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## NESO reply to consultation comments

NESO acknowledged all the comments from National HVDC Centre and had a follow-up meeting to clarify their questions and concerns.

Based on the conversation and to respond to National HVDC Centre's question regarding 200 MW additional DC-L being arbitrary, NESO has presented higher granularity and extended the volumes in DC-L incremental analysis, e.g. 100, 150, ..., 450, and 500 MW. Our conclusion and recommendation remain unchanged, that 200 MW additional DC-L holding represents best cost benefit. We will include the updated analysis in the final FRCR 2025 report.

In the meeting, we discussed with National HVDC Centre their concerns raised in the consultation response proforma and their detailed comments in FRCR 2025 report and the methodology document. The key discussion points and actions are summarised as follows.

- **To consider variance in data assumptions**

National HVDC Centre suggested in the simultaneous statistical analysis NESO to consider uncertainties and variance from data inputs for a better understanding of risk sensitivity. We will explore this new methodology in the future and can also extend to other analysis in FRCR model, if not only in the simultaneous analysis.

- **To model LFSM-u capacity**

NESO has started exploring the modelling of LFSM-U by reviewing historic events. We will also investigate LFSM-U capacities from battery storage and interconnectors, which is required under the European Connection Network Codes and HVDC code. Whilst for now we keep the volumes as an additional buffer by not including them in response requirement calculation, until we better understand the volumes and their reliability under various system conditions.

- **To explore regional inertia and its impact to control system behaviours**

NESO and National HVDC Centre both agreed the importance of understanding regional inertia and its effect on system stability. We explained further discussion regarding regional inertia and regional RoCoF will be held in an upcoming industry workshop. We welcome views from industry on how to measure, monitor, and model regional inertia to derive relevant policies tackling wider operability issues.

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- **FRCR future governance and potential requirement of independent review vs. assurance**

During the meeting we explained the integrated assurance arrangement for FRCR 2025. Collating all the feedback from the industry regarding FRCR future governance, NESO will discuss with the SQSS Panel and Ofgem if an independent engineering assessment would be required, or a process assurance from an independent party would be sufficient for future FRCR.

- **To explore extension of FRCR analysis time horizon and its strategic direction**

In the meeting we explained current FRCR scope and time horizon. We also explained system operation strategic vision is scoped in the Operability Strategy Report (OSR) supported by our Market Roadmap. To set out strategic direction and to extend to a much longer time horizon in FRCR needs a clear steering from Ofgem and the SQSS Panel if the change is not yet covered by OSR. We will communicate any changes to the industry and run separate consultation prior to the changes.

- **To consider introducing a frequency containment margin in the SQSS frequency criteria**

National HVDC centre suggested FRCR policy to align with the approach taken to voltage stability within the SQSS by introducing a "Frequency containment margin". We recognised this is a huge piece of work which might need a separate industry mandate and would need substantially more resource and time of NESO's and from the industry. We will explore this further.

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The NESO would like to thank you for the participation in the FRCR 2025 consultation process. We appreciate all the comments and feedback. Please find our response to your valuable input below.

No	Questions	Comments	NESO Response
7	<b>Do you agree that the FRCR 2025 has been prepared appropriately? Please elaborate...</b>	<p>We agree FRCR 2025 has been prepared appropriately for consultation and appreciate the nature of the consultation undertaken both on methodology and outcome. We would however note the following points- i) whilst we understand the process has been separately reviewed by Accenture, we note that there is a big difference between an independent repeat of the process and a critique and validation of the assumptions used within the process. We observe that the outcomes of the process are highly sensitive to the confidence of underpinning assumptions, their operational visibility to inform on the day decisions and their variance. In future years if independent review is to be repeated, we would suggest focus on these areas and the outcome of that review also made available within the consultation materials.</p>	<ul style="list-style-type: none"> <li>• <b>Assurance Arrangement for 2025 FRCR cycle</b> An independent review of FRCR work was proposed by the SQSS Panel within the FRCR 2024 cycle. It was agreed with the Panel in the FRCR 2025 process that NESO would include a technical assurance assessment to validate that NESO had followed due process in driving the FRCR recommendation under the existing methodology. Accenture's review therefore did not assess the original data or assumptions in the model or repeat NESO's analysis, but to verify a rigorous process has been followed. This arrangement helped FRCR 2025 and has prevented significant delays.</li> <li>• <b>NESO's technical assurance</b> We run assurance checks by running post-event analysis studies based on real system data to make sure the inputs to FRCR are accurate and representative. The outcome of the checks will feed into NESO's operational policy and the next edition of the FRCR assessment.</li> <li>• <b>Future assurance / independent review arrangement</b> We value your feedback and would like to shape the future direction based on feedback from</li> </ul>

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			industry. We will collate all the feedback and discuss this with the SQSS Panel. Future arrangements will be communicated with the industry.
8	<b>Do you believe there has been sufficient industry engagement in preparing FRCR 2025? Please specify further suggestions.</b>	We are aware of the consultation and associated webinar. We are unable to judge the level of engagement for the wider industry. We would suggest you measure this based on the number of responses to the consultation.	<p>Thank you for the suggestion. We received 7 responses by the 7 April when the consultation closed.</p> <p>We will also measure the number of previous webinar attendees, and the number of questions asked &amp; answered during the webinars.</p> <p>We will consider other approaches to improve our engagement next year.</p>
9	<b>Overall, do you agree that the FRCR 2025 represents the appropriate level of development in determining the way that the NESO will balance cost and risk in maintaining frequency security while operating the system at a reduced inertia down to 102 GVA.s? Please use the boxes below for the bullet points.</b>	<p>We agree that the approach of quantifying risk and reward is the correct approach.</p> <p>Our view is that the report focuses on the central case in the statistical analysis and has some assumptions and unavailable data that will result in some uncertainty in the result. This may result in understating some risk. An understanding of the two standard deviation variance to assumptions would be helpful to understand this further</p> <p>Similarly, the report does not consider the regionality inertia which may result in different RoCoF values in different areas. This may impact the amount of minimum inertia requirement. As we note in our detailed comments within the RoCoF calculation are larger instantaneous effects which should also be examined to ensure that otherwise hidden converter protection/ control trip</p>	<ul style="list-style-type: none"> <li>• <b>Two standard deviations</b></li> </ul> <p>We can see your detailed comments in the main report and methodology report which we also discussed during the meeting. We understand your comment is initiated from the simultaneous event modelling, e.g. to consider the variance in historic occurrences to represent future the likelihood of simultaneous events. Your comment is also a valid point in the other FRCR analysis. In the current simultaneous event analysis 1) their historic occurrence has considered a “weighting factor” to advise their occurrence and, 2) the profile of simultaneous events in each Settlement Period has been classified into min, medium (50%), upper quantile (75%) and maximum. Based on those two points, a certain level of variance has been taken into account and the</p>

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		outcomes are being captured in the same way as residual RoCoF, vector shift and over voltage ones are as inertia falls.	<p>2sd approach might not be critical. We will continue exploring other better approaches to model simultaneous events. We also welcome your views in modelling and predicting simultaneous events. We will also consider introducing variance in other data inputs.</p> <ul style="list-style-type: none"> <li>• <b>Regional inertia / RoCoF</b></li> </ul> <p>We agree that regional inertia and RoCoF is the area we need to explore more in the future. As mentioned in FRCR future work, we welcome your views and will assess the impact internally and with the industry when a workshop is planned this summer. Although inertia can be linked with wider operability issues, the outcome from the engagement can be used to drive the direction of next year's FRCR.</p>
10	<b>Do you agree with the recommendation to reduce minimum inertia requirement down to 102 GVA.s?</b>	<p>We agree with the principle of reducing the inertia requirement using a risk/ reward approach. However, we have not seen enough evidence that a value of 102 is striking the correct balance. As the requirement approaches a minimum it would be expected that the risk would be growing faster and the benefit growing smaller. This appears already implied by the historic savings captured under FRCR as quoted and compared to the intended saving from this next reduction. There is insufficient evidence in the report that the value of 102GVA.s is the optimal value. In absence of this, a slower</p>	<ul style="list-style-type: none"> <li>• <b>Rational for 102 GVA.s</b></li> </ul> <p>We can see your comments also presented in the main document. Reducing to 102 GVA.s is not purely cost or risk driven. Comparing to the 120 GVA.s inertia level, analysis shows the residual risk remains at the same level and the cost saving presents extra benefits.</p> <p>We can therefore conclude from a frequency control point of view, that we are comfortable to manage frequency risks with fast response under lower inertia levels which helps achieving zero carbon operation capability.</p>

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		reducing in the minimum requirement may be justified until more data is available.	<ul style="list-style-type: none"> <li>• <b>Implementation</b></li> </ul> <p>We mentioned in the meeting, implementation of the lower inertia policy will be introduced in phased manner, i.e. first step to reduce to 110 GVA.s which will last for at least 5 weeks for monitoring, feedback and gaining experience, before the second step of reducing to 102 GVA.s. We will communicate this at the OTF and share operational experience with the industry.</p>
11	<b>Do you agree with the recommendation to secure all BMU-only events (including consequential RoCoF)? If not, please explain why.</b>	<p>Yes, based on the risk and cost data presented we agree with this recommendation.</p> <p>We recommend that risk of VS event is also reviewed based on variations in regional levels of inertia.</p>	<p>We discussed this question in the meeting. LoM VS residual risks are considered in the FRCR model following the completion of the ALoMCP work and following a recent review. The DER vector shift event risk, is managed separately and considered to be out of scope of the FRCR. During the meeting you mentioned the need to understand the behaviour of control systems during vector shift events, particularly for current grid following power electronic converters. We will follow up system events to improve the understanding of control system responses. We also discussed interactions between vector shift events and the regional inertia. You highlighted the susceptibility of control systems to phase angle deviations and the need for regional inertia to manage these risks. We are on the same page that grid forming technology would play a crucial role in arresting phase angle deviations and contribute towards maintaining system security.</p>

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12	<b>Do you agree with the recommendation to procure additional DC-Low service provision by 200 MW ? If not, please explain why.</b>	<p>We agree with increasing the DC low value from 100MW.</p> <p>The recommendation of 200MW seems a bit arbitrary, as only 100, 200 and 300MW was considered. If a monetary value for risk could be defined, a more justifiable value of DC could be chosen.</p>	<p>Thanks for the feedback. We have added more granularity and extended the volume in the DC incremental analysis, e.g. 100, 150, ..., 450, and 500 MW. We will also add this in the final FRCR 2025 report.</p> <p>Our conclusion and recommendation remains unchanged, that 200 MW additional DC-L holding is recommended.</p>
13	<b>Do you have any other comments to the recommendations?</b>	See specific comments as included on the commented report and methodology document (attached below).	<p>Thank you for your time and comments. We will summarise and combine your feedback with detailed comments in the report. Our responses are below.</p>
14	<b>In your view, what should the future FRCR focus on?</b>	<p>We agree that the approach of quantifying risk and reward is the correct approach and should be continued.</p> <p>Our view is that the report focuses on the central case in the statistical analysis and has some assumptions and unavailable data that will result in some uncertainty in the result. This may result in understating some risk. We would suggest sensitivity analysis within the two standard deviation range be undertaken to understand which variances the analysis is most sensitive to. Further consideration of the operational confidence should be given. We would also suggest that under innovation projects, code changes, and new processes/ services- there is the potential to address or limit some of the uncertainties being discussed.</p>	<ul style="list-style-type: none"> <li>• <b>Centralised statistical analysis vs. variance / sensitivity analysis</b> – see our response in the previous question.</li> <li>• <b>Address uncertainties through innovation.</b> From your comments in the Methodology document, we understand you propose some innovation potentials in modelling and predicting simultaneous events. We would like to discuss this with you further. You mentioned the regional system oscillation / system overshooting behaviour under various DC/DM/DR volumes. We would like to better understand your modelling approach outside of the FRCR work.</li> <li>• <b>LFDD operation when approaching 48.8 Hz and below.</b> We see your detailed comments from the Methodology document. To clarify,</li> </ul>

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		<p>Finally, we note the danger that risk assessing to the edge of national LFDD relay triggers leads through the potential for regional frequency differences and small differences in the underpinning assumptions above to a risk of cascading action. We believe that a number of technologies not armed for frequency response would naturally be operating with headroom that an LFSM-U provision could harness to create a further safety net below 49.5Hz which it would seem prudent to explore further.</p> <p>Similarly, the report does not consider the regionality inertia which may result in different RoCoF values in different areas. This may impact the amount of minimum inertia requirement. We suggest that investigation into the countering of inter-area difference at low inertias be instituting; considering both the spread of resources but also other measures such as POD control that could counter these effects. We further suggest that stand-alone simulations estimating current connected device tolerances to the expected transient frequency and phase angle jumps under low inertia conditions are used to anticipate the limits to next stage FRCR action.</p>	<p>the FRCR assessment refers to current SQSS frequency criteria of frequency ranges. The policy is to avoid / minimise the likelihood of LFDD events whilst achieving the cost benefits. In operation, we assess the system risk by referring to 49.2 Hz events and ensuring the frequency returns to 49.5 Hz within 60 seconds. Wider system risks when LFDD is triggered will be captured in the system resilience policy. We have forwarded your questions to our NESO resilience team for further comments.</p> <ul style="list-style-type: none"> <li>• <b>LFSM-U provision.</b> Thanks for clarifying the LFSM-U modelling during the meeting. We have started exploring the effective modelling of LFSM-U by reviewing historic events. As suggested, we will explore LFSM-U capacities from battery storage and interconnectors. Details will be shared. Whilst for now we keep the volumes as an additional buffer by not including them in the response requirement calculation, we will better understand the volumes and their reliability under various system conditions in the future.</li> <li>• <b>Regional inertia.</b> We will explore regional inertia and its impact to system frequency and operability. We discussed the comment of <i>“Stand-alone simulating current connected device</i></li> </ul>
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			<i>tolerance to the expected transient frequency and phase angle jumps under low inertia conditions are used to anticipate the limits to next stage FRCR action.” We will continue reviewing the grid following converter behaviours (including within transient time frames) following any significant system events to explore the impact from regional inertia.</i>
15	<b>Do you foresee any issues that may arise from moving the obligation to produce the FRCR to a NESO License Condition rather than an Annex to the NETS SQSS?</b>	No- but we have however noted that the SQSS would benefit from further definition of the FRCR process relating to the sensitivity and uncertainty of assumption- we suggest the definition of an “insufficient frequency containment margin” metric which defines required levels of sensitivity consideration (e.g. resilience to loss of single actor/ automatic system/ demand sensitivities; key methodology assumptions), aligning with the approach taken to voltage stability within the SQSS- and this should be adopted within whichever location the obligation is to be placed in the future.	<i>Thank you for your comment. We discussed your suggestion of “insufficient frequency containment margin” in the meeting. Similarly to the voltage stability requirements in the SQSS, we will explore an equivalent for frequency containment margin.</i>
16	<b>If the obligation to produce the FRCR and the governance rules surrounding that process are moved to NESO’s License, do you believe that the NETS SQSS Panel</b>	We believe there should be technical oversight and governance of the FRCR and that the NETS SQSS Panel is one possible appropriate approach. An alternative oversight panel could be justified also.	<i>Thank you for sharing your thoughts. We will collate all the feedback from the consultation and present to the SQSS Panel.</i>

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	<b>should continue to provide oversight?</b>		
17	<b>If your answer to question 16 is "Yes", to what extent should this oversight be? For example, should it include technically assessing the recommendations and approving/rejecting it, or should it be limited to confirming that the governance process has been followed correctly?</b>	<p>Reviewing the technical content of the methodology and review that the methodology has been followed. Identifying necessary work to improve the accuracy/ effectiveness of FRCR process- for example the need to develop new tools/ insights to inform its future application.</p> <p>Ensuring FRCR is not just an annual update but has a strategic direction to ensure its effectiveness at key points of large transitional change to GB power system- for example those driven from policy for 2025 2030,2035, 2040, 2045,2050.</p>	<p>We will feedback this to the Panel.</p> <p>Regarding FRCR scope and time horizon, under the current arrangement it is operational policy so a relatively short-term focus. Based on its methodology, its outcome and policy proposal are highly sensitive to the data and assumptions input into the model hence a medium to long-term view would not be beneficial.</p> <p>If a long-term time horizon is intended for FRCR to consider, the methodology will need to be revised. Operability strategy is currently set out in different publications where a longer-term view is presented. We will discuss this with the SQSS Panel and also run a separate consultation to shape the future FRCR work if needed.</p>

## Appendix: Extended simulation for overholding DC

Additional scenarios are simulated to cover 0 –500 MW additional DC holding with 50 MW step at 102 GVA.s inertia requirement, shown as the green dashed curve. It can be seen that the two curves largely overlap and extend to the left side as the DC is increased to 500 MW. The incremental benefit becomes very small once the 200–300 MW range is surpassed. There is a discussion about whether 200, 250, or even 300 MW is the optimal choice. However, 200 MW remains a viable option.

