Need for Enhanced and IBR-specific Essential Reliability Services

ESIG
ENERGY SYSTEMS
INTEGRATION GROUP

Intro to Essential Reliability Services

- **Introduction to ERS**
  - What are they and what are they currently
  - How are these linked to synch gen and conventional paradigm
- How are these problematic for IBR?
  - Are they directly applicable
  - Can IBR even do them?
  - How can IBR perform?
- How to adapt ERS paradigm to enable and maximize IBR capabilities for the system

Intro to Essential Reliability Services

- **Who specifies Essential Reliability Services?**
  - NERC developed essential reliability services through their ERSTF
  - Done as part of their duties as the Electric Reliability Organization
  - Created a framework document in **2015**
    - Lots of “smoke” but not much ”fire”
- **What is an Essential Reliability Service?**
  - **Simply put:** minimum characteristics without which the power system cannot be operated reliably
  - **Slightly deeper:** capabilities, controls, performance requirements, etc. that are used to help ensure system reliability
- **Policy makers need to be informed**
  - If these are “essential” they need to be mandatory

Intro to Essential Reliability Services

- **Essential Reliability Services in NERC footprint fall intro three categories:**
- **Frequency**
  - Managing system frequency
  - Planning for frequency excursions
  - Arresting and recovering
- **Ramping**
  - Resource adequacy
  - System balancing
- **Voltage**
  - Maintaining voltages
  - Reactive power capabilities

NERC ERSTF Recommendations

Source: NERC

Table 1: Summary of Measures and Industry Practices Recommendations					
Reference Number	**Title**	**Brief Description**	**BA or Interconnection Level**	**ERSTF Recommendation**	**Ongoing Responsibility**
1	Synchronous Inertial Response(SIR) at an Interconnection Level	Measure of kinetic energy at the interconnection level. It provides both a historical and future (3-years-out) view.	Interconnection	Measure	Resource Subcommittee and Frequency Working Group
2	Initial Frequency Deviation Following Largest Contingency	At minimum SIR conditions from Measure 1, determine the frequency deviation within the first 0.5 seconds following the largest contingency (as defined by the Resource Contingency Criteria (RCC) in BAL-003-1 for each interconnection).	Interconnection	Measure	Resource Subcommittee and Frequency Working Group
3	Synchronous Inertial Response at a BA Level	Measure 3 is exactly the same as Measure 1 but performed at the BA level. It provides both a historical and future (3 years out) view and will help a BA identify SIR-related issues as its generation mix changes.	BA	Measure	Resource Subcommittee and Frequency Working Group

NERC ERSTF Recommendations

ESIG

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Reference Number	Title	Brief Description	BA or Interconnection Level	ERSTF Recommendation	Ongoing Responsibility
4	Frequency Response at Interconnection Level	Measure 4 is a comprehensive set of frequency response measures at all relevant time frames: Point A to C frequency response in MW/0.1 Hz, Point A to B frequency response in MW/0.1 Hz (similar to ALR1-12), C:B Ratio, C:C' Ratio as well as three time-based measures (t_0 to t_C, t_C to $t_{C'}$, t_0 to $t_{C'}$), capturing speed of frequency response and response withdrawal.	Interconnection	Measure	Resource Subcommittee and Frequency Working Group
5	Real Time Inertial Model	Develop a real-time model of inertia including voltage stability limits and transmission overloads as criteria. This is an operator tool for situational awareness and alerts them if the system is nearing a limit and any corrective action is required.	BA	Industry Practice	BA

NERC ERSTF Recommendations

Reference Number	Title	Brief Description	BA or Interconnection Level	ERSTF Recommendation	Ongoing Responsibility
6	Net Demand Ramping Variability	Measure of net demand ramping variability at the BA level. It provides both a historical and future view.	BA	Measure	Reliability Assessment Subcommittee
7	Reactive Capability on the System	At critical load levels, measure static & dynamic reactive capability per total MW on the transmission system and track load power factor for distribution at low side of transmission buses.	TOP	Measure	Performance Analysis Subcommittee and the System Analysis and Modeling Subcommittee
8	Voltage Performance of the System	Measure to track the number of voltage exceedances that were incurred in real-time operations. This should include both pre-contingency exceedances and post-contingency exceedances. Planners should consider ways to identify critical fault-induced delayed voltage recovery (FIDVR) buses and buses with low short-circuit levels.	No Further Action	No Further Action	No Further Action

Source: NERC

NERC ERSTF Recommendations

Reference Number	Title	Brief Description	BA or Interconnection Level	ERSTF Recommendation	Ongoing Responsibility
9	Overall System Reactive Performance	When an event occurs on the system related to reactive capability and voltage performance, measure to determine if the overall system strength poses a reliability risk. Adequate reactive margin and voltage performance should be evaluated across all horizons (planning, seasonal, real time). This type of post-mortem analysis comports with various requirements in existing and proposed NERC standards.	BA	Industry Practice	Event Analysis Subcommittee
10	System Strength	Based on short circuit contribution considerations, determine if low system strength poses a potential reliability risk. When necessary, calculate short circuit ratios to identify areas that may require monitoring or additional study.	Planning Coordinator	Industry Practice	Planning Coordinator

Source: NERC

Key Takeaways from NERC Framework

- **The bulk of this work was performed in 2015**
  - Assumptions, trends, and realities have all changed substantially
  - There has been little to no work done and easily available to enhance ERS for the new paradigm
    - This topic is discussed in only 4 paragraphs in the 2024 LTRA
- **Numerous ERS are synchronous machine focused**
  - Multiple are actual 1-1 synchronous machine metrics
    - This isn't bad, but enhancement is needed as the grid transitions
  - Those that can also apply to IBR are framed with synchronous concepts
- **How do you ensure power system reliability when "essential" capabilities are based on a power system that no longer exists?**

IBR Need to be Involved: Technically

- **Inverter-based resources have extreme flexibility in controls and performance**
  - Many of these are currently underutilized
  - Unlocking these needs policy changes and information sharing
  - Industry needs more knowledge on what IBR can do and how they can do it
- As synchronous machines get **replaced** services need to come from **the resources replacing them**
- Inverter-based resources software-based nature is a strength
  - While synchronous resources are strongly bound to physics, IBR can create be flexible and create new solutions “quickly”
  - This has happened already in markets like ERCOT
  - Allows easier and faster linking between system needs and resource performance
- **Many major OEM already have solutions that are market ready and in use in Europe**
  - They aren’t utilized in North America because there is no requirement or incentive

What ERS can IBR Provide?

Grid Following	Grid Forming	Battery Energy Storage
Voltage Support	Grid following+	Grid Following+
Frequency Support	Providing System References	System Reserves and Balancing
Fast Frequency Response	Stable Operation in Weak Grid	"Cheap" GFM Capability
Advanced Controls	Microgrid or Islands	Headroom for "full" GFM Controls
"Custom" Solutions***	Blackstart***	Headroom in Hybrid Configurations

How to Procure Essential Services From IBR?

- **Two ways to make change on the power system:**
  - **Incentivize it**
    - Provide cost recovery to IBR resources who prove capability and provide essential services
    - How to manage this discussion in the context of resources provide these services "naturally"
  - **Require it**
    - Changes to FERC *pro forma* LGIA/LGIP
    - Changes to NERC Standards
    - How to ensure requirements sufficiently move the technical minimum forward
    - How to do this while staying **"technology agnostic"**