Constraints Collaboration Project – *Final Report*

July 2024

ESO

Introduction

Table of Contents

Objective

Objectives of this report

1. To share the conclusions of the assessment of the six constraint management options
2. To give a detailed view of the MDF assessment results
3. To outline next steps for detailed scoping of the short-listed options and indicative timeline for the work

Not in scope of this report

Full CBA, technical and operability assessments of the proposed constraint management measures

Executive Summary

Overview

- The ESO spent six months working with industry to identify and develop potential measures to manage thermal constraints on the network, which can be introduced in the short-term before more transformational market reforms.
- The six options taken forward for assessment fell into two broad categories: constraint management markets and technical solutions to increase the flow over boundaries.
- The options were assessed initially by the ESO's market design framework. If no MDF principles were assessed as red, it was then assessed in terms of its net consumer benefit by an external consultant. The full net consumer benefit analysis will be published separately to this report, referring to percentage savings only in this report.
- The constraint management market options show positive overall alignment with the market design principles, and initial results of the net consumer benefit indicate positive value. However, there are several significant concerns which need to be worked through in detailed design and a full cost benefit analysis.
- The technical options to increase boundary flow need further technical investigations to ensure power system compatibility before a net consumer benefit analysis is undertaken.

Industry ideas have been consolidated to determine six options for assessment

1. Constraints Management Markets (CMM)

1A. Demand for Constraints

- **amp** CLEAN ENERGY: Increasing demand for power in constrained areas for electrification of heat
- **eneus energy**: Flex PtX to produce green H_2 and related derivatives
- **Statkraft**: Demand signal product
- **ScottishPower**: Incentivising new discretionary demand (H_2 production and electricity storage)
- **Flexitricity**: 'COOLER HEATING' – commercial heat loads as responsive assets
- **sse** | Business Energy: Long-term constraint management contracts (incentivising new demand)

1B. Long-term Constraints Management Markets

- **TEL** the energy landscape: Constraints management markets (CMMs)
- **SCOTTISH FUTURES TRUST**: Long-term contract to manage a portion of the forecast constraint volumes
- **sse** | Business Energy: Competitively allocated season ahead constraint management availability contracts
- **EDF**: Long-term auction of excess wind

1C. Short-term Constraints Management Markets

- **ZENOBĒ**: Pre gate closure constraint management product using scheme 7 trade
- **sse** | Business Energy: Competitively allocated short-term constraint management contracts (D-7)
- **EDF**: Discounted demand turn up
- **EDF**: Weekly generation turn down market
- **Flexitricity**: The 'Big Friendly Battery' for ~8 hours duration

2. Increasing how much can flow over boundaries

2A. Extended intertrip scheme

- **FIELD**: Extended intertrip scheme
- **ZENOBĒ**: Intertrip scheme utilisation
- **sse** | Business Energy: Enhance utilisation of the transmission network
- **Eku**: Battery for constraints: Reducing the line rating from 10 to 3 mins

2B. Grid Booster: Post-fault

- **FIELD**: Grid booster
- **Kona Energy** DELIVERING THE ZERO CARBON FUTURE: Paired storage systems across key boundaries
- **ZENOBĒ**: Flexibility for Active Network Management (ANM) zones and Generation Export Management (GEMS)

2C. Transfer Booster: Pre-fault

- **ZENOBĒ**: Transfer booster

Key 🟫 Demand for Constraints 🟩 CMM – Long term 🟨 CMM – Short term 🟧 Increasing how much can flow over boundaries

Description of the options assessed

1

Constraints Management Markets (CMM)

Instead of curtailing demand through the BM, BMU and non-BM generators can provide bids to turn down and sources of demand can provide offers to turn up, thereby reducing the volume of constrained generation.

1A

Demand for Constraints

A long-term (10 year), ancillary service contract, which would offer reduced cost of electricity for increased demand at times of maximum constraint. The aim is to incentivise new, strategic demand in locations with excess renewable energy.

1B

Long-term Constraints Management Markets

Long-term constraint markets could secure flexibility seasons or years ahead, from all kinds of generation and demand, either in the BM or outside of it. This flexibility can be secured through availability payments, with utilisation payments at times of deployment. The aim is to provide investment signals to participate in the service at times of peak constraint.

1C

Short-term Constraints Management Markets

Short-term constraint markets could be used to procure flexibility when there is certainty over constraint forecasts. This is typically between week-ahead and real-time and would likely be in the form of procuring a firm service. Both generation and supply would be able to participate, on both sides of the constraint. The aim is to manage constraints ahead of time, via a broad range of providers, at a lower cost than the BM.

2

Increasing how much can flow over boundaries

Proposed solutions range from expanding the intertrip scheme to reducing the volume of curtailment actions performed by ESO through pre and post-fault services using flexible assets to increase effective transmission capacity. The proposals represent potential incremental gains rather than a step change.

2A

Extended Intertrip Scheme

The ESO's intertrip scheme is already successfully enabling the ESO to maximise the use of the existing capacity. This option would expand the scope of the intertrip by increasing the largest loss the ESO has to manage. The aim is to allow even more power to flow by securing the boundaries with more assets and intertrip connections.

2B

Grid Booster: Post-fault

This option proposes using batteries to help manage the system after a fault. The batteries would be able to absorb power quickly where it can no longer flow and discharge power on the other side of the fault. The aim is to provide insurance against loss of electricity supplies with a low carbon, quick response asset.

2C

Transfer Booster: Pre-fault

This option proposes using batteries to help smooth out the flow of electricity over a boundary by absorbing excess electricity from a gust or replacing it during a lull. Batteries could either be one the side of the excess generation or placed on both sides of the constraint, one side to absorb, one to discharge. The aim is to enable the ESO to reduce the amount of 'spare' capacity allocated on a transmission line to any fluctuations in flow.

Summary of Market Design Framework Assessments

Policy Options		1A. Demand for Constraints	1B. Long-term Constraints Management Markets	1C. Short-term Constraints Management Markets	2A. Extended intertrip scheme	2B. Grid Booster: Post Fault	2C. Transfer Booster: Pre Fault
I. Efficient Dispatch	Competition (Short Run)	N/A	🟩	🟩	▨	▨	▨
	Locational Signals in Dispatch	🟩	▨	🟩	▨	▨	▨
II. Efficient Dispatch and Investment	Coherency*	▨	▨	▨	🟥	🟥	🟥
	Transparency	🟩	🟩	🟩	🟩	🟩	🟩
	Whole System Flexibility	▨	▨	▨	🟩	▨	▨
II. Efficient Investment	Competition (Long Run)*	▨	🟩	🟩	▨	▨	▨
	Locational Signals in Investment*	🟩	🟩	🟩	🟩	🟩	🟩
	Investor Confidence*	🟩	🟩	▨	🟩	🟩	▨
III. Value for Money	Value for Money*	▨	▨	▨	N/A[#]	N/A[#]	N/A[#]
	Deliverability*	▨	▨	▨	🟥	🟥	🟥
	Adaptability	▨	▨	🟩	🟩	▨	▨
Next steps		Detailed design and CBA	Detailed design and CBA	Detailed design and CBA	Technical assessment needed	Technical assessment needed	Technical assessment needed

[#] Due to being discounted due to Coherency and Practicality/Deliverability, no Net Consumer Benefit analysis could be completed

Level of Alignment to MDF principles: 🟥 Negative ▨ Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Executive summary

1. Constraints Management Markets (CMM)

Option	Summary of assessment and recommendation
1A. Demand for Constraints (DfC)	**Positives:** This service has potential in terms of supporting investment in strategic demand in Scotland, maximising use of renewable generation capacity and delivering a positive net consumer benefit (initial view shows savings could be on average 3% of thermal constraints costs, per annum, compared to BM counterfactual). **Concerns**: There are concerns about eligibility, how to treat new baseload (inflexible) demand and how to practically implement the scheme (including DNO impacts). **Recommendation:** Take forward for further design development. Conduct an in-depth Cost Benefit Analysis (CBA) in parallel with detailed service design considering interactions with existing ESO services and the BM.
1B. Long-term Constraints Management Markets	**Positives:** A constraints market with both long term and short term contracts has potential due to competition thanks to the availability of large volumes across a range of technology types as well as potential for a positive net consumer benefit (initial view shows that using a CMM could create savings could be on average 6% of thermal constraint costs per annum, compared to BM counterfactual*). For short-term CMM there is a track record of existing day-ahead, utilisation payment-based flexibility services, such as DFS and LCM, which should help with implementation. **Concerns:** Gaming risks, interactions with the BM for both long-term and short-term as well as additional risks for long-term from procuring volume years/season ahead. **Recommendation:** Take forward for further design development. Conduct an in-depth Cost Benefit Analysis (CBA) in parallel with detailed service design and building on learnings from our Local Constraints Market. The detailed service design will further consider other boundaries, interconnectors and interactions with existing ESO services and the BM.
1C. Short-term Constraints Management Markets	

***Net consumer benefit was calculated for constraint markets in general, not separately for long-term and short-term contracts, as they would be the same at point of dispatch.**

Executive summary

2. Increasing how much can flow over boundaries

Option	Summary of assessment and recommendation
2A. Extended Intertrip Scheme	**Positives:** Proposal builds on an existing scheme, which should make implementation more straight forward (initial estimates for the intertrip scheme were approx. £20m per annum). Compatible with different, potential REMA outcomes. **Concerns:**. Currently full use of the existing intertrip scheme is limited sometimes, due to other constraints relating to stability and reactive power in certain locations. Increasing the volume of the intertrip is therefore not possible because of the same limits to how much stability and reactive power are available. Additionally, this could adversely impact the volume of response/reserve available. **Recommendation:** Undertake further technical studies of the system with regards to the existing intertrip and other constraints such as stability and voltage.
2B Grid Booster: Post Fault	**Positives:** Innovative use of batteries to help system operation. Compatible with different, potential REMA outcomes. **Concerns:** The feasibility of this option is linked to the same issues as the intertrip scheme, where we have concerns relating to the interactions between stability, voltage and how this option could be deployed. There is also a concern that this would split the existing dynamic response and reserve markets, meaning it scored red on coherency. This needs the ESO to first undertake further studies on the behaviour of the system when tripping large volumes is combined with the new injection of power, looking at the impact on both voltage collapse and system stability. **Recommendation:** Undertake further technical studies of the system with regards to the existing intertrip and other constraints such as stability and voltage.
2C. Transfer Booster: Pre Fault	**Positives:** Innovative use of batteries to help system operation. Compatible with different, potential REMA outcomes. **Concerns:** This option does not reflect how we are currently managing constraints, which undermines the proposed potential savings. We would need to look at the full range of the different actions we take now to deal with short-lived changes in flow. This, alongside an assessment of the potential interactions with nested constraints, dynamic response services and numerous automatic systems, needs to be done first before we can design a commercial mechanism. Potential impact is limited by physical network capacity. **Recommendation:** Undertake more analysis and possibly trials before being able to design a commercial service.

Next steps and wider policy implications

- Q&A session for industry scheduled for **7th August at 10.00 – 11.00**. You can sign up for the session here.
- Continued assessment and engagement with industry will start immediately, with the aim to complete detailed design and full CBA or the necessary technical assessment within 9-12 months. Until this is completed, the ESO cannot commit to the implementation of any of the options.
- Detailed design of the constraint market options will include an assessment of:
    - How to treat new baseload for Demand for Constraints
    - Consideration of other boundaries and interconnectors for constraints markets
    - The interactions between constraint markets and Demand for Constraints.
- Other policy considerations, which have arisen from our assessment and engagement:
    - Green policy costs (financial consumption levies) currently present a barrier to distributed flexibility and the electrification of heat (learning from the local constraints market)
    - Hydrogen Production Business Model should be complementary to helping manage constraints and Hydrogen Allocation Rounds should also increase the weighting of the benefit to electricity system of locating in Scotland.
    - TNUOS reform was also flagged as an area for action by stakeholders, for example negative pricing for demand TNUOS.

Detailed MDF assessment results

Introduction and clarifications to the assessment

- The CCP’s scope is to review co-created ideas from industry, assess the consolidated options and undertake an initial market design framework assessment. **It is intentionally a high level review to assess the potential for consumer and system benefit, not a detailed design process and full cost benefit analysis.**
- The key criteria to pass are first, Coherency, Competition, Location Signals for Investment, Deliverability and then, Value for Money.
- We have used the Scottish/English boundary as an illustrative example for this phase of the assessment. Wider boundaries will be considered at detailed scoping.
- The counterfactual is the existing market structure and uses historical BM prices as a reference. The **modelling results are not forecasts** as they are using one example boundary only as an illustration. They are used purely to show the relative potential for consumer benefit, not a forecast of constraints costs or the associated savings.
- Interconnectors have not been included in this assessment, however will be part of the next phase.
- As a reminder, the ESO has to be technology agnostic in all new market designs.
- The output of this phase of the work is to identify next steps for the options assessed. **Where we are progressing to detailed design and cost-benefit assessment, there is still no commitment to implement.**

Policy Option 1A: Demand for Constraints

1A

Demand for Constraints

Description	An ancillary service contract which offers reduced cost electricity (that would otherwise have cost the ESO to curtail) in certain locations to incentivise new sources of demand. This could deliver benefit by reducing the volume of renewable curtailment as well as delivering revenue (from the sale of electricity) back to consumers.
Possible Contract Lengths	The longer the duration of the contract, the stronger the investment signal for new demand to be located north of the constraint. A contracting period of 10 years is ideal for investor requirements given alignment with debt repayment terms. The contract would include a 'sunset clause' and appropriate provisions in place should wider market reform take place to ensure that the product remain investable.
Possible Value/Price/Costs	Industry suggested a payment structure with two elements: £/MW per annum demand payment to service provider for capacity installed; and £/MWh utilisation payment to ESO for electricity consumed from otherwise-curtailed energy.
Possible Volumes	An agreed annual volume could be set as a proportion of the forecast constraints (e.g. 50% of the time we have forecast constraints per year or e.g. 1,500 hours in 2030 and 2,500 hours in 2035). In parallel, the new demand facility must report their availability to take on the forecasted curtailed electricity volume in advance (e.g. 36-hour notice to allow scheduling). If less electricity was consumed than allocated, there would be penalties that participants must pay.
Who Could Participate	New electricity demand behind the constraint, achieving sustainability goals through additionality. The new, additional, demand should be 1 MW minimum for the BM to be able to dispatch. This could include hydrogen electrolysers, data centres, large electric boilers, and vector shifting from gas to electricity.
Where It Would Be Active	North of Scottish boundaries (e.g. B6) initially, aligning with Beyond 2030's expectation that 5 GW of strategic demand will locate in Scotland.
Lead Time	Could be relatively short - service launch could be achievable within two years. ESO would need to put in place the capability to instruct, settle, and structure the contract. Industry would need to ensure their plant can come online in time.

Disclaimer: these proposals have been sourced from organisations above and the template does not indicate any endorsements or firm commitment for future commercial opportunities from the ESO

Market Design Framework Analysis: Demand for Constraints (1/2)

Proposed by: amp CLEAN ENERGY · eneus energy · Statkraft · ScottishPower · Flexitricity · sse Business Energy

Proposal		Demand for Constraints
I. Efficient Dispatch	Competition (Short Run)	**N/A – Demand for Constraints is a long-term service contract of 10 years thus short run competition is no applicable.**
	Locational Signals in Dispatch	**Long-term contract with a payment mechanism formulated based on availability and utilisation would give a locational signal in dispatch.** Additionally, this scheme enables demand to be dispatched in areas of high congestion
II. Efficient Dispatch and Investment	Coherency*	**Some alignment with ESO services and DSO markets.** This proposal would act as long-term revenue support mechanism so it does not overlap with day-ahead procurement of response and reserve services. If the assets connect to the distribution network, then there is potential conflict with DSO requirements and services that would need to be understood. Increases in demand outside of constrained periods could increase the wholesale clearing price and affect BM prices.
	Transparency	**Information could be provided in a clear and predictable way.**
	Whole System Flexibility	**Nature of long-term contract limits ESO ability to maintain optionality**. This proposal provides longevity of support (10 years) to benefit investment decisions. However, longer term contract would inhibit ESO ability in being open for emerging technology that comes along the way. Accessibility is also considered to be moderate given the requirement for the demand to be new.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Market Design Framework Analysis: Demand for Constraints (2/2)

Proposed by:		amp CLEAN ENERGY · eneus energy · Statkraft · ScottishPower · Flexitricity · sse Business Energy
Proposal		**Demand for Constraints**
III. Efficient Investment	**Competition (Long Run)***	**Potential for good long-run competition with a range of technology types, but new-demand requirement poses a challenge.** Within these technology types there is potential for replacement of gas with electricity and sources of entirely new demand. The exclusion of current demand from participating limits long-run competition.
	Locational Signals in Investment*	**Strong potential to incentivise new, flexible demand in constrained areas.** Assuming a contract length of 10 years with a sunset clause for any REMA related market changes, this will provide locational signals for investment for new sources of demand.
	Investor Confidence*	**Long-term contracts are advantageous for investors - providing a more stable flow of returns.** This scheme would provide a medium to long-term revenue stream and build investor confidence for new flexible demand, encouraging investment in constrained areas. The guarantee of a low power price for new flexible demand also de-risks the project sufficiently to attract private financing.
IV. Value for Money	**Value for Money***	**Initial analysis suggests that flexible demand could reduce consumer costs by 3% on average per annum between 2024 and 2035**, assuming demand is perfectly responsive to signals to consumer during constrained hours and no additional demand outside constrained hours.
	Deliverability*	**Requires multiple new ESO processes to be practical to operate**. These capabilities span across multiple areas: settlement mechanism and process; baselining approach for flexible demand; new contract management capability to dispatch (or cancel) and forecast the real time demand; and new methodology for co-optimising the operational use of different tools with differing constraint value across varying cost impacts. Whilst some ESO capability exists, this still adds operating complexity with high integration impact on ENCC strategy, operational process and systems.
	Adaptability	**The 'lock-in' risk of long-term contracts limits adaptability.** To effectively incentivise new demand may require guaranteed volumes, and so it may be difficult to adjust volumes down once contracting has been completed. Change in Law from potential future market reforms could be addressed through an appropriate provisions in place.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Policy Option 1B: Long-term Constraints Management Markets

1B

	Constraints Management Markets
Description	A constraint market offers the ESO to contract for flexibility with generators and demand in advance of real time, thereby reducing the volume of higher cost actions required by ESO last minute in the BM. The volume would be contracted using an availability payment and then a utilisation payment would be payable if the assets are nominated for dispatch at day ahead.
Possible Contract Lengths	The units could be secured with 1 year contracts at Y-1 or Y-4 and nominated for dispatch at day ahead. By utilising a medium to long-term contract length, service providers should have adequate notice and incentive for enrolment and systems development. Most savings are expected from nominating volumes at day ahead improving the efficiency of the nominations and reducing the actions that would need to be undone as further positions are set closer to real time.
Possible Value/Price/Costs	The primary consumer savings would be achieved by the CMM achieving a more mutually beneficial alternative to the BM counterfactual through a more efficient and competitive dispatch solution at day ahead. Further value could be achieved from participation of non-BM generation turn down (t/d) when assets come off their CfD contracts.
Possible Volumes	Utilising demand and generation turn down and turn up would allow gigawatts of volumes to be eligible (I&C and residential demand, wind, EVs, heat, etc). CMM target volume could be set at proportion of forecast constraint volume (e.g., if forecast constraint is 2TWh then we secure 1TWh through Y-1 auction), or up to forecast plus error/uncertainty using options if justified by favourable pricing compared to actions closer to real time which could include a short-term CMM (e.g., if low options price then for forecast range of 1.5-2.5TWh we could secure 2 or 2.5TWh).
Who Could Participate	All forms of generation or demand on either side of the boundary with appropriate metering at a level to demonstrate service delivery, which can provide flexibility either through shifting or increasing or decreasing their energy flows. For long-term contracts, the investment signals could support the creation of new, flexible assets.
Where It Would Be Active	Potential for national participation with demand turn up and generation turn down behind the constraint and demand turn down and generation turn up in front of the constraint.
Lead Time	Service launch should be achievable within two years. The procurement timeframe (Y-1 or Y-4) would then set the time to first service delivery.

Disclaimer: these proposals have been sourced from organisations above and the template does not indicate any endorsements or firm commitment for future commercial opportunities from the ESO

Market Design Framework Analysis: Long-term Constraints Management Markets (1/2)

Proposed by:		TEL the energy landscape, sse Business Energy, EDF, Scottish Futures Trust, Flexitricity
Proposal		**Long-Term Constraints Management Markets**
I. Efficient Dispatch	**Competition (Short Run)**	**Broad eligibility has potential for large volumes** across a range of technology types; limits undue concentration of market power. Variety of price mechanisms, wide participation from both BMU and non-BMU units could boost competitive offers for CMM (although will be in competition with BM prices when dispatched). Using combined batteries to extend the effective duration of delivery of a battery unit could improve the effectiveness of storage participation in this service resulting in improved diversity and liquidity, as proposed in the Big Friendly Battery solution.
	Locational Signals in Dispatch	**The different proposals offer a range of reasonable locational signals in dispatch.** The long-term contract using availability/options and utilisation payments does offer reduced locational signals in dispatch compared to the utilisation only short-term CMM. However, the proposal for competitively allocated season-ahead constraint managing contracts does send good locational signals in dispatch, as the ESO is specifically buying contracts featuring availability and utilisation components in shorter-timescales.
II. Efficient Dispatch and Investment	**Coherency***	**This proposal is partially coherent with existing ESO markets and there is risk of competition between ESO and DNO markets, alongside gaming with the BM**. The difference in timeframes of nomination between day-ahead in a constraint management market and the balancing mechanism presents a very real gaming risk, which needs more investigation. The service would not be entirely coherent with reserve due to a lack of explicit co-optimisation between two services however co-optimisation is not thought to be required due to differences in potential asset types as a result of reserve's stricter delivery and performance monitoring requirements. Interaction with distribution networks and ANM zones would need to be fully assessed and incorporated in the service design to achieve coherency.
	Transparency	**The proposals indicate transparent delivery,** with information on service rules and methodology being established and provided to market participants in a collaborative and clear way. Ahead of time forecasts are already provided to help with provider certainty and procurement transparency. We would ensure that information is provided in predictable way that minimises information asymmetries and uncertainty around decision making.
	Whole System Flexibility	**Moderate whole system inclusion**. Long-term contracts utilising availability payments increase ESO's flexibility to maintain optimality. These availability payments would not provide the same certainty for some cross-vector shift such as electrification of industrial processes or hydrogen electrolysis compared to DfC. Nor would it provide the same flexibility for participation as a short-term CMM with daily opportunities for new assets. However, one year contracts would provide a balance with some investment support for new technologies or systems without precluding future technologies from participation.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Market Design Framework Analysis: Long-term Constraints Management Markets (2/2)

Proposed by:		TEL the energy landscape; sse Business Energy; eDF; SCOTTISH FUTURES TRUST; Flexitricity
Proposal		**Long-Term Constraints Management Markets**
III. Efficient Investment	**Competition (Long Run)***	**Competition is boosted by growth of flexible assets** including residential flexibility, transmission and distribution connected battery storage and electric vehicles in the long-run (more so than short-term CMMs due to the improved certainty of revenue streams provided by the availability payment). Higher number of wind farms/distributed generation should also improve long-run competition – with generators especially further enhanced when some generation assets begin to roll off their CfD schemes.
	Locational Signals in Investment*	**A constraints management market would be active for a certain constraint(s), providing a clear indication for location of investment.**
	Investor Confidence*	**Long-term contracts provide reliability of revenue streams.** Assuming a contract length of 12 months or seasonal, long-term CMM would provide confidence over future revenue streams. This scheme could be important in securing debt or equity to finance initial construction, and as such they could provide a useful investment-timescale incentive to locate in particular areas. The magnitude and degree of investability, however, depends on the type of assets.
IV. Value for Money	**Value for Money***	**Initial analysis suggests small savings for consumers (~6% per annum) could be realised** based on the assumed efficiency improvement compared to the BM combined with growth of flexibility service providers in ESO constraint markets. This savings is still subject to further assessment and risks such as gaming, lower volume growth, that could erode or entirely outweigh any benefits. Conversely, these savings could be higher if we see increased participation or more favourable CMM pricing compared to estimations.
	Deliverability*	**Extended capability would be needed to enable practical use of running long-term CMM auctions.** These extended capabilities span across multiple areas: new ESO forecasting of MW pull-back to enable operators to make effective decisions across a variety of new longer-term market timescales; compensating metered imbalances; more advanced mapping tools to determine where asset would be procured; substantial integration with control room systems and configuring of operational forecasts; commercial co-optimisation of long-term CMM contract and BM to ensure volume is procured at the appropriate timescales. There would be additional complexities for long-term CMM compared to short-term CMM due to the challenges of procuring volume years/season ahead.
	Adaptability	**Partially adaptable due to multi-year procurement and delivery cycle.** The need to provide more certainty years/season ahead and securing that availability limits the volume flexibility for this service. Change in Law from potential future market reforms could be addressed through an appropriate provisions in place. If national pricing persists ESO may need to maintain this scheme until the required network build out is delivered.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

ESO

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Policy Option 1C: Short-term Constraints Management Markets

TEL the energy landscape · sse Business Energy · EDF · ZENOBĒ · Flexitricity

1C

	Constraints Management Markets
Description	A constraint market offers the ESO to contract for flexibility with generators and demand in advance of real time, thereby reducing the volume of higher cost actions required by ESO last minute in the BM. These markets can be run at day-ahead of the constraint with a utilisation payment made for any volumes contracted for dispatch.
Possible Contract Lengths	Short-term CMM could utilise firm 30 min contract blocks nominated at the day ahead (DA) of the constraint. Although it presents higher gaming risk, most savings are expected from nominating volumes at day ahead improving the efficiency of the nominations and reducing the actions that would need to be undone as further positions are set closer to real time.
Possible Value/Price/Costs	The primary consumer savings would be achieved by the CMM achieving a more mutually beneficial alternative to the BM counterfactual through a more efficient and competitive dispatch solution at day ahead. Further value could be achieved from participation of non-BM generation turn down (t/d) when assets come off their CfD contracts.
Possible Volumes	Dependent on service design but utilising demand and generation t/d and t/u would allow gigawatts of volume to be eligible (Industrials & Commercials, domestic, wind, EVs, heat, etc). Short-term CMM could be used independently as a solution to constraint management or in combination with solutions for other time horizons such as long-term CMM and DfC providing us with potentially lower cost long-term secured volume to meet high certainty forecasted requirement and this option nearer to real time when the forecast is more certain.
Who Could Participate	We are assessing a range of options including using generation and demand in front of or behind the constraint and we would consider proceeding with any combination which we expect to deliver value. These assets would need appropriate metering at a level to demonstrate service delivery who are able to provide flexibility either through shifting or increasing or decreasing their energy flows. Whilst it could be used to improve the investment case for new assets these would likely require stronger signals such as a long-term CMM.
Where It Would Be Active	Potential for national participation with demand turn up and generation turn down behind the constraint and demand turn down and generation turn up in front of the constraint.
Lead Time	The lead time for implementing the scheme could be relatively short but would need to be discussed further.

Disclaimer: these proposals have been sourced from organisations above and the template does not indicate any endorsements or firm commitment for future commercial opportunities from the ESO

Market Design Framework Analysis: Short-term Constraints Management Markets (1/2)

Proposed by:		TEL the energy landscape, SSE Business Energy, EDF, ZENOBĒ, Flexitricity
Proposal		**Short Term Constraints Management Markets**
I. Efficient Dispatch	**Competition (Short Run)**	**Broad eligibility has potential for large volumes** across a range of technology types; limits undue concentration of market power. Variety of price mechanisms, wide participation from both BMU and non BMU units and cost bases could boost competitive offers for CMM. Using combined batteries to extend the effective duration of delivery of a battery unit could improve the effectiveness of storage participation in this service resulting in improved diversity and liquidity, as proposed in the Big Friendly Battery solution.
	Locational Signals in Dispatch	**The proposals satisfy locational signals in dispatch,** giving both volume and location signals varying by time when the constraints are active. For the market to work, the ESO must give quality volume, time and location signals.
II. Efficient Dispatch and Investment	**Coherency***	**This proposal is partially coherent with existing ESO markets and there is risk of competition between ESO and DNO markets, alongside gaming in BM**. The difference in timeframes of nomination between day-ahead in a constraint management market and the balancing mechanism does present a risk for gaming and a risk to liquidity. The LCM trial has also shown that competition with the BM prevents this service being used very much, which could well be the same here. The service would not be entirely coherent with reserve due to a lack of explicit co-optimisation between two services however co-optimisation is not thought to be required due to differences in potential asset types. Interaction with distribution networks and ANM zones would need to be included in the service design to achieve coherency.
	Transparency	**The proposals indicate transparent delivery,** with information on service rules and methodology being established and provided to market participants in a collaborative and clear way. Ahead of time forecasts are already provided to help with provider certainty and procurement transparency. We would ensure that information is provided in predictable way that minimises information asymmetries and uncertainty around decision making.
	Whole System Flexibility	**Short-term contracts lack longevity required** to drive emerging technology investment decisions and short timescale requirement for assets to ramp up/down may make it harder for wider flexibility to access. Conversely, short-term agility can increases ESO's flexibility to maintain optimality, keeping our options open for emerging technology and supporting whole systems potential.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Market Design Framework Analysis: Short-term Constraints Management Markets (2/2)

Proposed by:		TEL the energy landscape, sse Business Energy, EDF, ZENOBĒ, Flexitricity
Proposal		**Short-Term Constraints Management Markets**
III. Efficient Investment	**Competition (Long Run)***	**Competition is boosted by growth of flexible assets** including residential flexibility, transmission and distribution connected battery storage and electric vehicles the long-run. Higher number of wind farms/distributed generation should also improve long-run competition – with generators especially further enhanced when some generation assets begin to roll off their CfD schemes.
	Locational Signals in Investment*	**A constraints management market would be active for a certain constraint, providing a clear indication for location of investment.**
	Investor Confidence*	**Shorter timescales and no availability payments inhibit the ability for potential providers to forecast long term revenue streams.** Cost correcting metered imbalances will be important to enable investment case to be made for many potential providers to participate in this scheme.
IV. Value for Money	**Value for Money***	**Initial analysis suggests small savings for consumers (~6% per annum) could be realised** based on the assumed efficiency improvement compared to the BM combined with growth of flexibility service providers in ESO constraint markets. This savings is still subject to further assessment and risks such as gaming, lower volume growth, that could erode or entirely outweigh any benefits. Conversely, these savings could be higher if we see increased participation or more favourable CMM pricing compared to estimations.
	Deliverability*	**New capability needed across multiple areas**: These extended capabilities span across multiple areas: new ESO forecasting of MW pull-back to enable operators to make effective decisions day ahead; compensating metered imbalances; more advanced mapping tools to determine where asset would be procured; substantial integration with control room systems and configuring operational forecast tools; commercial co-optimisation of long-term CMM contract and BM to ensure volume is procured at the appropriate timescales; added capabilities for DSO/DNO planning and operational tools and systems. DNOs may also need new industry process for forward investment in headroom plus Primacy processes to operate increased flexibility. For Big Friendly Battery proposal, utilising combined batteries for an extended effective duration, diverse aggregation of flex would still need accurate forecasting per grid supply point (GSP) or potentially lower network levels to enable DNO operability.
	Adaptability	**Highly adaptable to future market reforms.** Ability for eligible assets to deliver in one or more service windows allows greater flexibility of volumes to be contracted. Assuming that true value of carbon would be reflected in detailed service design, this scheme has potential to ensure low carbon, flexible assets are effectively dispatched thus supporting UK's decarbonisation goals.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Policy Option 2A: Extended intertrip scheme

Eku sse Business Energy ZENOBĒ FIELD

2A

	Extended intertrip scheme
Description	Intertrip schemes enable the ENCC to facilitate more power to flow on the existing transmission infrastructure pre-fault, thus reducing the amount of generation being curtailed pre-emptively when the expected flow exceeds the current capability of the circuits. Existing constraint management intertrip scheme could be further enhanced by increasing the largest infeed loss limit to allow for a greater quantity of generation to be armed. This in turn would contribute to the increase in the effective boundary capacity by consequences of faults and flow uncertainty. In addition, EKU suggest reducing the line rating from 10 minutes to 3 minutes or less on specific boundaries could see up to a 40% increase in transmission capacity.
Possible Contract Lengths	1 to 10 years, with 4 years targeted to provide trade-offs of flexibility for ESO and allowing new investment for developers.
Possible Value/Price/Costs	Payment structures would follow the existing intertrip service being made up of an arming fee (£11/MWh in 2023/24) which the ESO pays when the user is armed and an intertrip fee which is made up of either a Tripping Fee (£/trip) when the user is tripped (~200ms) following a network fault or a De-loading Fee (£/de-load) when the user performs a de-load action (ranging from seconds to minutes post fault). Potential saving from this scheme will be the difference between arming fee and the cost from the Balancing Mechanism.
Possible Volumes	Field Energy suggested increasing the largest infeed limit to 2.3 GW would require an additional 200 GW.s of inertia to be procured and could prevent an additional 0.9TWh/year (c. 14.75% of total constraints volume in 2023) of renewable energy being curtailed when compared to the existing intertrip scheme. Currently the ENCC is arming up to 1.2GW, but will seek to contract with capacity at least double this to enable competition and account for the reduced load factor of wind.
Who Could Participate	Open to new and existing generators that are able to meet the technical requirements of the Constraint Management Intertrip Service.
Where It Would Be Active	The ESO constraint management intertrip service currently operates and aims to reduce network congestion costs in the Anglo-Scottish boundary (B6) and the East Anglian (EC5) region. The proposals are targeted at enhancing the existing intertrip schemes and can be extended to other areas of with large thermal constraint volumes.
Lead Time	Could take approximately up to 3 years to implement. This would be dependent on availability of new or existing sites to provide the service, and detailed stability analysis by the ESO of increasing the largest infeed loss limit.

Disclaimer: these proposals have been sourced from organisations above and the template does not indicate any endorsements or firm commitment for future commercial opportunities from the ESO

Market Design Framework Analysis: Extended intertrip scheme (1/2)

Proposed by:		Eku, sse Business Energy, ZENOBĒ, FIELD
Proposal		**Extended intertrip scheme**
I. Efficient Dispatch	**Competition (Short Run)**	**Limited available sources in the short-term challenge liquidity and may reduce competition:** Sources of inertia are decreasing, which results in there being limited available sources to support the proposal of increasing the largest infeed loss. As a result delivering this service before adequate assets are available has the potential to not only fail to achieve liquidity but also significantly reduce competition in other markets (e.g. stability, response, reserve). Additionally, to increase system inertia to support an increased LIL would significantly reduce the liquidity for the service and negatively impact competition. It is noted that there are no eligibility rules which appear to exclude technically capable providers.
	Locational Signals in Dispatch	**Moderate alignment with locational signals in dispatch**: The proposals do not directly send locational signals for dispatch and are more aligned to increasing participation and investment in intertrip providers and reviewing existing system operating standards and procedures
II. Efficient Dispatch and Investment	**Coherency***	**High interdependencies with existing ESO services pose challenge to coherency:** Increasing the largest loss will impact reserve, response and stability markets leading to more procurement of dynamic response – depending on demand and system inertia – that would further increase the cost of these services significantly as procurement increases over 1,100MW. Decisions to increase response, inertia and reserve procurement will also need to be simultaneously considered against wider ESO system impact and security of supply. The risk of curtailment in this solution may also prevent assets from providing DNO services, potentially impact the liquidity in DNO markets.
	Transparency	**Strong track record of existing scheme providing transparent information.** The proposals indicate adequate transparency levels through the provision of complete service rules and methodology, as well as forecast information to establish requirements for procurement windows.
	Whole System Flexibility	**Potential to unlock whole energy system flexibility**: Annual procurement cycle proposed for extended intertrip scheme suggests ability to maintain optionality, while longer contract length (e.g. 4 years) provides capability to hedge effectively. Experience with existing intertrip scheme suggests a reduction in pre-emptive curtailment and an increased flows across constrained boundaries, improving system operability and thus enabling effective optimisation across the system.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Market Design Framework Analysis: Extended intertrip scheme (2/2)

Proposed by:		Eku, sse Business Energy, ZENOBĒ, FIELD
Proposal		**Extended intertrip scheme**
III. Efficient Investment	**Competition (Long Run)***	**Ongoing investment in new battery assets ensure adequate competition for increased service requirements:** There is an additional 4GW of assets that could be connected in Scotland by the end of 2026. However, with increasing penetration of renewables, stability on the system is forecast to continue to decline and the cost procuring additional inertia could be significant. Adequate notice of additional volume is important to ensure required assets could be procured through a competitive tender.
	Locational Signals in Investment*	**Strong alignment with locational signals in investment:** The proposals would allow for the product design to tackle a specific boundary constraint and therefore clearly indicates a location signal for investment.
	Investor Confidence*	**Provision of additional revenue stream for asset providers is advantageous:** Assuming revenue model for extended intertrip scheme is similar to the existing Constraint Management Intertrip Service (CMIS) with Arming Price Caps and Intertrip Fees set on an annual cycle, this scheme presents an additional opportunity for small scale revenue provided revenue stacking is permitted.
IV. Value for Money	**Value for Money***	**N/A – not assessed due to deliverability/coherency concerns.** Savings quoted in the proposals have been reviewed and discussed with the providers. It was agreed that they are overstating the benefits.
	Deliverability*	**Limited alignment due to stability, reactive power and system operability considerations.** These prevent the implementation of this solution at the moment, before the ESO has undertaken further studies into the risks, which include additional transmission connected and/or embedded generation tripping, the lack of inertia and reactive power providers and the overall risk appetite for greater utilisation of the intertrip service. Additionally, considering impact on the volume of response/reserve available (locationally where necessary) at optimum cost will be important. In terms of the thermal limit, higher amount of tripping does not directly correlate with a higher, maximum (pre-fault) limit, as you may hit a pre-flow load limit on a circuit pre-fault that prevents you utilising a short-term rating. Post-fault and with the outage of a double circuit, there is also a restriction around how much you could trip. Past experience suggests intertripping 900MW post-fault has caused system stability problems, whilst intertripping 600MW did not.
	Adaptability	**Annual contracting and ability to adjust armed volumes suggests higher degree of adaptability:** The proposals indicate that the procurement method is flexible to changes in market requirements and technology mix. For the expansion of the intertrip scheme, contracts could be signed annually with the possibility to seek longer contract periods as necessary.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Policy Option 2B: Grid Booster (post-fault)

Kona Energy DELIVERING THE ZERO CARBON FUTURE FIELD Eku

2B	Flexible assets to support capacity increase (Grid booster/post-fault)
Description	Increasing and/or more effectively coordinating energy storage assets around the constraint boundary to allow boundary transmission infrastructure to be run closer to maximum capacity could reduce curtailment volumes. This could be achieved by arming storage capacity behind the constraint in case of a fault or by creating storage capacity in front of the constraints to provide contingency. EKU proposes installing a battery on the demand side of the constraint, directly connected via an intertrip similar to the generation on the other side of the constraint which allows ESO to reduce the line rating from 10 minutes to 3 minutes.
Possible Contract Lengths	Options requiring new storage assets to come online would need contract lengths of at least 1 year. Industry prefers a long-term contract (T-4), providing greater investment signals, increasing market liquidity, and reducing the financing costs and the cost to the end-consumer.
Possible Value/Price/Costs	Payment for the service was proposed to be a combination of availability and utilisation, which could be priced at around £10/MWh assuming that this service is "stackable" with as many other revenue streams as possible. Alternatively, pricing could be set in a dynamic way depending on the contract length.
Possible Volumes	Kona suggested 250 MW of energy storage for constraint alleviation for at least two hours in Scotland (B6) would be available for this scheme. The service could be utilised around 10% - 25% of the year during periods of highest wind or when a constraint is active, as this is likely to have small opportunity costs to batteries/storage providers. The longer the service period is, the higher the prices that batteries would factor in for the lost opportunity cost of other markets.
Who Could Participate	Open to all new and existing assets located near constrained boundaries.
Where It Would Be Active	Initially in areas of large constraint volumes (e.g. B6), but could also be deployed in front of the constraints to support effective capacity increase.
Lead Time	Could be relatively short. Longer lead times if expansion of storage assets is required to increase the capacity of the scheme.

Disclaimer: these proposals have been sourced from organisations above and the template does not indicate any endorsements or firm commitment for future commercial opportunities from the ESO

Market Design Framework Analysis: Grid Booster (post-fault) (1/2)

Proposed by:		Eku FIELD Kona Energy
Proposal		**Grid Booster (post-fault)**
I. Efficient Dispatch	**Competition (Short Run)**	**Limited available sources in the short-term due to liquidity achieved in other battery provided response markets.** There is limited surplus battery volume to deliver this service in Scotland, with the majority of the volume operated by a small number of providers. Volume improvements could be achieved with participation from hydro, although with only two hydro plants this would not significantly improve competition and those plants may not have the capability to respond fast enough to provide this service. Therefore, delivering this service before adequate battery assets are available can challenge market liquidity and also significantly reduce competition in other markets.
	Locational Signals in Dispatch	**Moderate alignment with locational signals in dispatch**. The Grid-Booster and EKU concepts require the BESS to have inter-trip communications hard-wired for the specific fault, and therefore this system is specific to fixed boundaries. This means that Locational Signals In Dispatch are weak as, for example, the design of the solution is not aligned to allowing the cost of procurement to vary by both time and location simultaneously.
II. Efficient Dispatch and Investment	**Coherency***	**Service is not coherent with current methods of managing reserve and response.** Introducing this service, which is akin to dynamic response, would split the market for dynamic response and undermine competition. Additionally, upfront costs of post-fault service associated with connecting to intertrip relay could increase the cost of procuring dynamic services significantly from its historical low level of £1-2 MWh. In terms of alignment with DNO markets, the level of coherency with DNO network and market operation depends on the detailed technical design of the service.
	Transparency	**Information could be provided in a clear and predictable way.** The proposals indicate that market design would be able to clearly outline the eligibility, frequency of procurement, lead time, product duration, payment structure and clearing principles. A competitive tender process is proposed, and this would allow procurement decisions to be made in a clear and predictable way to minimising uncertainty around ESO's decision making. Timing and content included in forecasts should be prioritised to ensure suitable levels of transparency, minimising gaming risks and to enable greater participation and competition.
	Whole System Flexibility	**Service lacks long-term support options for emerging technology mix.** Highly desirable to maintain optimality given short-term contracts offered. Nevertheless, the nature of this service suggests exclusivity towards batteries/storage providers, limiting accessibility of other emerging technology types to participate.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Market Design Framework Analysis: Grid Booster (post-fault) (2/2)

Proposed by:		Eku FIELD Kona Energy DELIVERING THE ZERO CARBON FUTURE
Proposal		**Grid Booster (post-fault)**
III. Efficient Investment	**Competition (Long Run)***	**Potential for good levels of new assets in the future but competition levels could be hindered by asset ownership**. Battery deployment projections indicate an additional 4GW of assets could be connected in Scotland by the end of 2026, provided by a dozen asset owners although the majority of this volume would be owned by one organisation. Deployment of battery assets in Great Britain is forecast to exceed 10GW with a diverse ownership which should ensure adequate competition.
	Locational Signals in Investment*	**Strong alignment with location signals in investment**. The service would be relating to a specific boundary constraint, so this will provide a clear indication for location of investment, ensuring that capacity is constructed and that services are procured in the right places.
	Investor Confidence*	**Nature of service provides revenue certainty and flexibility concurrently.** The use of flexible assets to support transmission and distribution networks is expected to create additional revenue streams, for flexible asset providers. Provider would be 'armed to export' for a maximum % of the year in line with the proportion of time the constraint or they could make their batteries available for a higher % of the year (e.g. 50%) in exchange for a longer duration contract e.g., 3 years. The higher certainty over revenues from a long-term contract should reduce cost of capital which would significantly lower the required target revenue for the battery. This ultimately leads to reduced 'lost opportunity' cost and price required to deliver the service.
IV. Value for Money	**Value for Money***	**N/A – not assessed due to deliverability/coherency concerns.** Savings quoted in the proposals have been reviewed and discussed with the providers. It was agreed that they are overstating the benefits.
	Deliverability*	**Limited practicality due to implementation complexities and new ESO capabilities requirement.** A post-fault service will need new systems of control and investigations into the battery control system configurations in order to deliver necessary operational assurance, charge or discharge at the correct rates to support management of the constraint**.** These systems would require new capabilities to interface with the existing ESO intertrip signalling control systems. With the concern around stability, there is a need for the ESO to undertake further studies of transient behaviour of the system to investigate the interactions of tripping large volumes combined with the new injection of power and millisecond timing implications for both voltage collapse and system instability. Initial work suggests that these studies are very challenging to perform due to extreme sensitivities to detailed chosen modelling boundary conditions. Due to these practical issues, further analysis of impact on the system is needed before progressing with commercial design.
	Adaptability	**Partially adaptable to changing balancing service requirements and technology mix**. Armed volumes can be altered during each settlement period according to the forecasted constraint event, with a short lead time, presenting alignment with adaptability. The technical requirements of this service would preclude other forms of technology from providing this service other than battery storage. Thus, limiting adaptability to future technological mixes. In the case of market reform, this service would be an enduring solution, providing equal utility and value in both national and zonal markets. However, the need for this service could diminish with more network and other demand flexibility services on the system in the future.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Policy Option 2C: Transfer Booster (Pre-fault)

Kona Energy ZENOBĒ

2C

Flexible assets to support capacity increase (Transfer booster/pre-fault)

Description	Battery storage, with rapid, bi-directional response times to act as a shock absorber – importing power during wind gusts and exporting power during wind lulls, all during a continuous period of constraint. This could unlock extra network capacity at constrained boundaries due to the reduced need to keep reserve capacity, or headroom on the network. Kona proposes using paired storage systems across key boundaries as a pre-fault action with a battery on standby ready to charge at times of constraints and another on the unconstrained side, ready to discharge replacement energy.
Possible Contract Lengths	Contract length will be a minimum of 12 months with further extensions at the discretion of the ESO, on a rolling annual basis.
Possible Value/Price/Costs	If deployed between 2025 and 2035, Zenobe believes this service could save £180m in balancing costs. This would be achieved by avoiding the need to hold excess margin against a constraint boundary to manage volatility in the transfer as it would reduce expenditure on both bids (i.e., curtailment payments to wind farms north of the constraint) and offers (i.e., generation payments to gas plant south of the constraint). Prices to be set through competitive tender and service would be designed mirroring dynamic services which could adopt either availability or availability/utilisation payment. This could be either fixed contract or predefined periods determined by ESO.
Possible Volumes	Up to 300 MW 2 hr duration 'Transfer Booster' would be an appropriate start.
Who Could Participate	Open to any asset in the right location which can modulate supply or demand in the right way.
Where It Would Be Active	Initially in areas of large constraint volumes (e.g. B6), either just behind or behind and in front of the constraint.
Lead Time	Could be relatively short. Longer lead times if expansion of storage assets is required to increase the capacity of the scheme.

Disclaimer: these proposals have been sourced from organisations above and the template does not indicate any endorsements or firm commitment for future commercial opportunities from the ESO

Market Design Framework Analysis: Transfer Booster (Pre-fault) (1/2)

Proposed by:		Kona Energy DELIVERING THE ZERO CARBON FUTURE ZENOBĒ
Proposal		**Transfer Booster (Pre-fault)**
I. Efficient Dispatch	**Competition (Short Run)**	**Limited available sources in the short-term due to liquidity achieved in other battery provided response markets.** There is limited battery volume to deliver these services in Scotland, with the majority of the volume operated by a small number of providers. Therefore, delivering these services before adequate battery assets are available could challenge liquidity in response markets. Battery volume across GB is growing and may not be a concern in a couple of years but currently it does not greatly exceed the requirements for response and reserve services, which could present risks for competition in all three service areas.
	Locational Signals in Dispatch	**Moderate alignment with locational signals in dispatch**. Whilst the proposals for paired storage systems and 'transfer booster' have merit in being able to increase the flow over a certain boundary, they do not offer locational signals in dispatch. The paired storage system is a specific technical solution based on locational signals in investment rather than dispatch; and the transfer booster, which flexes to charge/discharge in line with wind gusts/outputs, is also linked to a specific boundary.
II. Efficient Dispatch and Investment	**Coherency***	**Services are incoherent with ESO services as they could impact provision of other ancillary services.** They two proposals both have the potential to overlap with and interact with dynamic response services, which are designed to manage sudden frequency imbalances resulting from intermittent generation such as the effect of wind gusts. ESO has been procuring fixed amount of dynamic services and is seeking to move towards locational procurement. Adding pre-fault service could undermine competition by splitting the size of the dynamic markets. The level of coherency with DNO network and market operation also needs to be considered.
	Transparency	**Information could be provided in a clear and predictable way.** The proposals indicate that market design would be able to clearly outline the eligibility, frequency of procurement, lead time, product duration, payment structure and clearing principles. A competitive tender process is proposed, and this would allow procurement decisions to be made in a clear and predictable way to minimising uncertainty around ESO's decision making. Timing and content included in forecasts should be prioritised to ensure suitable levels of transparency and a level playing field for all technology types to enable greater participation and competition.
	Whole System Flexibility	**Service lacks long-term support options for emerging technology mix.** Highly desirable to maintain optimality given short-term contracts offered. Nevertheless, the nature of this service suggests exclusivity towards batteries/storage providers, limiting accessibility of other emerging technology types to participate.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Market Design Framework Analysis: Transfer Booster (Pre-fault) (2/2)

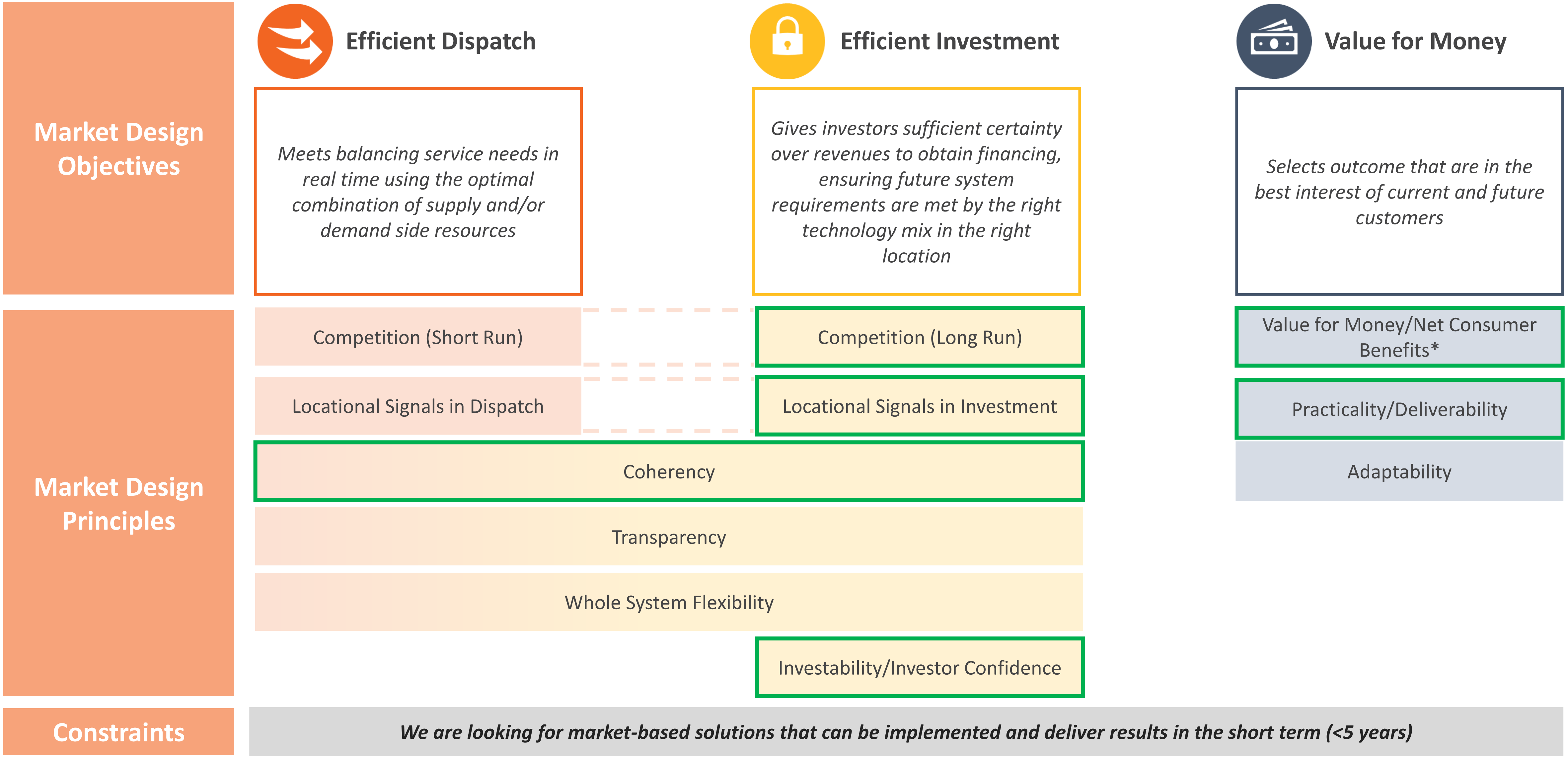
Proposed by:		Kona Energy DELIVERING THE ZERO CARBON FUTURE ZENOBĒ
Proposal		**Transfer Booster (Pre-fault)**
III. Efficient Investment	**Competition (Long Run)***	**Potential for good levels of new assets in the future but competition could be hindered by asset ownership**. Projections indicate an additional 4GW of assets could be connected in Scotland by the end of 2026, provided by a dozen asset owners although the majority of this volume would be owned by one organisation. National deployment of battery assets is forecast to exceed 10GW with a diverse ownership, ensuring adequate competition.
	Locational Signals in Investment*	**Strong locational signals for investments as the location of the batteries needs to be right in order for this service to be of use.**
	Investor Confidence*	**Potential for additional revenue streams for developers but the exclusivity nature of pre-fault service, its standby requirement and potential for direct competition with existing ESO service challenge the investment case.** A 12-months contract would provide a signal to develop a project in a certain location, assuming that there is a specific locational need to alleviate constraints. However, ESO would expect a lot of existing capacity to be able to provide pre-fault service through existing procurement routes, such as Dynamic Moderation or Dynamic Regulation, so long-term contracts to ensure investment in additional capacity would not be justified.
IV. Value for Money	**Value for Money***	**N/A – not assessed due to deliverability/coherency concerns.** Savings quoted in the proposals have been reviewed and discussed with the providers. It was agreed that they are overstating the benefits.
	Deliverability*	**Implementation impractical due to added complexity to control systems.** As we don't currently allow for additional capacity for wind gusts, this is not something we can easily evaluate. Short imbalances that the transfer booster seeks to address are currently adequately addressed by our existing services. This service would require assigning capacity to one type of fault, while multiple constraints are typically active. Both a transfer booster and a paired storage system would introduce significant complexities due to interactions with frequency response systems and the control systems. Battery control systems would need to ensure correct charge and discharge rates to manage the constraints, requiring coordination among numerous automatic systems. These interactions would slow down the asset response (e.g., timescales of minutes rather than seconds), a highly complex controller design and 'virtual power solution', further complicating the energy balancing process. Assessing the dimensions of the requirement and selecting the right location for multiple batteries will also significantly impact the service's potential value and increases control scheme complexity. Due to these practical issues, further analysis of impact on the system is needed before progressing with commercial service design. A transfer-booster solution could be better suited as a TSO/DNO solution.
	Adaptability	**Service shows moderate levels of adaptability to changing balancing service requirements**. Armed volumes can be altered during each EFA period according to the forecasted constraint event, with a short lead time, presenting alignment with Adaptability. Technical requirements of this services would preclude almost all other forms of technologies from providing this service other than battery storage, thus potentially limiting the service's adaptability to future technological mixes. In the case of market reform, this service can be an enduring solution.

Disclaimer: The ESO is not committing to implementing any of these proposals without further design development and another CBA.

Level of Alignment to MDF principles: 🟥 Negative 🟨 Neutral – more investigation needed 🟩 Positive * Prioritised criteria

Annex: ESO MDF Methodology

Assessment criteria using the ESO Market Design Framework (1/5)



Market Design Objectives

Efficient Dispatch

Meets balancing service needs in real time using the optimal combination of supply and/or demand side resources

Efficient Investment

Gives investors sufficient certainty over revenues to obtain financing, ensuring future system requirements are met by the right technology mix in the right location

Value for Money

Selects outcome that are in the best interest of current and future customers

Market Design Principles

- Competition (Short Run)
- Competition (Long Run)
- Locational Signals in Dispatch
- Locational Signals in Investment
- Coherency
- Transparency
- Whole System Flexibility
- Investability/Investor Confidence
- Value for Money/Net Consumer Benefits*
- Practicality/Deliverability
- Adaptability

Constraints

We are looking for market-based solutions that can be implemented and deliver results in the short term (<5 years)

---

* Assessed by Baringa

Key ■ Efficient Dispatch ■ Efficient Investment ■ Value for Money □ Prioritised criteria

Assessment criteria using the ESO Market Design Framework (2/5)

Principles	Explanation and Rationale	Assessment Metrics
Competition **(Short Run)**	**What:** The solution creates a market in which multiple current or potential participants seek to offer better terms (prices and quantities) than those offered by other participants, which is open to all providers technically capable of providing the service	*What is the number and MW of existing capable providers?* *What is the market share of the three largest providers?* *How many technically capable providers are included and excluded by eligibility rules?*
	Why: Ensures service eligibility does not unduly discriminate against particular technologies	
Locational Signal **in Dispatch**	**What:** The solution provides insight to market participants on what's the value of their actions to the system in terms of location and incentivises dispatch that meets system requirement	*Would the proposal send sufficiently accurate and granular signals by time and location?*
	Why: Demonstrates ability to reduce overall volume of ESO actions and delivers value for money to consumers	

Key ▨ Efficient Dispatch * Prioritised criteria

Assessment criteria using the ESO Market Design Framework (3/5)

Principles	Explanation and Rationale	Assessment Metrics
Coherency*	**What:** The procurement methods enable market participants to make decisions about where to bid, which are efficient for both the market participants and the system, across all ESO and non-ESO markets (e.g. Wholesale and DSO markets)	*Will this solution be consistent with the procurement of other ESO services?* *How does this solution align with DSO's markets?*
	Why: Ensures the solution's procurement decisions are efficient and aligned with the evolution of ESO markets and other markets	
Transparency	**What:** Information is provided to market participants and procurement decisions are made in a clear and predictable way	*How much information about forecasting for the service can be shared?* *How will the ESO publish the service rules and methodology to ensure clarity for participants?*
	Why: Demonstrates ability to minimise information asymmetries and uncertainty around ESO's decision making	
Whole System Flexibility	**What:** Market design should incentivise market participants of all sizes (both supply and demand) to act flexibly where it is efficient to do so. It should also promote greater coordination across traditional energy system boundaries, to enable effective optimisation across the system as a whole	*Does this support an integrated, whole-system approach across different energy vectors (vendors/sectors/actors)?*
	Why: Ensures the solution enables effective optimisation across the energy system as a whole	

Key 🟥 Efficient Dispatch 🟨 Efficient Investment * Prioritised criteria

Assessment criteria using the ESO Market Design Framework (4/5)

Principles	Explanation and Rationale	Assessment Metrics
Competition (Long Run)*	**What:** The solution creates a liquid market through multiple players that can offer competitive terms (prices and quantities)	*How many providers could participate in this service in future?*
	Why: Ensures the solution enables price discovery and reduce overall cost to consumers in the long run	
Locational Signal in Investment*	**What:** The solution ensures that capacity is constructed and that services are procured in the right places	*Does the proposal provide a locational investment signal, to support development of new assets, which can help with either demand or generation useful for system operation?*
	Why: Demonstrates value that encourage investors to invest in new generation or storage assets, demand or sources of flexibility to build an optimised electricity system that accurately reflects the value of generation and demand to the system	
Investability / Investor Confidence*	**What:** Market design must drive the significant investment in technologies needed to deliver our objectives and deliver investment signals which market participants and investors can respond to and rely on	*Does this provide a clear business model for in-scope techs?* *What is the impact on investment across the life of an asset for in-scope techs? What is the contract length?* *Will the proposal provide revenue certainty for providers?*
	Why: Demonstrates ability to generate revenue to attract financing or investment	

Key 🟨 Efficient Investment * Prioritised criteria

Assessment criteria using the ESO Market Design Framework (5/5)

Principles	Explanation and Rationale	Assessment Metrics
Net Consumer Benefits / Value for Money*	**What:** The costs to consumers do not outweigh the benefits conferred by the procurement method	*What is the net consumer benefit of the solution? (does the solution generate savings to end consumer bills?)*
	Why: Ensures the solution reduce overall costs to consumers	
Practicality / Deliverability*	**What:** Changes to market design should be practical to implement, transition to and operate within designated timeframes and seek to minimise disruption during the transition, taking account of the highly complex and integrated nature of the power system	*How implementable is the option within timeframes planned? Does the procurement method require ESO to increase its operational capabilities?* *Will the solution require changes in industry systems or processes?*
	Why: Demonstrates ability to deliver in short term	
Adaptability	**What:** Market design should be adaptive, responsive to change, and robust to uncertainty. The solution should also be flexible to changes in balancing service requirements and the technology mix	*How often is ESO able to adjust the volumes procured for this service?* *Does it present any challenges to future decarbonisation, or decentralisation?* *Will the service be compatible with planned or potential changes to market design?*
	Why: Demonstrates ability to keep up with dynamic market and regulatory changes	

Key ▨ Value for Money * Prioritised criteria