electricity north west

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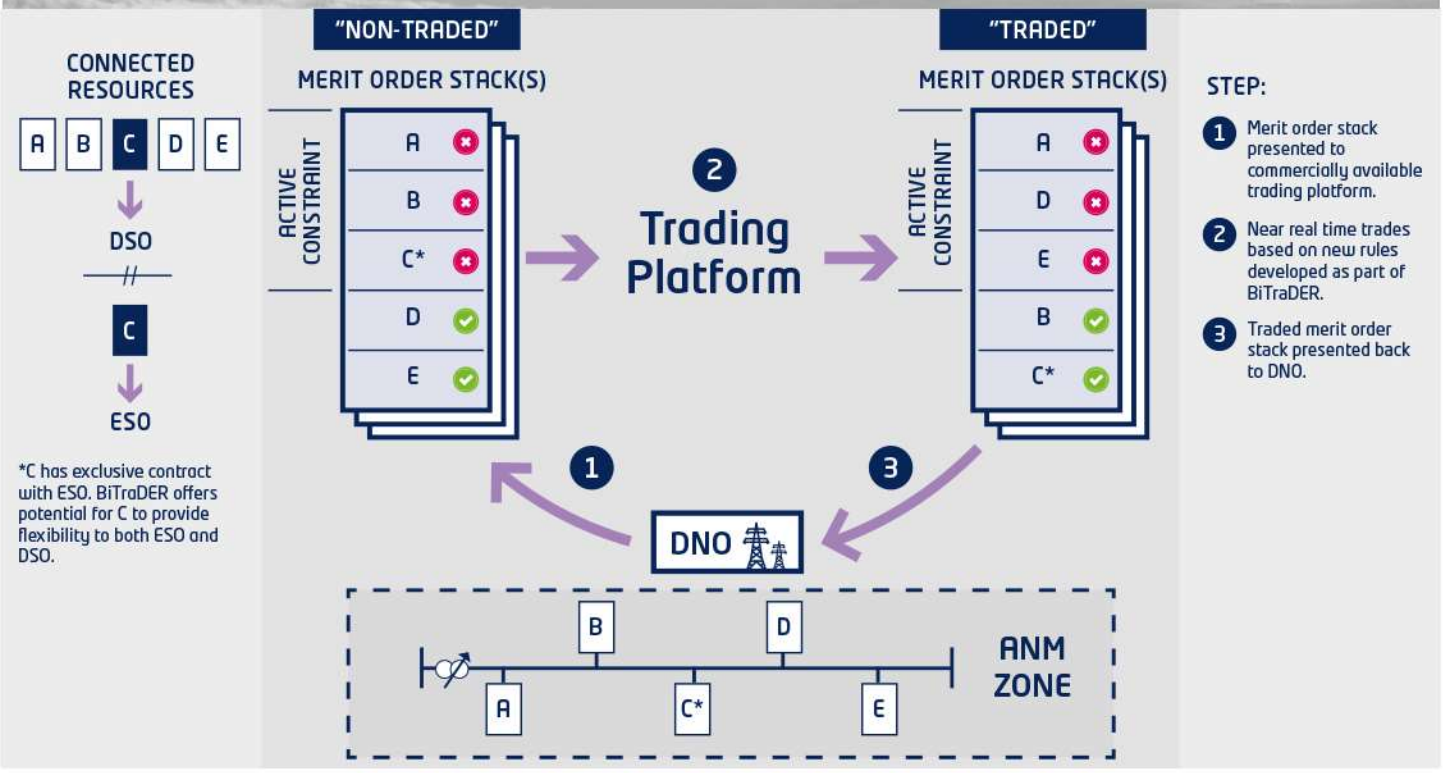
BiTraDER

Deliverable 5

Simulation Trials Report

May 2025



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Glossary

ANM	Active Network Management - The use of distributed control systems to continually monitor network limits, and provide signals to curtailable connections or flexible services to modify outputs in line with these limits
API	Application Programming Interface – A type of software interface between two systems
'All-in' Price	The maximum total price a buyer is willing to pay to avoid curtailment and the minimum total price a seller needs to be paid to take on a curtailment, summing availability and utilisation payment components
Availability Price	The price a buyer is willing to pay, or a seller is willing to offer to be available regardless of whether a constraint occurs or not
Baseline	The point from which any delivery of flexibility is measured
BaU	Business as Usual
'Buyer'	Party buying the ability to transfer their curtailment obligation to another connectee and accept a more favourable position in the merit order list
Connectee	Any individual or company connected to the electricity distribution network
Constraint	A demand greater than network ratings or voltage outside statutory limits. In this definition demand is used in the context of the load on the network (including generation).
Curtailable connection	Connection arrangements which allow Electricity North West to signal, in real time, a curtailment of demand or generation when there are network overloads or restrictions affecting the network local to the connectee whilst the network is operating in an intact, system normal state. Connectees will generally be given a curtailable connection where offering a non-curtailable connection would require network reinforcement which has cost and time implications on them being connected
Curtailment	The turning off, or down, of a connectee's import or export to alleviate a constraint based upon contracted and agreed principles of available capacity
Curtailment obligation	The requirement for a connectee to provide curtailment. The specific details of this requirement will be stated in their connection agreement
DNO	Distribution Network Operator - An organisation that owns, operates and manages the electricity infrastructure that distributes electricity from the transmission network operated by NESO, to end users (commercial and domestic properties).
DER	Distributed Energy Resource – Demand and generation assets that are embedded within the distribution network
ENA	Energy Networks Association
ENWL	Electricity North West Limited
Flexible services	Services purchased from a flexible service provider to provide demand turn down, and demand turn up to alleviate network constraints. These services are used to defer and avoid reinforcement, as well as to allow other customers to connect faster and cheaper to the network and can be provided from demand or generation

FSP	Flexible Service Provider – A demand or generation connectee providing flexible services to either the wholesale market or to the DNO and NESO
Flexibility	The modification of generation injection and/or consumption patterns, on an individual or aggregated level, often in reaction to an external signal, to provide a service within the energy system
kW	Kilowatts
MOL	Merit Order List – A list of connectees in a specific order for the ANM system to action
MW	Megawatts
NESO	National Energy System Operator – An organisation that monitors, controls and actively manages the power flows on the electricity transmission network to maintain a safe, secure and reliable electricity supply. NESO is a natural monopoly in the flexibility market, acting as a neutral facilitator
NIC	Network Innovation Competition
Non-curtailable connection	Under system normal conditions, a connection which is planned and operated such that it should not be curtailed; however, it may be curtailed in the event of the loss of any one or more elements (e.g. an overhead line route, a transformer, an underground cable)
ON	Open Networks – An initiative with input from networks and wider industry stakeholders to transition to a smart, flexible energy system ready for net zero.
PPA	Power Purchase Agreement
Peer to peer trading	Trading between connectees, independent of the DNO or NESO
'Seller'	Party selling the ability to accept a curtailment obligation from another connectee, within the limits of their connection agreement
Service Fulfilment (%)	Compares the seller's delivered volume against the instructed volume to calculate the settlement and payment

Executive summary

This report is the fifth deliverable for the BiTraDER (Network Innovation Competition) NIC project which is being delivered by Electricity North West Limited (ENWL) and its partners. The aim of this report is to explain the project progress to date, with a specific focus on the framework developed and learning outcomes from the simulation trials.

It builds upon the previously delivered and published report for the BiTraDER project:

1	BiTraDER Customer Engagement and Trading Scenarios	30/11/22
2	BiTraDER Trials Plan, Trading Rules and Initial Specification Report	30/06/23
3	BiTraDER Trading Platform Design	03/09/24
4	BiTraDER Architecture Build Lessons Learned Report	10/03/25

The main objective of the BiTraDER project is to demonstrate how access to a neutral market allows connected resources to trade their obligations bilaterally, encouraging more of them to offer flexible services, increasing availability of flexibility and thereby reducing whole system costs.

The project currently remains on track to meet its aims, objectives, and all deliverables outlined within the full submission.

This report gives an overview of the project and provides a short context to each stage of the trials phase. It then discusses in further detail the tasks completed and progress made throughout the simulation trials, including the lessons learnt.

1 Introduction

As part of the UK's journey toward net zero, Distribution Network Operators (DNOs) are experiencing an increase in requests by customers to connect low carbon, renewable energy sources to the network. These connections can cause network constraints which are usually resolved through expensive, time-consuming and disruptive network reinforcement.

As a more cost-effective solution, DNOs have introduced curtailable connections and flexible services which, when used alongside advanced network automation algorithms such as Active Network Management (ANM), can control the customer's generation or demand output in real-time to resolve constraints.

Curtailable connections allow customers to connect to the network without the need for traditional reinforcement. Therefore, these connections are lower cost and can be delivered within shorter timescales than a 'non-curtailable' connection. When accepting a curtailable connection, a customer accepts the obligation to curtail their asset's export or import, in response to a request from the DNO, under certain network conditions. This is referred to as a 'curtailment obligation' and the specific details are stated in the customer's connection agreement.

Although these connections are lower cost and quicker, many customers are hesitant to accept them due to the inherent risk of being curtailed, and the associated commercial risk. Instead, some customers prefer to pay more and wait for a non-curtailable connection with negligible risk of being curtailed. In the case of low carbon generation such as solar, owing to the high capital investment required to establish the facility in the first instance, customers need certainty of a high in-service utilisation factor, meaning they are particularly sensitive to the risk of curtailment and much less likely to accept a curtailable connection.

Additionally, customers can provide a 'flexible service' to the DNO by agreeing to increase generation output, or reduce demand, at times defined by the DNO in exchange for remuneration. Owing to the long-term commitment associated with a flexible service contract, some customers are similarly hesitant to offer this. The commitment can be perceived as a barrier if customers are unable to meet the contract requirements over a prolonged period of time (i.e., a year).

BiTraDER seeks to allow new and existing customers to mitigate the risks associated with curtailment obligations by enabling customers to trade their curtailment obligations bilaterally. BiTraDER will also provide an opportunity for customers to participate in flexibility on an 'ad hoc' basis, removing the risk associated with long term contracts and boosting liquidity in the market.

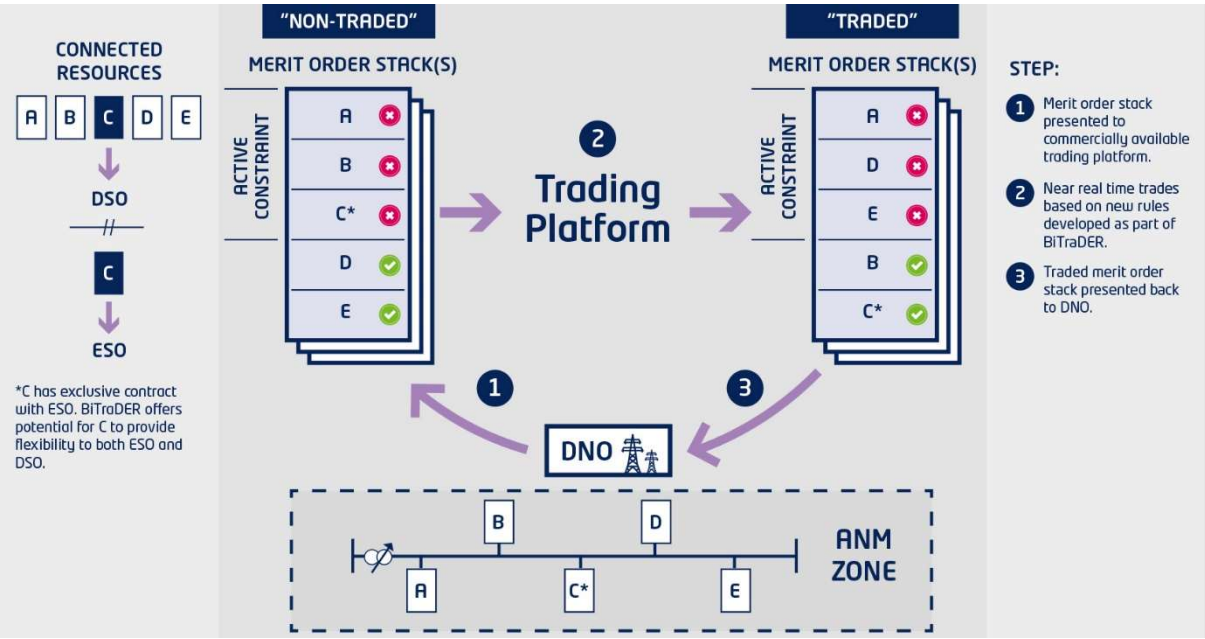
2 Overview of BiTraDER

BiTraDER will investigate, design, build and trial – on our live network – a brand new and highly innovative market allowing resources connected to the distribution network to trade their curtailment obligation bilaterally.

The project will assess current and future customers' appetite for bilateral trading, determine the data requirements to support operation of the market, design the interfaces needed to present all necessary information to the trading platform, develop the bilateral market trading rules determining what is and isn't a valid trade, explore the market's ability to operate in near real-time, and determine the functionality required to return the output of the market to the DNO and National Energy System Operation (NESO) systems for execution in real time.

BiTraDER is designed to facilitate independent trading, therefore ENWL will provide the necessary information to the market and receive the output of the market after close of trading. The project will examine the role of the market administrator and propose who might be best placed to operate the market in Business as Usual (BaU). Figure 1 shows the high-level illustration of the trading process as per the BiTraDER full submission.

Figure 1 BiTraDER illustrative method



BiTraDER will be completed in six phases, over a four-year period:

1. *Customer engagement* – engagement and recruitment of customers to inform the design of the trading rules and platform, during the design phase, and to participate in trading during the simulation and live trial phases.

2. *Design* – development of the core trading scenarios, market principles and trading rules, including validation and practical challenges associated with enabling trades. Design of the trading platform and end to end data architecture, taking into account cyber security and other associated risks. Capture of the technical requirements and the interface considerations for integrating the trading platform with the ENWL systems.

3. *Build* – build and test of the trading platform and data architecture using the outputs of the design phase. The acceptance criteria for testing will be developed during the design phase.

4. *Simulation trials* – a series of tests will be run using simulated network models and customer assets, allowing customers to participate in simulated trading of their curtailment obligations.

Following the simulation trials there is a 'Stage Gate' which provides the opportunity to ensure that the plan for implementation of the live trial is both reasonable and deliverable within the constraints of the approved project. Should the project pass the stage gate we will move to the live trial phase, otherwise we will progress immediately to project closedown and BaU transition.

5. *Live network trials* – a live trial of trading covering a specific area of the ENWL network, including the curtailment of assets connected to our network.

6. *Closedown and BaU transition* – analyse the costs and benefits of BiTraDER and produce a closedown report for dissemination. Develop the process for transition to BaU, provide training to internal planners and operational engineers on all new codes of practice, and publish a functional specification for BiTraDER.

3 BiTraDER trials

There are three stages of trials for BiTraDER, all of which are in the project plan including the mini trials which were an additional testing stage added to the original submission.

i. *Mini trials:* A one-day workshop ran on January 31 2024.

ii. *Simulation trials:* Ran from October 2024 to May 2025.

iii. *Live network trials:* Scheduled to run from June 2025 to January 2026 (subject to passing the stage gate).

3.1 Mini trials

As described in the BiTraDER Trading Platform Design report, the mini trials were added as an additional stage after completion of the trading rules design. The purpose was to de-risk the rules by carrying out some manual trading scenarios with a set of experienced participants which included asset owners, operators and aggregators.

In total seven participants attended the event and provided useful feedback for the project team to consider before commencing the BiTraDER system build:

- *Payment structure:* An availability payment was unanimously favoured to accompany the utilisation payment when submitting trades. The availability and utilisation price are then added together to form an 'all-in' price.

- *Baselining:* Along with a self-declared option, additional methods to determine day ahead baselines were requested. In response, the project team have opted to allow participants during future trials to use the (Energy Networks Association) ENA Open Networks (ON) flexibility baselining tool.

- *Concerns around liquidity:* The main concern that was highlighted to the project team was a concern on the number of assets that would be available to trade in the market.

3.2 Simulation trials

The simulation trials saw an initial prototype of the trading platform built to enable a series of trading scenarios, using simulated constraints sent via an Application Programming Interface (API) from an ENWL ANM test environment known as the ANM orchestrator.

The ANM orchestrator has ten in-built look-ahead and merit order lists (MOLs), using fabricated assets. Each list has a configurable timestamp ready to send out to a group of trial participants.

The constraints in the look ahead lists are of varying magnitudes and include both import and export over hourly time periods.

The half hourly MOLs contain ten assets per look ahead constraint, each having an associated 'Contract Operation Type', to determine whether an asset is a buyer or a seller and what service that asset can provide.

For BiTraDER buyers, there are two contract types:

- Constrained Demand – a flexible ANM connection whose import can be curtailed.
- Constrained Generation – a flexible ANM connection whose export can be curtailed.

For BiTraDER sellers, there is one contract type:

- Flexible Output Change – a non-curtailable connection who can provide a service to mitigate the constraint such as demand turn down or generation turn up.

Using an API, the trading platform will receive the lists from the ANM orchestrator and notify the trial participants of opportunities to trade. Once trading has taken place, the ANM orchestrator will receive the new traded MOL for each applicable half hourly trade period.

In a live network environment, should the constraint occur, the live ANM system would curtail assets based on the new MOL. Since this is a simulation environment, there won't be any live constraints taking place, the volume delivered, performance delivery and service fulfilment will be calculated manually using an excel based calculator tool.

To ensure that the simulation trials reflect how the market will operate in BAU, the lists are sent to the platform for constraints occurring the next day, in line with the day ahead market mechanism. Trial participants will have a two-hour window to trade before a conceptual gate closure limits further trades.

The project team and trial participants will have a meeting the next day to discuss the outcomes of the trade, which will include a visual presentation of the old and new MOLs, to gain an understanding of the implications and benefits of participating in BiTraDER.

Further details of the orchestrator, API and simulated look ahead/MOLs can be found in the BiTraDER Test Plan report.

3.3 Live trials

The live network trials will provide the opportunity to test the BiTraDER market under real network conditions with real money changing hands.

To enable this, further upgrades to both the trading platform and the live ANM system will be required.

The trading platform will need to perform additional steps in the end-to-end process such as trade verification, dispatch and settlement. This is discussed further in the BiTraDER Trading Platform Design report.

The upgrades applied to the ANM orchestrator will be transferred to the live ANM system and integrated with the trading platform. The integration process will need to take account of cyber security, and a robust testing regime will be required to ensure the new interface functions correctly and safely.

Due to the uncertain nature of demand and generation, it is impossible to guarantee constraints will manifest on the network and they may need to be simulated. It is important to note that even if the constraint is not real, the actions and consequences will be, allowing customers to understand how trading impacts them and whether this affects their appetite to trade.

To enable the live trials, there needs to be a high level of both existing demand and generation customers on the same part of the network, however meeting this requirement has thus far proved challenging. To address these challenges and facilitate the live trials the project team is exploring two options:

1. Utilising universities who are connected onto the ENWL network and have multiple assets. Each asset selected for participation by a university could be connected via a virtual network built within the live environment and a trading scenario could then be built up based on the type and size of assets signed up.

2. Utilising Electron's FSP register for flexible services to reach out to existing connected assets within the ENWL network. Again, it is likely that assets would not be connected within the same part of the network but could be connected via the virtual network to participate in the trade.

Through the utilisation of the above approach, a realistic trading scenario could be constructed which would enable a controlled live trade, albeit through a simulated constraint. Although the network would be virtual, the outputs from the assets connected would be live. The participants from their perspective, would see no difference between this setup and a live trade in BaU. The trade would be realistic and would enable the full end to end process including dispatch and settlement to be tested.

The engagement for both options is positive and there are several assets who have already shown interest in participating in the live trials. Thus, the project team is preparing to recommend to Ofgem that the project passes the stage gate and live trials will begin later this year, following updates to the trading platform and live ANM system.

4 Simulation trials in depth

The developments in the design and build phases, along with the learnings from the mini trials workshop have enabled the project team to proceed as expected with the simulation trials. This section provides a more detailed overview of the framework developed and subsequent learning outcomes from the simulated trades.

4.1 Structure and timeline

The simulation trials were designed to be held twice a month, with participants submitting trades online. A remote meeting was then held after the trade to inform participants of the result and provide more information on the outcome.

This structure was chosen to emulate a BaU trading scenario and its timings. The structure also allowed the BiTraDER team to incorporate customer feedback from earlier trial scenarios into later scenarios. Figure 2 shows the expected timelines of each trade throughout the simulation trials phase.

Figure 2 Trade structure and timelines

	Timing	Summary
Trade windows	First and third Monday of each month between November 2024 and April 2025 between 14:00 – 16:00. *Excluding bank holidays and pending team availability*	Participants will receive a constraint notification and will have two hours during the trading window to submit bids and offers.
Optional drop-in session	A 30-minute period during the trade window	Optional session to allow customers to ask questions as they submitted their trade.
Trade result and Teams meeting	First and third Tuesday of each month (the following day after the trade window) between November 2024 and April 2025 between 14:00 – 16:00. *Excluding bank holidays and pending team availability*	Along with announcing the trade result, some of the meetings will have a discussion theme about aspects of BiTraDER.

4.2 Trading scenarios

There were 10 planned trades in total, each designed to reflect different network and market conditions. This would provide participants with a greater understanding of the different use cases in BiTraDER, highlighting the intricacies of the market.

The different variables of a constraint are:

- If the constraint occurs.
- The magnitude of the constraint if it does occur.
- When the constraint happens during the trade period.
- The constraint direction (import or export).

The ANM look ahead predicts constraints through short term historical data and therefore they are not guaranteed to happen. Should the constraint not happen, the availability payment would still be due from buyer to seller and participants should factor this into their trades. Similarly, the magnitude may be lower than expected, further preventing utilisation of the sellers.

Alternatively, the magnitude may be higher than expected, sometimes to the point where buyers could still be curtailed even though they may have traded their curtailable capacity. This is because curtailable assets still sit within the curtailable section of the merit order list even after trading.

Once a constraint occurs, the ANM will dispatch the necessary assets to curtail their outputs. This dispatch can start and stop at any point within a half hourly trade period and not necessarily on the hour or half hour. Testing this allowed us to demonstrate how the settlement process works for more complex instructed volumes.

Figure 3 shows the context of each of the 10 simulated constraints. Further details including the look ahead/MOLs for each constraint can be found in the BiTraDER Test Plan report.

Figure 3 Trade list and context

Constraint Number	Network scenario	Magnitude	Timing
1	Too much demand on a HV feeder causing a thermal import constraint.	Constraint occurs as expected. 2MW import.	Occurs at the start of the trade period and stops at the end.
2	Too much generation on a HV feeder causing a thermal export constraint.	Constraint occurs as expected. 3.5MW export.	Occurs at the start of the trade period and stops at the end.
3	Severe weather causes an import constraint on a HV transformer incomer.	Constraint occurs as expected. 5MW import.	Occurs at the start of the trade period and stops at the end.
4	Severe weather causes an import constraint on a HV transformer incomer with curtailment index update.	Constraint is less than expected. 5MW import.	Occurs at the start of the trade period and stops at the end.
5	Severe weather causes an export constraint on a transformer incomer.	Constraint is more than expected. 4.6MW export.	Occurs at the start of the trade period and stops at the end.
6	Severe weather causes an export constraint on a transformer incomer with curtailment index update.	Constraint doesn't occur.	N/A

7	Network topology changes on a BSP network due to a fault causes an export constraint.	Constraint occurs as expected. 10MW export.	Constraint occurs midway through the first trade period and stops midway through the second.
8	Network topology changes on a BSP network due to a planned supply interruption causes an import constraint.	Constraint occurs as expected. 8MW import.	Constraint occurs midway through the first trade period and stops midway through the second.
9	One upstream and one downstream import constraint (nested) occurs together – sellers get curtailed	Downstream (nested) constraint occurs only as expected. 2MW import.	Occurs at the start of the trade period and stops at the end.
10	One upstream and one downstream export constraint (nested) occurs together – buyers get curtailed	Downstream (nested) constraint occurs only as expected. 5MW export.	Occurs at the start of the trade period and stops at the end.

Once the trade period had finished, the team held a post trade meeting with the participants to discuss the outcomes of the trade including a summary of all the bids/offers submitted and further explanations on why the results occurred as they did.

Certain meetings covered the outcomes of the trade only, whilst others went more in depth on certain aspects of BiTraDER. The different content of each post trade meeting can be seen below in figure 4.

Figure 4 Post trade content

Constraint Number	Post trade meeting content
1	Trade outcomes Curtailment index
2	Trade outcomes
3	Trade outcomes Multiple contract order in the MOL

4	Trade outcomes Look ahead and trade verification
5	Trade outcomes
6	Trade outcomes
7	Trade outcomes Volume traded calculation
8	Trade outcomes Volume traded calculation
9	Trade outcomes Nested constraints
10	Trade outcomes Future developments

The curtailment index content covered the methodology on the resultant decrement of the curtailment index post trade. This is important to ensure that participants understand how buyers who participate in BiTraDER have a reduced likelihood of being curtailed the next time the constraint occurs should the seller they have traded with be curtailed.

The MOL content covered how multiple contracts between assets on the same site could occur with different security of supplies. An interesting use case shown in figure 5 is if an asset is curtailable under system abnormal connection but wants to enter its capacity into the flexible services market during a system normal constraint. In the example below, Asset 1 will provide a flexible service of 400kW demand turn down under a system normal constraint and will be paid by the DNO to do so. If the constraint magnitude is larger than the system normal threshold and encroaches onto the system abnormal, the asset will be curtailed down to 0kW and will not be paid to do so.

Figure 5 Multiple contracts in the MOL

Order	Resource ID	Contract	Value	Registered Capacity (kW)	Instruction	Security of Supply
1	Asset 1	Flexible service	-400	800	Drop by 400MW	Normal
2	Asset 1	Constrained demand	0	800	Drop to 0MW	Abnormal

The look ahead list was showed to participants and a discussion held on how the predicted constraints are verified on the day to check whether the trades are still valid.

Finally nested constraints were covered which highlighted what would potentially happen if an upstream and downstream constraint occurred on the same area of network occurs within the same trade period.

The methodology for handling nested constrains was reviewed during this stage by the project team. The outcome of this was that the original methodology still stands as is indicated in the BiTraDER Trading Rules report. That is by compensating the buyer through curtailment index decrementing should the buyer be curtailed and the seller not be able to provide a useful service.

However, ongoing conversations will take place with stakeholders throughout the project on market irregularities such as nested constraints and rules around under/over delivery which will be used to inform market operators in BaU.

4.3 Customer engagement

4.3.1 Outreach

The outreach for the simulation trials was conducted through two separate streams. Through the existing customers who attended the mini trials workshop and through potential new customers.

The seven customers who attended the mini trials workshop proved to be valuable stakeholders for driving key learnings to date on the project. The updates to the design from the mini trials feedback would be implemented during the simulation trials and so it was practical that these same stakeholders could have a further opportunity to test out the market.

LCP Delta, who are managing the customer engagement on the project and have a wide network of industry contacts, sent out a LinkedIn post encouraging potential stakeholders who may have an interest in BiTraDER to reach out if they are interested in attending the simulation trials.

The outreach lasted approximately three months and following this, an initial simulation trials workshop was set up. There were again seven businesses in total. Six were retained from the mini trials workshop and one new customer was signed up.

4.3.2 Initial workshop

The initial simulation trials workshop covered the following:

- An introduction to BiTraDER.
- Mini trial learnings.
- Simulation trials overview.
- Platform introduction, including an example trade.
- Q&A.

The questions from the customers at this stage focussed on the practicalities and timelines of running the trades.

4.3.3 During trades

Throughout the trading, customers were encouraged to submit questions to the project team at the optional drop-in sessions during the trading windows and at the trade result meetings.

4.3.4 Final workshop

The final workshop was held to run a selection of additional scenarios in more depth and to provide an opportunity for customers to input on:

- Trading platform interface.
- Settlements.
- Performance verification.

It was also an opportunity for customers to feedback on what they would like to see from BiTraDER in BaU.

To support engagement, the format of the meeting was based on feedback from customers and can be seen below in figure 6.

Figure 6 Final workshop agenda

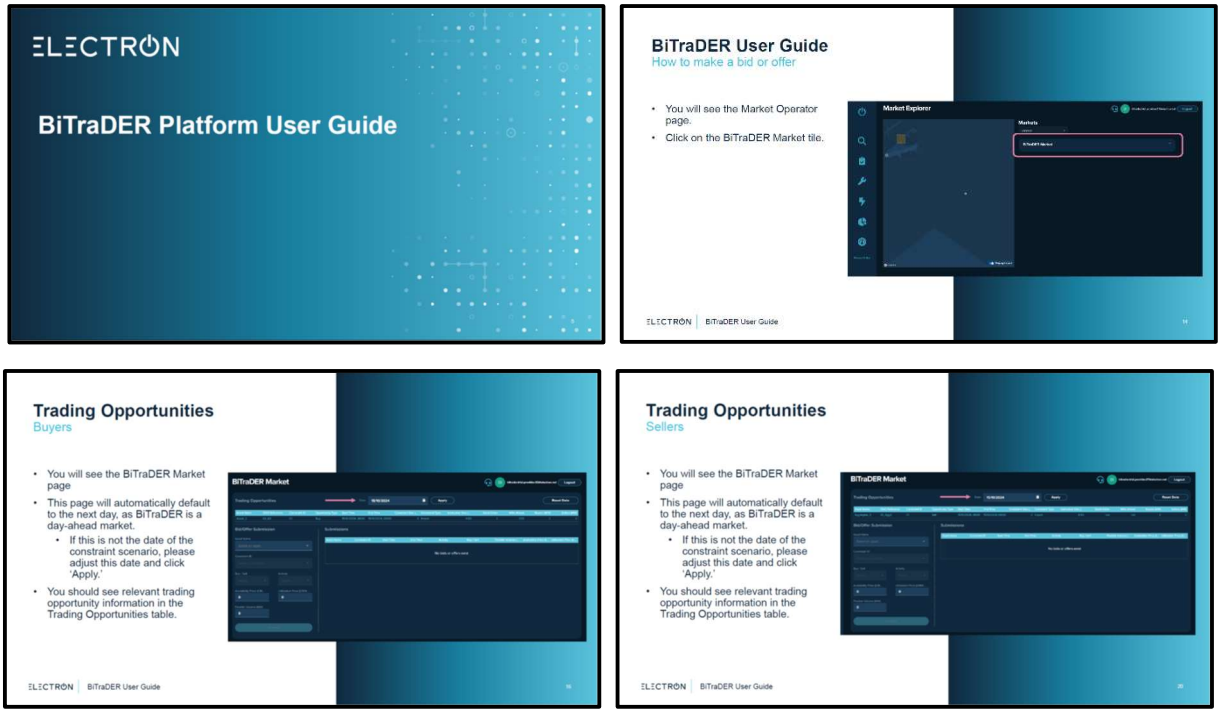
Time	Agenda
13:30 - 13:50	Introductions Recap of project, trading rules and previous simulation trial scenarios

13:50 - 15:10	Constraint scenario overview Group discussion 1: Asset technology types Simulated trade Overview of dispatch and settlement process Group discussion 2: Settlement Trade results Group discussion 3: BiTraDER in Business-As-Usual
15:10 - 15:30	Collect any further feedback Next steps: BiTraDER live trials

4.4 User guide

Ahead of the first trial, customers were provided with a 'BiTraDER User Guide', some of which is shown in figure 7. The user guide provided information on what was needed to participate in the trials, including a refresher of the trading rules and guidance on accessing the platform to submit bids and offers.

Figure 7 BiTraDER user guide



4.5 Trade example

Once the bids and offers were received from participants, the algorithm in the trading platform sorted and matched the trades as per the methodology in the BiTraDER Trading Rules report. An example of the results from Scenario 1 is shown below.

This constraint is located within the Cumbria area of the ENWL network where the scenario depicts a 2MW import constraint on a HV feeder fed from Keswick primary substation. The feeding area from Keswick primary substation is shown in figure 8.

The scenarios were designed so that the magnitude of constraint was equal to or greater than the total capacity of the buyers. That way, all the buyers would be liable to be curtailed and therefore encouraged to submit a bid in BiTraDER. This also meant there would be more opportunities for the sellers to trade.

Figure 8 Keswick primary substation feeding area

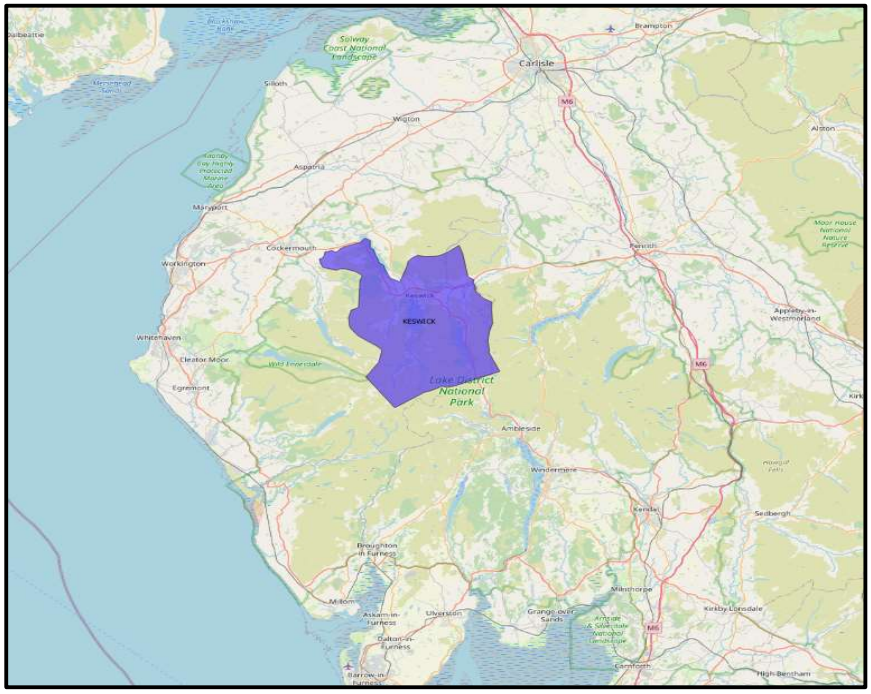
Scenario: 1

Date: 05/11/24

Time: 08:00 – 08:30

Magnitude: 2MW

Direction: Import



The table below shows the matched trades for Scenario 1. Both buyers 1 and 2 had a curtailable capacity of 0.2MW and were both liable to be curtailed.

The cleared total price consisting of both utilisation and availability payments for Buyer 1 was £1350/MW/h whilst for Buyer 2 this was £500/MW/h. These were both higher than the total offered payment from Seller 1.

The cleared availability payment was £10/MW/h which was submitted by Seller 1 and was lower than the availability payments from buyers 1 and 2.

The result of the trade is shown in figure 9.

Figure 9 Scenario 1 results

Buyer	Seller	Capacity (MW)	Cleared total price (£/MW/h)	Cleared availability price (£/MW/h)
Buyer 1	Seller 1	0.2	1350	10
Buyer 2		0.2	500	10

5 Cyber security

The architectural approach to cyber security has full traceability in a bi-directional way between what has been implemented, and the origins of certain decisions being made.

Within the design process we adhere to cyber security standards and frameworks which contain obligatory security controls across physical, network, operating system, application, and data stacks. These controls must be met to reach compliance with the particular standard and thus become measurable.

In implementing these controls, we create architectural principles, which any given control may apply to one or more principles. The principles apply the security controls to business risk, technical, and user requirements, which in turn inform the design.

In terms of BiTraDER, the approach in figure 10 applies:

Figure 10 BiTraDER cyber security approach

BiTraDER deliverable	Cyber security deliverable	Rationale
D1 – Customer engagement and scenarios	None	Initial engagement with customers to determine the appetite for the peer to peer trading model
D2 – Trading rules and technical requirements (including business process maps and information models	Business impact assessment	Business processes are mapped such that key business impacts can be analysed
	Threat analysis	There are existing threat models that can be applied to the documented BiTraDER business processes
	Security principles	These are generic and are applied across all projects
	Security requirements	These are based on ISO 27001 standards

BiTraDER deliverable	Cyber security deliverable	Rationale
D3 – Trading platform design	Risk assessment	Risk assessment needs IT assets to be determined as part of the design phase
D4 – Architecture build	Penetration testing	The built architecture is tested from a security perspective to ensure that the security requirements have been met
D5 – Simulation trials	None	The simulation trial system has already incorporated the necessary requirements to account for cyber security risks

5.1 BiTraDER cyber security report

The information within the full BiTraDER cyber security report contains sensitive information that could be used by an adversary. The full report can be provided to parties who require it to conduct their duties in delivering the project.

6 Lessons learnt

The simulation trials enabled the project team to test for the first time the user interface of the BiTraDER trading platform. Participants were instructed to register on the platform and submit trades in response to simulated constraint notifications.

The feedback gained at this stage was that users found the platform intuitive to use, but found the simulation format too simplistic, limiting their ability to apply real-world expertise when submitting bids and offers.

Attempting to emulate these realistic market conditions to fit more with the ‘real-world’ proved quite challenging and 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 in BaU.

For instance, the way a solar farm operates under a Power Purchase Agreement (PPA) differs to the way a battery operates under wholesale market arbitrage. The market conditions would need to be optimum for the two to feasible trade in BaU. Due to the lack of wider market information at the time of the simulated constraints, participants found it quite hard to decide on what bids or offers to submit.

It was decided that guide prices would be provided to participants as a starting point for submitting trades. However, this had the effect of removing the ‘real world’ from the trades and actual prices hovered around the guide price.

Nevertheless, this successfully tested the market rules which were found to be robust enough to provide successful trade outcomes. This was also reflected in the positive response from participants in the potential willingness to operate their assets in BiTraDER should this market progress to BaU.

One of the challenges previously identified in starting up a market such as BiTraDER is the limited liquidity of trading assets. The businesses involved in the simulation trials first and foremost had BaU tasks as a number one priority. Thus, it was seen at times that participation in BiTraDER was secondary to these conflicting BaU priorities.

Since, there were only seven businesses signed up to the simulation trials, liquidity was a significant challenge, particularly as frequency of the trades were biweekly. It appeared quite early on that this commitment to biweekly trades was too frequent for some of the businesses.

Some of the trades therefore were supplemented by the teams at ENWL and Electron. One of the benefits of this was that it gave the internal team greater autonomy over which trades matched which could lead to better example results. The disadvantage again is the fact that it takes away from realistic market conditions.

The points above generated key learnings to be taken forward, specifically when considering the live network trials.

Any asset signed up to participate in the live network trials will be examined in depth to create a 'perfect hindsight' model of the market operating conditions for that particular asset. So, at the time of a live network trial trade, the team can set some realistic background market information that a participant can relate to BaU operating characteristics.

To achieve this, further customer engagement is necessary to understand what is required, including previous trade and market history including price information and what the entry barriers are.

The timeline for the live network trials need to reflect appetite for involvement in the project. So, as opposed to regularly biweekly trades, this should be shortened to maximise participant involvement.

It could be said that the simulation trials have successfully proved most of the functionality of the trading platform and ANM system (albeit a test version of the ANM system). It has also proven that stakeholders are keen on peer-to-peer energy markets such as BiTraDER. Participants have gained a thorough understanding of how the market works and are keen to see the project progress to BaU.

What is still slightly unclear is how exactly the market will look in BaU. This should be taken forward as the main aim of the live network trials with a particular emphasis on ensuring the participants submit realistic prices to trades based on a thorough background analysis of the operating markets.

7 Conclusions and next steps

This report addresses the requirements for the BiTraDER D5 deliverable. The next step is to determine whether the project can either pass the stage gate and progress to live network trials or stop at the stage gate and progress to close down.

There have been ongoing conversations over the past few months between the project partners and the wider innovation team at ENWL around the stage gate decision. Ultimately, given the fact that the desire for a peer-to-peer market such as BiTraDER is evident, and there is still work to do to further ascertain how the market will look in BaU, the internal teams have unanimously favoured the project should continue onto live network trials.

A recommendation to pass the stage gate will be submitted along with this deliverable to Ofgem confirming that the team believe the economics and forecast benefits of a live network trial remain valid and that those benefits identified at the start of the project are still relevant today.

Following this step, the team will prepare for live network trials. The customer engagement for this is already underway. The team is looking to recruit assets that are connected to the ENWL network to participate. This will be done through two approaches.

1. engaging with universities that that have potential assets that could be turned up/down such as lighting/chillers in campuses and laboratory equipment.

2. Electron's network of FSP providers.

The assets that are successfully recruited will be assessed in further detail as explained in Section 6 to address some of the shortfalls of the simulation trials.

Further down the line, the combination of simulation and live network trials will determine the benefits to be put forward into the end of project cost benefit analysis to assess a more accurate picture of the feasibility of the project in BaU.