electricity north west

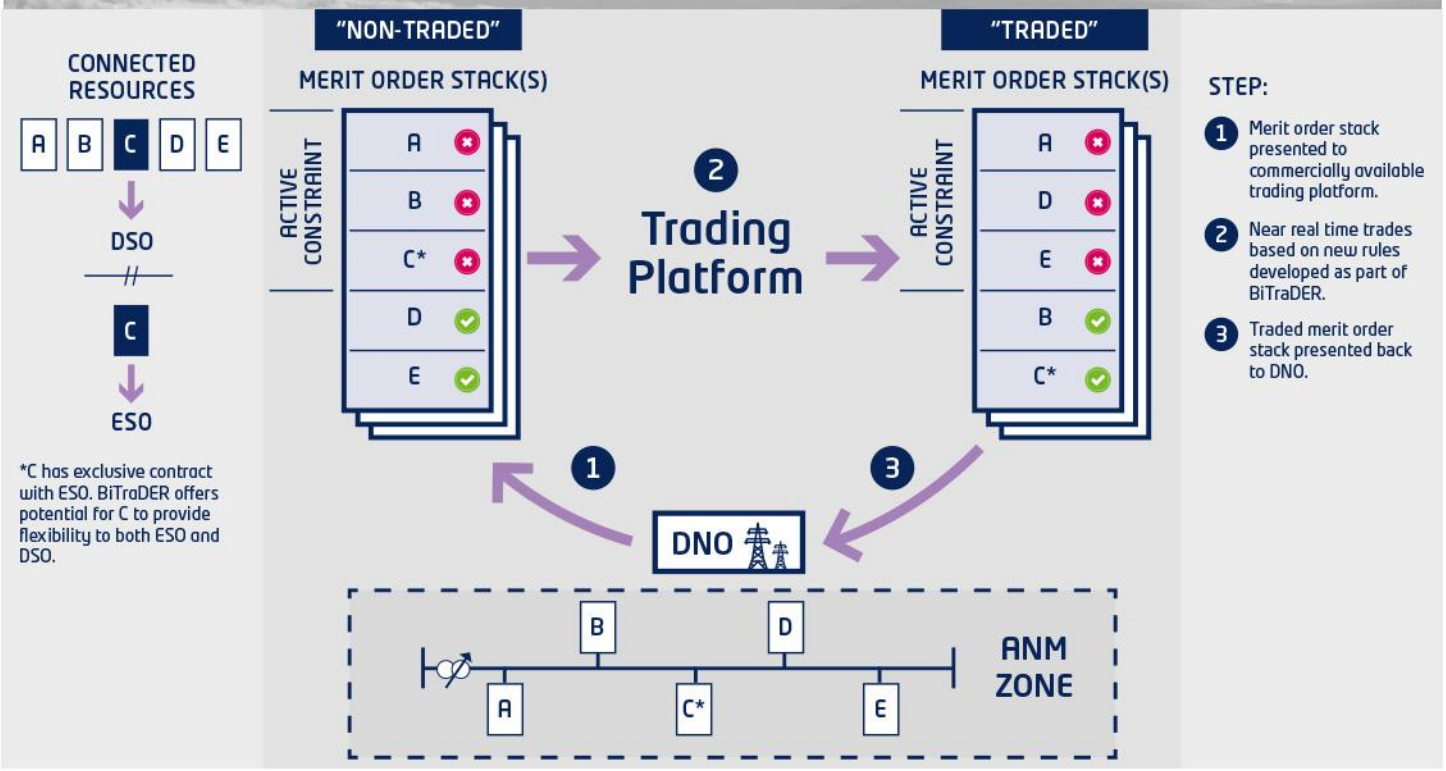
Bringing energy to your door

BiTraDER

Deliverable 1

Customer Engagement and Trading Scenarios

November 2022



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Version

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Review

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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	Advanced Programming Interface – A type of software interface between two systems
Aggregators	Organisations that contract with a number of smaller organisations and use the collective capacity to trade in the flexibility market
BaU	Business as Usual
BESS	Battery Energy Storage System
'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 the ESO, to end users (commercial and domestic properties). These regional companies are natural monopolies and are therefore regulated by Ofgem
Demand increase (flexible service)	A connectee providing a flexible service where the outcome is an increase in demand (this could be provided by either generator reducing export, or a demand connectee increasing import within their maximum import capacity limits)

Demand reduction (flexible service)	A connectee providing a flexible service where the outcome is a reduction in demand (this could be provided by either generator increasing export within their maximum export capacity limits, or a demand connectee reducing import)
EV	Electric Vehicle
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
Flexible service provider	A demand or generation connectee providing flexible services to either the wholesale market or to the DNO and ESO
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
I&C	Industrial and Commercial – businesses in the industrial and commercial sector
Merit order list	A list of connectees in a specific order for the ANM system to action
ESO	Electricity 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. ESO is a natural monopoly in the flexibility market, acting as a neutral facilitator
'N-1' conditions	N-1 means that is network is planned, and operated, such that the loss of any one element (e.g. an overhead line, a transformer, an underground cable) still allows the network to operate securely and to continue serving demand
Non-curtailable	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)
Peer to peer trading	Trading between connectees, independent of the DNO or ESO
SCADA	Supervisory Control and Data Acquisition
'Seller'	Party selling the ability to accept a curtailment obligation from another connectee, within the limits of their connection agreement
V2G	Vehicle to Grid - a technology that enables energy to be pushed back to the electricity network from the battery of an electric vehicle

1 Introduction

D1 Scope: Document introducing the Project and detailing the BiTraDER scenarios and initial findings from the customer engagement.

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[1] in real-time and resolve constraints.

Curtailable connections allow customers to connect to the network without the need for traditional reinforcement and therefore at lower cost, and within shorter timescales than a 'non-curtailable' connection. Where customers accept a curtailable connection, the DNO can curtail the customer's asset export or import under certain network conditions. This is effectively a 'curtailment obligation' on the connectee, to turn down or switch off their import or export when required by the network, and the specific details are stated in the connection agreement. Typically, in Electricity North West's licence area, these arrangements are in place for generation customers, however similar obligations are being gradually introduced for some demand customers who choose to connect with a curtailable connection.

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 to their connected asset. 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 connected customers to trade their curtailment obligations bilaterally, with other peers in their region (where technically possible). 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.

[1] Note: these ANM controls do not incorporate hard control, but provide signalling to the connectee's control system to allow them to control their own equipment.

2 Overview of BiTraDER

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

As part of the project, we will assess 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, the DNO and Electricity System Operator (ESO) systems, and the interfaces needed to present all necessary information to a suitable market trading platform, with the appropriate cyber security considerations.

It will also develop the bilateral market trading rules, determining what is and isn't a valid trade, exploring the market's ability to operate in near real-time, and determining the functionality required to return the output of the market to the DNO and ESO systems for execution in real time.

As BiTraDER is designed to facilitate peer to peer trading of curtailment, Electricity North West will provide the necessary information to the market and receive the output of the market after close of trading. However, the market will be designed to be independent, without involvement of the DNO. As such, we will examine the role of the market administrator and propose who might be best placed to operate the market and why, and whether more than one market can exist.

We are working with three project partners on BiTraDER, each providing targeted expertise and value for the project deliverables. LCP Delta are an energy research consultancy providing customer engagement expertise and leading on the recruitment and engagement activities throughout the project. Electron is an energy technology organisation specialising in digitally optimising markets. BiTraDER will be building on their established platform ElectronConnect. Finally, AFRY is an engineering and design consultancy and will be developing the trading rules for the market, and providing Cost Benefit Analysis of the BiTraDER initiative.

2.1 Method

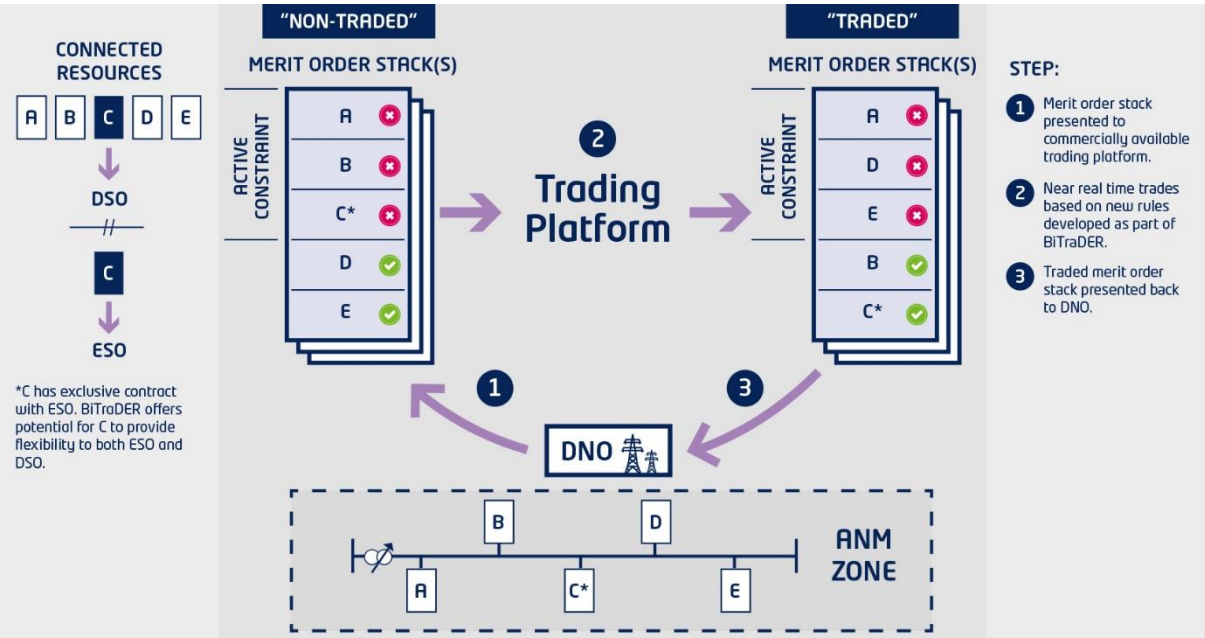
To ensure that we are facilitating and enabling the market, but not directly participating, the trading platform will be completely independent of Electricity North West. Our project partner, Electron, will be hosting the platform and presenting information provided from our ANM system as and when constraints are forecast. A summary of the anticipated process is provided below and in Figure 1; the actual process and timing of elements such as timing of gate closure and trade validation processes will be explored and defined during the project.

1. The ANM system has a 'look ahead' functionality which forecasts potential constraints. Using the forecasted demand, network topology and outage plans, the ANM system will create a merit order list of connected assets (such as flexible service providers and curtailable connection customers) that can be curtailed or called on, to alleviate the constraint. The merit order list will then transferred to the third-party trading platform.

2. The trading platform presents customers with the merit order list and facilitates trading based on agreed trading rules. Trading is completed and the traded merit order list is transferred back into the ANM system upon gate closure. During the trading window, all proposed trades are validated to ensure the new traded merit order list will successfully resolve the forecasted network constraint.

3. The ANM system receives the traded merit order list and dispatches instructions based on this revised order. The instruction will be sent via SCADA where applicable, or by an Advanced Programming Interface (API) or similar for non-SCADA participating customers.

Figure 1: BiTraDER illustrative method



2.2 Phases

BiTraDER will be completed in five 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. Capture of the technical requirements and the interface considerations for integrating the trading platform with the Electricity North West systems. Design of the market platform and end to end data architecture, taking into account cyber security and other associated risks.

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.

   There is a stage gate following the simulation trials providing 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 Business as Usual (BaU) transition.

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

2.3 Knowledge Transfer

BiTraDER sits alongside a number of previous innovation projects including, but not limited to, TraDER (SSEN), TRANSITION (SSEN), EFFS (WPD), FUSION (SPEN) and Energy Exchange (UKPN). These projects are predominantly focused on the provision of flexible services to the DNO or direct capacity trading, rather than peer to peer trading of curtailment obligations. However, there is transferrable knowledge being generated within these projects and as such we will continue to monitor their outputs to ensure BiTraDER aligns and compliments the learning provided by other projects. The outcomes and learnings from BiTraDER will also inform the relevant Open Networks workstream.

3. Introduction to BiTraDER Use Cases

3.1 Overview

The main purpose of the BiTraDER use cases is to document the anticipated trading scenarios, thereby providing context for the functional requirements of the end-to-end process and platform. The use cases should facilitate a common understanding of the requirements, at a high level, and include the following:

- The scope of the trade envisioned
- The motivations and/ or initiator of the trade
- The primary market actor or seller
- The secondary market actor (or actors) or buyers
- The pre-conditions to the trade
- The post conditions to the trade
- The flow of events and anticipated outcome
- Any other considerations or possible extensions

The trading use cases will be used to inform the design requirements of the trading platform, its interface with Electricity North West's and customers' systems, the design of the market model, supporting market trading rules, and finally, planning for the simulation and live trials.

3.2 Use case template

We developed a use case template (Figure 2) to present each potential trading scenario for accessibility and standardisation. The use of a template supports consistency when considering all the associated parameters and combinations as well as facilitating common understanding when making comparisons between use cases.

As BiTraDER is a market-focused project, the trading use cases need to capture the market drivers of trades, market actors and outcomes. The impact on alleviating the network constraint is assumed in all the use cases, rather than explicitly explored.

Figure 2: BiTraDER use case template

Use Case Name					
Use Case Number		**Version**		**Status**	
Use Case Description					
Seller					
Buyer					
Opportunity to Trade					
Preconditions					
Post Conditions					
Data required					
Main Success Scenario	**Steps**	**Actions**			
	1.				
	2.				
	3.				
	4.				
	5.				
	6.				

3.3 Market actors

We identified potential market actors using learning from other innovation projects and a series of workshops with internal stakeholders responsible for flexibility in Electricity North West. These were then tested with our project partners, project participants and with representatives from the Open Networks WS1a Product 6 group.

A trading 'matrix' was developed to outline the different possible market actors who may wish to participate in trading, and the combinations of trades between them that could feasibly occur. The market actors included:

- *'Buyers'* – defined as a party or organisation **buying a more preferable position in the merit order stack**, increasing its ability to continue uncurtailed via trading liabilities associated with curtailment obligations.

- *'Sellers'* - defined as a party or organisation **selling their ability to adopt the curtailment obligation** of another connectee via trading liabilities associated with curtailment obligations.

Within these categories, we defined the market actors as either:

- *Demand connectees* – customers with asset classes Industrial and Commercial (I&C), Electric Vehicle (EV) charging, Battery Energy Storage Systems (BESS) in import mode and aggregators with a demand portfolio; or,

- *Generation connectees* – customers with intermittent or non-intermittent generation, BESS in export mode, Vehicle to Grid (V2G) operators or aggregators with a generation portfolio.

For the purposes of BiTraDER, the demand and generation connectees were then further classified as those with either:

- *A 'non-curtailable connection'* – defined as a connection with negligible risk of curtailment for system normal conditions.

- *A 'curtailable connection'* – defined as a connection with management arrangements allowing Electricity North West to signal, in real time, a curtailment of demand or generation under certain network conditions.

Flexible service providers and the ESO were also identified as potential, secondary market actors.

3.4 Use case development

We used a matrix to identify all possible combinations across the defined market actors, as shown in figure 3. Early review and assessment of the matrix was carried out by the BiTraDER project team, followed by a further review with our internal stakeholders. These reviews tested the validity, practicality and probability of each proposed use case with the aim of developing a refined and targeted set of use cases to test within the simulation and live network trials.

Figure 3: BiTraDER initial use case matrix

				Buyers								
				Demand		Generation		Flexible service provider				ESO
								C		N/C		
				C	N/C	C	N/C	demand reduction	demand increase	demand reduction	demand increase	
Sellers	Demand	Curtailable		1	3	5	7	17	21	25	29	33
		Non-curtailable		2	4	6	8	18	22	26	30	34
	Generation	Curtailable		9	11	13	15	19	23	27	31	35
		Non-curtailable		10	12	14	16	20	24	28	32	36
	Flexible service provider	C	Demand increase	37	41	45	49	53	57	61	65	69
			Demand reduction (generation and/or demand side response)	38	42	46	50	54	58	62	66	70
		N/C	Demand increase	39	43	47	51	55	59	63	67	71
			Demand reduction (generation and/or demand side response)	40	44	48	52	56	60	64	68	72

Key: C = Curtailable; N/C = Non-curtailable

These were then worked into detailed use cases using the template in Figure 2, with more information added to motivation and outcome. This included a detailed description of the opportunity to trade, the trade to be explored, and the relevant market actors and associated requirements of the trade (ie the relevance of stack position if both market actors were non-firm and affected by the same constraint).

The reviews undertaken concluded that:

- As BiTraDER is based on the principle of trading liabilities associated with curtailment obligations, rather than 'spare capacity', the use cases of trades between non-curtailable sellers and non-curtailable buyers should be excluded; this represents peer to peer capacity trading because neither actor has curtailment obligations to trade.

- By extending the same logic, all use cases where a non-curtailable customer was classified as the 'buyer' were also unlikely. As a non-curtailable customer, it is highly unlikely that they would be affected by a constraint and therefore would not initiate a trade. However, these non-curtailable actors could remain as 'sellers'; where they were taking on the curtailment liability from a curtailable buyer.

- Similarly, use cases that involved non-curtailable customers buying from non-curtailable flexible service providers, or non-curtailable flexible service providers acting as 'buyers', are also unlikely, and are therefore excluded.

- Any use cases where a flexible service provider would be the 'seller' of a curtailment obligation to another flexible service provider was unlikely and should be excluded. The flexible service provider would be motivated to trade to ensure it could be called upon for a service. In these use cases, the two service providers may be in competition for the same service, and as such, would be unlikely to trade a curtailment obligation with each other.

- The ESO was considered as a market actor, from a perspective of enabling a flexible service provider to be called upon to deliver a service. However, on reflection, we believed that the ESO may fund the trade on behalf of the flexible service provider, but would be unlikely to participate directly, as the trades in BiTraDER would be at distribution level. Instead, it is more likely that the ESO will contract directly with the flexible service provider, with the service provider then choosing whether to trade at the distribution level to ensure delivery of their agreed service. As such, all cases where the ESO was considered as a 'buyer' of a curtailment obligation were removed.

- The logistics of the trade should be used as the primary differentiator between use cases, rather than motivation. In doing so, we agreed that cases should be excluded where trading motivations varied, but all the other essentials of the trade were the same. This therefore applied to all use cases drafted with flexible service providers as market actors.

Through the process of reviewing and refining the use cases, we reduced the number to eight core use cases. See Figures 4 and 5 for the core use cases and their high-level description. The full details of each use case are in Appendix 1.

The eight use cases focus on trading between non-curtailable and curtailable customers, and trading between curtailable and other curtailable customers. Although the latter is less likely, these are still potential trading situations and therefore merit consideration from an operational and legal perspective within the project.

To ensure that the use cases were applicable across the industry, we approached the relevant Open Networks WS1a Product 6 working group for feedback and comment. Both SSEN and ESO reviewed the use cases and provided feedback, supporting the decisions made in refining them, whilst also providing suggestions for further considerations across the project. For example, incentives for connected assets to trade and opportunities for 'gaming', the impact on merit order lists caused by assets that can switch between generation and demand, the whole system cost impact of trading and the system interfaces required to enable effective trading. These will be considered as part of our deliverables capturing trading rules, cost and benefit analysis, and functional requirements anticipated later in the project.

These use cases are anticipated to be continually reviewed and refined, as appropriate, based on continued learning throughout the project. As such, the use cases listed here may not represent the final set we take forward to test in our simulation and live network trials.

Figure 4: Core use cases developed for BiTraDER

			Buyers	
			Demand	Generation
			Curtailable	Curtailable
Sellers	Demand	Curtailable	1	5
		Non-curtailable	2	6
	Generation	Curtailable	9	13
		Non-curtailable	10	14

Figure 5: High Level Description of core use cases developed for BiTraDER

'Buyer': Demand curtailable connectee	
1	Curtailable demand connectee buying the ability to continue uncurtailed from another curtailable demand connectee.
2	Curtailable demand connectee buying the ability to continue uncurtailed from non-curtailable demand connectee
9	Curtailable demand connectee buying the ability to continue uncurtailed from a curtailable generation connectee
10	Curtailable demand connectee buying the ability to continue uncurtailed from a non-curtailable generation connectee
'Buyer': Generation connectee	
5	Curtailable generation connectee buying ability to continue uncurtailed from curtailable demand connectee
6	Curtailable generation connectee buying the ability to continue uncurtailed from a non-curtailable demand connectee
13	Curtailable generation connectee is buying the ability to continue uncurtailed from another curtailable generation connectee.
14	Curtailable generation connectee buying ability to continue uncurtailed from a non-curtailable generation connectee

4 Customer Engagement Overview

4.1 Approach

4.1.1 Customer groups

The solution will be open to all commercially sized, demand and generation, curtailable and non-curtailable connections, irrespective of technology type. As such, we targeted our recruitment for existing and new (i.e., those in application stage or developers making frequent applications) commercial customers with connections of 1MW or above. Additionally, we also considered connected commercial customers who are either currently or interested in offering flexibility services to the DNO or ESO. More details are set out in our published Customer Engagement Plan.

4.1.2 Recruitment

Recruitment was originally intended to be targeted using internal contact information associated with connection agreements within the Electricity North West distribution area, where contacts would be mined, filtered and provided to LCP Delta for initial contact. However, during project mobilisation, further checks were carried out on the proposed approach set out in the bid. We identified a new opportunity for customers to be approached by Electricity North West initially, as these were customers connected within our licence area. This ensured that the correct permissions were in place regarding sharing of customer data across project partners.

All initial contact made with customers based on stored connection agreements was made by the Electricity North West project team. Once an initial phone call and briefing about the project was complete and permission provided in writing, Electricity North West shared the contact information with LCP Delta for follow up and in-depth interviews.

Early in the recruitment phase we recognised that the curtailable connected customers in our network area were showing some interest but were not as committed as we had initially expected. This was due to the minimal experience they had, to date, of curtailment in our area. Additionally, we recognised that there were limited demand flexible connections in our area though these connections are expected to become more prevalent in future.

To boost recruitment progress and ensure the breadth of representation across our target customer groups, we agreed to adopt a staged, national approach to recruitment. This approach focused on the three key areas where the project requires customer engagement:

1. Stage 1: Development of trading rules and market model
2. Stage 2: Participation in and feedback on simulation trials
3. Stage 3: Participation in and feedback on live trials

Recruitment was initially intended to identify and bring customers on board that would remain on the project for the duration of the project, such that the trials could benefit from accumulated customer learning and understanding from earlier phases. Through identifying and carving out separate streams of engagement in the project, we were able to explore aspects where national engagement could introduce greater learning and benefits. The BiTraDER solution will be designed to be implemented as BaU activity across all GB DNOs and as such national customer development of the trading rules and input into the customer interface aspects of design, could create a market model and platform learning that could be directly replicated in other DNO areas.

Additionally, we acknowledge that experience of ANM and curtailing connections has, historically, been more prevalent in specific zones of other DNO licence areas. Therefore, in opening our recruitment to customers in other geographical areas we are introducing an additional wealth of experience in active management and understanding of the impacts of curtailment to the project.

The national approach to recruitment was delivered by drawing on the professional networks of all project partners. All project partners approached relevant contacts in their professional networks to test interest and obtain consent for their contact details to be shared with LCP Delta (in the cases where the contacts were not sourced by LCP Delta directly).

However, the final stage of the project, the live trials, will still require recruitment of customers connected to our network, and in a specific location. In taking this staged approach to recruitment we believe we are broadening the potential for learning from the project but will require extended efforts ahead of the live network trials.

4.2 Progress to date

The project aimed to engage with up to 50 customers with a view to securing up to 15 active participants (i.e., those willing to attend all project workshops, participate in research calls and fill out surveys). To date, we have engaged 44 customers and reached our target in securing verbal agreements with 17 active participants, with seven providing signed agreements to participate.

These participants have provided representation across the following customer groups:

- Connected customers
    - Non-curtailable connections
    - Curtailable connections
    - Generation
    - Demand
    - Mix of technologies: solar, gas, battery, wind, including co-location
    - Range of organisations: asset owner/operators, investors, aggregators, developers, energy management companies (offering optimisation services)
    - Companies offering flexibility services and those interested in offering services in future
- Connecting customers
    - Applying for non-curtailable connections but interested in curtailable options

4.3 Lessons learned

4.3.1. Initial contact

At bid stage, the project team, including the project partners, were anticipating access to a pre-prepared list of connected customer contact details from which LCP Delta could recruit participants. However, the project team agreed it was right to make initial contact directly, rather than through

project partners. This ensured that the customers were 'warmed up' for conversations with project partners and had provided the required permissions for sharing contact details.

In future, it is recommended that the team considers contacting customers directly to promote successful recruitment and establish robust relationships with customers, particularly where the project is invested in customer retention throughout the duration of the project.

4.3.2 Benefit of national recruitment

Initially the project expected to recruit 10-15 active participants from commercial customers connected to Electricity North West's distribution network. However, contact with current connected customers identified that the level of experience of active curtailment in our network was low. We have offered connections which require the connectee to be constrained under system abnormal conditions, however those who had taken these options had not experienced significant curtailment as a result of network constraints.

In taking a national approach, we have recruited participants who have experience operating under ANM zones in other DNO areas, and extensive experience of curtailment. Introducing customers with greater understanding of the impact of curtailments both financially and on asset management will provide clear benefits for project learning.

As the project will require local recruitment to support the live network trials, we have implemented a staged approach to recruitment. Initial recruitment will support the development of trading rules and simulated trials (where 'local' location of participants was unnecessary). Follow up recruitment will then be implemented later in the project to support the trials. Such participants may come from the current pipeline of new connections based at a number of identified constrained areas.

Taking this staged approach in recruiting national connected customers has provided an injection of a wealth of experience into the trading rules development and customer interface design, potentially more so than we would have achieved by limiting recruitment to the North West.

4.3.3 Participant diversity

Across each of the customer segmentation groups we identified a range of different types of organisations with connected assets. These all potentially could have an interest in the project and bring a unique perspective to the trading market. This includes asset owners, investors, investment portfolio companies with assets connected across the UK, or operator companies who operate and maintain assets on behalf of owners.

Initially, it was expected that the customers we would recruit would be 'typical' large connected asset owners; however, the level of interest shown from the commercial and investment sector was much greater than we anticipated. As such, the materials for engaging and approach to engagement have required a more tailored and thought-out approach based on a range of levels of awareness and understanding of flexibility and markets. Although all are professionals and experts in their own right; each brings a slightly different understanding and assumptions to the process, which is helpful to develop a diverse marketplace and more resilient solution.

4.3.4 Feedback

We carried out introduction and briefing sessions with each recruited participant. In these sessions we provided an overview of the project, aims, timescales and the stages of engagement we were looking to recruit customers to. In these calls we were able to develop an overview of the company's

asset base (i.e. size, location and technology mix), their experience with ANM and what interested them about the project. Many of the participants raised areas of particular interest for them, and motivations for participating which aligned strongly to the project objectives, for example:

- New revenue opportunities for all connectees
- Risk reduction for customers considering curtailable connection offers
- Useful introduction to flexibility, for those who haven't participated before but understand the potential importance for their portfolio and customers

However, the range of feedback was surprising; whilst many noted a vested interest in some of the aspects the project is looking to explore, there were additional perspectives that the team had not initially considered.

One participant which was an energy management organisation raised an additional benefit for them as participants; that by engaging in trades and the wider marketplace they were able to provide their clients additional revenue, but also additional carbon saving benefits (depending on the trading parties and their technology mix).

All DNOs provide a measure of anticipated curtailment, either through a curtailment index, or curtailment assessments. These are designed to provide more information to support customers' decisions regarding curtailable connections and the impact of accepting on original business case value. One project participant was particularly interested in understanding the value of trading, to allow them to quantify the business risk of curtailment. As a developer, they were keen to understand what other opportunities trading could bring before making their decision on whether to proceed with a connection offer. The learning generated as part of this project to support that decision-making process was regarded as particularly important to their business, and other developers.

Alongside benefits and areas of particular interest, customers also flagged questions and key areas of concern around how the marketplace would work based on current challenges. The following feedback is based on initial interviews and questions that came out of the webinar:

- Customers wanted to know generally how the signal to trade would work
- Issues with delayed projects due to transmission related works and how this would impact on their participation in the project
- The transparency of data from DNOs and what data is required of participants to trade. One customer provided the feedback that they would find it useful to have data on why a fault may occur, this way it allows them to make a decision on whether they should back out of other trades or not, e.g. wholesale market
- The need for installation of any management or monitoring kit on their assets to participate in trades
- There were concerns over the liquidity of the market:
    - Firstly, if a large asset was trying to sell its curtailment, there may not be enough assets large enough to fulfil the 'buy side' of the trade
    - Secondly, as ANM is geographically specific there is a concern that in remote places and rural areas there wouldn't be enough assets to complete a trade with

- Interaction with other pre-existing market platforms and the need for standardisation across other DNO areas
- Timing of gate closure relative to knowledge of the upcoming constraint/curtailment
- Implications of the network access reforms on the use of the marketplace
- The impact trading would have on business credit risk
- Interaction with balancing mechanisms and ancillary services to the ESO
- Impact of trading in day-to-day optimisation of assets from a maintenance perspective
- The broader point that developers would need to be on board throughout this project as they are the ones who initially need to accept a curtailable (flexible) connection. Some customers commented how investors were becoming more aware of this and were happy to steer developers

We will continue to capture feedback throughout the project via ongoing interviews, surveys and annual workshops. The focus of the next stage of customer engagement will be on understanding preferences for the trading market rules.

Appendix 1 – Trading use cases

Figure A1: Use case 1 – curtailable demand buying from another curtailable demand

Use Case Name	Curtailable demand connectee buying the ability to continue uncurtailed from other curtailable demand connectee.				
Use Case Number	1	**Version**	2	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting network constraints. A curtailable demand connectee would be required to reduce import to mitigate constraint. The curtailable demand connectee is unwilling to meet the constraint and therefore wishes to buy a more favourable position in the merit order stack. We wish to explore whether other (one or more) curtailable demand customers of asset classes I&C, EV, aggregators and BESS would be willing to sell their stack position, or adapt their demand to accept the additional curtailment obligation, in return for payment.				
Seller	I&C, EV, BESS (in import mode) and aggregators with a demand portfolio who have a curtailable connection.				
Buyer	I&C, EV, BESS (in import mode) and aggregators with a demand portfolio who have a curtailable connection. Buying curtailable customers would be in a higher stack position than the seller.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Merit order list published, connectee identifies the need to trade				
Preconditions	Constraint identified, connectee wishing to trade The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits).				
Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required.				
Data required	Specifics of demand on site (details within the connection agreement) that may impact trade validity				

Main Success Scenario	Steps	Actions
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement

Figure A2: Use case 2 – curtailable demand buying from non-curtailable demand

Use Case Name	Curtailable demand connectee buying the ability to continue uncurtailed from non-curtailable demand connectee				
Use Case Number	2	**Version**	3	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting network constraints. A curtailable demand connectee would be required to reduce import to mitigate constraint. The curtailable demand connectee is unwilling to meet the constraint and therefore wishes to buy a more favourable position in the merit order stack. We wish to explore whether other (one or more) non-curtailable demand customers of asset classes I&C, EV, aggregators and BESS would be willing to sell their stack position or adapt their demand to accept the additional curtailment obligation, in return for payment.				
Seller	I&C, EV, BESS (in import mode) and aggregators with a demand portfolio who have a non-curtailable connection.				
Buyer	I&C, EV, BESS (in import mode) and aggregators with a demand portfolio who have a curtailable connection.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Merit order list published, connectee identifies the need to trade				
Preconditions	Constraint identified, connectee wishing to trade Assumption that the planned reduction in demand by the seller does not affect the constraint. The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits).				
Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required.				
Data required	Specifics of demand on site (details within the connection agreement) that may impact trade validity.				

Main Success Scenario	Steps	Actions
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement

Figure A3: Use case 5 – curtailable generation buying from curtailable demand

Use Case Name	Curtailable generation connectee buying the ability to continue uncurtailed from curtailable demand connectee				
Use Case Number	5	**Version**	3	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting a load related network constraint. A curtailable generation connectee would be required to reduce export to mitigate constraint. The curtailable generation connectee is unwilling to meet the constraint and therefore wishes to buy a more favourable position in the merit order stack. A curtailable demand connectee may wish to sell their merit order stack position and/or increase their import to offset the export curtailment obligation. We wish to explore whether other (one or more) curtailable I&C, EV, BESS (in import mode) and aggregators with a demand portfolio would be willing to offset that obligation and accept a higher position in the merit order stack in return for payment.				
Seller	I&C, EV, BESS (in import mode) and aggregators with a demand portfolio who have a curtailable connection.				
Buyer	Intermittent, non-intermittent generation, BESS (in export mode) or generation aggregators who have a curtailable connection Buying curtailable customers would be in a higher stack position than the seller.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Load related network constraint (not voltage or thermal) Merit order list published, connectee identifies the need to trade				
Preconditions	Constraint identified, connectee wishing to trade The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits). The network constraint does not require the curtailment of both demand and generation.				

Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required. If the curtailable generation connectee accepts new position, merit order list must refer to connectee as providing a flexibility service to enable the ANM system to dispatch 'turn up' instructions.	
Data required	Specifics of demand/export on site (details within the connection agreement) that may impact trade validity. For example, asset type (generation type), historical trend of typical export capacity during constraint period.	
Main Success Scenario	**Steps**	**Actions**
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement

Figure A4: Use case 6 – curtailable generation buying from non-curtailable demand

Use Case Name	Curtailable generation connectee buying the ability to continue uncurtailed from a non-curtailable demand connectee				
Use Case Number	6	**Version**	3	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting network constraint. A curtailable generation connectee would be required to reduce export to mitigate a constraint. The curtailable generation connectee is unwilling to meet the constraint and therefore wishes to buy a more favourable position in the merit order stack. We wish to explore whether other (one or more) non-curtailable demand connectees of I&C load, EV charging, BESS or aggregators with a demand profile, are willing to sell merit order position, or adapt import to allow the generation connectee to continue without curtailment.				
Seller	I&C load, EV charging, BESS (in import mode) or aggregators with a demand profile with a non-curtailable connection				
Buyer	Intermittent, non-intermittent generation, BESS (in export mode) or generation aggregators who have a curtailable contract.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Assume the constraint is caused by a reduction in demand on the network and/or the reduction in demand is not sufficient to resolve the constraint. Merit order list published, connectee identifies the need to trade				
Preconditions	Connectee wishing to trade The planned reduction in demand by the non-curtailable demand connectee would trigger curtailment on a curtailable generation connectee; therefore upturn of demand would reduce impact of curtailment. The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits).				
Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required.				

Data required	Specifics of demand/export on site (details within the connection agreement) that may impact trade validity. For example, asset type (generation type), historical trend of typical export capacity during constraint period.	
Main Success Scenario	**Steps**	**Actions**
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement

Figure A5: Use case 9 – curtailable demand buying from curtailable generation

Use Case Name	Curtailable demand buying the ability to continue uncurtailed from a curtailable generation connectee				
Use Case Number	9	**Version**	3	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting thermal network constraints. The curtailable demand connectee would be required to reduce import to mitigate a constraint, but is unwilling to meet the constraint and wishes to buy a more favourable position in the merit order stack. We wish to explore whether other (one or more) curtailable connected generation customers of intermittent, non-intermittent generation, BESS or generation aggregators would be willing to adapt their export, or accept a higher position in the merit order and additional curtailment obligation on top of their existing curtailment obligation.				
Seller	Intermittent, non-intermittent generation, BESS (in export mode) or generation aggregators who have a curtailable connection				
Buyer	I&C, EV, BESS (in import mode) and aggregators with a demand portfolio who have a curtailable connection. The buyer would be in a higher stack position than the seller.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Merit order list published, connectee identifies the need to trade				
Preconditions	Connectee wishing to trade The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits). Network constraint is assumed to be thermal rather than voltage.				
Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required.				
Data required	Specifics of export on site (details within the connection agreement) that may impact trade validity. For example, asset type (generation type), historical trend of typical export capacity during constraint period.				

Main Success Scenario	Steps	Actions
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement

Figure A6: Use case 10 – curtailable demand buying from non-curtailable generation

Use Case Name	Curtailable demand connectee buying the ability to continue uncurtailed from a non-curtailable generation connectee				
Use Case Number	10	**Version**	2	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting network constraints. A curtailable demand connectee would be required to reduce import to mitigate a constraint. The curtailable demand connectee is unwilling to meet the constraint and wishes to buy a more favourable position in the merit order stack. We wish to explore whether other (one or more) non-curtailable generation customers of intermittent, non-intermittent generation, BESS or generation aggregators would be willing to sell their merit order position, or adapt export to allow the curtailable demand connectee to continue without curtailment.				
Seller	Generation customers of intermittent, non-intermittent generation, BESS (in export mode) or generation aggregators with a non-curtailable connection.				
Buyer	I&C, EV, BESS (in import mode) and aggregators with a demand portfolio who have a curtailable connection.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Merit order list published, connectee identifies the need to trade				
Preconditions	Connectee wishing to trade The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits).				
Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required.				
Data required	Specifics of demand/export on site (details within the connection agreement) that may impact trade validity. For example, asset type (generation type), historical trend of typical export capacity during constraint period.				

Main Success Scenario	Steps	Actions
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement

Figure A7: Use case 13 – curtailable generation buying from curtailable generation

Use Case Name	Curtailable generation connectee is buying the ability to continue uncurtailed from another curtailable generation connectee.				
Use Case Number	13	**Version**	2	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting voltage network constraints. Both curtailable generation connectees would be required to reduce export to mitigate the constraint. One is unwilling to meet the constraint and wishes to buy a different position in the merit order list which is less affected by the constraint. We wish to explore whether other (one or more) curtailable connected generation customers of intermittent, non-intermittent generation, BESS or generation aggregators would be willing to undertake additional export curtailment obligation/sell their more favourable position in the merit order stack.				
Seller	Intermittent, non-intermittent generation, BESS (in export mode) or generation aggregators who have a curtailable connection.				
Buyer	Intermittent, non-intermittent generation, BESS (in export mode)or generation aggregators who have a curtailable connection. The buyer would be in a higher stack position than the seller.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Merit order list published, connectee identifies the need to trade				
Preconditions	Connectee wishing to trade The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits).				
Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required.				
Data requirements	Specifics of export on site (details within the connection agreement) that may impact trade validity. For example, asset type (generation type), historical trend of typical export capacity during constraint period.				

Main Success Scenario	Steps	Actions
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement

Figure A8: Use case 14 – curtailable generation buying from non-curtailable generation

Use Case Name	Curtailable generation connectee buying the ability to continue uncurtailed from a non-curtailable generation connectee				
Use Case Number	14	**Version**	2	**Status**	Approved – for Deliverable 1
Use Case Description	For both system normal and worst-case N-1 conditions the look ahead ANM system is forecasting network constraints. A curtailable generation connectee would be required to reduce export to mitigate constraint. The curtailable generation connectee is unwilling to meet the constraint and wishes to buy a more favourable position in the merit order stack. We wish to explore whether other (one or more) non-curtailable connected generation customers of intermittent, non-intermittent generation, BESS or generation aggregators would be willing to sell their merit order position, unused capacity or reduce export to undertake the curtailment obligation of a curtailable generation connectee.				
Seller	Intermittent, non-intermittent generation, BESS (in export mode) or generation aggregators who have a curtailable connection.				
Buyer	Intermittent, non-intermittent generation, BESS (in export mode) or generation aggregators who have a curtailable connection.				
Opportunity to Trade	ANM look ahead case 1 – system normal overload ANM look ahead case 2 – projected N-1 overload Merit order list published, connectee identifies the need to trade				
Preconditions	Connectee wishing to trade The seller is able to adopt curtailment liability/trade merit order position within the limits of their connection agreement (participating in the trade must not result in a breach of connection agreement limits).				
Post Conditions	Trades completed, re-ordered stack issued to ANM for dispatch if required.				
Data requirements	Specifics of export on site (details within the connection agreement) that may impact trade validity. For example, asset type (generation type), historical trend of typical export capacity during constraint period.				

Main Success Scenario	Steps	Actions
	1.	Trading platform informed of constraint, stack, and trading opens
	2.	Trading rule review – ordering based on number of factors: bid price, confidence in delivery, environmental impact weighting
	3.	Effectiveness of trade reviewed from Electrical Power Systems Perspective
	4.	Gate closed in trading platform
	5.	Traded Stack sent to ANM
	6.	Settlement