**IBRWG Meeting Minutes**

**December 2024**

**Chair: Julia Matevosyan, Vice-Chair: Miguel Cova Acosta**

**IBRWG met on December 13th (Webex, Open Meeting).**

The agenda and the presentation slides are available [here](https://www.ercot.com/calendar/12132024-IBRWG-Meeting-_-Webex)

82 people attended the meeting (at peak)

**IBRWG Main Meeting**

**NERC Update**

Rachele Coyne (TRE)

* Presented status of NERC Projects as a part of Federal Energy Regulatory Commission (FERC) Order, No. 901 Milestone 2. NERC fulfilled the FERC deadline for these projects.

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* NERC is now gearing up for Milestone 3, the projects under this Milestone are listed on slide 3.
* Discussions underway regarding priority of Project 2022-04 EMT Modeling (FAC-002, MOD-032, TPL-001), not directly included as a part of Milestone 3 but very closely related to the scope.
* NERC will be holding a Technical Conference on Jan 15-16 in Phoenix to start engaging with industry early on these projects.
* Texas RE Regional Project Standard Authorization Request SAR-013 to revise BAL-001-TRE-2. NERC Member Representatives Committee (MRC) has approved the SAR on 9/18/2024 and accepts nominations to SDT since December 2024.
* The scope of the SAR is on slide 5
* provide for widening generator Governor deadband
* clarify roles of Generator Owner (GO), Balancing Authority (BA) and Compliance Enforcement Authority (CEA) pertaining to compliance time periods
* Define PFR performance requirements for Battery Energy Storage Systems (BESS)
* This SAR **will not** be expanded to address concerns with the impact of curtailment on wind generation discussed in the last two IBRWG meetings. A separate SAR can be drafted if necessary
* Rachel continued with Standards update, speaking about Category 2 IBR Registration – 20-75 MW initiative. Right now TRE is in the process of identifying facilities and owners for registration between May 2025-2026.
* There is NERC Standard underway [Project 2024-01 Rules of Procedure Definitions Alignment (Generator Owner and Generator Operator).](https://www.nerc.com/pa/Stand/Pages/Project-2024-01-Rules-of-Procedure-Definitions-Alignment_GO-and-GOP.aspx) Slide 6 has standards that will have to be revised as a result of this project. It has been a round of commenting and the SDT now is working through those comments.
* There has been NERC Level 2 IBR Modeling Alert Response, details on that on slide 7. Preliminary observations indicate widespread modelling concerns such as lack of verification, tools and metrics for accuracy. TRE will present the results at January IBRWG meeting.
* GADS reporting for Q1-Q3 due on Dec 19th, applies to conventional gen, wind and solar (100 MW and up) connected to 100 kV and up. In 2025 applies to solar 20 MW and up.

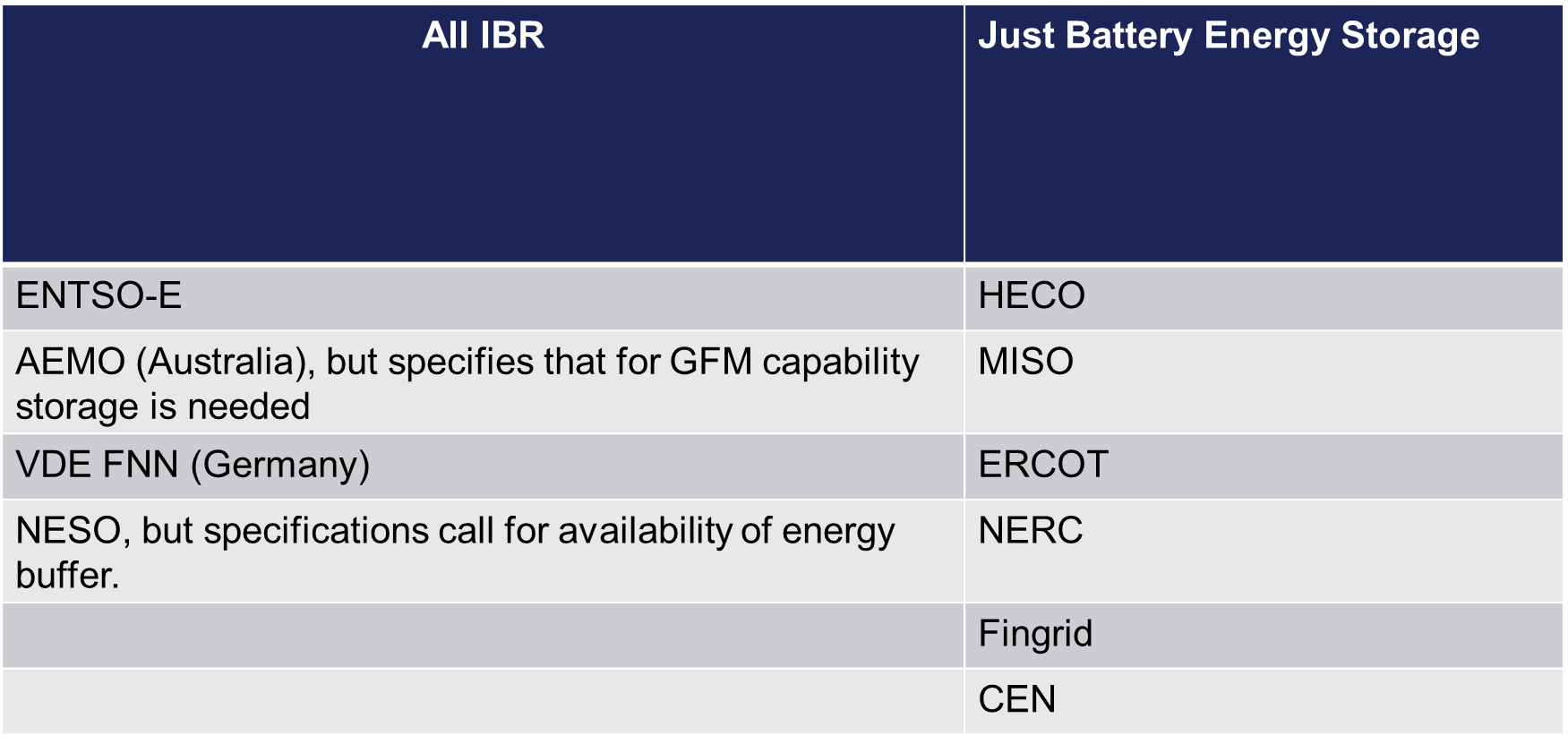
**Advanced Grid Support Requirements for Inverter-Based ESRs (NOGRR272 & PGRR121)**

Fred Huang (ERCOT)

* Fred went through NOGRR272 Advanced Grid Support (AGS) Requirements for Inverter-Based ESRs
* From 2023 ERCOT has been brining it status updates to IBRWG on this topic and appreciates group’s feedback so far.
* The draft NOGRR and PGRR were provided even before these were posted.
* Based on today’s meeting we will see the need for going in detail through these documents once again.
* Julia adds that as a minimum it would be good to show where all the relevant documents are, especially the document for modelling and testing and how this document is going to be incorporated in ERCOT’s binding documents going forward.
* Fred continues that ERCO successfully integrated large numbers of IBRs so far and the interconnection queue going forward is also dominated by IBRs. ERCOT is looking for ways to integrate them stably and with the least constraints. Solutions such as SynCons and transmission expansion are already being applied today but are lagging in time and insufficient to fully remove constraints. Moving forward, ERCOT is exploring additional viable options
* In the last 5 years grid forming technology has been picking up in regions experiencing similar growth in IBRs and similar stability issues.
* NERC also recognized the benefits of grid forming publishing two white papers in 2021 and 2023 respectively.
* ERCOT engaged Electranix to help identify and develop testing framework in case ERCOT were to adapt this technology.
* ERCOT does see benefit from grid forming technologies (1) with regard to transient dynamic voltage and frequency response, particularly in weak grid conditions (2) reduction of the risk of IBR tripping or unstable operation (3) increase od GTC limits which could reduce generation curtailment due to stability constraints.
* This is how the proposal for advanced grid support from ESR was developed. Fred highlighted that unlike in some other region at least at this stage ERCOT doesn’t require any additional hardware or additional overload/overcurrent capability for provision of these capabilities, i.e. all capabilities are required within equipment rating. ERCOT also doesn’t require any changes to energy market dispatch for provision of advance grid support capabilities.
* ERCOT will continue monitoring the technology development to see if such advanced grid support capability can be also reliably provided by wind and solar technology in the future.
* The NOGRR language describes high level capability required from ESRs with AGS.
* The planning guide RR provides additional information with regard to modeling details.
* [Advanced Grid Support Energy Storage Resource (AGS-ESR): Functional Specification and Test Framework](https://www.ercot.com/files/docs/2024/09/16/ERCOT%20Advanced%20Grid%20Support%20ESR%20Test%20Requirement_.pdf) that was presented in September IBRWG meeting is the initial proposal for tests that will be consequently included in DWG Procedure Manual as additional model quality tests that will be applied to AGS-ESR to assess their AGS capability.
* Kara Beckmann: Could proposed model quality tests go ahead separately from AGS-ESR requirements?
* Fred: One is talking about AGS capability, and the other one basically looks at once ERCOT does have this requirement how are they going to check for it and from that perspective these two are going hand in hand.
* Erik Wasik comments that generally related PGRR and NOGRR may reach TAC at different times, but TAC will table to vote on them together once both are ready.
* Kara also pointed out that the implementation date shall be set subject to final approval so that it doesn’t apply as soon as.
* Fred comments that certainly this is just placeholder and is subject to final approval. ERCOT would like to hear feedback about timing, especially if there are any technical limitations.
* Fred also notes that even looking at the interconnection queue with SGIA before 4/1/2025 we are already looking at 25-30 GW of additional IBR capacity. But certainly, ERCOT understands the impact on the ongoing projects and will work with stakeholders on a reasonable implementation date.
* Erin adds in the chat that submitting comments is strongly encouraged!
* Mohammed asked about how to provide comments. Fred said the commenters either can post their comments to NOGRR / PGRR or provide feedback directly to ERCOT.
* Mohammed asked about testing requirements. Fred showed the [Advanced Grid Support Energy Storage Resource (AGS-ESR): Functional Specification and Test Framework](https://www.ercot.com/files/docs/2024/09/16/ERCOT%20Advanced%20Grid%20Support%20ESR%20Test%20Requirement_.pdf) document again and mentioned that ERCOT shared it in September with IBRWG and walked the group through seven tests in previous meetings. This framework will be transferred into DWG Manual
* Mohammed says that yes, he is referring to this document, and for example in the voltage step test there is no requirement for damping or settling time, unlike in case of phase jump test, would ERCOT want people make suggestions / comments for these details?
* Fred says yes. Sun Wook adds that in terms of damping it’s not different for other IBRs. There is a criterion for damping requirement in Planning Guide Section 4, same will apply for AGS-ESR. For the phase jump the requirement is in the sub-cycle timeframe so additional detail apply there.
* Mohammed asks why there’s a specific requirement for 0.2 pu response per 10 deg phase jump, why wasn’t it made dependent upon operating point?
* Sun Wook: this was based on tests and recommended by Electranix. This was presented in July IBRWG. GFM models that ERCOT tests pass through that. This is not only the requirement but also requirement to rise time and come back time. This also includes some conservative assumptions for impedances between the inverter and the POI.
* Mohammed: Will there be any changes to the commissioning tests? Will there be some specific testing for AGS-ESR at commissioning compared to regular IBRs?
* Fred: No difference from existing IBRs. ERCOT is still looking into this but there are no additional requirements for this proposal.
* Julia: Considering that all of the discussion is based on the document that is currently not a part of NOGRR or PGRR, how can people submit comments to this?
* Fred: Directly to ERCOT in writing would help ERCOT to address these comments. ERCOT is also working on redline to DWG Procedure Manual and once it’s ready then comments can also be submitted to this one. But the sooner the better, as it helps ERCOT to address your comments sooner.
* Sun Wook: In October ERCOT went through the proposed test examples and in that [presentation](https://www.ercot.com/files/docs/2024/10/09/ERCOT%20AGS-ESR%20Oct-11-2024%20IBRWG.pdf) there is slide 4 with the next steps and timeline and email addresses for comments.
* Michael Jewell: Appreciate the walk through the details once again. There is a real concern about the practical process for 4/1/25 timeline, because people might have procured the equipment before SGIA was signed and there may be concerns about too fast adoption and stakeholders are working on some comments.
* Fred: there are several projects in the queue where developers see the benefit of grid forming already today, ahead of requirements being approved due to system conditions in areas where they would like to connect and looking to implement this technology today. And these are projects with SGIA but they are able to make this decision to turn it to GFM still, even though initially wasn’t planned as such.
* Michael: This is related point that this functionality is more beneficial in some areas more than others, while require from all? May be potential benefit from more targeted application?
* Fred: That’s a valid point. ERCOT thought about that one, but based on how the grid will move forward the regions with the issues will expand with further gen expansion dominated by IBRs. So ERCOT is trying to be ahead of the game and prevent future issues.
* Michael: Jupiter has filed some very helpful comments that need to be considered, because the benefit of AGS-ESR is very broad but the obligation is being placed on a very targeted group. And the concern that has been raised is very fundamental.
* Sun Wook: The plan is to bring DWG Procedure Manual redline in January or February
* Fred again encouraged stakeholders to submit comments in any way they see convenient either directly to ERCOT or through RR commenting process.

**Global overview of mandatory vs voluntary vs market-based requirements** Julia Matevosyan (ESIG)

* Based on the discussion at ROS there was a question about how other areas are implementing grid forming requirements around the world, so this is what this presentation is going to cover.
* Definition of GFM from NERC whitepaper on slide 2 just to set the scene. This definition is widely used for GFM even globally.
* Applications of GFM on slide 3, specifically weak grid, damping of voltage frequency oscillations, resistance to voltage magnitude and phase change, etc.
* On slide 4, a landscape of GFM requirements, the links to the latest documents are available [here](https://www.esig.energy/working-users-groups/reliability/grid-forming/gfm-landscape/specifications-and-requirements/). System operators that have GFM requirements or requirement drafts: HECO (Hawaii), AEMO (Australia, NESO (Great Britain), Fingrid (Finland), MISO, ENTSO-E (Association of European System Operators), ERCOT, CEN (Chile).
* Often times the GFM specifications have an accompanying document with testing specifications.
* All of the “tests” that are mentioned here are simulation-based except for Fingrid that has two additional commissioning tests (physical tests) for GFM capability.
* Germany has new inertia incentive that will be covered later in the presentation but anyone providing service under this incentive has to conform with GFM requirement.
* The table on slide 5 is sorting out the requirements into drafts vs approved and published by system operators vs research organizations
* High level functionalities in the requirements are well aligned but the level of details and details themselves vary.
* Requirements are often split into core capabilities (doesn’t require additional hardware design considerations) and advanced capabilities (that do), such as black start capabilities or capabilities to sustain a viable electrical island.
* GFM requirements are in addition to existing requirements for IBRs
* Next slide is showing which requirements are only for ESR vs for all future IBRs



* Next slide is showing GFM Progress Globally on the right-hand side listing system operators that already have the specs on the right-hand side OEMs that have commercial GFM offerings.

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* The table of real world grid-connected GFM projects is available [here](https://www.esig.energy/working-users-groups/reliability/grid-forming/gfm-landscape/projects/)
* The next slide is sorting out the requirements into voluntary, compulsory or based on incentives.

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* NESO in Great Britain started with voluntary, moved to incentivized through a tender process first and then through market, however, currently working on the proposal to mandate GFM capability from future IBRs and HVDC systems going forward, kind of following ENTSO-E efforts (even though GB is not a part of ENTSO-E any longer).
* In Germany the idea is to pay all inertia providers for a few years and then gradually switch to requirement of requiring this capability.
* The following slides 9-13 provide more details of each system operator and how they incentivize or require GFM.
* Jeff: on AEMO, I also saw a presentation last week that they are also moving towards requirements. This is something worth checking into.
* Julia: I heard the same thing but was not able to confirm it before the meeting.
* Jeff: Is it fair to say that majority is headed towards mandating grid forming?
* Julia: Yes, even without confirming AEMO if you look at the table on slide 8 it looks like the majority is moving towards requirements.
* Jeff: Another question there have been some comments that this is discriminatory towards one resource type, but this can be viewed as PSS requirement for thermal plants and this capability is not required from other technologies where it doesn’t make sense.
* Julia: Yes, it’s a good analogy. But another one also is PFR capability requirement. When ERCOT implemented it the idea was that it is beneficial for frequency control for ERCOT system and resources shall have capability to provide PFR. Resources that were not capable of providing PFR were exempted from providing it. A reserved headroom was not required and only provides the response when they have headroom available, on the other hand ERCOT also determines how much PFR they need as a minimum and procure it as a service but now they have resources to provide that service because all resources have this capability. The analogy with GFM is that “core” capability is required from all capable resources and in the future if there is a clear need to make sure certain amount of the services from these resources are available at all times then a market can be created to procure it and you’ll have resources capable to do so.
* Michael Jewell: Very helpful presentation. If you had a market where utility procures resources and they are required to be grid forming then there’s going to be compensation because any cost of GFM would be baked into their price. Is that correct?
* Julia: We can ask Li Yu from HECO to answer the question. But basically, it’s not a market, it’s a procurement. HECO is asking for resources they need with the capability they need and picks resources that comply with the requirements at lowest cost.
* Li Yu: There’s no market specifically for GFM, and no market in Hawaii, so the price in RFP covers everything.
* Michael: It makes sense. And there is a project that Plus Power has developed and has GFM inverters and it was part of the cost of the overall project, so they factored it into RFP and got paid for it in that context.
* Li Yu: Yes
* Michael: In Germany they are setting up an incentive to procure inertia and get people to come forward with that capability. So, one thing that I was wondering about ERCOT, couldn’t they do the same? And other resources like thermal generation could get paid for it as well. Just wondering about more “carrot” kind of approach?
* Julia: I would let ERCOT respond but for Germany I would just say that it’s a head start to incentivize early adopters, also recognizing that ENTSO-E’s requirement is in the approval process + implementation timeline and that there’s this window of opportunity now to capture the resources that could provide this capability already today that they don’t want to miss.
* Jeff: Yes, I can comment on ERCOT’s side. Inertia market idea is something ERCOT was considering for 8-10 years now and it’s some discussion on this in PUC’s AS study, the draft report. This is something that ERCOT is continuing to monitor. ERCOT just recently updated inertia whitepaper and would encourage the stakeholders to have a look at that <https://www.ercot.com/files/docs/2018/04/04/Inertia_Basic%20Concepts%20and%20Impacts%20on%20the%20ERCOT%20Grid_2024.docx>
* Michael: With AEMO moving towards mandatory requirements, is there a sense about how much lead time they are giving to implement this?
* Julia: As Jeff said this is fresh off the press and it’s hard to say how much lead time they are thinking about but overall from the documents that I have seen from the moment of requirement approval to commissioning date of the first GFM resource is 3 years.
* Michael: I don’t know how to translate that to the timeline from SGIA in ERCOT to the commissioning date? Because the developers are concerned about the implementation date.
* Julia: I just attended a training organized by local IEEE Chapter in Austin on the interconnection process and Jennifer Fernandez from ERCOT Resource Integration has presented there, she said in general it takes it takes 18-36 month for IBRs to connect to ERCOT grid, but not sure how long it takes from the initial application to the signed interconnection agreement. I believe in ERCOT Resource Handbook on [Resource Integration page](https://www.ercot.com/services/rq/integration) has examples showing approximate timelines for each of the steps.
* Michael: Just thinking about implementation timeline, if AEMO e.g. has 3 years implementation timeline to the commissioning of the first GFM resource being deployed, then ERCOT should count back from commissioning to SGIA and have something comparable.
* Julia: As we continue talking about AGS-ESR requirements would it be helpful to bring OEMs to talk about their capabilities and reflect on ERCOT’s requirements similarly to how we did during NOGRR245 process
* Michael: Yes, that would be very helpful and also get them to talk about any incremental costs
* Julia: Incremental costs are usually difficult to get out of OEMs. May be at least some feel for the cost, a ballpark or percentage is something we could get
* Caitlin: Yes, I also agree OEMs’ presentations will be helpful. Where we are struggling is that we haven’t been able to get feedback about their capabilities from our OEMs.
* Julia: The [link for existing and under construction GFM projects](https://www.esig.energy/working-users-groups/reliability/grid-forming/gfm-landscape/projects/) that were on the slides and for some of the projects you can see OEMs that they used (even though those were not included in the slides).
* Stephen Solis: Can OEMs also share the knowledge about wear and tear on the equipment from providing GFM capability, are there other things that have to be done on the PPC side. Understanding some of the integration issues may help shed some light on the impact on the rest of the plant.
* Julia: will try.