technical requirements (e.g. unit size, speed and duration) can be found here: https://www.neso.energy/industry-information/balancing-services/frequency-response-services

frequency response. Reserve markets offer structured payments to participants, including availability and utilisation payments.

These services typically activate within 1 to 20 minutes and can run for up to several hours, addressing both pre-fault and post-fault needs. NESO's Reserve Reform is modernising this space to replace products like Fast Reserve and STOR with a new suite: Quick Reserve, Slow Reserve, and Balancing Reserve.

Historically, Fast Reserve delivers rapid injections, typically from large pumped-hydro or gas turbines, while STOR relies on interruptible generation or load capable of responding within 20 minutes and sustaining output for at least an hour. These services are procured via tenders and paid both availability and utilisation fees. Both services still exist but will be phased out in favour of the new schemes.

Quick Reserve fills the gap between frequency response and slower reserves. It activates within one minute and runs for up to 15 minutes, targeting small, fast deviations. It is procured via day-ahead auctions and offers availability and utilisation payment structures. Quick Reserve has stringent ramping requirements precluding most technologies; main providers of this service are batteries and Pumped Storage units when operating in spin mode.

Slow Reserve is planned to replace STOR and will provide post-fault support for larger, sustained imbalances. It activates after a short delay (≥1 minute) and can run for up to two hours. Like Quick Reserve, it will be procured through co-optimised day-ahead auctions. Slow Reserve is dominated by gas-fired generation. Whilst longer duration storage assets could provide this type of reserve, opportunity cost of participating could be high if actual activation remained infrequent. Batteries in turn might be limited by duration constraints.

Balancing Reserve is a forward-looking product designed to secure firm reserve capacity day-ahead, ensuring consistent system resilience across all settlement periods. Providers commit capacity that cannot be sold elsewhere and are paid for availability. This product is particularly relevant during tight system conditions and is expected to be co-optimised with other services in NESO's unified auction platform. Its slower ramping requirement means it can be met by engines more cheaply than batteries. However, as the requirement grows faster than the rate of engine deployment, batteries start to play a bigger role in future.

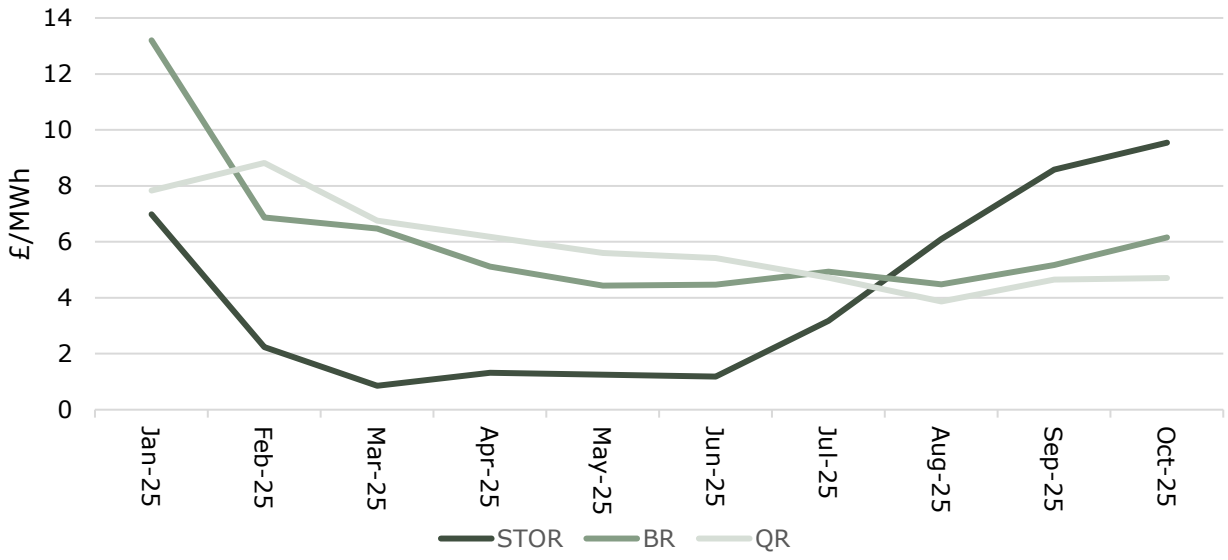
Exhibit 2.2 – Overview of reserve products

	Quick Reserve	Slow Reserve	Balancing Reserve
Target time of use	Pre-fault	Post-fault	-
Speed of response	<60 seconds	<15 minutes	<5 minutes
Operational range	Keep deviations below 0.2Hz	Recover to 0.2Hz within 15m	-
Delivery duration	5-15 minutes	30-120 minutes	30 minutes
Service window	Interim: 2 hours	1 x 23:00-07:00 8 x 2-hour blocks	30 minutes block
Symmetry	Positive and/or negative	Positive and/or negative	Positive and/or negative

The day-ahead auction format for Quick and Slow Reserve means participants can decide daily whether to offer into these services, and still be free to pursue other markets on days or hours they are not committed.

Since the launch of the new Balancing Reserve service in March 2024, a move from traditional headroom and footroom providers has been observed; namely, CCGT utilisation has been replaced by Batteries and Engines. The launch of Balancing Reserve has been driven by costly real-time Operating Reserve, which is procured directly in the BM. Rather, Balancing Reserve is procured day-ahead and allows for more effective utilisation of smaller scale generators.

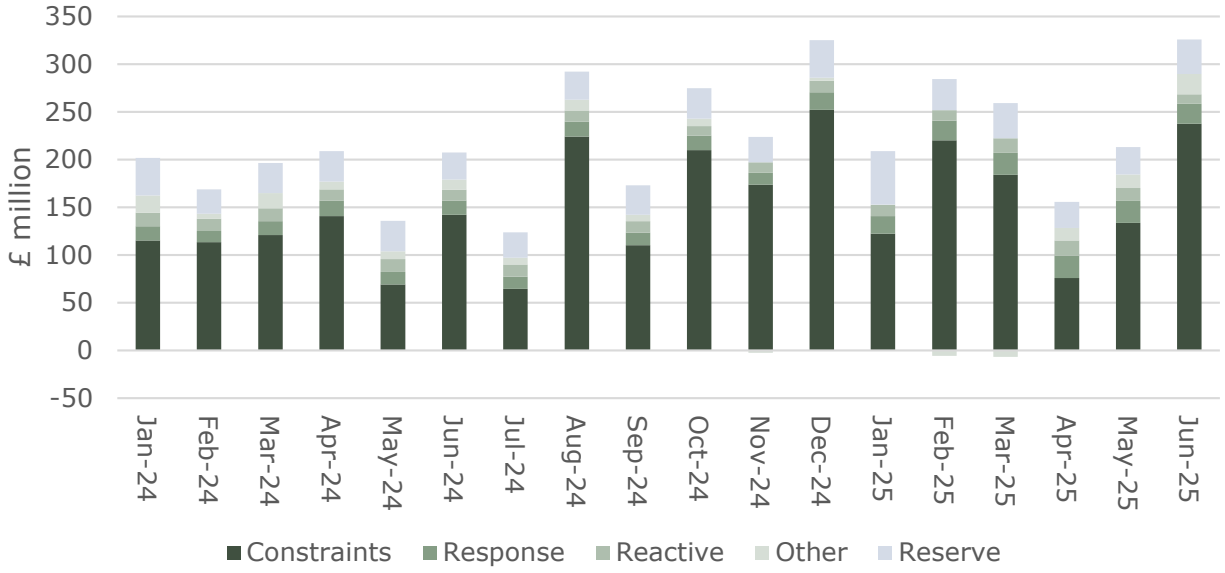
Exhibit 2.3 – Monthly average clearing prices by Reserve product (Jan-Oct 2025, £/MW)



2.1.5 Balancing costs and prices

In recent years, NESO have spent over £2bn p.a. on balancing, most of which is used for constraint management. Between 10-20% is used via the Reserve services, whereas 6-11% are spent on Response services.

Exhibit 2.4 – Total Balancing services cost in 2024 – June 2025 (£m)



2.2 DSO Flexibility Markets

Beyond the NESO markets, participants in the SP ENW region have further DSO-level flexibility markets to choose from. In these markets, participants can sell flexibility to SP ENW via competitive tenders, allowing the DSO to reduce demand or increase generation during peak periods or fault conditions.

SP ENW uses a standardised set of products aligned with the Open Networks framework:

- Scheduled Utilisation (Secure): Pre-agreed dispatch during predictable peaks (e.g. weekday evenings), typically with day-ahead notice. Providers are paid per MWh delivered, with no availability fee.
- Operational Utilisation (Dynamic): Post-fault response activated within minutes. Providers must be on standby and are paid only when dispatched.
- Operational Utilisation with Variable Availability: A hybrid of pre-fault readiness and dynamic dispatch, offering availability and utilisation payments.
- Peak Reduction: Non-dispatchable efficiency-based reductions, incentivised through performance-based payments.

Tenders are issued biannually, with location-specific requirements. SP ENW evaluates bids using a cost-benefit framework, comparing flexibility costs to network reinforcement alternatives.

For resources located in constrained pockets of the network, SP ENW's flexibility tenders present an additional revenue option on top of national markets. However, these local services can be less lucrative and more uncertain than national markets. The dispatch of DSO services can be unpredictable, and providers may go long periods without being called, making it difficult to rely on these contracts for consistent income. The overall revenue opportunity usually falls short of what could be earned in national markets during high price events. Committing capacity to a DSO service can also limit the ability to earn elsewhere at the same time, as contract structures often require exclusivity or restrict partial participation. In addition, the longer contract periods reduce flexibility, which can be challenging if market conditions shift and more lucrative opportunities emerge during the commitment window.

2.3 Participation Trends and Market Interactions

Many stakeholders in the SP ENW region engage in multiple markets to stack revenue. This stacking of market participation and revenues is governed by rules currently drafted by the market facilitator Elexon. There are three different types of stacking:

- jumping, whereby products can be provided at different moments by the same portion of a plant's capacity (generally possible for most product combinations);
- co-delivery where products can be provided simultaneously by the same portion of a plant's capacity (generally not possible for most product combinations – the Capacity Market being the notable exception); and
- splitting, whereby products can be provided simultaneously by different portions of a plant's capacity.

Naturally, splitting is the most restricted version of revenue stacking, with e.g. most Reserve services being incompatible with Frequency response services in the same time frame. Regarding NESO v DSO markets, a participant signed up to being dynamically dispatched via Operational Utilisation will be precluded from providing any NESO Reserve, Response, or BM service in the same time frame. Subsequently, providers must choose and manage their commitments carefully to avoid double-booking the same capacity.

Participation across flexibility and energy markets varies by asset type:

1. Large conventional generators (e.g. nuclear, CCGTs) typically participate in wholesale markets, the Balancing Mechanism (BM), and legacy mandatory frequency response. They are not typically active in DSO flexibility or ancillary tenders and are connected on a firm basis.
2. Renewable generators primarily trade in wholesale markets. Larger or aggregated sites may participate in the BM. Non-firm (curtailable) sites increasingly engage in DSO flexibility to monetise curtailment. Participation in the BM is less common unless integrated with a trading platform.
3. Peaking gas and diesel generators are active in the BM, and many have transitioned from STOR to Slow Reserve or Quick Reserve. They may also

participate in the Capacity Market and DSO tenders, particularly in constrained areas.

4. Battery storage is highly versatile, participating in wholesale, BM, and NESO ancillary services, and often the Capacity Market. Batteries located in constrained areas may also engage in DSO flexibility.
5. Industrial and commercial demand-side participants typically do not engage in wholesale markets but may participate in balancing services via aggregators. Some register in the BM to offer demand reduction, and many have historically provided STOR or Fast Reserve through on-site generation. Their involvement in DSO flexibility is growing.

Aggregators are expanding their role in DSO markets. While these assets are generally too small for direct wholesale or BM participation, they can respond to price signals and participate in NESO programmes like the Demand Flexibility Service (DFS).

2.4 Potential impact for BiTraDER

This review of existing flexibility markets has identified that participants already have multiple trading options available. These markets cover multiple timescales and delivery products. Therefore, it is important that the BiTraDER markets offers compatibility and additionality with these existing markets. This will allow participants to take advantage of the unique opportunity BiTraDER offers to optimise curtailment while not limiting any existing operations or revenues.

Through a combination of stakeholder feedback and quantitative modelling, the following assessment examines how BiTraDER can integrate with these existing markets and the potential revenues available to participants.

3 Approach to the Assessment

In this section we present our approach to the evaluation. We have undertaken both a qualitative assessment supported by a quantitative assessment (where possible) and we recognise that a robust process will be vital in satisfying Ofgem's requirements for the evaluation.

3.1 Assessment Criteria

Our assessment criteria are based on the aims and objectives of the Network Innovation Competition (NIC) – as defined by Ofgem. These criteria were used by Ofgem to understand whether a project proposed by a DNO was worthy of funding. We have reviewed these criteria and taken those relevant for a post-project assessment to form the basis for assessing the extent to which the BiTraDER project has been successful.

The criteria identified for the purpose of this assessment are:

- Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers
- Provides value for money to electricity distribution/transmission Customers
- Generates knowledge that can be shared amongst all relevant network licensees
- Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness

3.2 Evaluation Framework

The framework based on Ofgem best practice[2] has been designed to be robust and credible whilst also ensuring that it is both proportional and practicable given the information available. The evaluation will cover both qualitative and quantitative assessments – and will use the 'Assessment Criteria' identified above. Details on the two approaches are presented below.

[2] https://www.ofgem.gov.uk/sites/default/files/2021-10/RIIO-ED2%20Cost%20Benefit%20Analysis%20Guidance.pdf

3.2.1 Qualitative assessment

The qualitative assessment is driven by the learning from the trials and direct feedback from stakeholders.

Throughout the BiTraDER project we have engaged with industry stakeholders through information sessions and three separate trials (Mini, Simulation and Live). This feedback makes use of questionnaires, ad-hoc sessions, trial review workshops and direct one-to-one interviews with stakeholders. The SP ENW website provides an overview of the 'Customer Workstream' summarising the engagement undertaken in the project[3].

This feedback has been taken at different stages of the project ensuring that the project was developed in cooperation with Stakeholders. The feedback for the qualitative assessment includes feedback on the trading rules for the market alongside operational information from the use of the BiTraDER platform. Our qualitative assessment criterion also uses a simple scoring metric as set out in Exhibit 3.1.

Exhibit 3.1 – Qualitative assessment scoring description

Scoring	Description
✓✓	Meets assessment criteria
✓	Partially meets the objective
×	Does not meet the fund objectives

3.2.2 Quantitative assessment

The quantitative assessment assesses the administrative costs associated with the implementation and operating of the market, alongside the potential benefits in delivering a more efficient deployment of curtailable capacity on the network – split between the financial and carbon benefits of this. Specifically:

- **Implementation and operating costs**: this covers the cost of administering the scheme. These are the costs borne through the need for additional staff, external advice etc.
- **Costs associated with project funding**: the actual cost of the project; e.g. how much funding was granted by Ofgem to support the project. This category will also include costs faced by the DNOs that were not covered by the funding.
- **Current and future financial and CO2 benefits from the funded projects**: where possible we have identified financial or CO2 benefits that are likely to occur, as a result of the project.

[3] https://www.enwl.co.uk/future-energy/innovation/key-projects/bitrader/bitrader-library/customer/

4 Qualitative Assessment

The qualitative assessment focusses on the learning outcomes from the stakeholder discussion and feedback.

4.1 BiTraDER learnings

In this section we provide a summary of the stakeholder feedback and discussions across the development of the project. We have structured this assessment based on the three trial periods (i.e. Mini, Simulation and Live Trials) as these events provided key milestones for the presentation on the project progress and detailed discussions with stakeholders to help further enhance the BiTraDER market. The dates for the Trials are provided in Exhibit 4.2

Exhibit 4.1 – BiTraDER Trial Periods

Trial	Dates
Mini	January 2024
Simulation	October 2024 to May 2025
Live	November to December 2025

4.1.1 Mini-Trials

The Mini Trials were added as an additional stage after the completion of the design of the trading rules. The trading rules identified the first layer and high-level principles for trading rules, with simple examples to highlight how they can work. As part of this process certain assumptions were made and limitations identified.

Therefore, the purpose of the Mini-Trials was to investigate options for the rules by carrying out manual trading scenarios with a set of experienced participants which included asset owners, operators and aggregators. This additional feedback could be integrated into the market design prior to the development of the trading platform itself. Ensuring that the platform had the requisite functionality and flexibility to incorporate future changes.

Specifically, the Mini-Trials sought to further investigate aspects of the Trading rules that would benefit from increased stakeholder engagement.

This included both a theoretical discussion on these issues and an initial understanding of how they would work in practice. This included[4]:

- **Payment structure**: We presented the option of a utilisation payment or a combination of a utilisation and availability payment.
- **Baselining**: Participants requested that options for the timing of the baseline submission should be considered - for example day-ahead and closer to real time. Additionally, alongside a self-declared option, additional methods to measure baselines should be considered where practical.
- **Liquidity**: The concern that was highlighted to the project team was around the number of assets that would be available to trade in the market – this would limit price formation and the ability to match trades.

4.1.1.1 Stakeholder Feedback

Following the Mini-Trials, the participants were asked to provide feedback which the project team would use to inform whether any amendments were required to the trading rules before commencing the build of the market platform in preparation for the simulation trials.

- **Payment Structure**: The feedback identified a clear majority in favour of a two-part pricing structure with an **availability payment**. Following this feedback the two-part pricing was favoured when submitting trades. The availability and utilisation price are then added together to form an 'all-in' price and incorporated into the platform for both the simulation and live trials. Stakeholders stated that this approach reduced the risk of taking part in the BiTraDER by giving a level of revenue certainty.

However, there was more uncertainty in regard to baselining and liquidity. For example:

- **Baselining**: Participants agreed that for now a 'self-declared' baseline was preferrable. However, those participants with storage assets flagged the issue of day ahead baselining. There was a preference for baselining closer to real time as opposed to at the day-ahead stage. .
- **Liquidity**: The level of liquidity in the market remained a concern given the uncertainty over the number of potential assets participating and the innovative nature of the market. However, it is expected that as the level of flexible connections on DNO networks increases, BiTraDER will become more attractive to connected assets.

In both cases it was agreed that these aspects would remain under review throughout the simulation and live trials and learnings taken where possible.

[4] These issues are explained in more detail in the Trading Rules Report: https://www.enwl.co.uk/future-energy/innovation/key-projects/bitrader/bitrader-library/bitrader-project-deliverables/d3-trading-platform-design/

4.1.2 Simulation Trials

Following the developments in the design and platform build phases (along with the learnings from the Mini-Trials workshop) the simulation trials were undertaken to gain further learnings on the BiTraDER market ahead of the Live Trials. The Simulation Trials allowed participants to submit trades, and these trades were then followed by a detailed discussion with the participants to understand the impacts[5].

The Simulation Trials identified that users found the trading rules and associated trading platform intuitive. However, due to some necessary simplification in the design of the simulations, the participants were unable to apply real-world expertise when submitting bids and offers – which limited price formation and ultimately the matching of trades. The challenge of price discovery resulted from a combination of limited liquidity, unfamiliarity with the process and lack of real-world constraints.

Therefore, it was decided that guide prices would be given to participants as a starting point for submitting trades. The drawback of this was that it limited the learnings from the price discovery aspect. It was found that the pool of participants had differing asset technology types and each had their own conceptions of the way their individual assets operate. This price discovery aspect will be investigated further as part of the live trials.

Nevertheless, the Simulation Trials did successfully test out the market rules which were robust enough to provide successful trade outcomes[2]. For example, Stakeholders confirmed that the inclusion of an 'availability' payment alongside the 'utilisation' payment de-risked some of the revenue uncertainty that exists in the market. Participants also responded positively in their potential willingness to operate their assets in BiTraDER (based on the existing trading rules) should this market progress to BAU.

Finally, the trial identified that the trading environment (e.g. the trading rules and trading platform) is functional alongside the SP ENW Active Network Management (ANM) system (albeit a test version of the ANM system). Participant feedback also indicated an enthusiasm for peer-to-peer trading options, as offered by BiTraDER. The participants have gained a thorough understanding of how the market works and are keen to see the project progress to BAU.

4.1.3 Live Trials

The 'Live Trials' built on the learning of the 'Simulation Trials' further enhancing the participant interaction with the functionality of BiTraDER. The 'Live Trials' simulated constraints to provide a realistic trading scenario – enabling a more detailed understanding of how the full end to end process,

[5] A full explanation of the methodology and results from the Simulation Trials can be found here: https://www.enwl.co.uk/future-energy/innovation/key-projects/bitrader/bitrader-library/bitrader-project-deliverables/simulation-trials-report/

including dispatch and settlement operates and identified the challenges associated with each stage of the operation of the platform[6].

Following the completion of the Live Trials we undertook group and individual feedback sessions to understand the key learnings from the participants. To focus this feedback and to enhance the learnings for the qualitative assessment we structured the feedback into the following four categories (nb. the previous trials and subsequent engagement had focussed primarily on the Market Design aspect). These categories have been designed to ensure learnings can be taken forward to improve BiTraDER, where necessary, ahead of the deployment to BAU.

Market Design:

- To understand any potential improvements for the platform design. For example, are there any changes in the trading rules that could improve trading / participation? This included the potential to incorporate best practice (e.g. participant learnings) from other flexibility markets that could be transferred.

Price formation:

- To understand whether there is sufficient information available to participants to enable development of an efficient strategy for bid and offer pricing. Secondly, investigate the potential for different strategies to identify if it is likely that there will be bid / offer matching between different participants.
- And subsequently to investigate whether participants change strategy in response to different scenarios or through learnings over the course of the 'Live-Trial' period? E.g. between the two trial weeks.

Alignment with other market:

- To understand if the BiTraDER trading window aligns with the requirements of other flexibility markets. For example, would moving the BiTraDER trading window increase the opportunity to trade and reduce the risk of exposure in the other markets.
- To review the contractual requirements related to activity in other markets that could impact on participation in BiTraDER (e.g. penalties for non-delivery).
- **BAU operation**:
- To understand the level of cost / time impact from participation in BiTraDER. For example, is it likely that bids / offers would need to change on a day-to-day basis, or be broadly consistent? And how would participation change depending on the type of constraint?
- Expectations for the BiTraDER market to 'grow revenue' on an ongoing basis and based on current information, would you anticipate it having a material impact on commercial decisions?

[6] A more detailed summary of the Live Trials can be found on the BiTraDER website.

— The extent to which any current contracts (access) are non-firm? And would the existence of the BiTraDER market potentially impact on connection decisions (e.g. agree to a firm vs non-firm contract)

The feedback from participants is summarised in the table below.

Exhibit 4.2 – Summary of Feedback

Focus area	Key Feedback
Market Design	— Participants strongly emphasised the need for **transparency** when it comes to submitted bids (including unsuccessful ones), number & type of players, and their implied opportunity costs. This was described as a prerequisite for participation, to enable participants to have the best possible view of potential revenues - especially given the immaturity of the market. — More **flexibility in the bid structures** (for example this included allowing split volume bids at increasing prices) was also proposed as it would allow participants to increase flexibility to shape volume and price submissions. — The uncertainty associated with the market (e.g. whether the constraint would bind in real time) was noted as a downside. This impact was amplified by the short notification window before activation. Participants emphasised the business need to lock in value early and their preference for **revenue certainty** (which had been flagged earlier through the request for availability payments – this was confirmed through the bid structures), given by other scheduled flexibility products or availability payments.
Price formation	— Uncertainty around what could constitute a successful trade was quoted as a limitation to price formation. This uncertainty was also apparent because of the 'peer-to-peer' aspect of the BiTraDER market which inherently differs from other network operator-traded markets. Suggestions of a DNO-set benchmark value of flexibility could be one potential solution to increase price certainty. — Differences in technologies, industries and priorities of participants meant that approaches to price formation differed. And within this trial this appeared to limit the ability of the participants to match trades. However, it was expected that in BAU situation with increased liquidity the diversity of technology types and participants should make trades more likely.
Alignment with other markets	— Adjustments to the BiTraDER trading window (between the first and second live trial) improved compatibility with other markets. The new window was set between the wholesale Day Ahead auctions which allows flexibility across both markets. Although it does close before the EAC auction for reserve & response services, it has been described as convenient for traders to place their bids during the workday alongside other market decisions. — In live trials, participants reported a preference for short response windows after the auction window closes for improved operational efficiency. — Both the wholesale market, the balancing mechanism and reserve services have been listed as main "competitor" markets that currently take precedence over BiTraDER.

BAU	— Participants felt that engaging in BiTraDER did not require large amounts of extra efforts. Provided transparent data is given and the market continues to mature, integrating a new market into daily decision making was something participants were willing to do. — Based on the observed bid and offers during trials, doubts were raised as to the potential revenues available in the BiTraDER market both due to lack of liquidity (given the frequency of curtailment events) and opportunity cost structures (limited overlap). — The scope for BiTraDER to increase the willingness to take up a non-firm connection was described as limited. It was noted that the combination of potentially low likelihood curtailment and challenging bid matching would mean that only marginal improvements could be argued in an investment case for a non-firmly connected development. However, this would be kept under revie as the longer-term dynamic benefits may improve with increased liquidity and trading in a BAU situation.

4.1.4 Conclusions

The results from the trials identified a strong interest in the market from participants. The changes made to the trading rules (e.g. pricing options, timings of bid/offer submissions etc.) and platform functionality led to an improved experience for participants, and we would expect further learning to be identified as the market moves to BAU.

The main concerns for the participants remain the transparency of prices in the market and the likely level of liquidity. During the trials this led to gaps between the prices submitted by buyers and sellers to take part in in the market. This concern was increased due to the different strategies and priorities of the participant types based on the different demand / generation technologies (e.g. between renewable generators and carbon intensive assets).

Unfortunately, the trials were unable to provide a view of whether these concerns would be addressed overtime due to low customer numbers and large simulation component that was used. However, as mentioned previously, we would expect increased liquidity leading to greater diversity of technology types and participants which should make trades more likely.

The approach to baselining will remain under review. Preferences were made during the trials, and it was agreed that this aspect would continue to be examined in the post-trials / pre-BAU period. As part of this we would consider work undertaken in other innovation projects alongside the best practice identified during the development of the ENA Open Network Flexibility Baselining Tool and the latest guidance from Elexon.

Finally, the trials showed that those participants operating in flexibility markets would be keen to take part in BiTraDER (e.g. Group 1 in the quantitative analysis). And those with flexibility contracts would be willing to interact with the BiTraDER market on an ad-hoc basis (e.g. Group 2 in the quantitative analysis).

4.2 Evaluation against the Assessment Criteria

In Exhibit 4.3 we provide an evaluation against the assessment criteria for BiTraDER project. This evaluation draws on the learning outcomes from the project as presented in this section.

Exhibit 4.3 – Evaluation against the NIC Assessment Criteria

a) Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing customers	
Assessment rating	✓
It remains the case that BiTraDER has the potential to help the development of the low carbon energy sector in GB. The design of the trading rules and the outcomes of the trials have shown no insurmountable barriers to entry for all participant types. The trial identified initial trades between RES and non-RES participants enabling the continued operation of the RES asset. Thereby reducing the level of RES curtailment and thereby reducing overall emissions We would expect these benefits to increase in BAU as more participants come to market – noting that it was limited by the number of types of participants in the trial.	
b) Provides value for money to electricity customers	
Assessment rating	✓✓
The BiTraDER market has the potential to provide significant value for money to electricity customers. The design of the platform and the initial findings from the trials have shown that BiTraDER offers the potential for a more efficient and effective allocation of curtailment between participants in response to network constraints. This should help to improve allocation of resources on the network meaning that a more appropriate resource is constrained – based on the value of the curtailment to all relevant participants on the network. Through strong Stakeholder Engagement, BiTraDER has encouraged many participants, currently unfamiliar with flexibility markets to engage and understand the potential benefits for themselves. As a result, BiTraDER could boost the value of flexibility thereby encouraging new participants, promoting increased competition, and thus provide further potential benefit to customers through reduced overall costs. If successfully launched into BAU, BiTraDER has the ability to help minimise the impact of network constraints. It has the potential to allow network infrastructure to be optimised through managing capacity constraints with flexible resources and the deferral of investment – allowing investment to take place at more optimal times. Finally, it is also important to emphasise that the BiTraDER market has minimal costs to implement and integrate for SP ENW – leading to limited direct costs to customers. In addition, we anticipate that there will be potential cost savings from more efficient curtailment in the medium to long term. These quantitative benefits linked to costs savings are discussed in Section 5 in more detail.	

c) Generates knowledge that can be shared amongst all relevant Network Licensees	
Assessment rating	✓✓
The BiTraDER project, and the trials in particular, have generated substantial learning for network companies facing the challenges of increased constraints and curtailment. The project outputs have examined a new and innovative peer-to-peer method to allow market participants to trade curtailment obligations. This adds to the knowledge generated in other innovation projects and existing flexibility markets in regard to the behaviour of participants and the benefits and limitations of different approaches. It has also identified insights into the interactions with other markets (including the balancing mechanism, wholesale markets and other flexibility and reserve markets) and how they may constrain access to, or value from, assets if there is no alignment between them and the BiTraDER market. The substantial library of reports on the trading rules, platform design and stakeholder feedback should enable any relevant network company to understand the advantages and disadvantage of the BiTraDER market, allowing a DNO to start from a strong position if it was to develop a similar scheme.	
d) Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development and/or demonstration project to demonstrate its effectiveness	
Assessment rating	✓✓
The BiTraDER project has provided an innovative approach that has tested the ability of flexible resources to trade their curtailment obligations bilaterally with others, in a transparent independent market facilitated by the DNO. BiTraDER has also drawn together stakeholders who may not traditionally operate within existing flexibility schemes but are willing to interact with the BiTraDER market on an ad-hoc basis. This positive interaction with BiTraDER also has the potential to become a gateway for stakeholders to participant in other flexibility markets.	

The qualitative evaluation against the Assessment Criteria has identified a clear potential for benefits from the BiTraDER project. Our qualitative scoring based on this assessment is presented in Exhibit 4.4.

Exhibit 4.4 – Qualitative scoring against the Assessment Criteria

Assessment Criteria	Score
Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing customers	✓
Provides value for money to electricity customers	✓✓
Generates knowledge that can be shared amongst all relevant Network Licensees	✓✓
Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development and/or Demonstration Project to demonstrate its effectiveness	✓✓

5 Quantitative Assessment

The Quantitative Assessment provides an update on the original business case to ensure that it remains relevant. This includes updating the potential benefits identified in 2021 (for example: Reduction in load related expenditure, reduced curtailment and improving the interactions with NESO to understand how they evolved over time and if they remain an important part of maximising the potential for flexible solutions on the distribution network.

5.1 Benefits categories

The BiTraDER quantitative assessment is reflective of the benefits and drivers for BiTraDER. Using the initial 'Full Submission Proposal'[7] as a starting point we have reviewed inputs to ensure all quantitative data has been updated to reflect the market changes since 2021. At the same time, we have ensured that the approach is reflective of the learnings from the trials.

All assumptions used in the calculations are based on validated data and credible assumptions – in line with Ofgem best practice. In general, conservative assumptions have been chosen in recognition of the uncertainty of future benefits forecasts.

A description of the benefit categories, and the calculation approach for each, is presented in Exhibit 5.1 and Exhibit 5.2 respectively.

[7] https://www.enwl.co.uk/future-energy/innovation/key-projects/bitrader/bitrader-library/full-submission/

Exhibit 5.1 – Benefit categories

Benefit	Explanation
Reduced curtailment of RES [Financial and Carbon]	BiTraDER will enable a more economic selection of resources for curtailment, expected to lead to a reduction in curtailment of RES generation with flexible connections, replaced by curtailment of non-RES generation. The increase in RES generation at the expense of non-RES generation will lead to benefits in relation to the reduction in CO_2 emissions.
Optimised curtailment of non-RES [Financial]	A more economic selection of parties for curtailment will also bring a benefit on the curtailment of non-RES resources, as curtailment is applied to lower cost resources. BiTraDER will give the opportunity for non-RES participants to optimise the timing of curtailment e.g. the potential to avoid being curtailed at certain times.
Reduced generation investment [Financial]	As the BiTraDER market matures it has the potential to both reduce the levels of peak demand and maximise the output from the existing connected generation capacity. This has the potential to reduce the levels of additional (new) generation capacity that is necessary to deliver system adequacy.
Reduction in load related expenditure [Financial]	Through the optimisation of curtailment, BiTraDER has the potential to facilitate increased flexible connections on the distribution network for the same level of network capacity. This can lead to a limited deferral of the need for load-related expenditure as assets (e.g. existing substations) close to peak capacity need to be upgraded later or to a lesser extent.
NESO interaction [Financial]	By allowing more efficient trading of curtailment, BiTraDER has the potential to release flexible resources. This may allow these resources to free up capacity and offer services to both NESO and other DNO flexibility services, resulting in reduced NESO balancing service costs. This benefit will be dependent on the strategy and operation of the connected resources.

Exhibit 5.2 – Benefit categories, calculation approach

Benefit	Calculation approach
Reduced curtailment of RES	The approach allows for a realistic representation of expected curtailment benefit which is realized via a shift of curtailment from RES operators to non-RES generators. While costs for non-RES curtailment rise slightly as a consequence, this is more than offset by reductions in RES curtailment costs. In this case we have first calculated the reduction in RES curtailment and subsequent increase in non-RES curtailment (MWh) by the respective cost of RES / non-RES curtailment (£/MWh).
Optimised curtailment of non-RES	
Reduced generation investment	The benefit realised through the use of distribution connected assets being able to reduce peak demand so that it can replace a small amount of new generation capacity the system would otherwise need to procure via the Capacity Market This is based on a calculating the reduced capacity market action (kW) and de-rating factor and multiplying by the value of capacity (£/kW).
Reduction in load related expenditure	To quantify this benefit, we have assumed that a small share of the Base case investment requirement will be avoided in each year. In practice, this benefit might grow over time until the market reaches maturity. This is based on the demand forecasts to identify when each primary and BSP substation is expected to reach its firm capacity and the least cost option to solve the constraint (£million).
NESO interaction	To quantify this benefit, we assume that in both the Base and Method cases, a share of flexible resources are able to offer services both to the NESO and DNO. The additional share in the Method case compared to the Base case is expected to deliver financial benefits. The total financial benefit is calculated by estimating the utilisation of these additional resources by the NESO (ultimately in MWh) and multiplying by an assumed cost saving (£/MWh) compared to the alternative balancing resources.

5.2 Methodology

We have assessed the NPV of key metrics under the BiTraDER market against a counterfactual scenario without BiTraDER. Therefore, results represent the difference in benefits and costs between those two cases.

To assess each benefit more accurately we have defined three consumer groups. Each group has a different characteristic in regard to their relationship with flexibility markets – and the subsequent interaction with the BiTraDER market.

- Participation Group (G1): This group represents existing and future connected resources that would have contracted flexibility arrangements irrespective of the existence of the BiTraDER market. These participants have non-firm contracts and/or are already active in the other flexibility markets.
- Participation Group (G2): This group represents connected resources without contracted flexibility arrangements (or existing customers with

flexibility arrangements for part of their capacity) that do not currently wish to enter long term contracts to provide flexibility services or agree to non-firm contracts. However, they may be willing to offer (additional) capacity on an ad hoc basis to the BiTraDER market.

— Participation Group (G3): This group represents connected resources who might in future accept a contracted flexibility arrangements in the knowledge that there are ad hoc arrangements in place to trade their curtailment liabilities.

The SP ENW scale benefits include impacts of deferred investment, increased coordination and reduced curtailment. These benefits are assessed against the cost of developing and operating a platform to deliver BiTraDER, for both SP ENW and market participants. Benefits for SP ENW begin from 2027, which is when SP ENW plans to roll-out the BiTraDER market while costs for SP ENW begin from 2022 due to project costs. .

Finally, to calculate the GB scale financial benefits the assessment uses a scalar based on the SP ENW scale results. The GB scale benefits have been calculated from the SP ENW results based on the proportion of primary and BSP substations in SP ENW compared to that in GB. This scalar was derived using the DNOs' LTDS. It is assumed that the other GB DNOs will be in a position to roll-out the BiTraDER Platform from 2028, in line with the beginning of RIIO-ED3.

Exhibit 5.3 – Benefit categories, main assumptions

Benefit	Main Assumptions
Reduced curtailment of RES	- Benefit only realised via Participation Group G1 - RES curtailment in the Base case: 90% of total curtailment volumes - BiTraDER reduces RES curtailment to 75% of total volumes (Central, High & Low: 70% and 80%) by shifting to non-RES curtailment - Cost of curtailed RES: £35.5/MWh
Optimised curtailment of non-RES	- Benefit only realised via Participation Group G1 - Non-RES curtailment in the Base case: 10% of total curtailment volumes - BiTraDER increases RES curtailment to 25% of total volumes (Central, High & Low: 30% and 20%) - Cost of curtailed non-RES: £5/MWh - Benefit of shifting curtailment to RES: £30.5/MWh
Reduced generation investment	- Benefit only realised via Participation Group G1 - BiTraDER replaces capacity market requirements equivalent to 5% of G1 capacity - Value of capacity: £15.5/kW (Central, High & Low: £18.2/kW & £12.2/kW)
Reduction in load related expenditure	- Benefit realised regardless of Participation Group - BiTraDER benefit is realised 5 years after market start to account for maturing need, i.e. 2032 - BiTraDER avoided investment: 1% of Base case investment need (Central, High & Low: 1.5% & 0.5%)
NESO interaction	- Benefit realised via all Participation Groups - BiTraDER enables additional capacity offering to NESO: +20% of G1 connected capacity, no increase in G2, and +5% of G3 connected capacity in Central (High & Low: +/-10%pts) - Utilisation factor of additional capacity: 5% - Value of additional capacity: £3/MWh

5.3 Results

The quantitative assessment reveals that after netting off costs of operating BiTraDER, the scheme generates a cumulative total of £32m in benefits in the SP ENW region by 2050. At GB scale, these modelled benefits reach £551m.

In addition, emissions modelling shows that in the SP ENW region, 425ktCO_2 are avoided within the same time period (in addition to the financial benefits associated with emission savings). At GB level, the savings reach 5,693ktCO_2.

Exhibit 5.4 - Total financial and carbon costs & benefits

Scale	Benefit description	2030	2040	2050
SP ENW Area	BiTraDER benefits (£m)	4.9	24.4	45.4
	BiTraDER Costs (£m)	8.6	11.5	13.4
	Total Net Benefit (£m)	**-3.8**	**12.9**	**32.0**
	BiTraDER carbon savings (ktCO_2)	*5*	*129*	*425*
GB Wide	BiTraDER Benefits (£m)	51.5	314.0	595.7
	BiTraDER Costs (£m)	16.2	33.1	44.8
	Total Net Benefit (£m)	**35.3**	**280.9**	**550.9**
	BiTraDER carbon savings (ktCO_2)	*70*	*1,726*	*5,693*

All financial values are in real 2025 money. NPV are discounted to 2021. Discount rate at 3.50%

5.3.1 Financial benefits

The detailed breakdown of financial benefits is described in Exhibit 5.5. The financial benefits of BiTraDER are driven primarily by reduced generation investment and avoided curtailment of renewable generation, both of which increase significantly over time as the market matures. Additional benefits arise from enhanced NESO interactions and, to a lesser extent, deferred load-related network expenditure, which materialises only in later years.

These gains are partially offset by increased curtailment of lower-cost non-RES generation – reflecting an intentional shift towards more efficient system operation – as well as upfront and ongoing platform costs. Overall, while net benefits are initially negative at SP ENW scale due to early investment requirements, they turn positive over time and deliver substantial long-term value, with materially larger gains when scaled to GB level.

Exhibit 5.5 – Summary of the Financial benefits

Scale	Benefit description	Benefit (£m real 2025, NPV discounted to 2021)		
		2030	**2040**	**2050**
SP ENW Area	Reduction in load related expenditure	0.0	2.7	3.4
	NESO interaction	1.2	4.1	6.5
	Reduced generation investment	3.2	11.4	19.6
	Reduced curtailment of RES	0.4	7.0	18.5
	Optimised curtailment of non-RES	-0.1	-1.1	-3.0
	BiTraDER total costs	-8.6	-11.5	-13.4
	Total Financial Benefit (£m)	**-4.0**	**12.6**	**31.5**
GB Wide	Reduction in load related expenditure	0.0	36.8	45.7
	NESO interaction	12.5	51.1	82.7
	Reduced generation investment	32.6	143.7	253.2
	Reduced curtailment of RES	4.8	93.2	247.6
	Optimised curtailment of non-RES	-0.8	-15.3	-40.5
	BiTraDER total costs	-16.2	-33.1	-44.8
	Total Financial Benefit (£m)	**33.0**	**276.4**	**543.9**

All financial values are in real 2025 money. NPV are discounted to 2021. Discount rate at 3.50%

5.3.2 Carbon benefits

Beyond financial gains, BiTraDER is expected to improve the utilisation of RES, displace fossil generation and generate carbon benefits. Avoided emissions are estimated assuming that avoided RES curtailment leads to higher non-RES curtailment, and this is calculated using the CCGT emission factor (320kgCO2/MWh_{el})[8]. In addition to the emissions volume, the implicit financial benefit of avoided carbon emissions is calculated, using DESNZ's latest "Traded carbon values used for modelling purposes"[9].

Exhibit 5.6 - Summary of the Carbon benefits

Scale	Benefit description	2030	2040	2050
SP ENW Area Benefits and Costs	Total Carbon savings ($ktCO_2$)	5	129	425
	Total Carbon savings (£m)	0.18	0.33	0.52
GB Wide Benefit and Costs	Total Carbon savings ($ktCO_2$)	70	1,726	5,693
	Total Carbon savings (£m)	2.35	4.42	7.02

All financial values are in real 2025 money. NPV are discounted to 2021. Discount rate at 3.50%

[8] We note it may be more likely that a 'Gas Peaking Plant' is curtailed, which have a higher emission factor. However, we used the CCGT emission factor to provide a conservative estimate of savings.
[9] https://www.gov.uk/government/publications/traded-carbon-values-used-for-modelling-purposes-2025

5.3.3 Costs

We have separated the costs into those faced by the DNO and those faced by market participants. These are outlined below with additional information provided in Exhibit 5.7:

- SP ENW costs: The costs include upfront costs associated with the investment in developing the software to operate and monitor the BiTraDER market. Additionally, there will be ongoing operating costs associated with maintaining the platform infrastructure including additional staff costs associated with increased interaction with the market participants.
- Market participant costs: These costs include the upfront costs needed for installation of ANM systems (where necessary) to interact with the BiTraDER platform (noting that the majority of market participants will already have this infrastructure). However, learning from the trials has suggested these costs will not be significant. This is primarily due to the necessary IT infrastructure largely being in place, and the ease of integrating participation systems with their current platforms.

Exhibit 5.7 – BiTraDER Cost Assumptions

Category	Assumption	Notes
Project cost for SP ENW	As per Full Submission Cost spreadsheet	This cost is for the BiTraDER NIC project
DNO IT infrastructure to support BiTraDER market	SP ENW: £250,000 Remaining DNOs: £1m	For SP ENW, this cost is assumed to be incurred in 2027. For GB-wide , one year of lag is assumed between SP ENW and the remaining DNOs; a higher cost of £1m assumed to be incurred with a one-year lag for the remaining DNOs: evenly distributed to year 2028 and 2029
Management of infrastructure and licensing costs	£200,000/year	This is an annual cost incurred for all DNOs in each future year
Participants IT infrastructure to support BiTraDER market.	£5,000 per participant 10MW of connection capacity is assumed per participant	Cost to set up and configure the interface per new participants joining to the platform each year Number of participants estimated based on based on expected G1 connection capacity in future years divided by 10MW of connection capacity assumed per participant

5.3.4 Conclusions

The results from the quantitative analysis show a strong net financial benefit alongside a significant carbon saving from the introduction of the BiTraDER platform.

This analysis has been based on a set of robust assumptions using validated data and credible assumptions. In general, conservative assumptions have been chosen in recognition of the uncertainty of future benefits forecasts. This has been especially important when considering the likelihood of each of the benefit groups – with greater caution taken where the benefit group has greater uncertainty of materialising directly from the introduction of BiTraDER. To support the assumptions we have, where possible, used the learnings and additional evidence from the Stakeholder Engagement to ensure a more accurate picture of the feasibility of the project and any decision to move towards Business-As-Usual deployment.

5.4 Evaluation against the Assessment Criteria

In Exhibit 5.8 we provide an evaluation against the assessment criteria for BiTraDER project. This evaluation draws on the learning outcomes from the project as presented in this section.

Exhibit 5.8 –Evaluation against the NIC Assessment Criteria

a) Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing customers
The results of the quantitative analysis show a strong net financial benefit from the introduction of the BiTraDER. Based on the assumptions discussed in Section 5 a net benefit of £32 million is estimated for the SP ENW region and £544 million when scaled for all the GB distribution networks. These benefits accrue primarily from the reduced need to curtail RES generation and as a result of savings from avoided generation investment. Further to the financial benefits associated with reduced RES curtailment, the BiTraDER market also results in strong carbon savings as output from conventional thermal generation is replaced by lower curtailment of RES generation.
b) Provides value for money to electricity customers
The costs of BiTraDER of £13.4 million, estimated for the SP ENW region, are significantly outweighed by the benefits of introducing the market. Costs have been purposely minimised through the design of the market – this includes the DNO acting as a facilitator of the market, leaving the ongoing operation of the market to a more experienced market coordinator. In addition, initial upfront costs for new participants have been minimised due to the use of an API for communication as opposed to SCADA-based systems. This approach also ensures that the daily costs of interacting with the bilateral trading platform will be minimised. Finally, and as identified as part of the Stakeholder Engagement, the ongoing costs of interacting with the platform would appear to be low. The platform has been designed to be familiar with other flexibility market platform, ensuring efficiency in its use.

c) Generates Knowledge that can be shared amongst all relevant Network Licensees

As discussed, the qualitative assessment the BiTraDER project, and the trials in particular, have generated substantial learning for network companies facing the challenges of increased constraints and curtailment. The substantial library of reports on the trading rules, platform design and stakeholder feedback should enable any relevant network company to understand the advantages and disadvantages of the BiTraDER market, allowing a DNO to start from a strong position if it was to develop a similar scheme. For example, the learnings provide insights about interactions across different markets and the barriers to realising the potential flexibility capacity on the system.

In addition to the extensive evidence base developed through the project, the quantitative analysis has shown that there is also a strong potential financial and environmental benefit from the introduction of the BiTraDER on a GB scale. This emphasises the relevance to wider Network licensees.

d) Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development and/or Demonstration Project to demonstrate its effectiveness

The BiTraDER project has provided an innovative approach that has tested the ability of flexible resources to trade their curtailment obligations bilaterally with others, in a transparent market independent market facilitated by the DNO.

The resulting platform and market, based on these learnings, has shown significant potential to deliver benefits to customers, SP ENW and beyond. This is reflected in the positive results of the quantitative analysis. As a result, the net financial benefits identified a business case that warranted the development of the innovation project and the funding it received as part of the Network innovation Competition.

6 Conclusions

Since the submission of the original business case in 2021, the need for the deployment of flexibility to mitigate distribution network congestion and to help address the challenges of demand for new connections, has increased alongside the continued decarbonisation of the power system. There is widespread agreement that new forms of distribution connected demand and generation will trigger a need for substantial and expensive network capacity upgrades. However, the flexibility inherent in these distributed energy resources could deliver substantial cost savings and wider benefits to connected customers.

During the period since the original business case submission there has been an increasing focus on local flexible services; including:

- Increased need to understand local constraints through stakeholder engagement for the development of the RIIO price controls and Distribution Future Electricity Scenarios (DFES), including use of the Common Evaluation Methodology (CEM) to identify the need for flexibility; and
- Further development and coordination of flexibility products led by the ENA, alongside the launch of the Flexibility Market Asset Registration (FMAR) system to reduce administrative burden of multiple registration.

This project had shown that BiTraDER can be part of the solution to these issues by allowing new and existing customers on curtailable connection contracts the opportunity to trade their obligations bilaterally, thereby reducing their overall risk of being curtailed. For example:

- The qualitative learning through the trials and stakeholder engagement identified a strong interest in the market, and we would expect increased liquidity leading to greater diversity of technology types and participants that should make trades more likely; and
- The results of the quantitative analysis show a strong net financial benefit from the introduction of the BiTraDER. These benefits accrue primarily from the reduced need to curtail RES generation and savings from avoided generation investment.

Annex A Review of the Trading rules

This section provides an overview of the work undertaken to review the Trading Rules.

A significant amount of work has been undertaken on the BiTraDER project including Mini-Trials, Simulation and Live Trials. Annex A of the CBA Report provides an overview of how these findings have impacted on the development of certain building blocks of the trading rules since the publication of the 'BiTraDER Trading Rules Report' in 2023.

The focus of this review is on the potential impact of 'Nested Constraints' and reviewing the impact of 'Alternative Payment Structures'.

A.1 Qualitative review of Nested Constraints

In the 2023 'Trading Rules' report we identified a set of potential limitations that would be reviewed on an ongoing basis. Following the complete of the 'Simulation Trials' and ahead of the 'Live Trials' it was necessary to review the process for addressing nested constraints in the trading platform.

As identified in the 'Trading Rules' report as demand and generation increases on the network, the number of constraints will increase, and this is likely to lead to more nested constraints. We identified the following potential issues that may arise from nested constraints:

- Sellers not useful: Despite trading there is the potential that a Buyer would not avoid curtailment. In the payment structure which includes an availability payment, the Buyer will still have to pay an availability payment to the Seller, despite the fact that Buyer did not avoid being curtailed and the Seller could not help with the binding constraint.
- Buyer off the hook for the constraint: It is possible that the Buyer would still need to pay the Seller the utilisation payment even though the Buyer was not 'on the hook' for a specific nested constraint.

Following the review, it was decided to delay the decision on that the extent to which this design choice would be tested until the trials. This choice could then be made in discussion with market participants and following a more detailed understanding of the likelihood of nested constraints becoming a live issue in the short to medium term.

A.1.1 Revisiting the Options

To understand the continued impact of this potential issue we hosted a trading rules Workshop alongside the BiTraDER Project Partners. The outcomes of this workshop are set out below.

At a high level we identified that it remains acceptable (in line with the 2023 Trading Rules report) that nested constraints are not formulised within the Trading Platform at this stage – this is due to the low risk of occurrence and subsequent impact on the operation of the scheme. However, to ensure this remains the case it will be important to continue to monitor the following assumptions:

- Trades are only allowed for those constraints which are identified by the look-ahead, between a sub-set of parties who can solve that constraint.
- Utilisation payment is only made if the seller is called on to deliver (and actually delivers).
- There is no need to withhold the availability payment if the seller was unable to deliver due to a nested constraint (different rules for non-delivery).
- The curtailment index for the buyer is updated to reflect any delivered curtailment which is delivered by the seller on its behalf.

Given the scope of the 'Live Trials' (e.g. to reflect the current network conditions) the outcomes did not highlight issues related to nested constraints. It is likely that this may only become a material problem in response to a significant increase in the levels of generation / demand connections. As BiTraDER is moved to Business-As-Usual it will be important for the impact of Nested Constraints is monitored – including ongoing feedback from industry stakeholders – to ensure solutions are put in place where necessary.

A.1.2 Summarising the option

In Exhibit 6.1 we summarise discussions in relation to the potential impacts of 'Nested Constraints'. Initially we present the findings identified in the Trading Rules Report, and subsequently we consider the additional findings from the Simulation and Live trials.

Exhibit 6.1 – Development of discussion

	Summary
Trading Rules Report 2023	
Nested Constraints	As identified in the 'Trading Rules' report as demand and generation increases on the network, the number of constraints will increase, and this is likely to lead to more nested constraints. These constraints led to two potential impacts. First, a situation whereby sellers are not useful and despite trading there is the potential that a Buyer would not avoid curtailment. Second, a situation whereby the Buyer would still need to pay the Seller the utilisation payment even though the Buyer was not 'on the hook' for a specific nested constraint. Given the low likelihood of a nested constraint, it was decided to revisit the discussion and potential impacts during the trial stage of the project.
2026 Review	
Nested Constraints	At a high level we identified that it remains acceptable (in line with the 2023 Trading Rules report) that nested constraints are not formulised within the Trading Platform at this stage – this is due to the low risk of occurrence. However, as BiTraDER is moved to Business-As-Usual it will be important for the impact of Nested Constraints is monitored – including ongoing feedback from industry stakeholders – to ensure solutions are put in place where necessary.

A.2 Qualitative review of alternative payment structures

For this part of the review, we have qualitatively re-assessed the accepted and rejected 'pricing structures' discussed in the Trading Rules design based on further stakeholder discussions and trial outcomes.

A.2.1 Payment Structure

There are several possible approaches for structuring payments between buyers and sellers, including: matching trades based on submitted prices; and determining the price paid by the buyer to the seller from the submitted bids and offers.

As presented in the Trading Rules report we initially considered three alternative options for the BiTraDER payment structures. We based the availability of an asset; payments based on utilisation of the asset; or a combination of both. However, following engagement with participants during the mini and simulation trials it was agreed that would not take forward the 'utilisation only' payments as an option. Participants had stated that that detailed information around the risk of curtailment occurring would be required to allow them to price an 'utilisation only' payment.

As there has been no change in this respect we continue to believe an availability only option would significantly impact on the participation and success of the BiTraDER platform. However, for completeness this option is reviewed again below.

Therefore, as part of this review we will again consider the remaining two options put forward in the Trading Rules Report.

A.2.2 Understanding the options

As part of the Trading Rules design, we explored three options for determining the price paid by the buyer to the seller. These options are based on the current approaches take within existing electricity markets at this time and are familiar to market participants. As a result, we continue to believe the two approaches remain the most appropriate approach for the BiTraDER platform.

- Option A: utilisation payment only (pay as clear);
- Option B1: availability and utilisation payment with matching based on buyer's highest total bid and seller's lowest availability (pay as bid / offer); and
- Option B2: availability and utilisation payment with matching based on buyer's highest total bid and seller's lowest total offer (pay as bid / offer).

In the sections below we will summarise the option before providing an assessment across the different options. This assessment will consider the arguments put forward in the Trading Rules Report alongside any learning from the trials identified in this study.

A.2.2.1 Option A: Utilisation only (pay-as-clear)

Under this option buyers and sellers only submit one price component as part of their bid/offer; a utilisation payment in £/MW/hour. This payment will only be paid if the seller is asked to change its output due to a constraint.

Under this option price paid is 'pay as clear' and is determined by the bid of the marginal trade match. The clearing price could either be the marginal bid, the marginal offer or somewhere in-between. As a result, participants, except for the marginal bidder, would get a surplus / discount compared to what they were initially willing to offer/bid.

A.2.2.2 Option B1: Matching based on buyer's highest total bid and seller's lowest availability

Under this option buyers and sellers submit two-part price bids and offers consisting of an 'all-in' price (availability + utilisation) and the separate availability payment component.

Once submitted the trading algorithm will sort bids based on their 'all-in' price (availability + utilisation) from highest to lowest. Then, for the highest 'all-in' bid, qualifying offers will be identified (if two bids are equal, the asset higher up in the curtailment queue gets matched first). In this option the offers with the lowest required availability payment first. If there are multiple offers with the same availability price, the matching algorithm will pick the offer with the lowest 'all-in' price. Offers qualify if:

- the buyer's 'all-in' bid (availability + utilisation) ≥ the seller's 'all-in' offer; and
- the buyer's maximum availability bid ≥ the seller's required availability offer.

Under this option, payment is a combination of pay as bid and pay as offer. Sellers get paid the 'all-in' price as bid by the buyer, but the availability price as offered by the seller. The utilisation payment is therefore the buyer's 'all in' bid minus the seller's availability offer.

A.2.2.3 Option B2: Matching based on Buyer's highest total bid and Seller's lowest total bid

Option B2 offers a similar structure to that described in Option B1. Again, this option buyers and sellers submit two-part price bids and offers consisting of an 'all-in' price (availability + utilisation) and the separate availability payment component.

Bids will again be based on their 'all-in' price (availability + utilisation) from highest to lowest. Then, for the highest 'all-in' bid, qualifying offers will be identified (if two bids are equal, the asset higher up in the curtailment queue gets matched first).

However, in this case, offers will be matched first on the lowest 'all-in' offer first. If there are multiple offers with the same 'all in' offer, then the matching algorithm will pick the offer with the lowest availability price. Offers qualify if:

- the buyer's 'all-in' bid (availability + utilisation) ≥ the seller's 'all-in' offer; and
- the buyer's maximum availability bid ≥ the seller's required availability offer.

Under this option payment is a combination of pay as bid / pay as offer but it is different from option B1. But in this option the sellers get paid the 'all-in' price and the availability price as offered by the seller. The utilisation payment is therefore the seller's 'all in' offer minus the seller's availability offer.

A.2.2.4 Preferred Option

Following further detailed review and engagement with participant it was decided that the trading rules for the platform design and subsequent trials would be based:

- Buyers: Submit an availability and utilisation price – based on the maximum they are willing to pay. Bids are ordered by the 'all in' bid (availability + utilisation) price and the higher the 'all-in' price the greater the possibility of matching.
- Sellers: Submit an availability and utilisation price – based on the minimum they are willing to pay. Offers are then prioritised on the basis of the lowest 'utilisation price' first and then the lowest 'all-in' price. Offers are then accepted if the required availability is less than the maximum buyer availability price and the all-in offer is below the buyer 'all-in' price.

A.2.3 Summarising the options

In Exhibit 6.2 below we summarise the key pros and cons between Option A and Option B1 / B2. Initially we present the findings identified in the Trading Rules Report, and subsequently we consider the additional findings from the Simulation and Live trials.

Exhibit 6.2 – Pros and cons of the options

	Summary Option A	Summary Option B1 / B2
Trading Rules Report 2023		
Pros	Trade matching is a simple concept to understand. Having a market based solely on a utilisation payment reduces some of the externalities in the case of nested constraints. Clearing price allows for price discovery.	Availability and utilisation payment included. Customer feedback has suggested an availability payment would help more sellers participate in the market.
Cons	Does not incorporate an availability payment, which (based on customer feedback) may discourage some sellers from participating in the market.	Trade matching more complicated to understand. Trade matching does not always produce the optimum matching of trades. The lowest cost seller may not always clear, and trade matching may not lead to the greatest societal value from all trades being extracted
Cost Benefit Analysis 2026		
Pros	Participants did state that a utilisation only could have advantages in a market with greater liquidity. This would come in the form of a simpler approach to developing bids and offers and a may enable participants to anticipate the bids / offers of other sellers, thus increasing the likelihood of matching.	Participants continue to believe that this pricing structure should be maintained – due to increased robustness and flexibility (and the two-pricing structure). This approach also leads to greater revenue certainty which is important given both the immaturity and low levels of liquidity in the market at this stage.
Cons	The likelihood of a constraint binding and the subsequent curtailment remains low. Therefore, participants continued to favour an availability payment in order to make engagement with the market economic (e.g. to compensate for the resources required to submit bids). However, it will be important to continue to return to this question as liquidity in the market increases.	The combined approach to pricing increased the difficultly of participants in price discovery (although this was only a contributing factor to the overall issues linked to liquidity, reflecting actual market conditions and accounting for how different participants operate). It was necessary to provide guide prices to participants in order to ensure matches - however, this diluted the real-world impacts.

A.3 Additional Market Design Choices

In addition to the bid / offer structure we have concerned to impact of other market design choices discussed during the trial period. These choices are linked to ability of participants to accurate understand the value of participating in the BiTraDER market at any point in time. These were raised with the intension of attempting to mitigate the risks linked to the levels of liquidity.

- **Gate Closure**: As part of the initial trading rules design the gate closure was set in the morning of the day prior to the 'constraint day'. The intention here was to give participants sufficient time to make necessary operational changes reflect a new position in the curtailment merit order.

  However, as part of the trials some participants identified that the current gate closure position impacted on their ability to operate in other markets. This could potentially leave them exposed to other contractual and energy delivery obligations. And since the potential revenues available in the BiTraDER market are lower than other markets these participants would either not participate or include a large premium to bids/offers to mitigate this risk.

  As a result, it was agreed during the live trials that the gate closure position would be moved. This new position was tested and considered an improvement. As a result, this will be taken forward into BAU.

- **Bid/Offer Visibility**: As part of the initial trading rules development, it was assumed that the participant bid and offers should be private (except in the case of a bid/offer match) to protect strategies and commercial positions. However, as part of the trials it became evident that there were significant differences in the pricing strategies being operated by the different participants. This was driven by the different operations of participants and their interaction with other markets (e.g. both energy and ancillary).

  Given that this design choice had not been explored in depth and the case for change not convincingly made, it was decided not to change the rules for the trials on a forward-looking basis. However, as a mitigation it was decided that at the end of each trial day, we would share with participants all bids and offers on an anonymised basis. It was decided that this would have limited impact on the future trials (and potential bias and learnings linked to price discovery) given each trail day based on a different type of 'constraint use case'.

  Going forward it is recommended that this design choice is considered in more detail prior to BAU roll-out. Initial discussions with participants identified advantages linked to the ability to understand other participant positions and increase the change the matching while the liquidly improves. But both the potential commercial impacts as well as potential unintended consequences on the market in the long term remain a risk and must be considered in more detail and in consultation with all participant groups, before any change is made.

A.4 Conclusions

This end of project review of the Trading rules considered the outstanding issues from the initial trading rules report. This primarily covered the impact of 'nested constraints' on the market, and increasingly more importantly from a stakeholder perspective, the liquidity and revenue certainty within the market.

For 'Nested Constraints' it was viewed unlikely to have an impact in the short-to-medium term given the types of constraints currently faced on the network. It may only become a material problem in response to a significant increase in the levels of generation / demand connections. As BiTraDER is moved to BAU it will be important for the impact of Nested Constraints is monitored and solutions are put in place where necessary.

As mentioned above the design choices surrounding market 'liquidity' and 'revenue certainty' were the priorities identified through the project by the participants. These concerns revolved around the level of liquidity and revenue certainty in this new and immature market. Therefore, for this review we have focussed primarily on the bid/offer structure to help review and improve where necessary the ability of participants to engage with the market, while reducing the risk of any adverse impacts on the day-to-day operations.

In the end and following the completion of the stakeholder engagement and market trials, there was very little evidence to move away from the agreed two bid structure. Participant continued to believe that in the short-to-medium term, and given the fundamentals of this market, there was lower risk and greater revenue certainty in this approach. However, this issue should remain under review, as the benefits of a single price could simplify the market as liquidity improves and participants become more familiar with their own strategies and the strategy of other participants.

Through the stakeholder engagement and trials, we were able to make direct changes (e.g. timing of gate closure) to the trading rules to improve allow participants to more accurate develop a strategy for BiTraDER alongside the other markets and operational obligations that already have.

Finally, and following the completion of the trials, design choices not raised during the initial development have been identified. These choices, such as increased visibility of trade, were discussed as a mitigation to try and improve trade matching while liquidity remained. Therefore, prior to deployment into BAU we believe there would be a benefit in further discussion with participants to understand the potential pros and cons of increasing bid/offer visibility for all participant types. And identifying whether this can be a short-term mitigation or would lead to longer term unintended consequences.

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