ESO

ESO response to National HVDC Centre

The ESO acknowledged all the comments from National HVDC Centre and had a follow-up meeting to clarify their questions and concerns. Based on their concerns, ESO colleagues specialising in system stability, voltage management, operability modelling, Grid Code Modification, Technical Code and Operability Strategy, also joined the discussion.

It was agreed with National HVDC Centre, in responding to their FRCR 2024 consultation responses, the ESO would reply to address their direct concerns regarding FRCR 2024 policy recommendations and the methodology, model and assumptions that drives the recommendations. Questions around system operability under reduced system inertia condition and with more penetrated zero-carbon technologies situation have been discussed in the meeting and it was re-ensured by the ESO that,

- ESO acknowledges the impacts from reduced inertia to system operability. Although addressing operability concerns is beyond the scope of FRCR 2024, it is currently managed by expertise in other ESO workstreams.
- We continue learning from recent system events by monitoring system and running investigations. Following investigations, our approach would involve,
    - follow up individual unit through compliance route and restrict its output until it is fully compliant.
    - If the issue is identified to be more common presented by multiple units and not covered within existing code, ESO can initiate Grid Code Modification process and start engaging with the industry. ESO will introduce mitigation measures to remain system security.
    - ESO will initiate innovation research, develop new operational strategies, tools and processes if a new operational risk is observed, e.g. regional inertia, allocation of response services, etc. Research outcomes and operational changes will be factored into future FRCR.

Comments around inertia estimation and monitoring are also taken into account into relevant ESO workstream. We appreciate all the comments related to system operability and have passed them to the relevant ESO team who manages the Zero-Carbon operation roadmap to ensure all the projects are running hand-in-hand. ESO plans to communicate Zero-Carbon operation plan and its readiness to the wider industry.

We also acknowledged and appreciated comment around simultaneous events definition raised by National HVDC Centre at the meeting and will review this within FRCR 2025 cycle. We agreed with National HVDC Centre to have further discussions regarding operability modelling and analysis.

Response presented in this document focuses on questions related to FRCR.

No	Question	Comments	ESO Response
1	Overall, do you agree that the FRCR 2024 represents appropriate development in determining the way that the ESO will balance cost and risk in maintaining security of supply while operating the system?	The method for National frequency containment relating to swing equation calculation is consistent with past FRCR and clearly articulated. However, its less clear how evolving risks associated with the trajectory towards a lower inertia system supported in containment by more complex layers of services supported by a wider range of technologies is secured across a range of growing scenarios and uncertainties (see section 6- other comments for further discussion)	Thank you for your comments and inputs into FRCR 2024 consultation. The primary focus of the FRCR policy is to conduct a comprehensive cost-benefit analysis to manage post-fault frequency stability effectively. The inertia policy in FRCR is the national inertia requirement for managing major frequency excursions. System stability under lower inertia conditions (e.g. system strength, potential oscillations, etc) are beyond the scope of FRCR and managed by other workstreams in the ESO. Please refer to [Operability Strategy Report (OSR)] as the summary of our current understanding of system operability including interactions between minimum inertia and other operability workstreams. We continue learning from recent system events by monitoring and running investigations. We introduce mitigation actions before we fully understand the cause of the event and clarify further operability issues and risks. We are developing new operational strategies, tools and processes to ensure we have visibility and can manage these challenges in a coordinated manner. We are also running innovation projects and widely collaborating with industry. More communication on system operability will be initiated by the ESO soon.
2	Do you agree that the FRCR 2024 has been prepared appropriately? Please elaborate.	See points above as unpacked in section 6- other comments. We would additionally note from the detailed comments there is a danger that too much focus on nadir of	Agreed that resilience is indeed a crucial aspect to avoid unnecessary demand disruption. We do consider the RoCoF related consequential losses and our policy is to

		containment, without consideration of the rate of change of frequency within each frequency band of containment may lead to an under-estimate of the risk- the most important aspect of frequency containment from a resilience perspective being the ability to ultimately contain an acceptable range of scenarios avoiding larger demand disconnection for a reasonable range of sensitivities to those scenarios. It would be helpful to examine whether those layers of defence remain robust as the inertia level falls against the performance of a more IBR concentrated system.	secure all BMU loss together with the consequential RoCoF loss depending on the system conditions. In terms of the risks of IBRs with increased RoCoF due to reduced inertia. FRCR and current practise considers the known risks such as embedded generations with LoM relays. From operational perspective, this is calibrated and validated against frequency event post-event analysis to ensure effective mitigation strategies are in place. By running post-event investigation, if we identify the causes of trips, our approach would involve, • through compliance route to follow up with individual unit and restrict its output until it is fully compliant. • If the issue is identified to be more common presented by multiple units, ESO can initiate Grid Code Modification process and start engaging with the industry. • ESO can initiate innovation research if a new operational risk is observed. ESO will collaborate with the industry.
3	Recommendation: ***Maintain minimum inertia requirement at 120 GVA.s***	Further clarification is needed a) as to what this minimum inertia figure represents- as that relates directly to the scenarios being captured and how concurrent they would be b) what the certainty of inertia of non BMU elements actually is c) to what extent DR and other products are implicitly procuring	The minimum inertia requirement sets out the lowest inertia level we would maintain at to make sure frequency stability are acceptable. This minimum inertia requirement does not conflict with other system requirements (e.g. voltage & SCL requirements) since it is a requirement to keep inertia no lower than this limit. Operationally, this minimum inertia requirement will be

		inertia and d) what the handshake between inertia and frequency response is and should be as there is cost benefit assessment necessary beyond the first 1sec of any event between the two that should be considered here.	met (if necessary) after solving locational constraints such as thermal and voltage. For the interaction between inertia and response, this is independent of the minimum inertia requirement. Under the current market arrangement, response services are much more efficient than synchronising conventional units to increase inertia. However, this cost-benefit assessment might change when there are more market routes for providing inertia.
4	Recommendation: ***Consider additional DC-Low requirement***	Considering the comments above and their more detailed unpacking below we would agree that there is further argument for additional DC low.	Thanks for your feedback
5	Do you agree ESO to propose lower minimum inertia requirement before FRCR 2025	No. in our view based on the comments above and their detailed unpacking there remains uncertainty over how risks evolve across a lowering inertia strategy. We note that ESO has initiated research on some of these areas and the outputs of this work and consideration of the other concerns highlighted should be considered further ahead of reducing national inertia. It is not even clear whether a national inertia objective alone is the appropriate objective as the total level of inertia available falls. In our view it would be helpful to separately map the trajectory towards lower inertia in parallel to the initiatives that inform that	We appreciate the comments and have passed this question to the relevant ESO team who manages the Zero-Carbon operation roadmap to ensure all the projects are running hand -in-hand so GB system has adequate resilience and security associated with all the operability related trajectory. ESO plans to communicate zero-carbon operation plan and its readiness to the wider industry. Regarding further reducing minimum inertia policy, we will ensure this happens through industrial consultation and stakeholder engagement once our analysis indicates the system is ready.

		approach and the evolution of the metrics of resilience and security associated with the trajectory and directions of service evolution. FRCR can then refer to that document and its rate of future inertia reduction then be dependent on review of milestones along that trajectory- this would act to provide transparency of activity and avoid risk of delay in future FRCR consultation.	
6	Do you have any other comments?	See points unpacked below the table to avoid otherwise inefficient formatting (in National HVDC centre's response to FRCR 2024 consultation)	Here is a summary to your comments in section 6. Q1.1 - The inertia policy in FRCR is the national inertia requirement for managing major frequency excursions. System stability under lower inertia context (e.g. system strength, potential oscillations, etc) those are beyond the scope of FRCR and managed by other workstreams in the ESO. We will also ensure to involve the relevant teams to further engage on these topics. Q1.2 - Agreed that resilience is indeed a crucial aspect to avoid unnecessary demand disruption. We do consider the RoCoF related consequential losses and our policy is to secure all BMU loss together with the consequential RoCoF loss depending on the system conditions. In terms of the risks of IBRs with increased RoCoF due to reduced inertia. FRCR and current practise considers the known risks such as embedded generations with LoM relays. Operationally, this is calibrated and validated with frequency event post-fault analysis to ensure effective mitigation strategies. If we identify the causes of trips,

			our approach would involve a) via compliance mechanism to regulate individual performance if an issue would be found post-fault and introduce mitigations, and/or b) trigger GC modification if it would be a common issue. Q1.3 – Device level stability and reliability is beyond the FRCR scope. And we will refine and update the FRCR policy on this area when we have more input from the relevant workstreams. Q1.4 – This is related to response services design and how to address the performance and availability of the services. We have implemented performance monitoring measures to ensure that service providers are delivering the appropriate services. Additionally, our response holding is dynamically scaled up based on the availability factor derived from historical performance monitoring data. Q1.5 – Some of the Q2 and Q4 responses can fit into this comment too. Additionally, the stacking of multiple services such as frequency response with grid forming is the service and market design problem. Currently, we allow stacking of multiple frequency response services (e.g. Dynamic Containment with Dynamic Regulation), and each individually has its energy requirement and state of change recovery requirement to ensure they are continuously available. Q1.6 – Further review and exploration can be conducted on the topic of locational inertia and its implications for response and RoCoF. The impact of locational inertia on

			existing services and future service design is an area that warrants research and improved system modelling. Understanding this behaviour and developing appropriate operational policies if needed are important considerations. We will take away this as a research topic and will factor this into future FRCR analysis. Q1.7 - We appreciate the suggestions provided. In terms of operation, we continually review frequency performance to assess and adjust response requirements accordingly. Additionally, we have taken into account response unit availability during procurement mentioned in Q4 and maintain ongoing monitoring to ensure its effectiveness. Q1.8 - The mentioned points are covered under the current FRCR, and ESO retains the right to operate the system deviating from existing policy when necessary, meaning we take additional defensive measures to increase response and inertia, for situations such as extreme weather conditions. Q1.9 – thanks for this comment and suggestion.