FRCR Consultation Response Proforma

FRCR Consultation

Industry parties are invited to respond to this consultation expressing their views and supplying the rationale for those views, particularly in respect of any specific questions detailed below.

Please send your responses to box.sqss@nationalgrideso.com by **5pm** on **Friday 17th May 2024.** Please note that any responses received after the deadline or sent to a different email address may not receive due consideration.

If you have any queries on the content of this consultation, please contact box.sqss@nationalgrideso.com

Respondent details	Please enter your details
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Please express your views in the right-hand side of the table below, including your rationale.

FRCR Assessment and Methodology Consultation questions		
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)
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 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.
Feedback on the specific recommendation in FRCR 2024		
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 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.
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.
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 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

Further comments

Question 1

Evolving risk

1. Reduction in inertia coincides with the continued “demand destruction” in net transmission system demand being observed. This is at least partially accounted for in the growth of distributed connected resources (generation, storage) that are at a more modest subject to limited observability at a given instance of operation.

a. Changes envisaged in REMA to increase observability will be important, alongside real-time monitoring of grid state in estimating residual demand inertia, which at lower periods of overall inertia will form an increasingly more material element to frequency containment analysis, and are changes that should have linkage with transition to lower inertia levels.

b. The distributed generation and distribution connected are not subject to the same range of performance criteria as transmission generation would. This particularly applies to legacy plant and equipment. Not only do the distribution system frequency ranges for generators remaining connected not align, but there is also less clarity as how these generators actually perform across frequency deviations- for example do embedded CHP generators remain at constant power output over a given frequency deviations, reduce power linearly with increased frequency decline as can be the case with transmission connected CHPs and CCGTs, or just trip? These effects mean that beyond the actions of inertia alone, additional frequency response to cover residual uncertainties may be warranted, and that particular locations of IBR concentrated connection at transmission level may see locationally different effects upon voltage angle and local frequency due to these behaviours.

c. The inherent behaviour of load itself is changing as it also becomes subject to IBR interface and control. For example unlike motor load, a constant current controlled IBR load is unlikely to change its MW demand across a given frequency range up to the point it reaches a point whereby its control would trip that IBR. IBR resources associated with EV supply or storage devices may seek immediately following an event to “catch-up” on their state of charge, leading to greater need for post fault dynamic regulation resources. As load becomes less resistive, IBR performance becomes less subject to damping of oscillatory modes than it would have seen previously. It is unclear how such effects are factored into the FRCR methodology to date. Again these may justify further response holding.

2. The current methodology is overly focussed on the nadir of events rather than the trajectory within them. Respecting max RoCoF of 0.5hz/s as sampled over 500ms is mentioned, however within such RoCoF instantaneous frequency deviation or rate of frequency deviation can lead to IBR control error in controller response. This error has the potential to lead to delays in performance, limiting/ tripping phenomena from IBRs, and/or unhelpful performance during an event. Its not clear how these risks are quantified.

   a. Note that whilst codes and standards relating to IBRs have changed over time, many legacy IBR are not subject to the same capabilities in withstand as current codes and standards would require and it would be helpful to identify bands of performance to dimension the scale of the risk being held.

   b. As inertia falls, so also does short circuit level and other measures of network strength also decay which in turn impact IBR performance. Frequency containment also becomes linked to these factors.

3. In an IBR dominated system, transmission fault conditions which result in generation loss present IBR with a rating issue as both voltage and frequency support and stabilisation are required instantaneously from the device and require prioritisation within the MVA rating of the convertor. This will lead both to different frequency performance in different areas of the transmission system, and the associated IBR seeing both larger local RoCoF and associated

voltage phase angle jumps. Inherently fast response in these areas can lead to the exacerbation of phase angle movements, against a context of voltage and frequency recovery locally, which needs to be considered with care in terms of the IBR stability in such areas. We should emphasise this different to the comparatively slow sampled RoCoF and vector shifts discussed in the methodology, but rather relates to PLL and outer loop tuning of IBRs and small signal resilience of the overall controller to the local effects derived above. Internationally in recent years, see US (CAISO, ERCOT, Dominion Energy TSO) experience and others (AEMO, southern state grid China) have encountered scenarios of IBR disconnection during such events, which do not relate to loss of mains relay actions but rather IBR control & protection action.

4. It is to be noted that frequency response services have evolved from mandatory grid code services to a range of focussed layered services providing greater opportunities for market participation across the greater range of options (for example the combination of DM, DR, DC) across frequency regulation, containment and recovery). Whilst this is to be welcomed it should be recognised that this more complex overlapping picture is exposed to more potential risk, particularly as inertia falls- for example in the following respects- higher RoCoF introduces more measurement uncertainty both of performance and thresholding of different performance from devices such that the layering envisaged may not occur in practice due to these reasons. Further the exposure to availability and performance in each service has knock-on impacts on those other services expected to be delivering complementary action to them.

5. More generally RoCoF increase risk for an unplanned scale of recovery not only has impacts to the frequency nadir but also how the services and emergency actions beyond these function for unexpected events. This is not only important to the net loss position but also to understanding how devices providing the service behave. For example there may be a risk that battery technologies and others delivering grid forming inertial response excessively during the hand-over between inertia and dynamic containment in turn exhaust stored energy too quickly and then worsen that event. Whereas delivering focussed inertia support limited in inertia constant ahead of dynamic containment not only provides a more predictable behaviour to such excessive events, but also provides the option under other additional actions to release head-room in recovery. This is where improvements in the construction of solutions and their nesting can have the potential to improve resilience and ahead of that the assumptions around resilience of the current position need to be considered carefully.

6. As we move to a lower inertia position this drives consideration of locational need of inertia, whether inertia purely at 50Hz or damping is critical or whether inertia may need to be more broadly defined as small signal damping across a range of frequencies, and whether this definition strictly needs to apply to periods beyond the initial disturbance itself and the response of services in relation to it- as broader definitions risk confusing device performance and efficiency and the securing of events. It would be helpful to be considering the inertia required at each timeframe within a frequency event and how that trades off against the response products being used, both to capture holding vs inertia uncertainty but also clarify the value of inertia response to recovery beyond the initial period of the event- informing service specification to achieve best grid forming device specifications and priorities in performance.

Reasonable range of sensitivity and scenarios.

7. Whilst we would agree that this analysis should start with the ETYS scenarios for the coming year, the expected ranges of market position across the year, there is considerable uncertainty within that which FRCR could seek to encompass- for example

    a. Visibility and controllability of demand side; estimating the range of uncertainty present and consideration of what worst case changes might represent in real-time operation (e.g. could holding be re-positioned quickly enough to respond to that uncertainty and if not what would that look like vs a risk conservative holding of DC or other service- and is this an additional reason for that holding or additional need for that holding)

    b. Unintended and undesirable flexibility behaviours of ramping of battery/ interconnectors/ other – how big could that be and how would that effect risk- how herded and rapid unexpected changes to lead to a deficit of holding at a given point in the days operation.

    c. Plant reliability and intermittency- how wide a range of uncertain dispatch on the day might influence the holding of response, and the accuracy of forecasting these changes on the day (i.e. how many risk becoming surprises to the operator on the day)

    The above individually or cumulatively have the potential to influence the base supply/demand balance and starting point of the frequency excursion, the size of the effective loss condition from that expected or the

8. Management of periods of higher than normal system risk- e.g. storm conditions, other extreme weather effects etc where the system disturbance impact could be greater or there is a greater risk of generation unavailability which are highly uncertain in dimension

    a. Some consideration should be given to the running of greater levels of inertia at times where the dynamics of the system are more uncertain, and where the impacts upon the system are diversified, considering the distribution of that inertia across the system, in contrast to where more regionalised, looking to focus on those regions of impact to lessen the impact of regional IBR control leading to less robust overall frequency event management. In principle it should be possible to quantify these trade-offs.

    b. Consideration should be given to the availability of the inertia and response available following an event- how long would it take to reposition to a robust inertia level and holding following an event? With that information available it should be possible to look at not only concurrent event but also repetitive event risk and look at the probability of repeated/ additional disturbance over those periods- these will be different for IBR dominated environments to those we have historically seen.

9. Similar to vector shift analysis, but being done on instantaneous rather than time sampled behaviour the event effect on voltage and frequency behaviour should be quantifiable across areas of network affected and via generic/ vendor & developer specific modelling and review the effect on IBR in those regions delivering response or otherwise contributing to supply/demand balance quantified; in consultation with industry this can lead to a generic dimensioning of unexpected performance risk to be fed into FRCR methodology, and may inform future device specification and code further.

Question 2

Echoing the points above- we attach specific comments on the methodology in the version below. Please feel free to contact us to discuss further.

FRCR methodology for consultation_NHV