April 6 Workshop Stakeholder Questions
Date Posted: June 8, 2023

STAKEHOLDER QUESTIONS ON RESPONSE RESERVE SERVICE (RRS) PRIMARY FREQUENCY RESPONSE (PFR) LIMIT STUDY DISCUSSION FROM APRIL 6, 2023

Below is the feedback that was received following the discussion on the topic "Update on RRS PFR Limit Study" at the RRS-PFR Limits Study Workshop held on April 6, 2023. Also included are ERCOT's responses to the specific concerns raised.

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Question 1

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I wanted to clarify – separate resources smaller than 157 MWs behind the same POI will not exceed the limitation? Are there any special registration or interconnection requirements for resources like this?

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ERCOT RESPONSE

In the context of this assessment, a single unit refers to a single registered/modeled Resource within ERCOT systems that is qualified for providing RRS-PFR and is not tied to transmission interconnection setup of that specific Resource or in case of some Resources such as Inverter Based Resources (IBRs) the nature of design/aggregation that the modeled Resource represents. On Inverter-Based Intermittent Renewable Resources (IRRs), it is worth noting that Nodal Protocol 3.10.7.2 (13) covers the basis under which aggregation of generation equipment may occur. While similar language doesn't explicitly exist in the protocols for Inverter-Based Energy Storage Resources (ESRs), similar spirit would apply when considering modeling approach for ESRs. Back to the question asked, if there are multiple RRS-PFR qualified Resources that are registered and modeled behind the same Point of Interconnection (POI), each Resource will be individually subject to the proposed RRS-PFR MW limit. This study does not change any registration or interconnection requirements that currently exist. The risks associated with the loss of Resources that are connected to the same getaway or POI are currently addressed through the existing Transmission Network Analysis and Security Constrained Economic Dispatch processes. These existing processes will continue to apply in future as well and are currently sufficient to address the risk associated with too many RRS-PFR MWs behind the same getaway or POI. ERCOT notes that as the ERCOT grid evolves, if there comes a situation where the existing processes alone are not sufficient, changes may be needed.

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Question 2

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Please see my initial questions attached. Let me know if you need more information.
I would like to see Weifeng's presentation along with the bigger set of GE material.

	Study Question	***Contextual Comment***
1	*What damping constant did you assume?*	*At higher loads the damping is higher reducing the load imbalance. Note that inertia is typically higher at higher loads.*
2	*How did the study account for the kinetic energy withdrawn from the system and the affect of different inertia levels? If a governor inertial data file was added, how was it reconciled for the kinetic energy withdrawn?*	*Governor model tests do not include affect of inertia; however, inertia data has been submitted separately along with the inertia constant submitted in the generator model data sheet.*
3	*How did the study account for the governor model limitations and inaccuracies at lower frequency nadirs (large transient) ?*	*Governor models accuracy is generally limited to a frequency event nadir to 59.85 Hz.*
4	*On page 5 of the PDF presentation, the PFR is shown as 1519MW SM PFR and 1503 MW BESS PFR. Please explain the total 2STP load loss, PFR, and load response allotment.*	*BAL-003 indicates 2750 MW and 1209 MW Credit for Load Resources*
5	*On page 5 of the PDF presentation, the frequency recovery stops at 15 sec with flat response. How does the system get back to 60Hz?*	

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ERCOT RESPONSE

Weifeng's presentation is posted at this link. Following contains responses to the specific concerns that have been raised in the question above.

1. The load damping ratio in these studies is 2%, consistent with Dynamics Working Group (DWG) flat start cases and ERCOT's RRS studies.
2. Kinetic energy stored on the system is the total inertial energy stored in all rotating turbines/generators online. Every thermal generator has its own generator model in which inertia constant is included along with a governor model, an exciter model, etc. to fully model a generator's dynamic behavior. The models used in this study are directly form the Dynamics Working Group (DWG) cases which are also used in the RRS study. Dynamic simulation software PSS/E and TSAT were used to conduct dynamic simulations in this study. Both PSS/E and TSAT read all the models users provide and solve the "swing equation" which accounts for inertial response from all inertia contributors.
3. All governor models used in this study are directly from Dynamics Working Group (DWG) without any modifications. The sensitivity study conducted to investigate system's sensitivity to PFR failure is focused on the sensitivity around 59.4 Hz which is 100mHz above the UFLS set point. As has been noted in slide 3 of Weifeng's presentation, this margin helps in capturing differences between study setup/assumptions and Real Time that may affect response, including model limitations and model inaccuracies at lower frequency nadirs.
4. In the studies conducted in slide 5, for both scenarios i.e., "All SM PFR" and "All BESS PFR", the total loss of generation/supply studied is 2,805 MW, the total amount of response from Load on under frequency relays (UFR) is 1,150 MW and the mix of resources that provide headroom for PFR (synchronous machine vs batteries/ESRs) is altered. The PFR mix changes

are such that the effective PFR (computed by taking UFR equivalency ratio in account) in both scenarios is consistent with the approach used in ERCOT's RRS studies including ensuring that for the loss of 2,805 MW frequency nadir stays above 59.4 Hz as shown in slide 5. The total available PFR capacity for the "All SM PFR" scenario is 3,695 MW, all from synchronous machines (effective RRS-PFR = 6,439 MW = 3,695 + 2.39 * 1,150 MW) and for "ALL BESS PFR" scenario is 3,691 MW of which 2,800 MW is from batteries/ESRs and 891 MW is from synchronous machines (effective RRS-PFR = 6,435 MW = 3,691 + 2.39 * 1,150 MW).

To respond to the question asked, the actual total PFR response from synchronous machines and batteries/ESRs in the "All SM PFR" scenario is 1,519 MW (all from synchronous machines) and in the "All BESS PFR" scenario is 1,503 MW (322 MW from synchronous machines and 1,181 MW from ESRs).

5. These studies are set up to demonstrate how the available frequency responsive headroom will respond when there is a frequency event triggered by loss of 2,805 MW. As has been noted in NERC's Reliability Guideline for Primary Frequency Control, following an frequency event PFR aids in arresting the decline of frequency and rebounding frequency to its "B point". After frequency has settled, secondary control mechanisms such as Regulation reserve deployment and redispatch are relied upon to recover frequency back to 60 Hz – this what ERCOT would rely upon as well to recover frequency back to 60 Hz to the extent possible.

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Question 3

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My follow up questions for the RRS Study are:

1. *With regard to the proposed single unit limit value for RRS of 157 MW, how will a "single unit" be defined? In particular, I am asking about IBR's. And I'm curious about a large ESR, with the potential to install more than one inverter. Would two inverters mean two units? What about three inverters? Or, is a separate inverter and a separate step up transformer required in order to consider it a separate unit? Or is a single battery always a single unit, regardless of any other equipment design?*

2. *Are any geographic or regional limitations needed for RRS? I am inclined to think no such limitation for this is needed, given the 157 MW single unit limit, and combining that limit with any reasonable set of assumptions around RRS distribution. However, I would be curious if a reliability limit for RRS MW value specifically coming out of the far west Texas location (with its lower power loads, and limited power transmission lines to reach load centers), would make sense. I do not have enough knowledge around those transmission capabilities, or what the potential RRS MW capacity out there might be, in order to assess this in any meaningful way. But if I were to just think in hypotheticals, some sort of limit there might be useful – even if we are presently pretty far away from it*

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ERCOT RESPONSE

Following contains responses to the specific concerns that have been raised above.

6. Please see response to Question 1 above.
7. In its assessment to test the question on the need of a location/region based RRS-PFR limit, GE has setup scenarios to test if any compliance/reliability risks existed when all PFR was from the Resources in one region vs another. In referring to slide 4 in this slide deck, scenario 3 was specifically a case where all PFR from Resources in the west region. In these studies, no significant issues were noticed to justify recommending a region-based limit.

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Question 4

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What are the Next Steps on this effort?

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ERCOT RESPONSE

There are several recommendations that have been made by this study. GE's slide 11 also identifies some risks that have not been fully evaluated by this effort and could be considered in a new study in the future. ERCOT is actively evaluating each recommendation from the current study to determine appropriate action and priority for each. Over time, where necessary, ERCOT will file proposed changes to the Nodal Protocols, Nodal Guides and/or Binding Documents to incorporate the recommendations. ERCOT will coordinate with PDCWG on this topic as appropriate.