

Presentation Package

Emerging Large Loads Technical Conference

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February 24-25, 2026

Opening Keynote Speaker

Jim Robb, President and CEO, NERC



Opening Remarks

Kal Ayoub, Director of the Office of Electric Reliability, FERC



Keynote Speaker

Bill Fehrman, Chairman of the Board, President, and CEO, AEP



Keynote Speaker



Dado Slezak, Executive Vice President, Utility Innovation, QTS Data Centers

Keynote Speaker

Suzanne Keenan, Chair of the NERC Board of Trustees



Panel: Data Center Industry Initiatives to Address Grid Reliability

Moderator – Hasala Dharmawardena, Senior Engineer, NERC

Anurag Jinanani

Vice President Global R&D Data Center Systems
Schneider Electric





Schneider Data Center UPS Behavior

A Comparison of Traditional vs. Emerging Operational Characteristics

Jim Simonelli, CTO Data Center Segment

Parameter estimation for a Power Factory UPS model

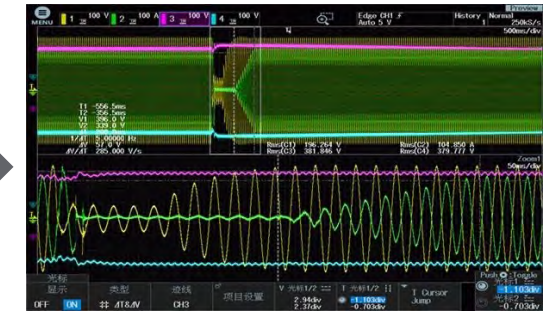
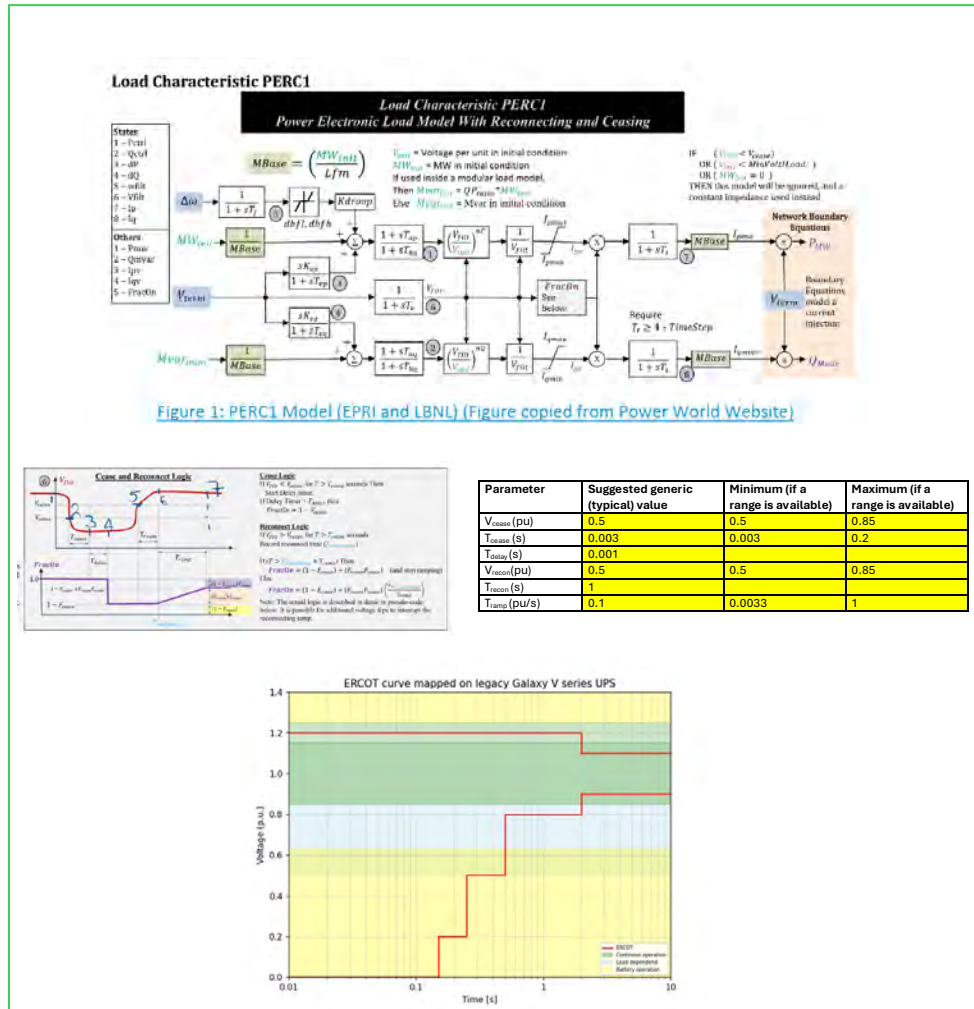
Input Disturbance



- A-phase and B-phase voltages drop below 0.7pu for >20 msec
- Active power reduction in A-phase and B-phase consists of 80% of total reduction (52 MW)
- Current spikes to 160% of pre-fault current during fault
- Facility returns to pre-fault consumption in ~2 hours



Model



Actual lab test results to compare model behavior against

Galaxy V series 20kVA to 1.5MVA

Galaxy VS Standalone
20-150kVA (2019)



Galaxy VL
200~500kVA (2021)



Galaxy VX
500~1500kVA

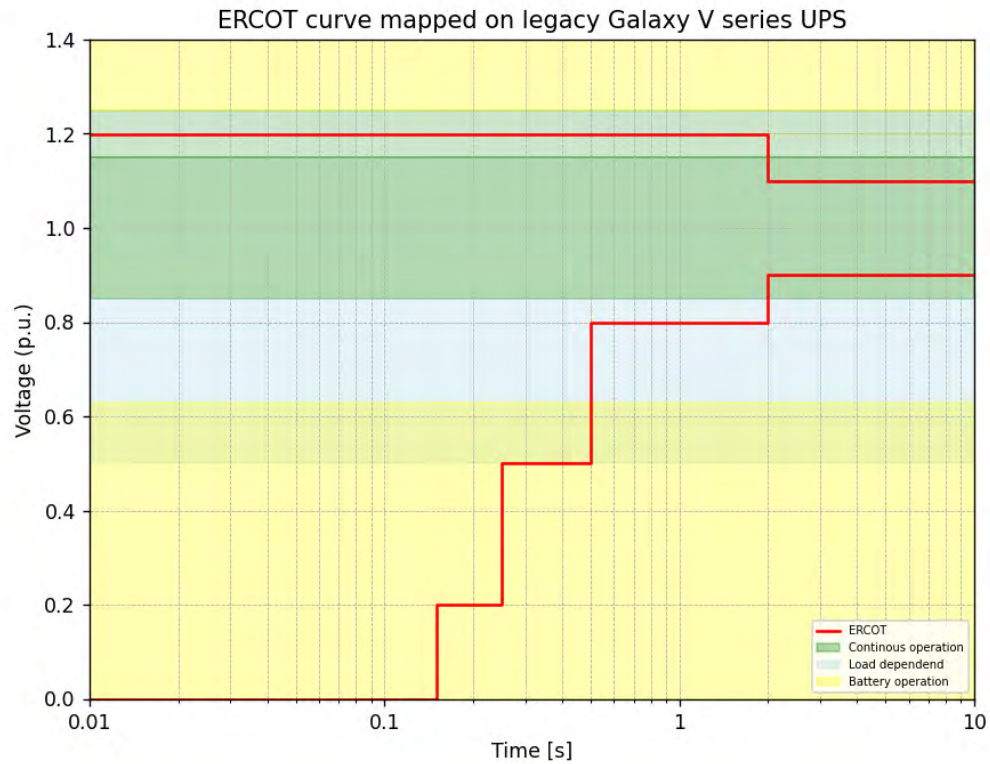


NEW Galaxy VXL
500~1250kVA)

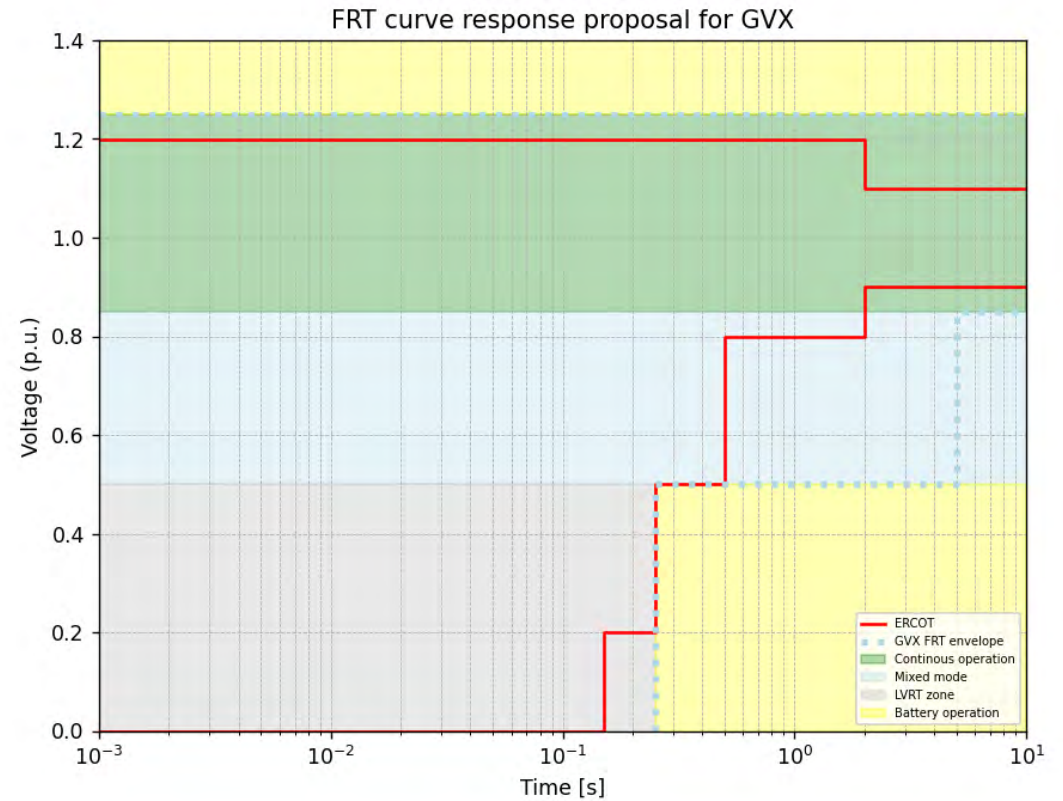


We will cover legacy FRT behavior and updated behavior (post FW update)

Traditional

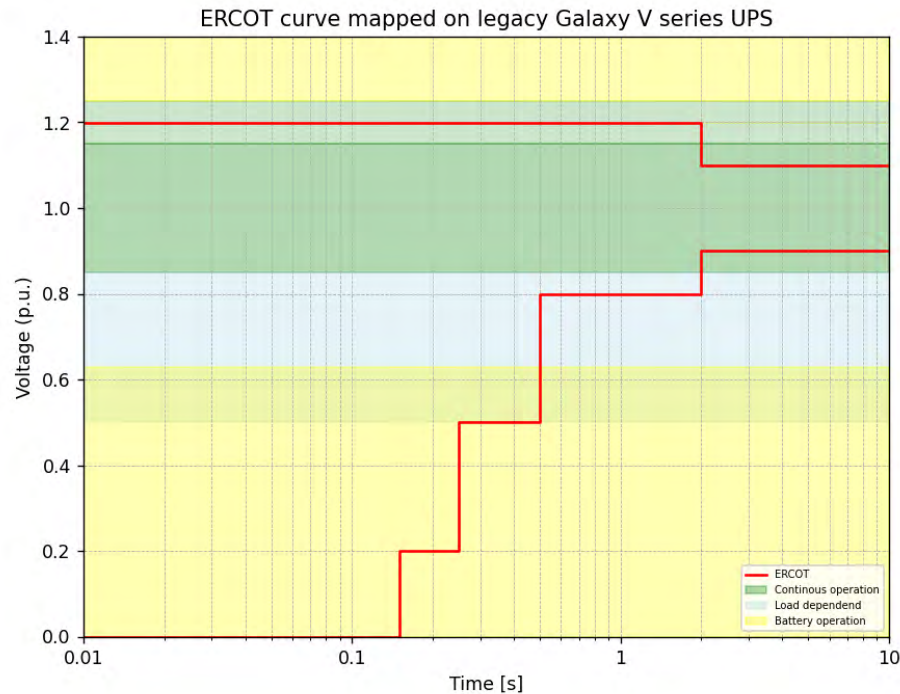


Updated



Traditional UPS Behavior

Mission: Protect the critical load



Red line is ERCOT proposed VRT requirement

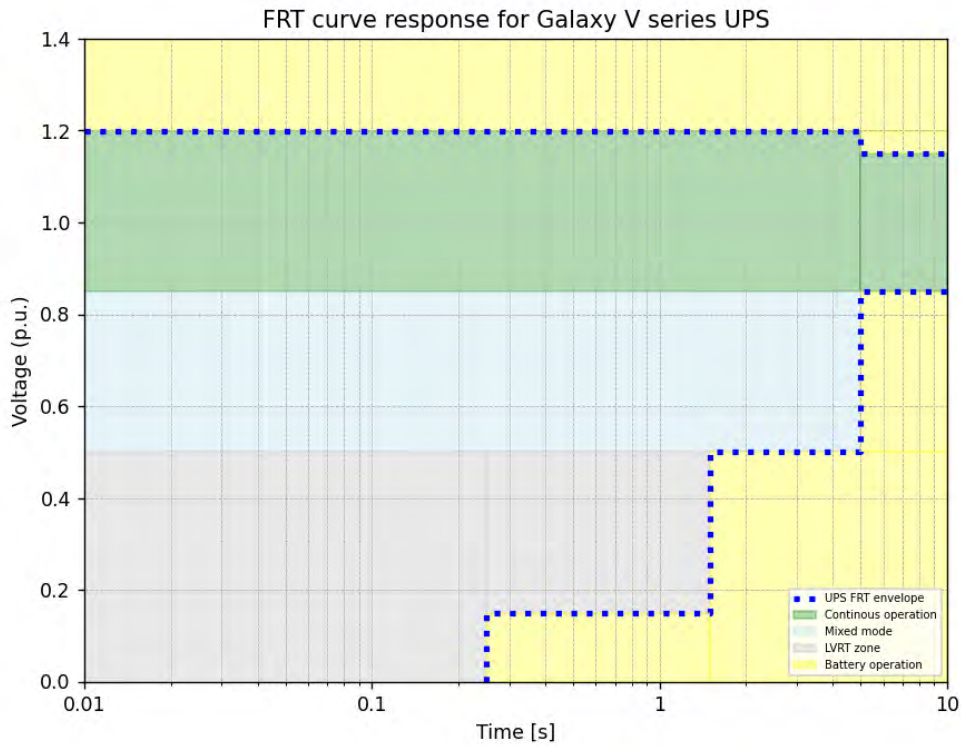
Area	Voltage limits	Behaviour
Green area <i>Continuous operation</i>	$1.15pu < V < 1.25pu$	UPS family specific. GVX will trip to battery operation at 1.25pu, but other GalaxyV families will trip at 1.15pu
	$0.85pu < V < 1.15pu$	UPS operates in normal operation continuously, taking all power from grid
Light blue area <i>Load depend</i>	$0.63pu < V < 0.85$	UPS operates in a normal operation; all power is taken from grid. If the load on UPS causing input current limitation is activated, the UPS will trip to battery operation
	$0.5pu < V < 0.63$	Galaxy VX will trip to battery operation, but other Galaxy V UPS families will continue down to 0.5pu, if load on UPS is not causing an input current limitation
Yellow area <i>Battery operation</i>		In this area the UPS transfers fully to battery operation and awaits a stable grid for 1 second, before transitioning back to grid operation, using the standard ramp-in function. (10 seconds as default). This is the same behavior as the current implementation.

Behavior: Go to battery when voltage on any phase is reduced to the point where the rectifier hits current limit. Ramp load slowly when stable voltage returns.

Updated UPS Behavior with FW update

Mission: Protect the critical load and the grid

	Voltage limits	Behaviour
Green area <i>Continuous operation</i>	$1.15pu < V < 1.20pu$	UPS operates in normal operation for minimum 5 seconds, taking all power from grid Note: GVX will support up to 1.25pu for 60 seconds
	$0.85pu < V < 1.15pu$	UPS operates in normal operation continuously, taking all power from grid
Light blue area <i>Mixed mode</i>	$0.5pu < V < 0.85$	UPS operates in a mixed mode where power is taken from both grid and battery. This mode is time limited to minimum 5 seconds. Note: This is UPS model specific, some may have longer durations 0.5pu can likely be lowered to 0.3 or 0.4, but there is a HW limitation on these products that limits this. 0.5 is guaranteed on all existing systems without firurther testing.
Grey area <i>LVRT zone</i>	$0.15pu < V < 0.5pu$	UPS operates in battery mode, taking all power from battery, but it does not switch the UPS mode to battery operation but will show normal operation, and will recover fast if the voltage exits this area within 1.5s
	$0pu < V < 0.15pu$	In this range the time limit is decreased to 250ms
Yellow area <i>Battery operation</i>		In this area the UPS transfers fully to battery operation and awaits a stable grid for 1 second, before transitioning back to grid operation, using the standard ramp-in function. (10 seconds as default). This is the same behavior as the current implementation.



Behavior: Stay grid connected as much as possible.
Restore load quickly if grid interruption is short.
Long interruptions behave traditionally.

- PFAPR:** Post Failure Active Power Recovery
 - Recovery to 90% power within 0.3 seconds, when $V > 0.9pu$
- Frequency**
 - Window: 40Hz – 70Hz
 - ROCOF > 5Hz/s

Janne Paananen

Data Center Systems Architect
Eaton

Mike Della Penna

Data Center Transmission Planning & Analysis
Google

Doug Golden

Vice President, Power
Core Scientific Inc.

Chris Ruppel

Director of Distributed Energy Resources and Energy Origination
MARA

Panel: Utility Approaches to Improve Reliability when Integrating Data

Moderator – Rich Bauer, Principal Engineer, NERC

Patrick Gravois

Principal Operations Engineer
ERCOT

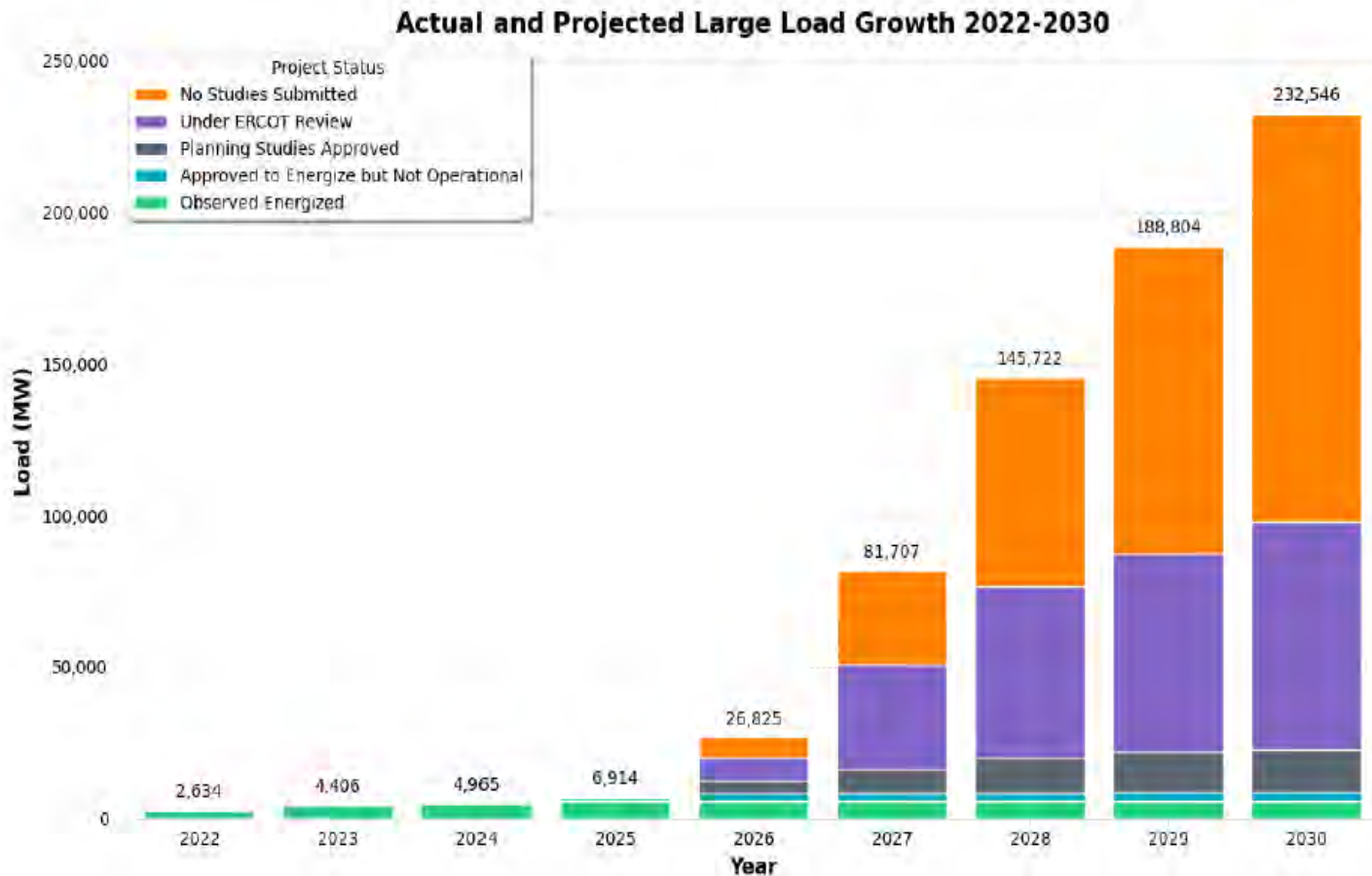


ERCOT Large Electronic Load Ride-Through Requirements (Proposed)

Patrick Gravois
Principal Operations Engineer

NERC Emerging Large Loads Technical Conference
February 24, 2026

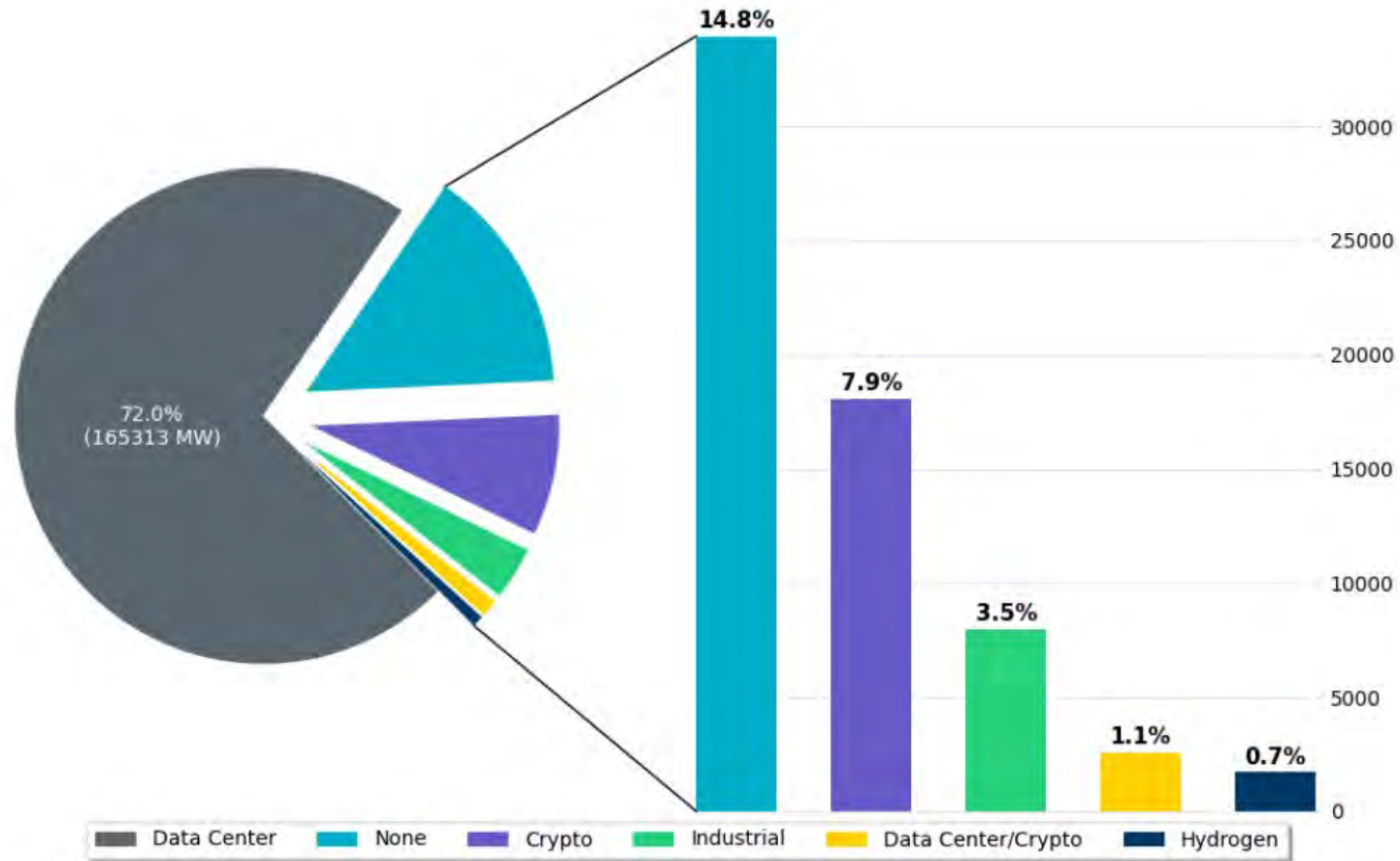
ERCOT Large Load Queue



Project Status	(MW)
Operational	5,728
Approved to Energize but Not Operational	3,058
Planning Studies Approved	14,123
Total	22,909

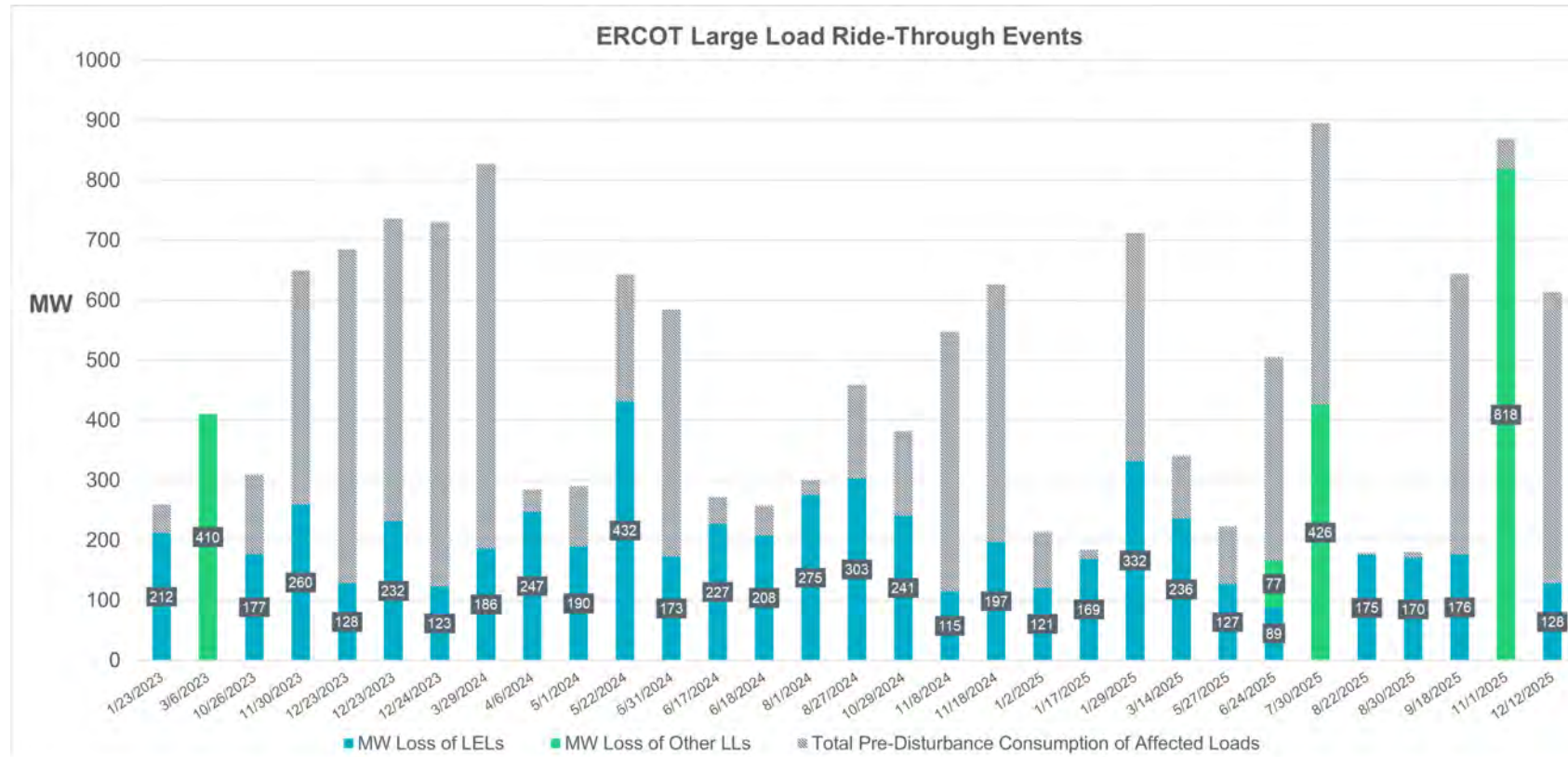
**Numbers above only reflect LLs that have gone through ERCOT's Large Load Interconnection process

Large Load Project Distribution by Type



**Majority of unidentified type expected to be data centers and crypto

ERCOT Large Load Ride-Through Events (2023-present)



- All events involve Large Load loss following a system fault; does not include consequential loss
- Events on 3/6/2023, 7/30/2025, and 11/1/2025 involve single industrial Large Load driven by VFDs
- Event on 6/24/2025 involve oil and gas sites (green) and crypto facilities (blue)
- All other events involve crypto facilities only

ERCOT Large Electronic Load Ride-Through Requirements

- ERCOT submitted two Revision Requests on November 14, 2025, proposing frequency and voltage ride-through requirements applicable to Large Electronic Loads (LEL)
 - [Nodal Protocol Revision Request \(NPRR\) 1308](#) defining Large Electronic Load
 - [Nodal Operating Guide Revision Request \(NOGRR\) 282](#) proposing technical ride-through requirements on LELs
- NPRR 1308 defines LEL as “a Large Load in which 50% or greater of the Demand at the site consists of power electronic based load, specifically computational load, such as data centers and cryptocurrency mining facilities.”
 - Large Load currently defined in ERCOT Protocols as “one or more Facilities at a single site with an aggregate peak Demand greater than or equal to 75 MW behind one or more common Points of Interconnection (POIs) or Service Delivery Points.”
- ERCOT has temporarily limited the ride-through requirements to LELs based on the following:
 - Due to recent and projected growth of data centers and cryptocurrency mining facilities, ERCOT identified an immediate reliability risk from simultaneous loss of load from LELs during a single system disturbance
 - LELs exhibit very sensitive voltage ride-through characteristics; more so than traditional Large Loads (with the exception of certain VFD driven Large Loads)
- ERCOT intends to propose ride-through requirements for other types of Large Loads

Exemptions to ERCOT LEL RT Requirements

- ERCOT LEL ride-through requirements ***are not retroactive***
 - Operational LELs and those that have received written approval to energize from ERCOT before November 14, 2025, are exempt
 - LELs that meet following criteria are also exempt
 - LEL has signed interconnection agreement with Transmission Service Provider (TSP), or Generation Resource if co-located, before November 14, 2025
 - Interconnecting TSP received notice to proceed with construction of required Interconnection Facilities and have received financial security to fund Interconnection Facilities
 - And one of the following were met:
 - LEL completed and received ERCOT approval for Large Load Interconnection Studies (LLIS) before November 14, 2025
 - ERCOT received attestation from interconnecting TSP that LLIS were not required, and LEL is expected to energize before 12/31/2026

ERCOT Frequency Ride-Through Requirements for LELs

<u>Frequency (f) in (Hz)</u>	<u>Minimum Ride-Through Time (seconds)</u>
<u>$f > 61.8$</u>	<u>May ride-through or trip</u>
<u>$61.2 < f \leq 61.8$</u>	<u>299</u>
<u>$58.8 \leq f \leq 61.2$</u>	<u>continuous</u>
<u>$57.0 \leq f < 58.8$</u>	<u>299</u>
<u>$f < 57.0$</u>	<u>May ride-through or trip</u>

- LEL shall ride through frequency disturbances of the magnitude and duration specified in table above
- Exceptions for LELs performing in accordance with UFLS program or frequency regulation services
- LEL not required to trip for frequency deviations beyond those in table above
- LEL shall continue consuming near pre-disturbance active power from grid during frequency deviations requiring ride-through
- LEL shall not trip due to instantaneous frequency measurements
- Will likely increase high frequency threshold to 63.0 Hz

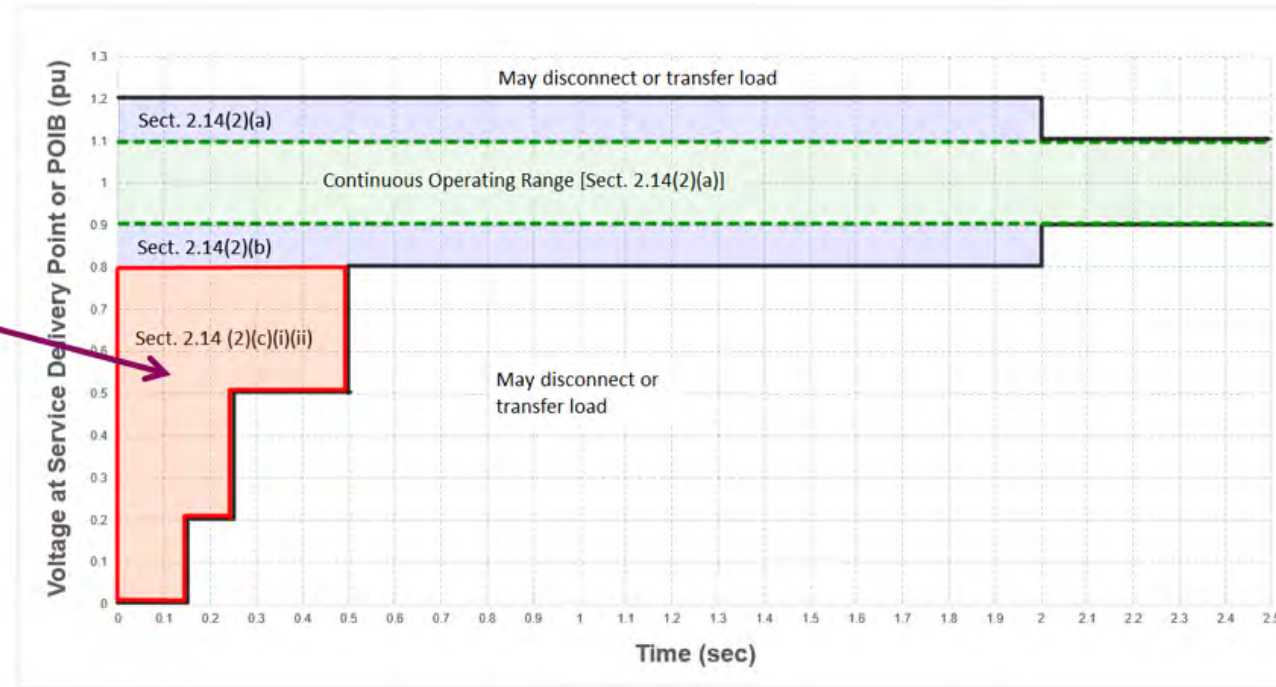
ERCOT Voltage Ride-Through Requirements for LELs

<u>Root-Mean-Square Positive Sequence Voltage (p.u. of nominal)</u>	<u>Minimum Ride-Through Time (seconds)</u>
<u>$V > 1.20$</u>	<u>May ride-through or trip</u>
<u>$1.10 < V \leq 1.20$</u>	<u>2.0</u>
<u>$0.90 \leq V \leq 1.10$</u>	<u>Continuous</u>
<u>$0.80 \leq V < 0.90$</u>	<u>2.0</u>
<u>$0.50 \leq V < 0.80$</u>	<u>0.5</u>
<u>$0.20 \leq V < 0.50$</u>	<u>0.25</u>
<u>$V < 0.20$</u>	<u>0.15</u>

- LEL shall ride through (remain connected to Transmission Grid) voltage conditions of the magnitude and duration specified in the table above
- Ride-through curve applies to entire LEL facility
- Overcurrent during voltage sag shall not exceed 125% of maximum current consumption during normal operations
- LEL not required to trip for voltage deviations beyond those in table above (should maximize VRT performance to equipment tolerance)
- LEL shall not implement load trip or transfer scheme due solely to a certain number of voltage sags or swells within a certain period of time

Post-Fault Active Power Recovery Requirements

May temporarily reduce active power consumption



- LEL may temporarily reduce consumption during low voltage ride-through (red area above)
- LEL shall return to 90% of pre-disturbance consumption within 2 seconds of voltage at POI returning to 0.9 pu
- After January 1, 2028, LEL shall only reduce active power consumption proportional to voltage sag for voltage between 0.5 and 0.8 pu
- LEL may reduce consumption as much as needed for voltage below 0.5 pu, as long as LEL returns to pre-disturbance with 2 seconds of voltage recovery

Stakeholder Feedback and Next Steps

- Technical requirements being reviewed at stakeholder working groups
 - Dynamics Working Group and System Protection Working Group (non-public; TSP led)
 - ERCOT Large Load Working Group (public; includes Large Load entities)
- ERCOT has met with various LEL developers during development of requirements and after submittal
 - Some developers have provided positive feedback and find requirements achievable with small modifications
 - LEL community has expressed concern that requirements only apply to LELs and not all Large Loads
 - ERCOT expecting to receive additional comments from LEL developers on specific technical requirements soon
- Targeting vote in April/May at stakeholder committees
- Targeting June approval

Katelyn Vance

Manager, Electric Transmission Planning & Strategic Initiative
Dominion Energy

Dominion Energy Virginia

Dynamic Data Center Performance, Monitoring, & Interconnection Updates

NERC Emerging Large Loads Technical Conference
February 24, 2026

Katelynn Vance, Ph.D. – Manager, Electric Transmission Planning & Strategic Initiatives

Dominion Energy Virginia at a Glance

Virginia, North Carolina, West Virginia

6,800 miles of transmission lines

- **500 kV** – 1,315 miles
- **230 kV** – 2,979 miles
- **138 kV** – 64 miles
- **115 kV** – 2,309 miles
- **69 kV** – 78 miles

1000+ substations

~50,000 transmission structures

Own distribution and generation assets



Dominion Energy Virginia at a Glance

Virginia, North Carolina, West Virginia

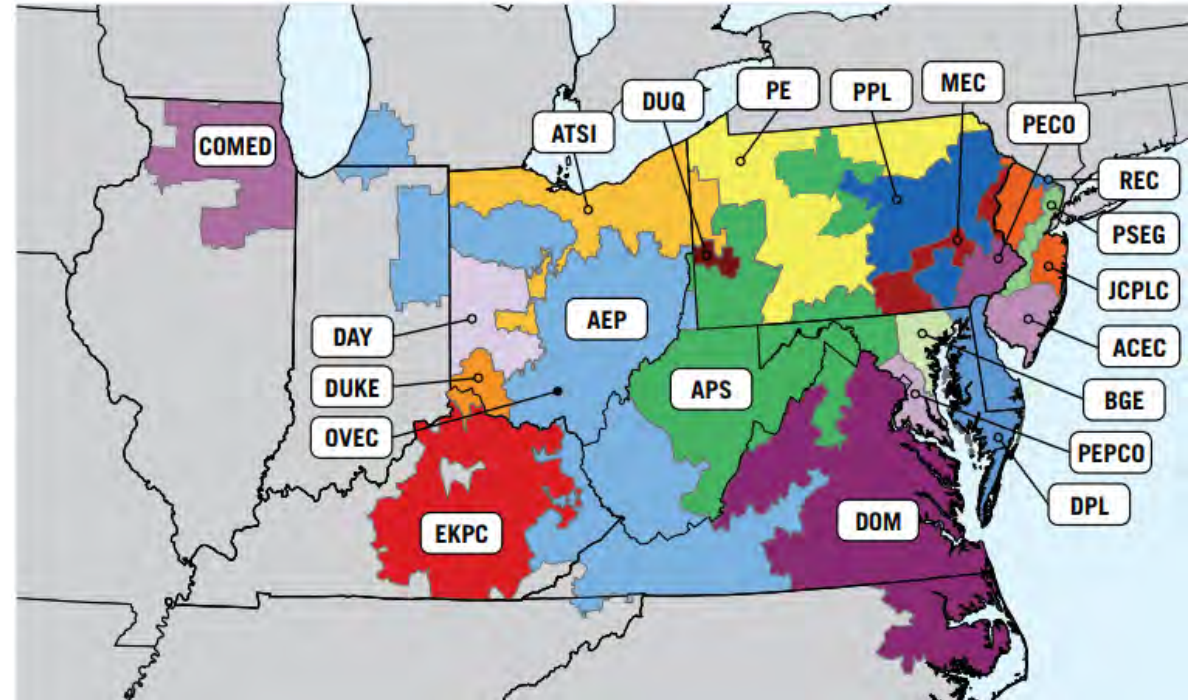
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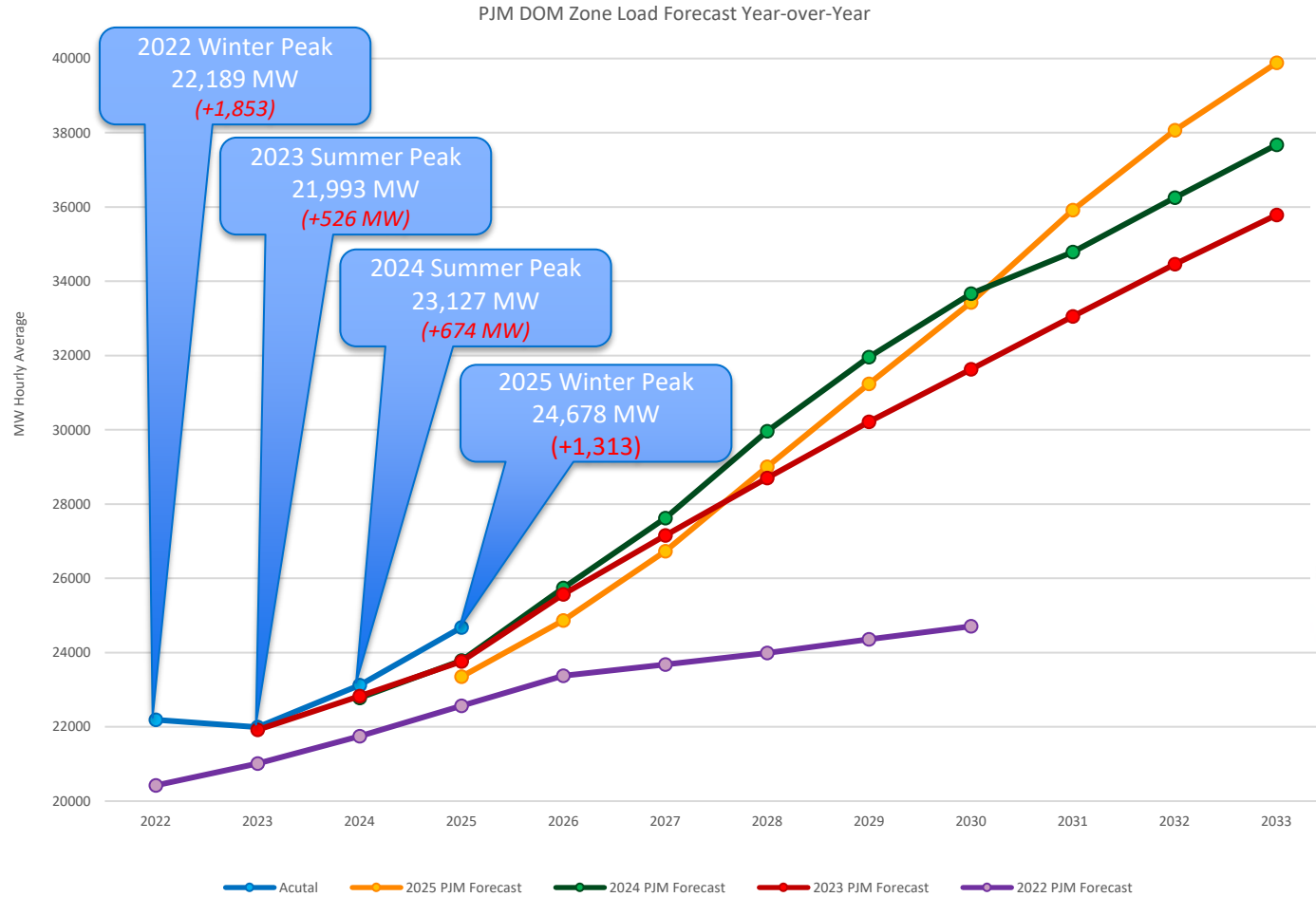
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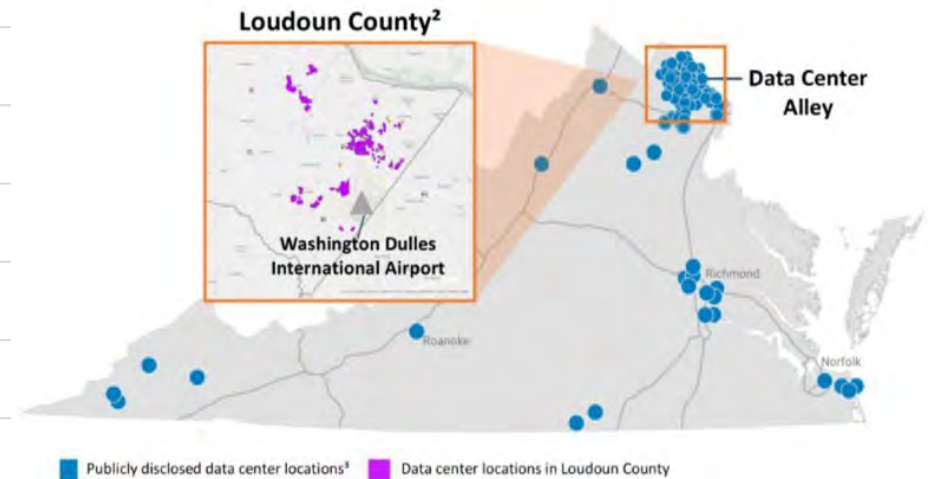
Own distribution and generation assets



Year-over-year PJM DOM Zone forecast



Zonal 10/15 Year Load Growth		
SUMMER	5.6%	4.8%
WINTER	5.1%	4.3%



²February 2022 Loudoun County Data Center Land Study
³Data Center locations provided by Data Center Hawk

Load Transfer Events

Multiple load transfer events from 500 – 1700 MWs since July 2024

- All events were line lockouts in general Northern VA area
 - Inside and outside of Loudoun County data center alley area
 - All transmission protection functioned exactly as designed
- First two events: Transferred load returned after 3+ hours
 - Other events saw the majority of load return in ~1 – 15 minutes
- Impacted between 18 – 40 substations depending on event
- Data center recovery profile differed across customers
 - Some differences in the same customer based on design of facility
- Required many meetings across customers to understand variation in responses

July 10, 2024 Event Overview & System Impacts

Fault Cause: Failed Arrestor

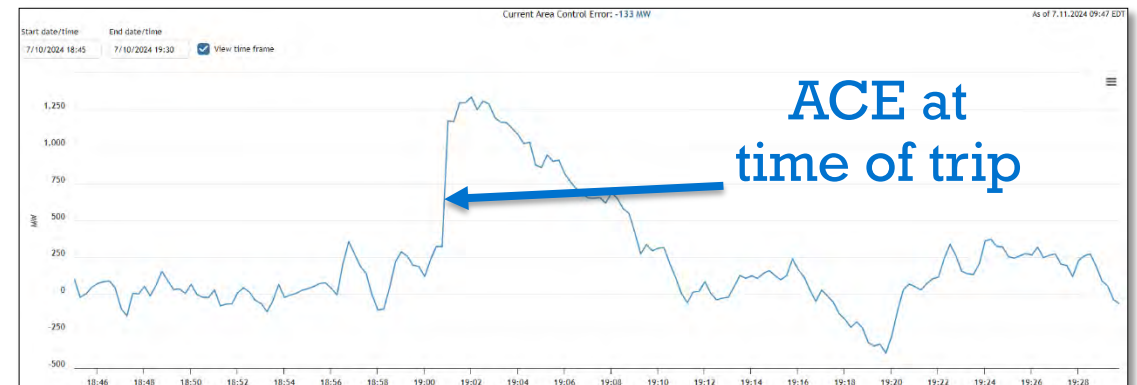
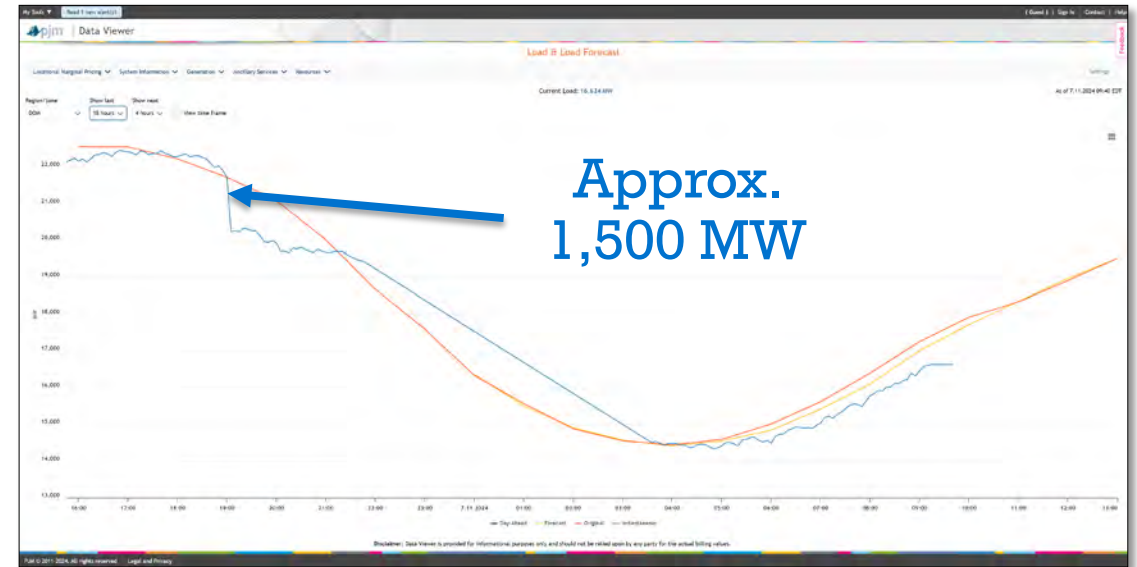
Fault Isolation:

5 reclosing attempts and line lockout

PJM and DEV SOC determined ~1,500 MW of load removed from the system and determined it was data centers transferring to backup generation *unexpectedly*

System Operators experienced 10kV voltage rise

- SOC took immediate action by removing **nine** 230 kV capacitor banks within seven minutes to return to nominal voltage
- Nearby SVCs both absorbed around 120 MVAR each



July 10, 2024 Event Overview & System Impacts

Fault Cause: Failed Arrestor

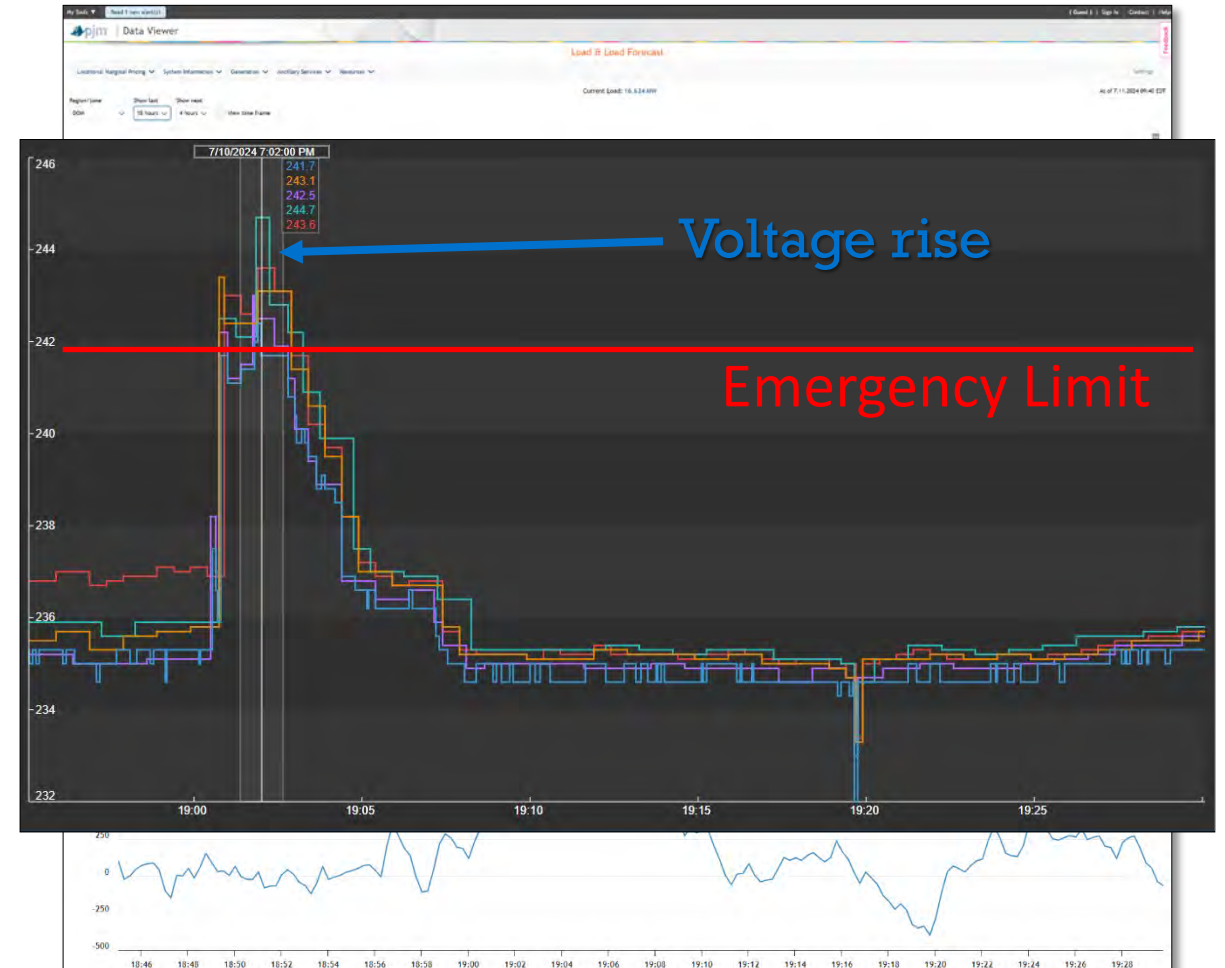
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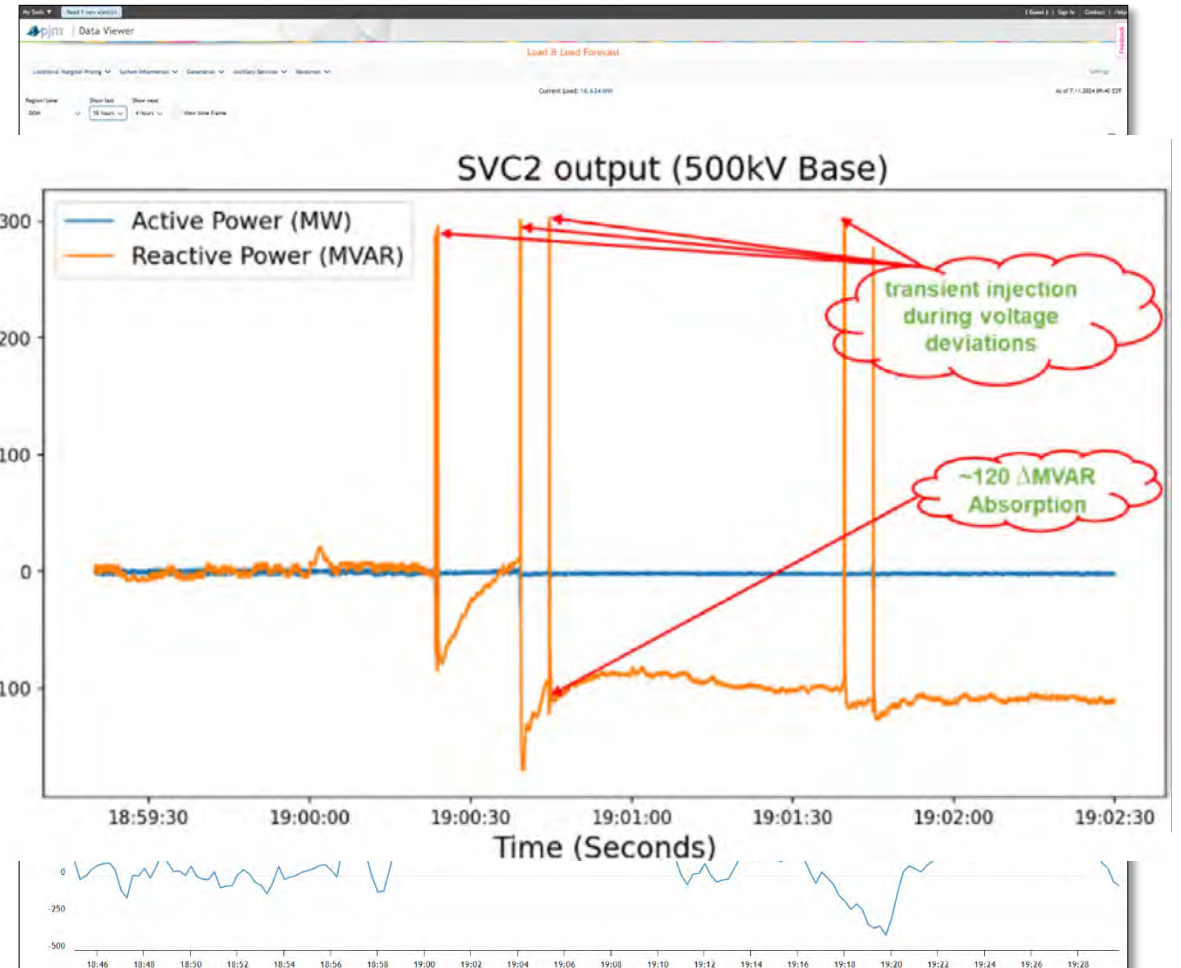
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How did individual data centers react?

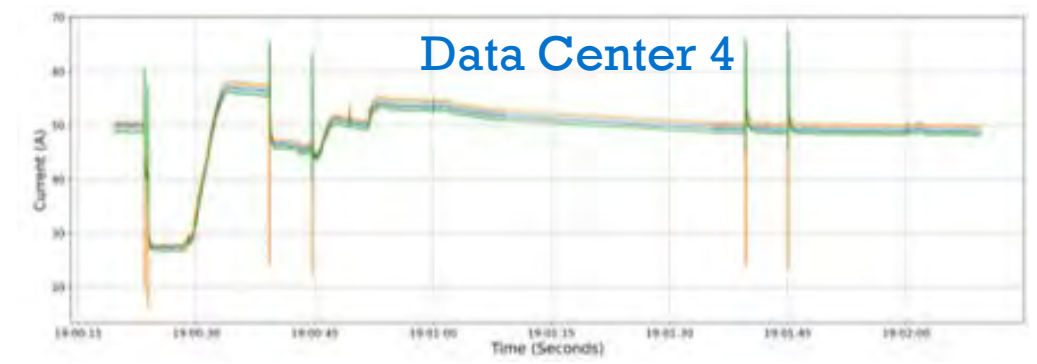
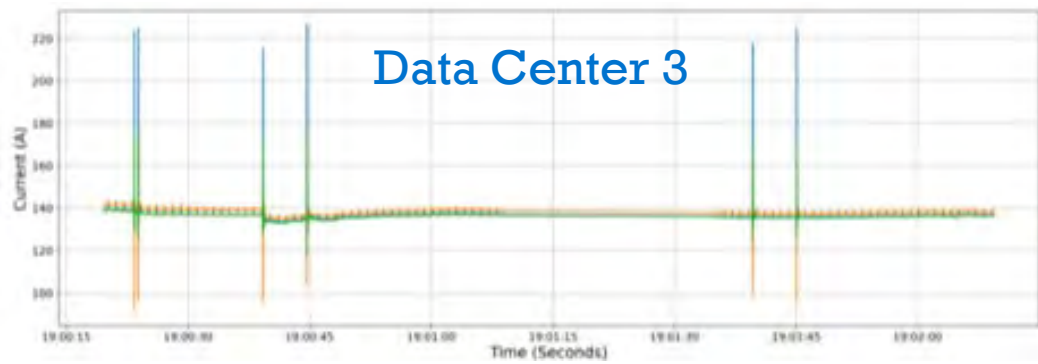
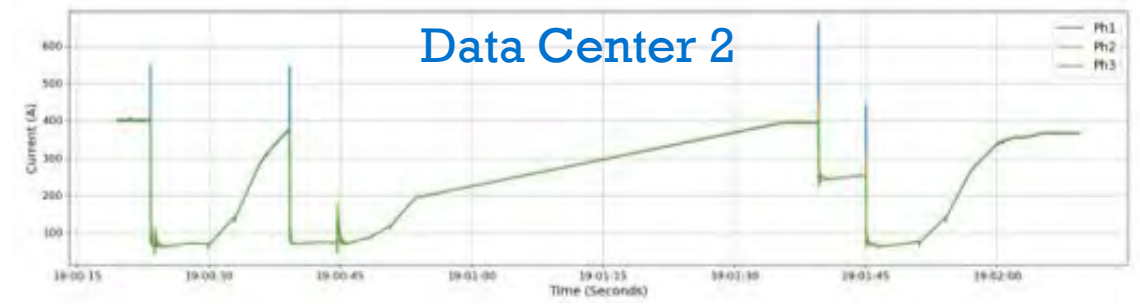
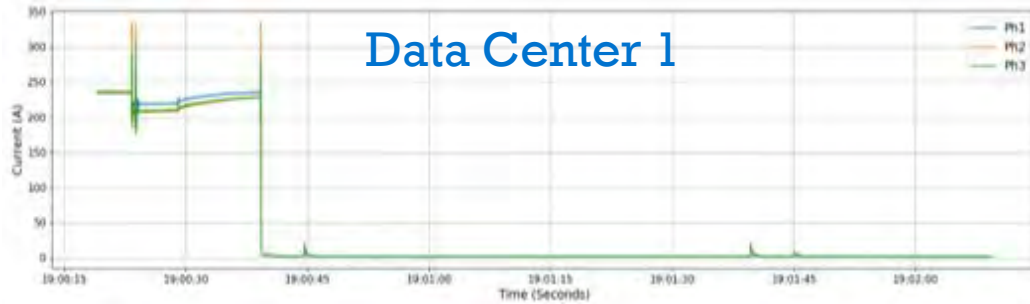
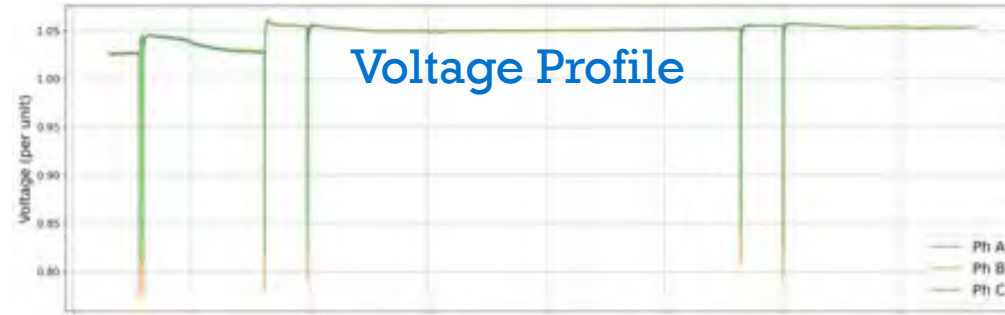
- ET network is fully observable with synchrophasor and/or digital fault recorder point-on-wave metering
 - Transmission substation-level metering (high side, lines mainly)
 - Insufficient to determine individual data center response
- Point-of-interconnection (POI) metering
 - PQ meters installed at POI of 51 data centers
 - POI is next to the revenue meter (not transmission level data)

Some companies' responses differed across facilities even if the voltage depressions/durations were similar

Effective RCA requires the ability to isolate behavior of individual facilities based on customer and location. Some RCAs complicated by difficulty correlating data center location to transmission station at time of event.



Selection of Data Center Responses



Key Findings

- Data centers responded with varying degrees of load transfer and recovery
- Customer conversations were critical to deeper understanding of load behavior
- A subset of data centers rode through the fault without any load transfer, irrespective of their distance from the fault position
- **Impossible** to determine behavior of individual facility without high-resolution POI data

Facility Interconnection Requirements (FIR)

The FIR dictates standards for transmission connected loads* and generation

Attachment 2 – Customer Request Form

- [NERC Data Center Information Collection Questionnaire](#)
- Phasor-domain data center dynamic model

Attachment 8 – Performance/Monitoring Requirements

- Required to ride-through six **50 – 70 ms** voltage depressions without transferring to long-term backup generation
 - Six depressions (fault + all reclosing attempts)
 - Review of 5 years of clearing time data, shows this time range is realistic
 - *Need to set voltage/time dependent thresholds for ride-through*
- Requires POI monitoring

***Note:** Load is still connected at distribution level, but requirements set for customers > 50 MWs

POI Monitoring & Data Use

- Varied use of normal and alternate distribution feeders to serve load makes it difficult to determine what load is be fed from where and when – so DEV is requiring PQ monitoring on all feeds that could be used to serve the customer.
 - Enables verification of compliance with ride-through standards
 - Supports model validation
 - Reduces complexity of RCAs
 - Upcoming FIR update will include detailed diagrams to avoid confusion from current language
- How are we going to manage all of this data effectively?
 - Automating data ingest across all different streams/time scales (SCADA, synchrophasor, power quality, point on wave)
 - Already have robust synchrophasor data analysis platform to leverage
 - *Ease of access to data is almost as key as having the data*

Ongoing Efforts

- Continued FIR updates
 - Does not go through the same stakeholder consensus processes associated with RTOs/ISOs
 - Allows for consistent, incremental progress since it is updated every 6 months
 - Plans to include voltage ride through curves, magnitude and frequency limits for (dynamic) ramp rates
- Interrogation of reactive power management (FACTs, generator settings, etc)
- Automating data retrieval across streams/platforms for model development/validation/RCA
- Benchmarking of system and load models against data
- Continued customer engagement



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Matt Twardy

Engineer, Integrated Transmission Planning – West
Xcel Energy

NERC, EMERGING LARGE LOADS TECHNICAL CONFERENCE

PANEL – UTILITY APPROACHES TO IMPROVE RELIABILITY WHEN INTEGRATING DATA CENTERS

Matt Twardy | Sr. Engineer, Integrated System Planning – West

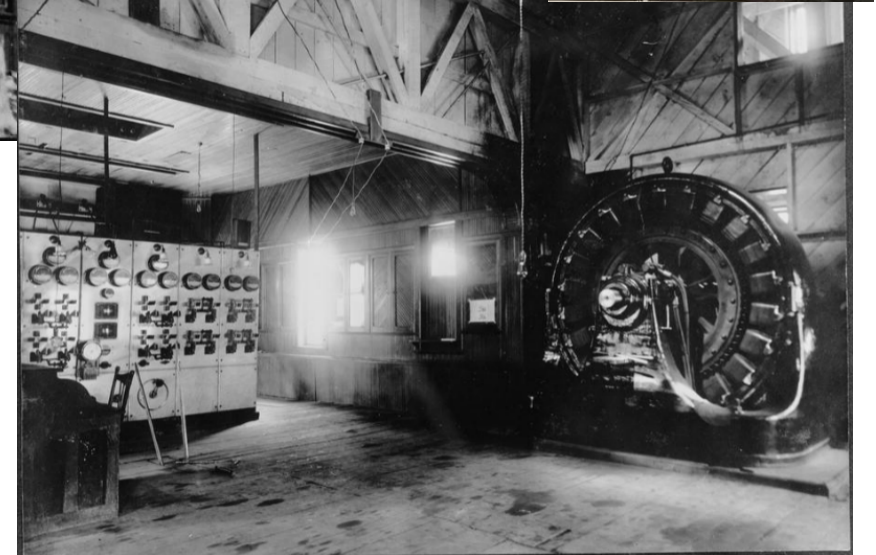
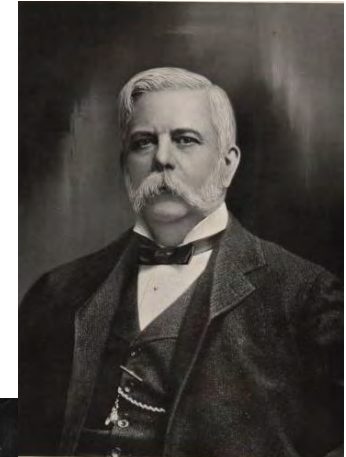
Xcel Energy, PSCo

February 24, 2026



AMES POWER PLANT, 1891 TELLURIDE, CO

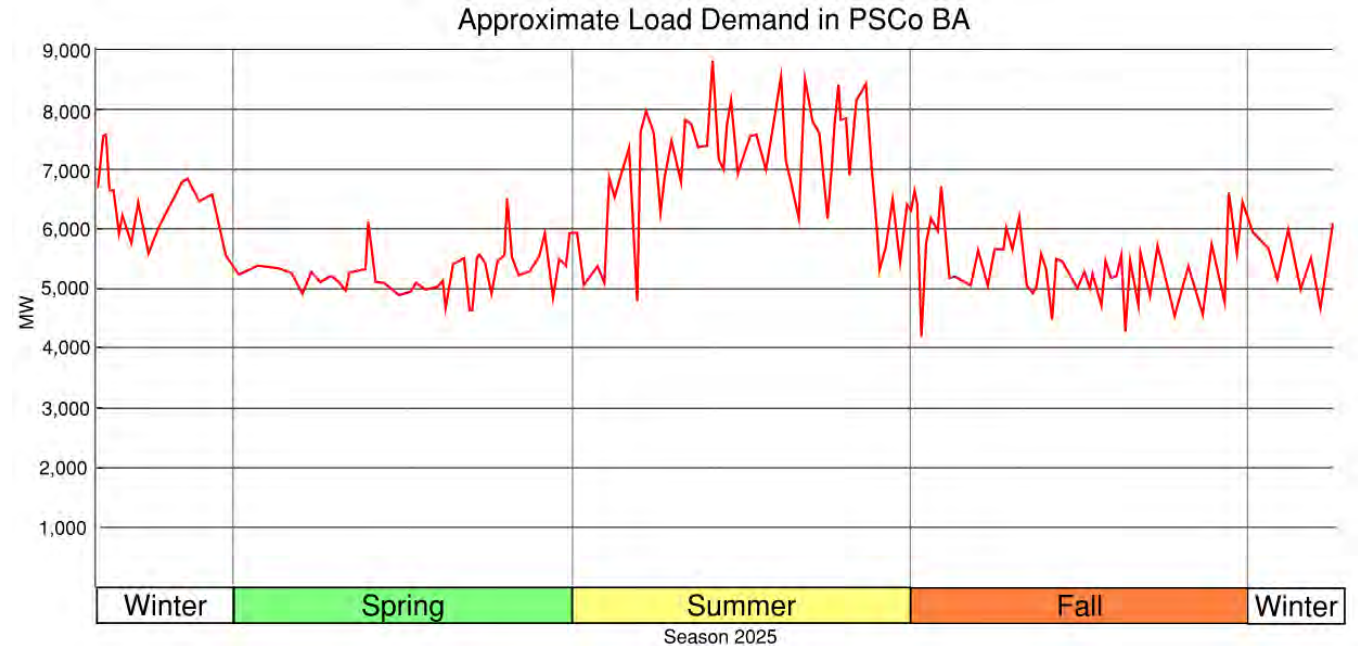
- World's first AC transmission line to service a commercial operation
- 3 kV, 133 cycle, single phase power, 2.6 miles of transmission to power the Gold King Mine stamp mill
- Acquired from Colorado Ute Electric Association by Xcel Energy in 1992
- Current Hydroelectric Capacity = 3.8 MW



LOAD DEMAND, CONCERNS

2025 Approximate Peak Demand
July – August = 8,830 MW

13,800 MW Large Loads under
study or queued to be studied



Concerns of rapid load expansion

- Reactive Margins and System voltage performance
 - Additional load depletes available reactive power available to support real power transfers
 - Especially apparent in long transmission facilities and dense load pockets
- Resource Adequacy
 - Retirement of existing fleet as thermal resources age-out
 - Timeline to identify, approve, and in-service new resources
- Interactions of Large Loads with System
 - Responses to transient events: ride through, disconnect & reconnection
 - Behavior of Large Loads indeterminate

LOAD BEHAVIOR AND MONITORING

Gather, and validate, information about the expected behavior and size of the interconnecting Large Load.

- Retail Transmission-to-Load (T-L) Interconnection applications need to include details about the proposed Large Load
 - Strongly based on the [NERC Large Load Alert](#)
 - Modeling and expected behavior of proposed facility
 - Interconnection configuration
 - Dynamic models
 - Electromagnetic Transient models
- Installation of Phase Measurement Units (PMU) and Power Quality (PQ) meters

INTERCONNECTION & PERFORMANCE CRITERIA

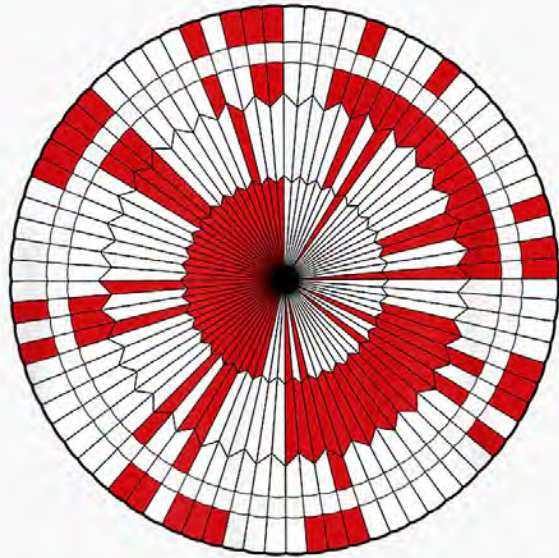
- Response to Transient events
 - Ride through capabilities and settings
 - Hz and kV transient events
 - Separation and reconnection practices
- Participation in existing NERC Reliability Standards
 - PRC-006, Underfrequency Load Shed Program
- System voltage support facilities (identified in steady-state analysis)
 - Capacitive (Cap)Shunt Banks
 - FACTS devices (STATCOM)
 - Synchronous Condensers

INTERCONNECTION STRATEGY(IES)

- Load demand vs. resource adequacy
 - Development of a “Transmission Ready Network”, facilities rated to meet proposed future load demand
 - Concentrating pockets, development of “Data Center Row” load area(s)
 - Costs to Interconnect
 - Pioneer facilities and cost recovery methods
 - Cost allocation / Cost sharing to establish shared transmission corridors
 - Large Load Tariffs and Reliability Requirements

“Far better it is to dare mighty things, to win glorious triumphs, even though checkered by failure, than to take rank with those poor spirits who neither enjoy much nor suffer much, because they live in the gray twilight that knows not victory nor defeat”

- Theodore Roosevelt, 1899



DARE MIGHTY THINGS

34° 11' 58" N 110° 10' 31" W



Kevin Conway

Senior Manager of Non-Tariff Programs
Western Power Pool (WPP)



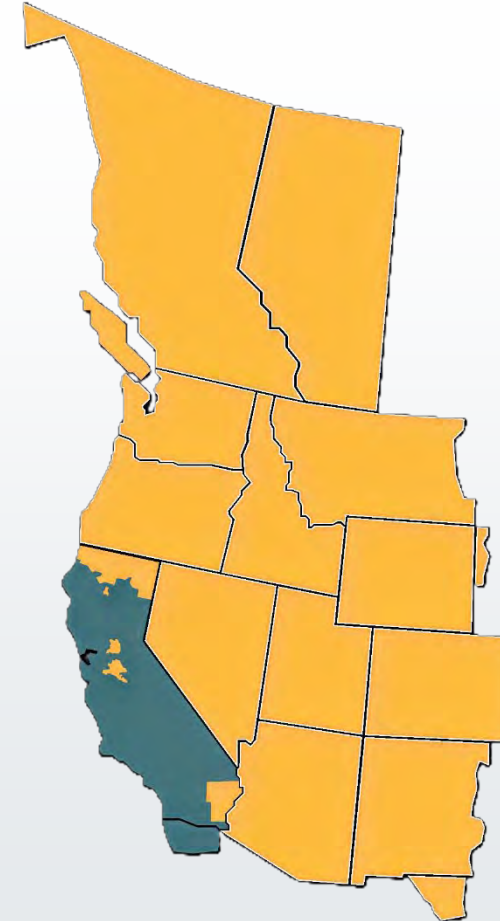
Large Load Integration – Small Entity Perspective

Kevin Conway, Senior Manager of Non-Tariff Programs

These are my personal opinions based on my experience and not that of the Western Power Pool or its Members

Western Power Pool

- » Formed in 1941
- » Non-Profit Member Driven Organization
- » Over 40 Members
- » Provide a broad range of services
 - » Reserve Sharing Group (35 BAAs)
 - » Frequency Sharing (24 members)
 - » System Operations Training
 - » Transmission Planning and Expansion
 - » Resource Adequacy



Small Entity Organizational Challenges

- » Proposed Large Loads can be a surprise
 - » Many are not prepared to address Large Load interconnection requests
 - » Small entities may encompass rural or depressed economies
 - » Requests may be discovered through second-hand sources
 - » Requests can exceed the entity's native load
 - » Developers tend to put a priority on inexpensive real estate and locations near transmission lines
 - » Developers feel smaller entities are more likely to accommodate their needs
 - » Developers may promise jobs, economic stability, and tax revenue
 - » Small entities can succumb to public or political pressure

Small Entity Administrative Challenges

- » Large Load Interconnection requests have been traditionally treated like Large Generation Requests
 - » The environment has changed and this no longer works
 - » System Impacts have been left to the utility to manage
 - » There is a lack of formal processes for Large Load interconnections
 - » Agreements can be complete before operations and compliance have a chance to be involved
 - » Requirements are imbedded in agreements and disputes generally result in litigation, but not regulatory enforcement
 - » Lack of enforceable performance outside of the agreements
 - » How are the ratepayers protected from the costs?

Small Entity Performance Challenges

- » There may be a lack of a clear plan for load profiles and the end goal of the facility
- » Required information and data must be negotiated and imbedded in the agreements
- » Services provided by the load must be detailed in the agreement, and they will be provided during operations
- » Operation deviations must be considered, and how the entity will address them
- » Disconnecting the load is a threat, but rarely practicable
- » Poor performance can expose the utility to compliance liability

Considerations

- » Changing negotiated contracts due to NERC reliability concerns is not practicable or efficient
- » NERC should clearly define entity responsibility
 - » Consider resurrecting the Load Serving Entity
 - » Consider a new functional model
- » Consider extending NERC Standards and performance to Large Loads, much like Generator Owner Operators
- » Expand NERC FAC-001 and FAC-002 to include requirements for Large Loads interconnection requests

Tom Pierpoint

Vice President of Operations
Northern Virginia Electric Cooperative

Assessment of Gaps in Existing Practices, Requirements, and Reliability Standards for Emerging Large Loads

Draft Large Loads Working Group (LLWG) White Paper
Jack Gibfried, Engineer II, NERC

Overall Gaps and Recommendations

Existing Reliability Standards, and the existing processes and requirements related to BPS planning, operations, security, and other areas are **inadequate** to address the risks posed by emerging large loads.

Updates are needed to registration criteria, Reliability Standards, processes/requirements, and other areas.

Key Gaps

Planning and Resource Adequacy Gaps

- TPL-001 and associated processes
- Analysis of loss of multiple large loads
- Historical data, well-established practices, and information for large load demand forecasting
- Resource adequacy assessment practices

Balancing and Operational Gaps

- Provision of data, such as models and ramp rates
- Short-term forecasting methods
- BAL-001, BAL-002, BAL-003 and associated processes
- Interpersonal communication capabilities
- Impacts of large-scale ramping, disconnection, or reconnection events in operations planning- and operations-related NERC standards

Key Gaps

Disturbance Ride-Through and Stability Gaps

- Voltage or frequency disturbance ride-through
- Allowable limits for forced oscillations
- Coordination on large load ramping to pre-disturbance demand after a voltage disturbance
- Understanding of mechanisms by which large loads can impact converter-driven or resonance stability
- Existing practices related to rotor angle stability, voltage stability, and frequency stability studies

Security and Event Analysis Gaps

- NERC CIP requirements
- Review of data center security protocols
- Large load communication protocols
- Design basis threat assessments
- Bad actor access and control of large load operational systems
- Large load disturbance monitoring and reporting

Key Gaps

Modeling Gaps

- Phasor domain load models
- Information/experience necessary for utility engineers to properly parameterize large data center models
- Model validation
- Clear data and model sharing requirements
- Clear understanding of the requirements for grid modeling
- Consistent industry approach for performing model quality testing for large loads
- Guidance related to EMT modeling/studies for large loads

Interconnection Processes and Requirements Gaps

- Interconnection requirements
- Model quality requirements
- Coordination of protective settings
- Coordination on key large load design decisions

Recommendations

Recommendations

#1: The LLWG recommends that NERC pursue registration of new entity (or entities)

#2: The LLWG and other groups should propose SARs to address unmitigated risks

#3: The LLWG should identify improvements to existing planning/operations processes and interconnection procedures (upcoming Reliability Guideline)

#4: Registered entities should coordinate/collaborate with large load entities and update practices

#5: TOs should coordinate with TP/TOP/PC/BA/RCs to update interconnection requirements. PCs and TPs should update interconnection study processes.

#6: The Load Modeling Working Group should address applicable gaps

Recommendations

#7: The Security Working Group should further assess security gaps and propose mitigations

#8: The System Protection and Control Working Group should further investigate gaps related to system protection and control systems.

#9: Federal/state regulators should consider the gaps and coordinate with utilities to assess whether incorporating additional interconnection requirements/studies are appropriate.

#10: State regulators should work with regulated utilities to review how new loads and planned additional generation impact existing planning and risk assessment frameworks.

#11: Policymakers should review interactions between interconnection requirements / existing state regulations / planning processes / regional grid operator requirements.

Risk Mitigation for Emerging Large Loads

Reliability Guideline from NERC's Large Load Working Group
Evan Mickelson, Engineer, NERC

Agenda

- Motivation
- Reliability Guideline Scope
- Risk Mitigations
- Next Steps

Motivation

LLWG's Primary Objective:
Understand the reliability impact(s) of emerging large loads on the BPS

NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Characteristics and Risks of Emerging Large Loads

Large Loads Task Force White Paper

July 2025

RELIABILITY | RESILIENCE | SECURITY

The cover features a blue header with the NERC logo, a white background with a faint grid pattern, and a blue footer with a row of five images: a control room, a power plant, a transmission tower, a wind turbine, and solar panels.

NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Assessment of Gaps in Existing Practices, Requirements, and Reliability Standards for Emerging Large Loads

NERC Large Loads Working Group White Paper

March 2026

RELIABILITY | RESILIENCE | SECURITY

The cover features a blue header with the NERC logo, a white background with a faint grid pattern, and a blue footer with a row of five images: a control room, a power plant, a transmission tower, a wind turbine, and solar panels.

NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Risk Mitigation for Emerging Large Loads

Large Loads Task Force Reliability Guideline

Q2 2026

RELIABILITY | RESILIENCE | SECURITY

The cover features a blue header with the NERC logo, a white background with a faint grid pattern, and a blue footer with a row of five images: a control room, a power plant, a transmission tower, a wind turbine, and solar panels.

Motivation

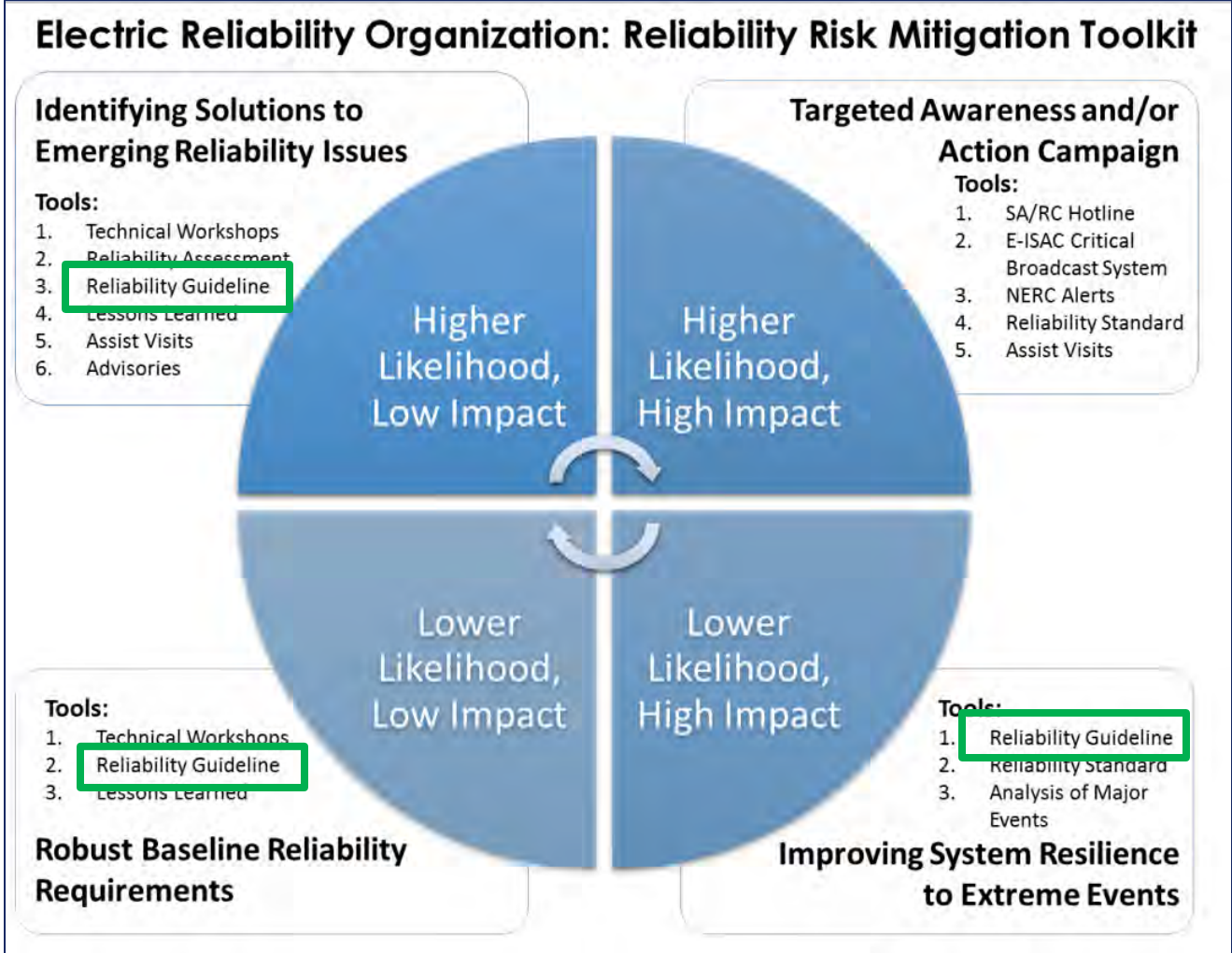
NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Assessment of Gaps in Existing Practices, Requirements, and Reliability Standards for Emerging Large Loads

NERC Large Loads Working Group White Paper

March 2026

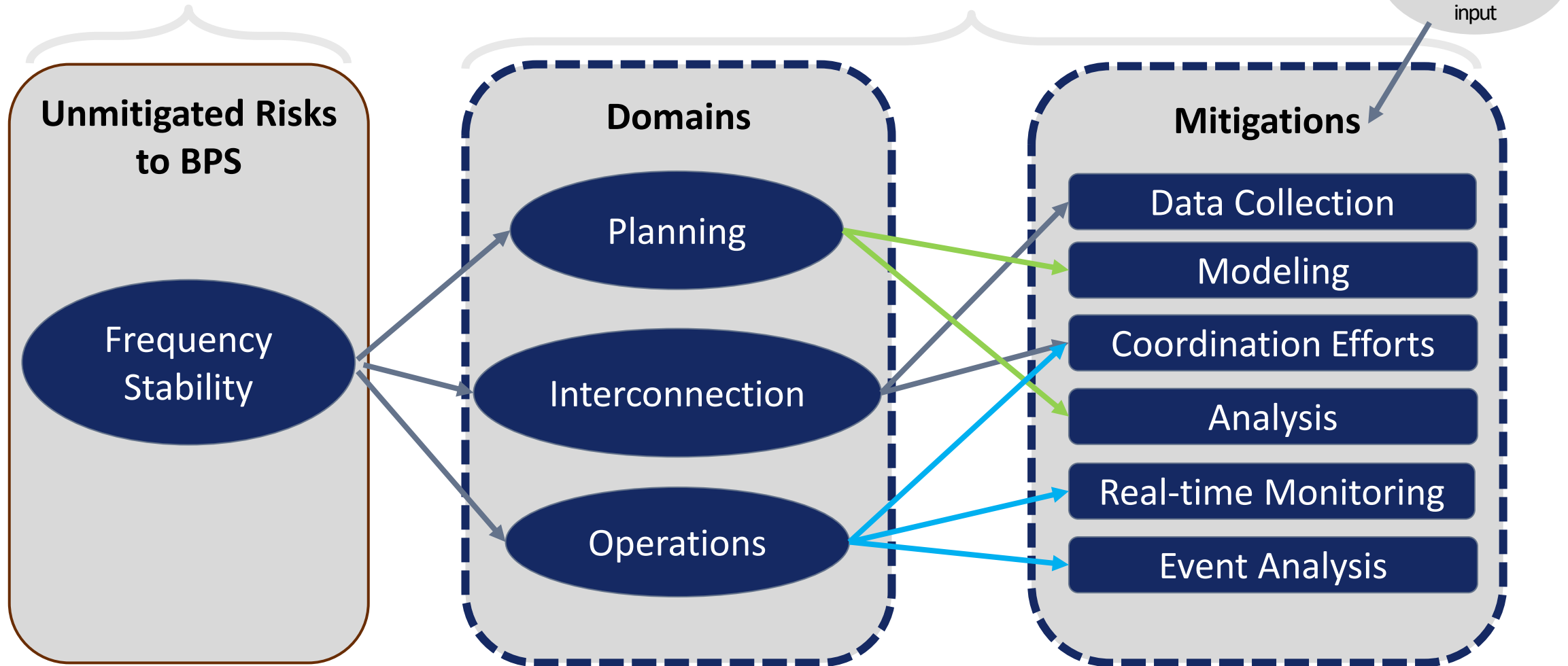
RELIABILITY | RESILIENCE | SECURITY



Reliability Guideline Strategy

White Papers 1 and 2

Reliability Guideline



This is only one example to demonstrate the structure.

Reliability Guideline – Applicable Entities

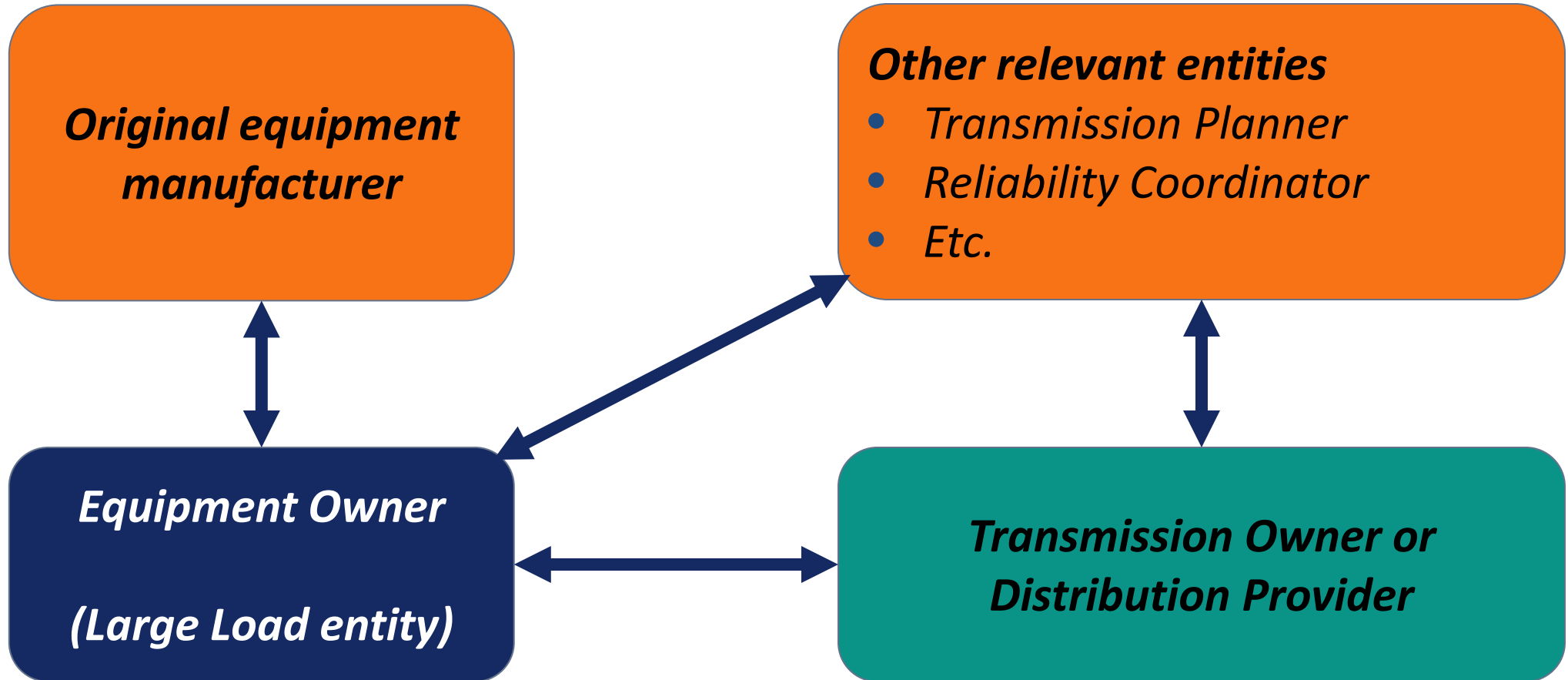
NERC Registered Entities

- Transmission Owners, Transmission Operators
- Balancing Authorities, Reliability Coordinators
- Transmission Planners, Planning Coordinator

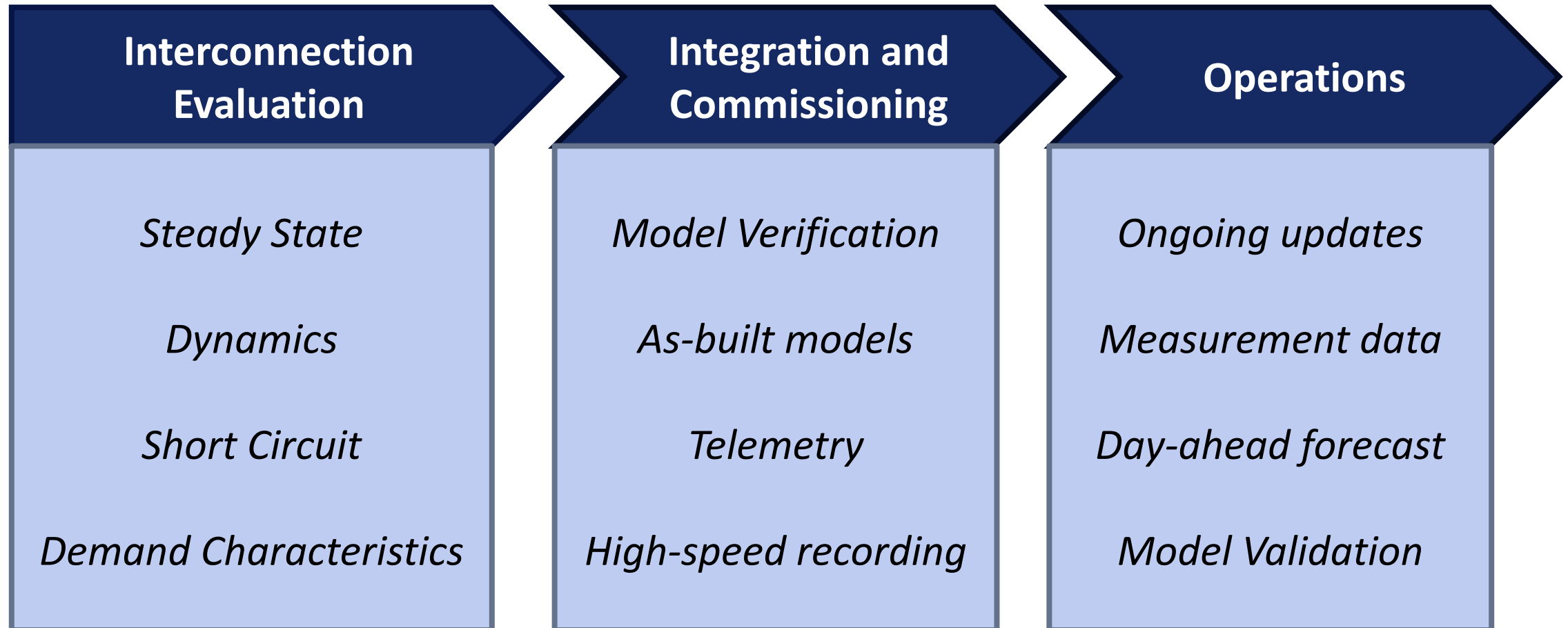
Non-registered Entities

- Large load owners
- Large load operators
- Original equipment manufacturers

Data Collection, Monitoring, and Sharing



Data Collection, Monitoring, and Sharing



Data Collection, Monitoring, and Sharing

- LLWG acknowledges preliminary data is **preliminary**
- Expectation of updates to modeling data up to and after initial energization
- Need for high-speed monitoring equipment plus post-event data sharing and analysis
 - Model Validation
 - Performance validation
 - Event analysis
- For each of these data collections, Transmission Owners / Distribution Providers should collaborate with their higher-level entities on data requirements and sharing:
 - Transmission Owners, Transmission Operators
 - Balancing Authorities, Reliability Coordinators
 - Transmission Planners, Planning Coordinator

Interconnection & Commissioning Improvements

Minimum
Interconnection
Request
Requirements

Large Load Study
Agreement and
Process

Data Collection
and Sharing

Near-Term
Regional Studies
for Approval to
Energize

Commissioning
Process

Oscillation Studies
and Monitoring

Disturbance Performance Criteria

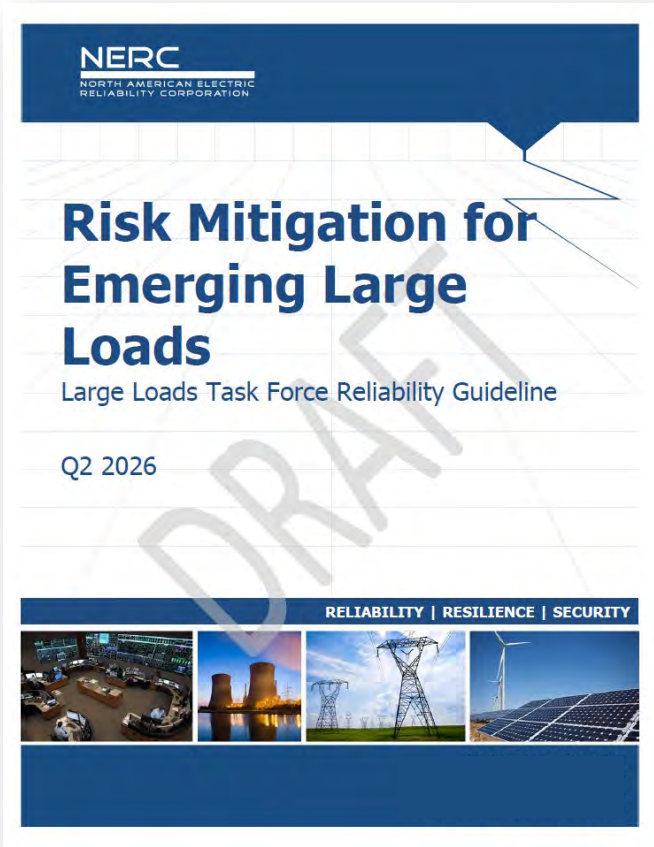
- Transmission Owners should coordinate with Transmission Planners, Planning Coordinators, and Reliability Coordinators to establish disturbance performance criteria, including but not limited to:
 - Rate of Change of Frequency ride-through
 - Phase jump ride-through
 - Low-voltage ride-through
 - High-voltage ride-through
- To mitigate voltage and frequency instability risks
- Coordinated studies should inform stability thresholds



Conclusion

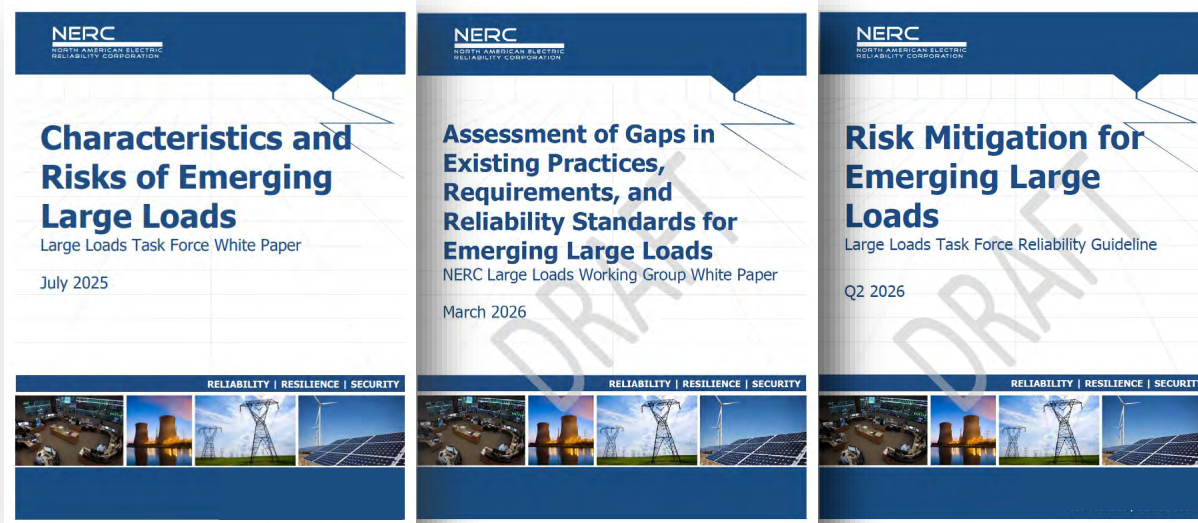
- Numerous process improvements are suggested to all entities to address new risks
- Key Categories include:
 - Data collection, monitoring, and sharing
 - Interconnection processes and studies
 - Commissioning and real-time operations
 - Physical and cyber security
 - Resilience

***Planned for release
in Q2 of 2026***



Next Steps

- Reliability Guideline offers voluntary, non-binding guidance on mitigating BPS reliability risks associated with the integration of emerging large loads
- Large Loads Working Group will continue to work on updating the reliability guideline as per the RSTC charter



Remarks

Alex Fitzsimmons, Acting Under Secretary of Energy and Director of the Office of Cybersecurity, Energy Security, and Emergency Response, U.S. Department of Energy

Super Panel: Pathways to Address Unmitigated Risks from Data Center Grid Integration

Moderator – JP Skeath, Manager, Engineering & Security Integration, NERC

Panelists

Mike Della Penna, Data Center Transmission Planning & Analysis, Google

Janne Paananen, Data Center Systems Architect, Eaton

Chris Ruppel, Director Energy Development, MARA

Doug Golden, Vice President, Power, Core Scientific Inc.

Katelynn Vance, Manager, Electric Transmission Planning & Strategic Initiatives, Dominion Energy

Patrick Gravois, Principal Operations Engineer, ERCOT

Kevin Conway, Senior Manager of Non-Tariff Programs, WPP

Tom Pierpoint, Vice President of Operations, NOVEC

Matt Twardy, Engineer, Integrated Transmission Planning – West, Xcel Energy

Rich Bauer, Principal Engineer, NERC

Keynote: Addressing the Risk of Emerging Large Loads: The Way Forward

Mark Lauby, NERC Fellow and Chief Engineer, NERC



Panel: Data Centers – The Reliability Perspective

Moderator – JP Skeath, Manager, NERC

Mark Lauby

NERC Fellow and Chief Engineer
NERC

Chris Pulong

Senior Director, Operations Planning
PJM



NERC Emerging Large Loads Technical Conference

Chris Piong

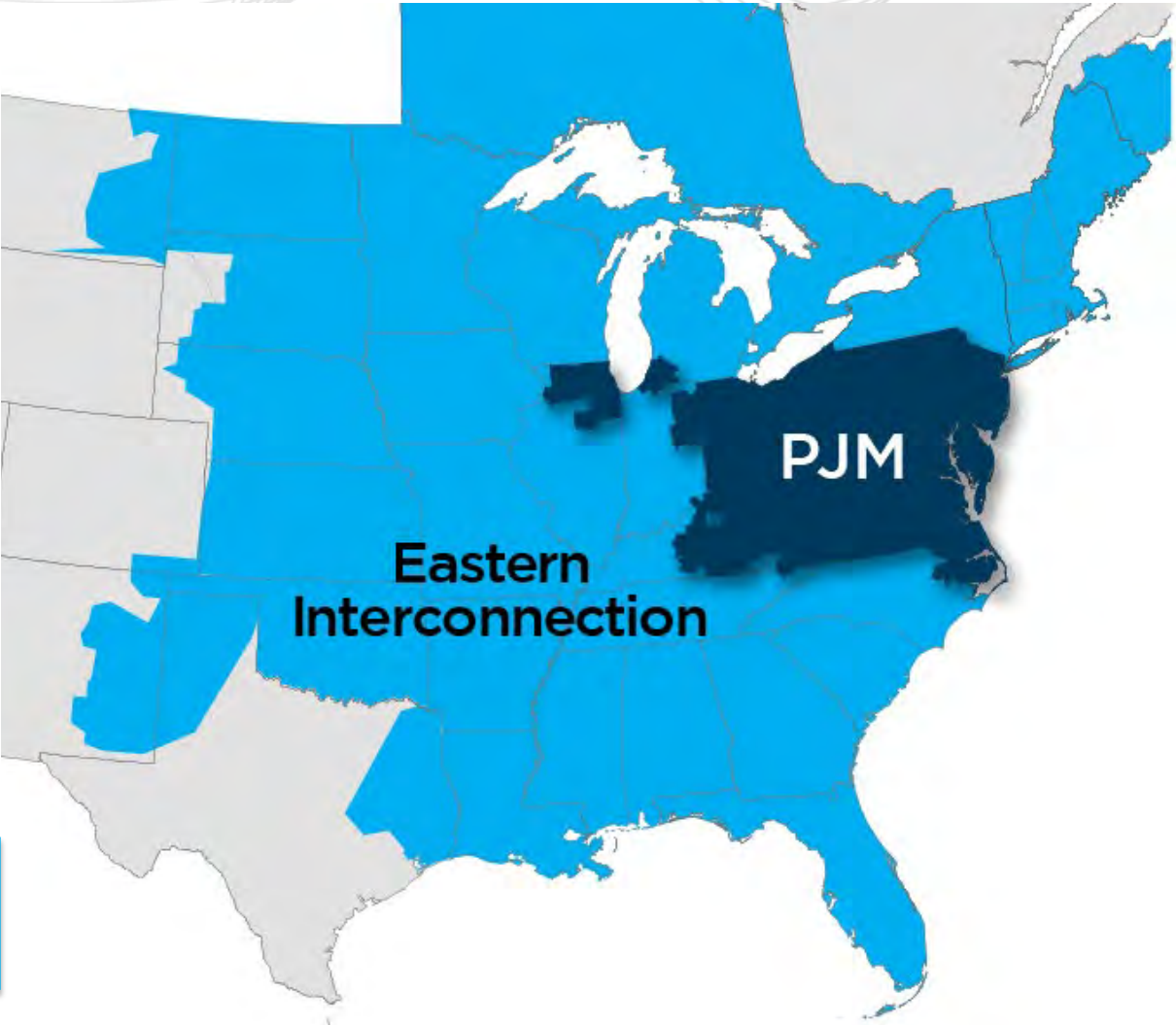
PJM



PJM as Part of the Eastern Interconnection

Key Statistics	
Member companies	1,116
Millions of people served	67+
Peak load in megawatts	165,563
Megawatts of generating capacity	185,989
Miles of transmission lines (BES)	88,333
Gigawatt hours of annual energy	828,161
Generation sources	1,673
Square miles of territory	368,906
States served	13 + DC

- 25.6% of generation in Eastern Interconnection
- 25.2% of load in Eastern Interconnection



As of 2/2026



PJM's Role as a Regional Transmission Organization

PLANNING



Planning for the future like...



OPERATIONS



Matches supply with demand like...



MARKETS



By Zone	
AE	\$20.59
AFP	\$25.55
APS	\$25.18
ATSI	\$25.46
RC	\$37.91
COMED	\$25.68
DAYTON	\$26.22
DFOR	\$25.38

Energy Market Pricing like...

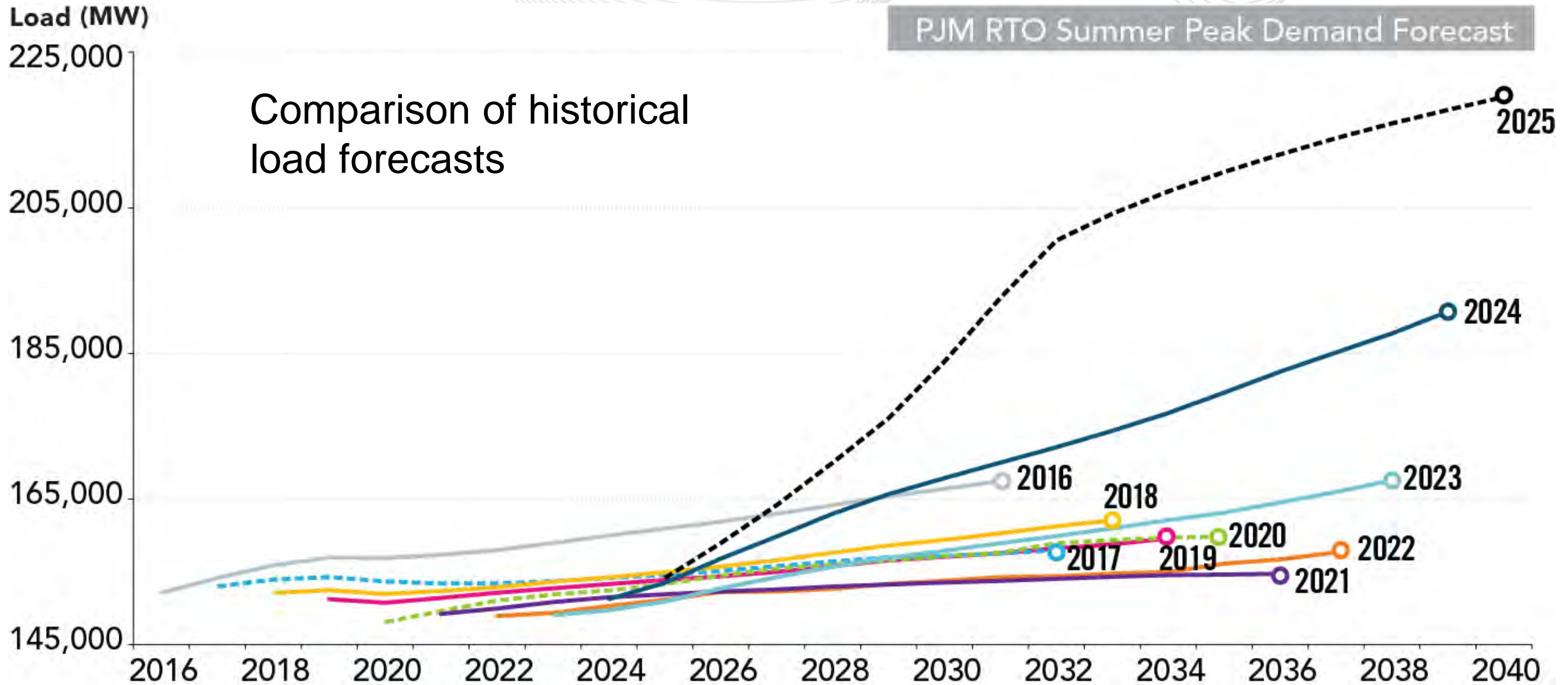




Electricity Demand Growth

PJM RTO Summer Peak Demand Forecast

Comparison of historical load forecasts



Diego Rodriguez

Technical Solutions Lead
Reactive Technologies

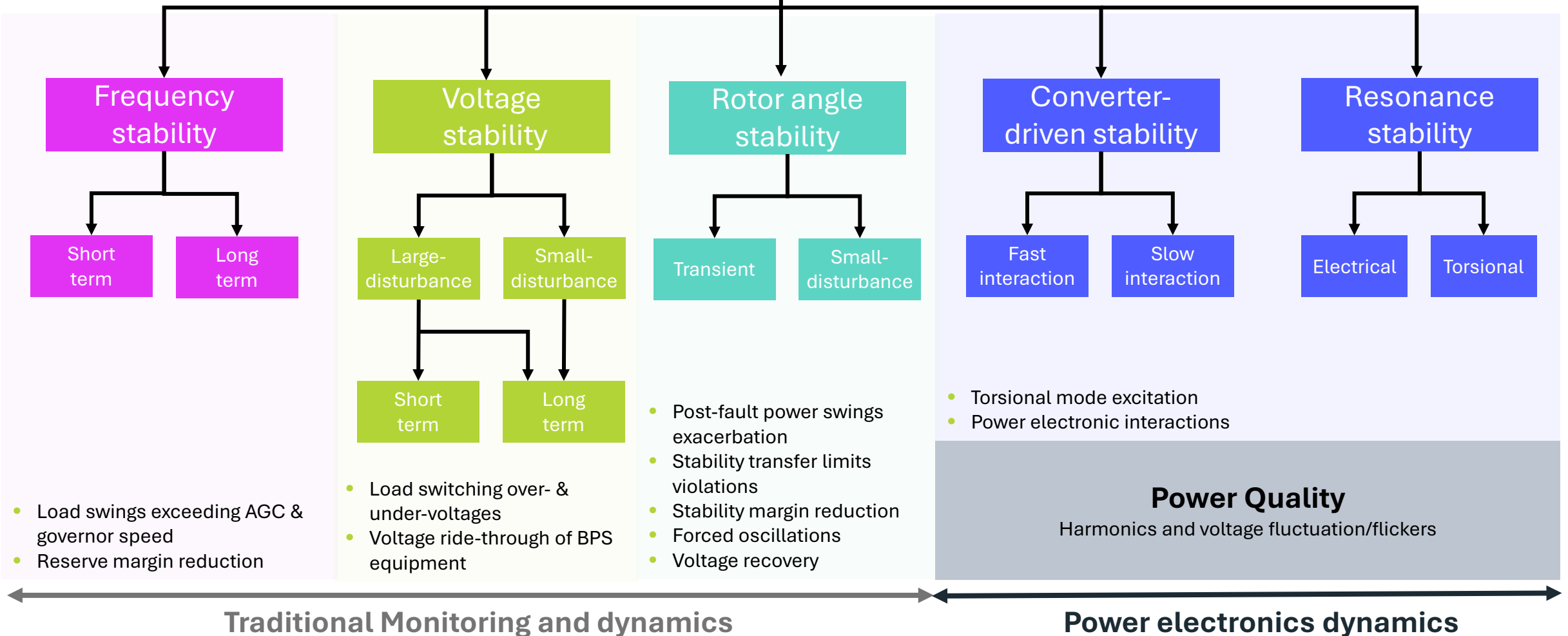
NERC - Emerging Large Loads Technical Conference

The role of high-resolution technology to enhance System reliability when integrating computational loads

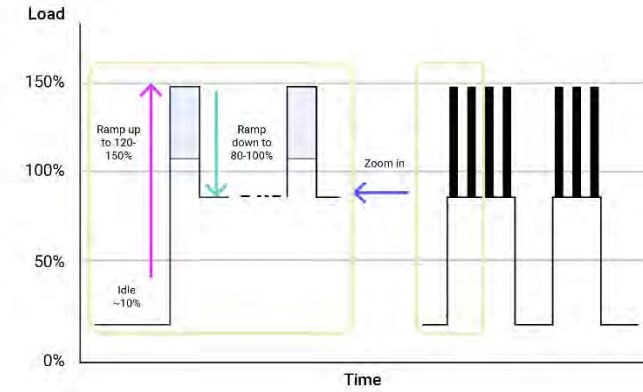
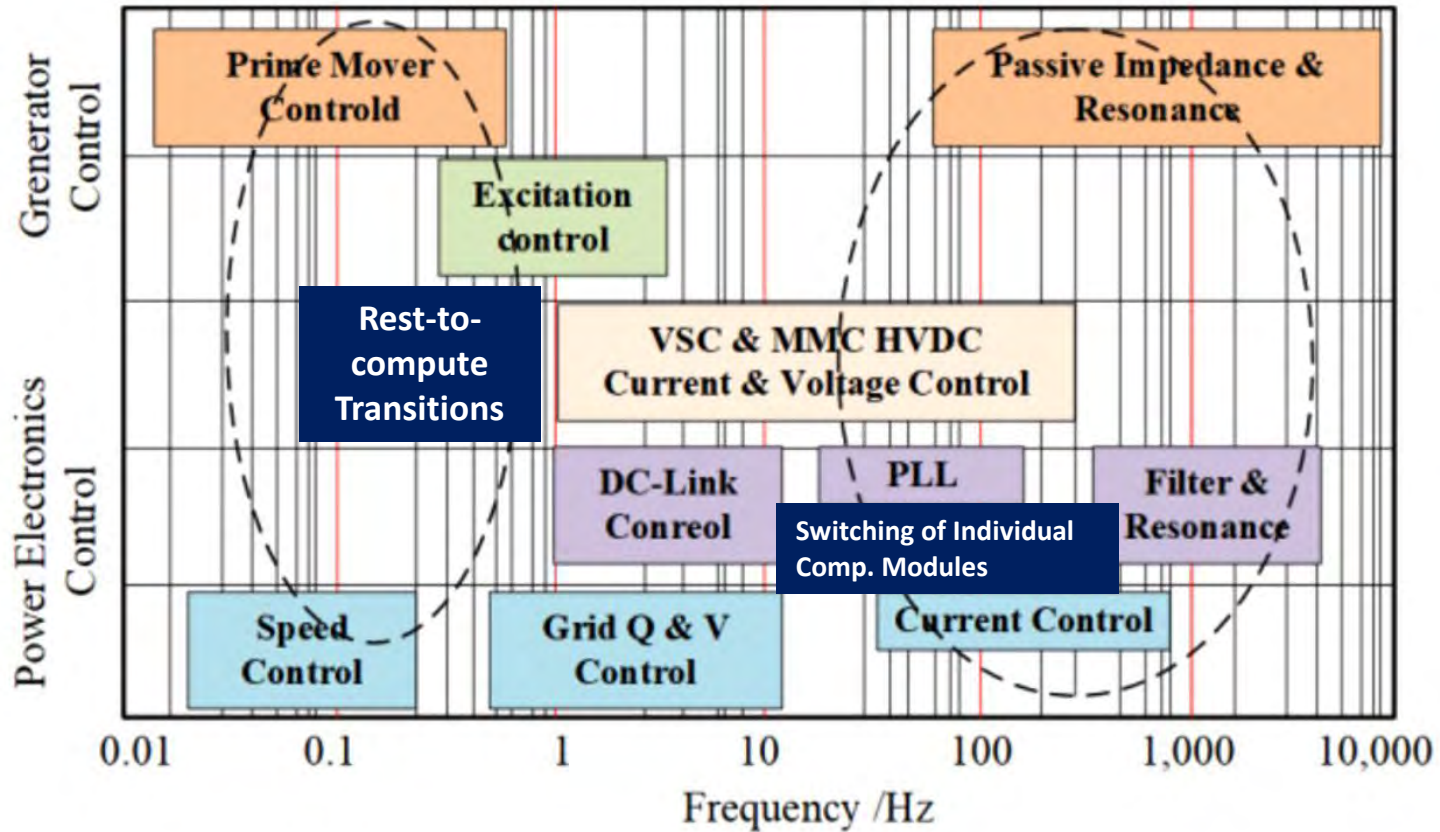
Diego Rodriguez
Technical Solutions Engineer
diegor@reactive-technologies.com



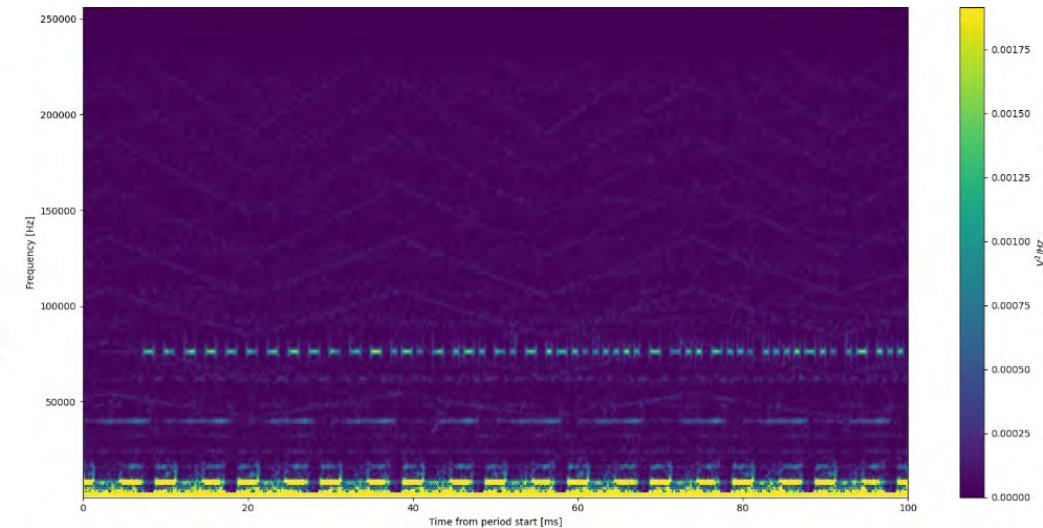
Power System Stability



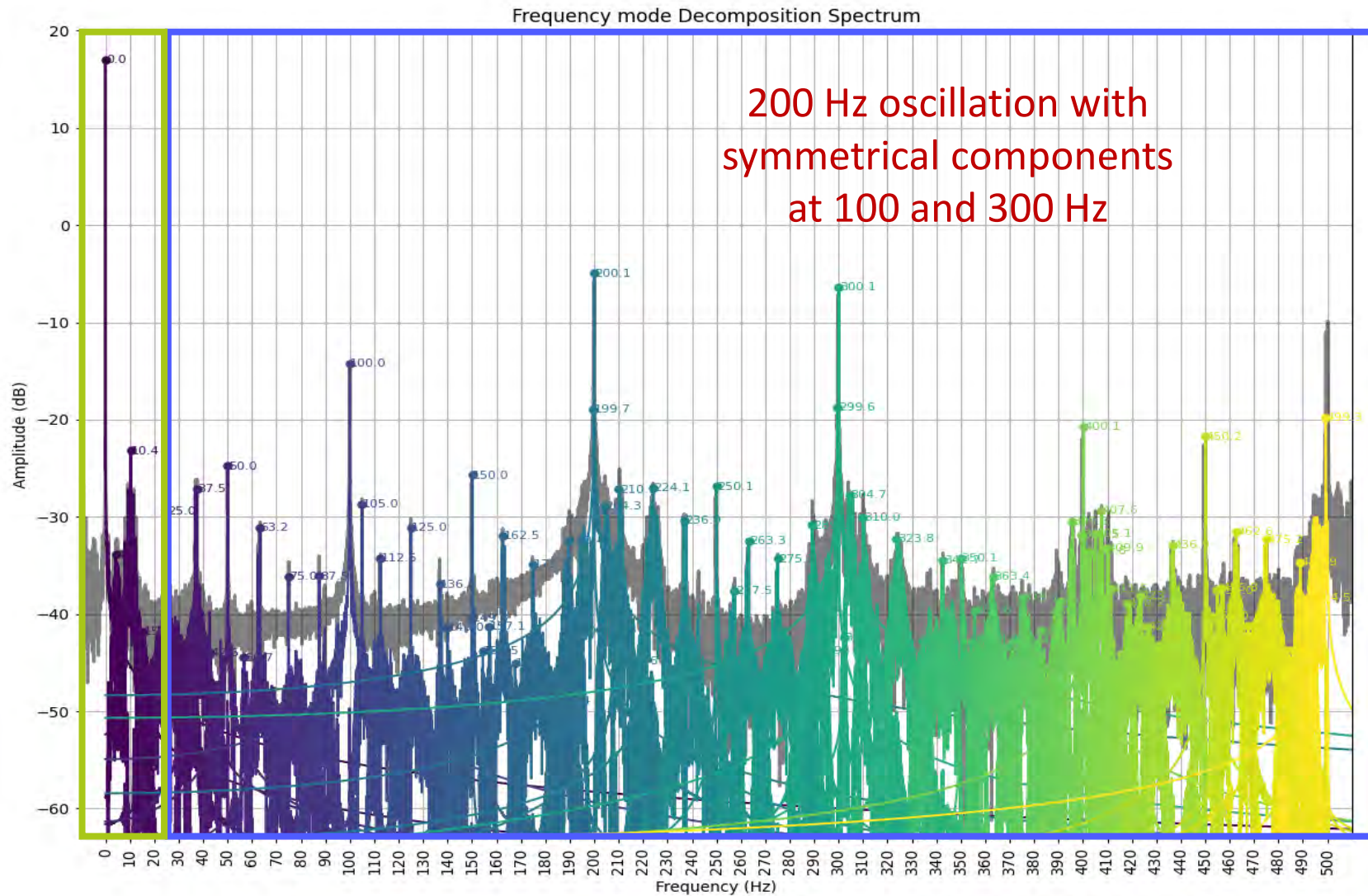
High-frequency oscillations visibility is key in high Power-Electronics-dominated grids



Source: WECC "An Assessment of Large Load Interconnection Risks in the Western Interconnection"



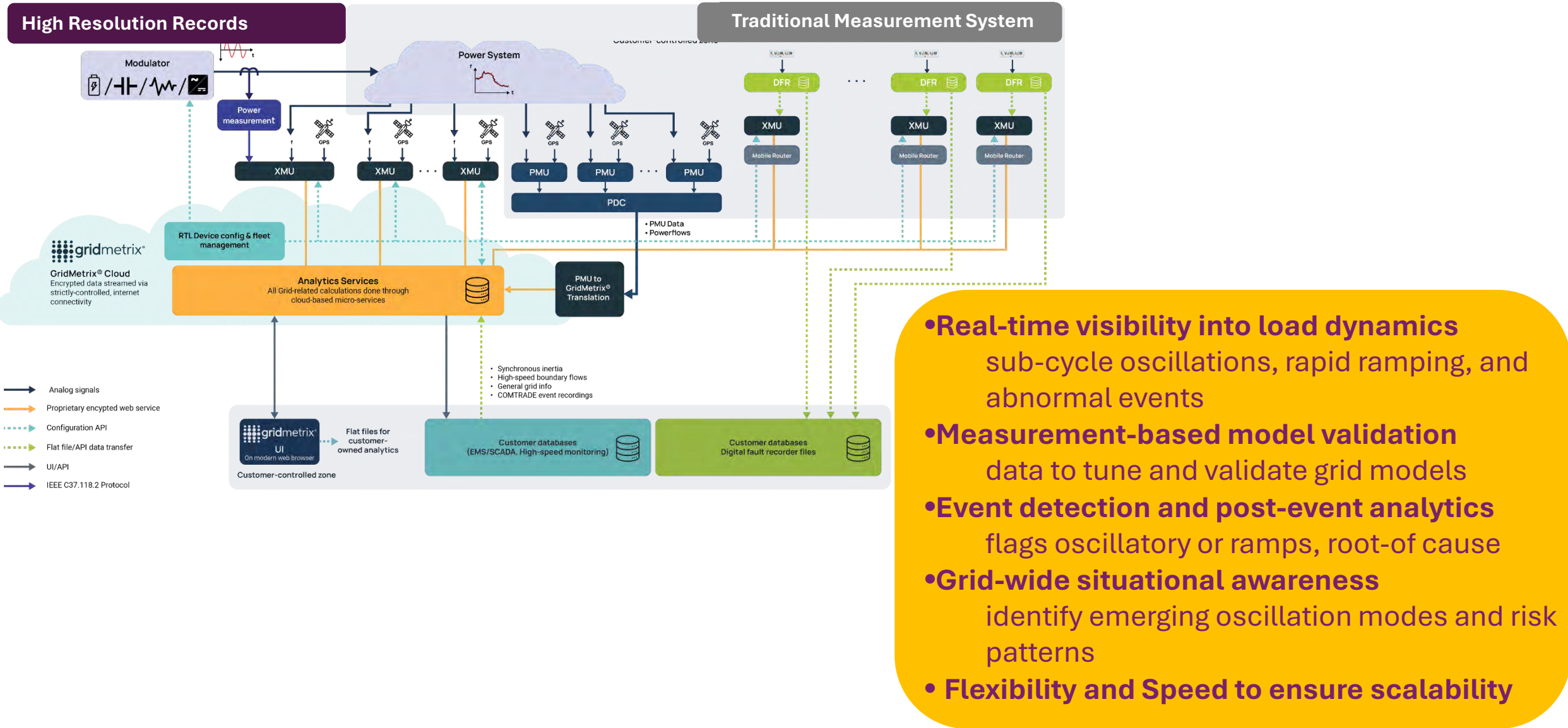
High-frequency oscillations visibility is key in high Power-Electronics-dominated grids



Required
Visibility

What is visible
with
traditional
Measurements
Systems

High-resolution Platform Overview



- **Real-time visibility into load dynamics**
sub-cycle oscillations, rapid ramping, and abnormal events
- **Measurement-based model validation**
data to tune and validate grid models
- **Event detection and post-event analytics**
flags oscillatory or ramps, root-of cause
- **Grid-wide situational awareness**
identify emerging oscillation modes and risk patterns
- **Flexibility and Speed to ensure scalability**

Eric Mannarino

Design Delivery Principal, Electrical Engineering
Equinix

David Molteni

Senior Manager, Digital Modernization
Constellation



Co-located Load Challenges and Opportunities

NERC Conference Panel Discussion
February 2026

Constellation At A Glance

Our Business

Constellation is the nations largest producer of clean, carbon-free energy and a leading supplier of energy products and services, including sustainable energy solutions.

48 states

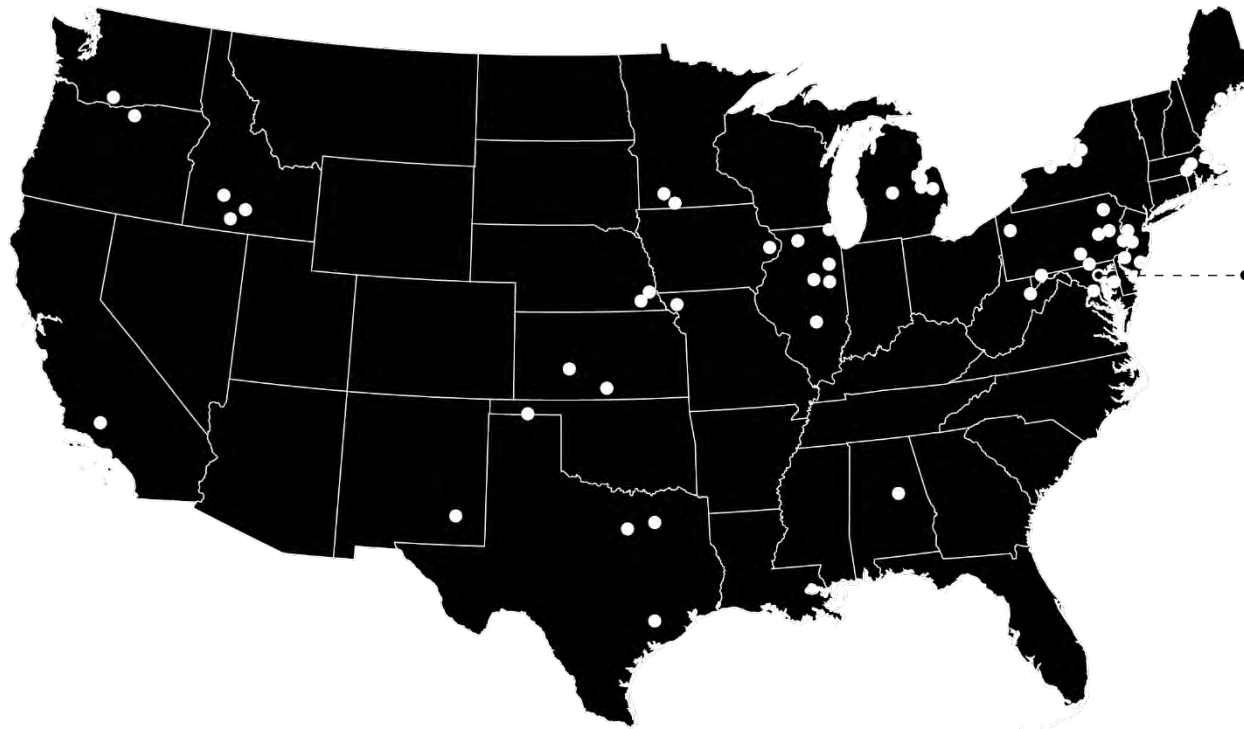
Operates in 48 U.S. states, the District of Columbia, Canada and the United Kingdom.

>33,000 MWs

Constellation has a generating capacity of more than 33,000 MWs and an annual output that is nearly 90 percent carbon-free, generating enough clean, carbon-free energy to power the equivalent of 16 million homes.

~10%

Constellation produces approximately 10 percent of the carbon-free energy in the U.S.



Headquartered in Baltimore

~14,000

Employs almost 14,000 people.

~2 million

Constellation serves approximately two million residential, public sector and business customers through our family of retail businesses.

75%

Constellation supplies energy products and services, including sustainability solutions, to 75 percent of Fortune 100 companies.

Data Center Land & Power Requirements and Realities

Must Have

- Land capable of a data center build (generally less than 15 degree slope)
- Outside of 500 year flood zone
- Limited wetlands
- Limited impacts from endangered species and historical artifacts
- Clear path to land entitlement: zoning and permitting
- Access to large sources of generation

Nice-to-Haves

- 300+ contiguous acres
- Known utility capacity and approvals
- Direct access to high voltage power
- Redundant power feeds
- Fast-track site readiness to build
- Permitted, Zoned and Entitled land
- Local and state tax incentives
- Carbon Free energy source
- Competitive power prices
- Water for cooling

Nirvana

- 500+ contiguous acres
- No flood, wetlands or other risk elements
- Fully entitled, zoned, permitted
- Direct substation access
- Utility approval for interconnection
- 100+MWE on day 1
- 1000+ MWE by year 3
- Full local and state tax incentives
- Carbon Free energy source
- Competitive power prices

Electrical Studies and Other Considerations For Large Load Co-location

- Steady state and Transient stability analysis
- Short circuit, fault currents and harmonics – both grid and generator
- Zones of protection, Protection schemes
 - Generator and Grid protection coordination
 - NERC protection requirements
- Necessary and/or Load Deliverability studies
 - Grid support could involve VARs, thermal overloads
- Operation and Maintenance isolation
- Capacity derating - for Behind The Meter / Private Use Network configurations
- Best Practices:
 - IEEE 519 – Harmonic Control in Electrical Power Systems
 - Parallel or advanced independent grid studies
 - EPRI – BTM Large Electric Load analysis

Hard Spots and Potential Solutions

- Speed of interconnection is not supporting short term connections in ongoing projects:
 - Cluster processes showing signs of further slowing speed to market
 - Utility resource constraints become a factor for grid reliant solutions
 - Configurations that relieve grid stress such as behind the meter need clarity in treatment
 - FERC guidance of interconnection still ongoing further discourse holding collaborative solution development
- Large up-front load study fees and letters of credit can help screen out speculative projects
- Developers and IPP's seeking to partner and help the Utilities move faster and reduce risk:
 - Acquisition of long lead equipment (transformers, HV breakers, . . .)
 - Preferential vendors and equipment manufacturers that differ from utility standards
 - Utilities drive decisions on use of available long lead equipment and configurations
- Timeline to sign a TSA is inadequate for some projects/customers

Opportunities and Considerations

- Analysis timelines have shown ability to be reduced in various projects based on external influences versus new standard practice
 - This efficiency should be looked at to be universally applied.
- Transparency of analysis results is improving and allowing better understanding and challenge of selected solutions and margin development.
 - Continued collaboration is needed and clearer design margin maintenance is needed to help justify cost transference and upgrade needs
- Additional performance data from the operating data centers is needed to aid in analysis and develop confidence in solutions.
- Contract terms are essential to establish performance requirements and protection needs to ensure reliability is in base design and maintained through cycle life.

Thank You!

Tom Galloway

President and CEO
NATF





Large Load Technical Conference

Data Centers: The Reliability Perspective (Feb 25, 2026)

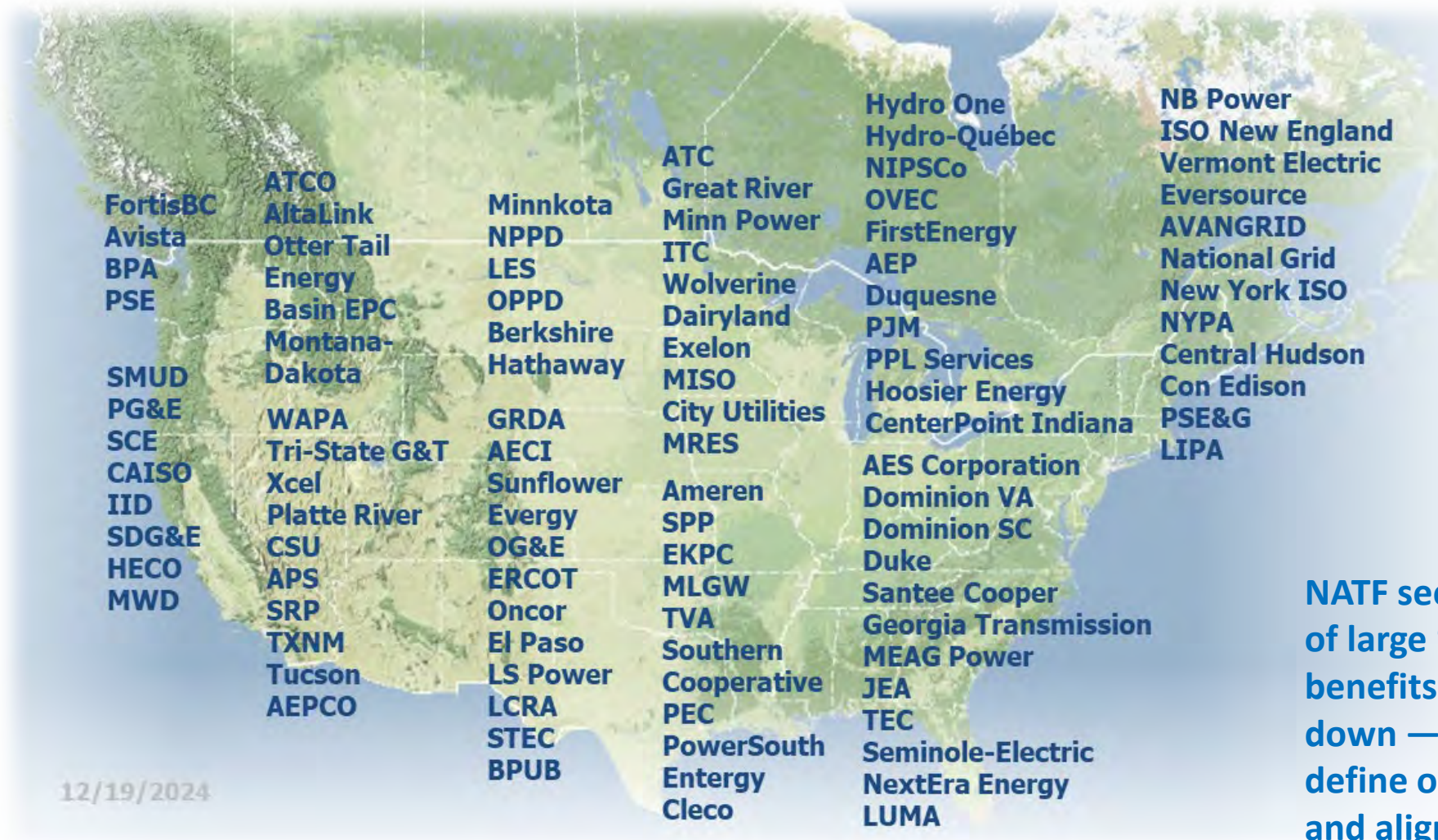
T.J. Galloway Sr., NATF President & CEO

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NATF Membership

MISSION: Promote excellence in grid reliability, resilience, security, and safety



- 100 members plus 100 affiliates
- 5 member types
 - IOUs
 - Municipals
 - Co-ops
 - ISO/RTO
 - Fed/Provincial
- Represents 85% U.S. & Canadian HV transmission (circuit miles/peak demand)

NATF seeks to enable the rapid addition of large “datacentric” loads. Numerous benefits. The path forward is not to slow down — it is to engineer responsibly, define operating expectations clearly, and align policy with physical realities.

Large Load Interconnection

The fastest way to interconnect at scale is to clearly define the electrical operating envelope at the point of interconnection

Not IF, but HOW

Challenges (include):

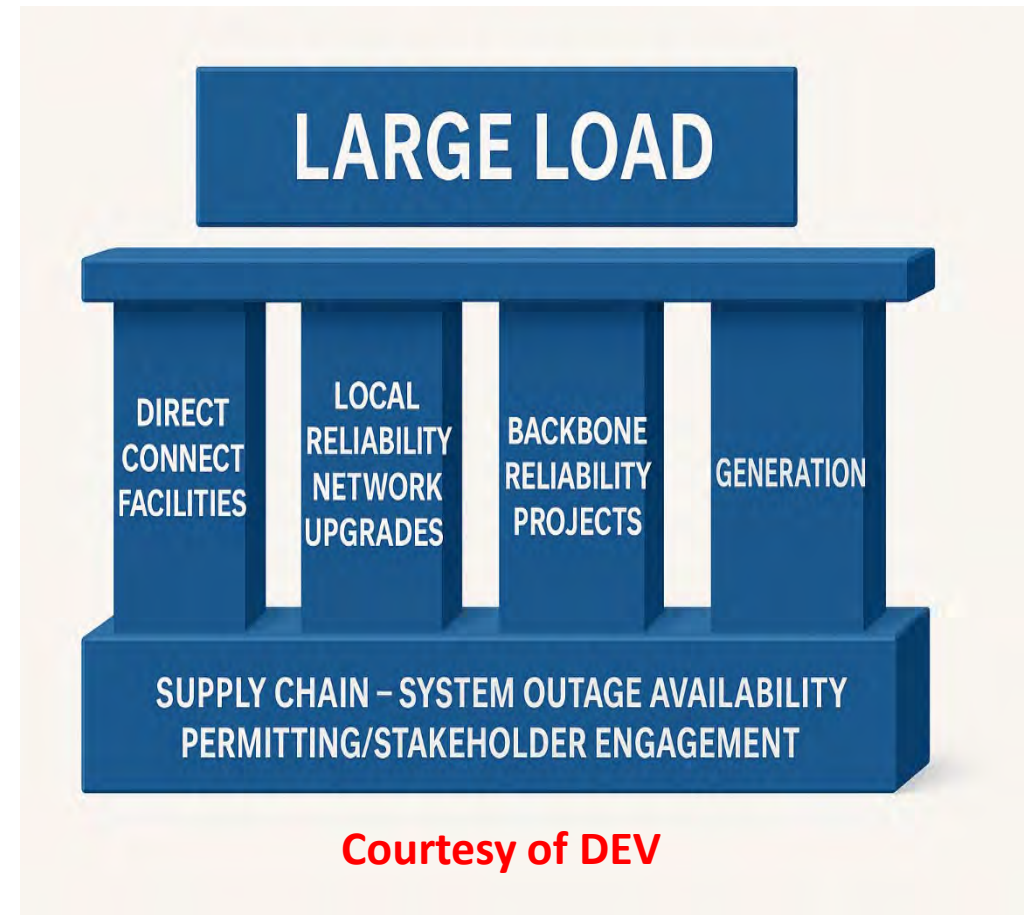
- Planning uncertainty
- Resource adequacy
- Deliverability and constraints
- Operational characteristics
- Cost allocation
- Supply chain (security)
- Pacing

Reliable Addition of Large Datacentric Loads (RALDL) Project Approach



Modifying the System

- Substations to serve load
- Local network upgrades
- Backbone grid strengthening (345 kV +)
- Generation **AND** Transfer capability
- Underpinning needs:
 - Supply chain
 - System outage windows
 - Permitting
 - Stakeholder support



Fastest path to reliable datacentric load growth is transparency — about magnitude, characteristics, constraints, and responsibilities. If Clear rules of engagement are needed to connect this load at scale without compromising the reliability foundation that supports it

Panel: Modeling and Studying Data Center Impact on Power Systems

Moderator – Patrick Harwood, Senior Engineer, NERC

Katelynn Vance, Ph.D.

Manager, Electric Transmission Planning & Strategic Initiatives
Dominion Energy

Eric Meier

Supervisor, Planning Model Administration
ERCOT

Jay Senthil, Ph.D.

Senior Key Expert
Siemens Industry, Inc.

Lakshmi Sundaresh, Ph.D.

Engineer

Electric Power Research Institute (EPRI)

Keynote NERC Registration: Doorway to Membership in the World's Largest Machine

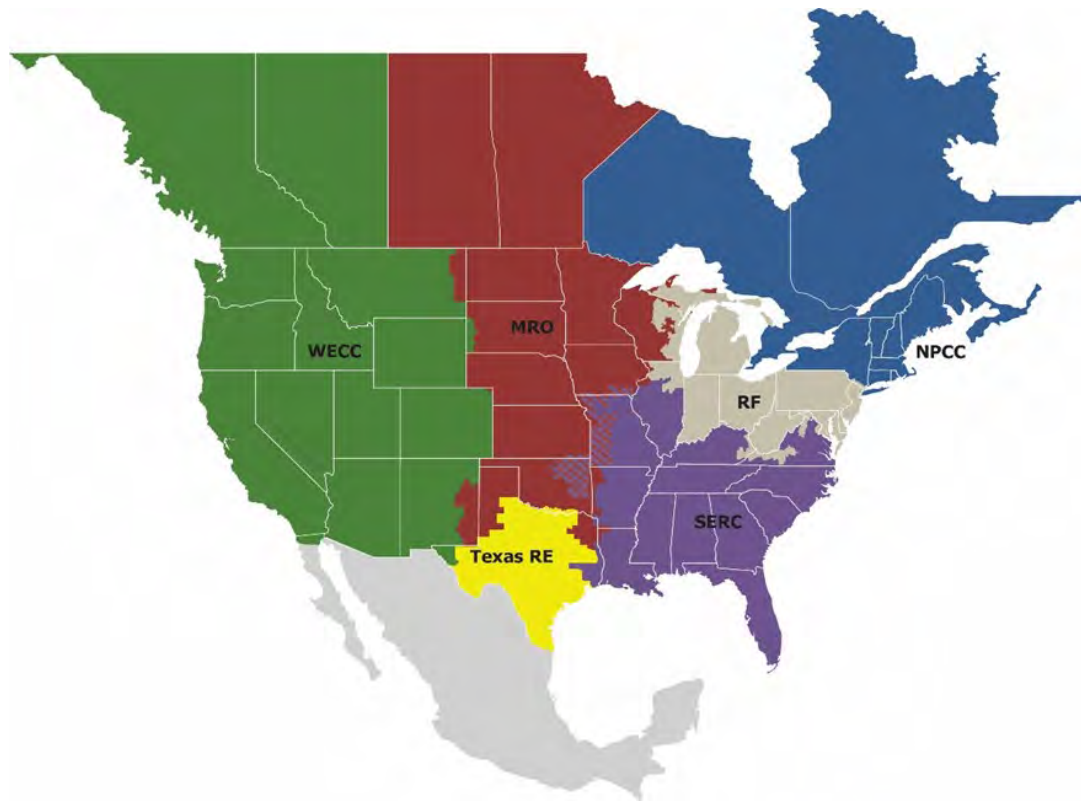


Howard Gugel, Senior Vice President, Regulatory Oversight

As the international multi-jurisdictional ERO, NERC is authorized

Monitor	Conduct	Certify	Maintain
<p>Monitor compliance with and enforcement of the NERC reliability standards of the Bulk Electric System (as subject to regulatory oversight and approval by FERC in the United States or applicable authorities in Canada.);</p>	<p>Conduct near-term and long-term assessments of the reliability and future adequacy of the North American bulk power system (BPS);</p>	<p>Certify BPS operators as having and maintaining the necessary knowledge and skills; and</p>	<p>Maintain situational awareness of events and conditions that may threaten reliability.</p>

The ERO Enterprise is comprised of NERC and the six Regional Entities



Midwest Reliability Organization (MRO)

Northeast Power Coordinating Council, Inc. (NPCC)

ReliabilityFirst (RF)

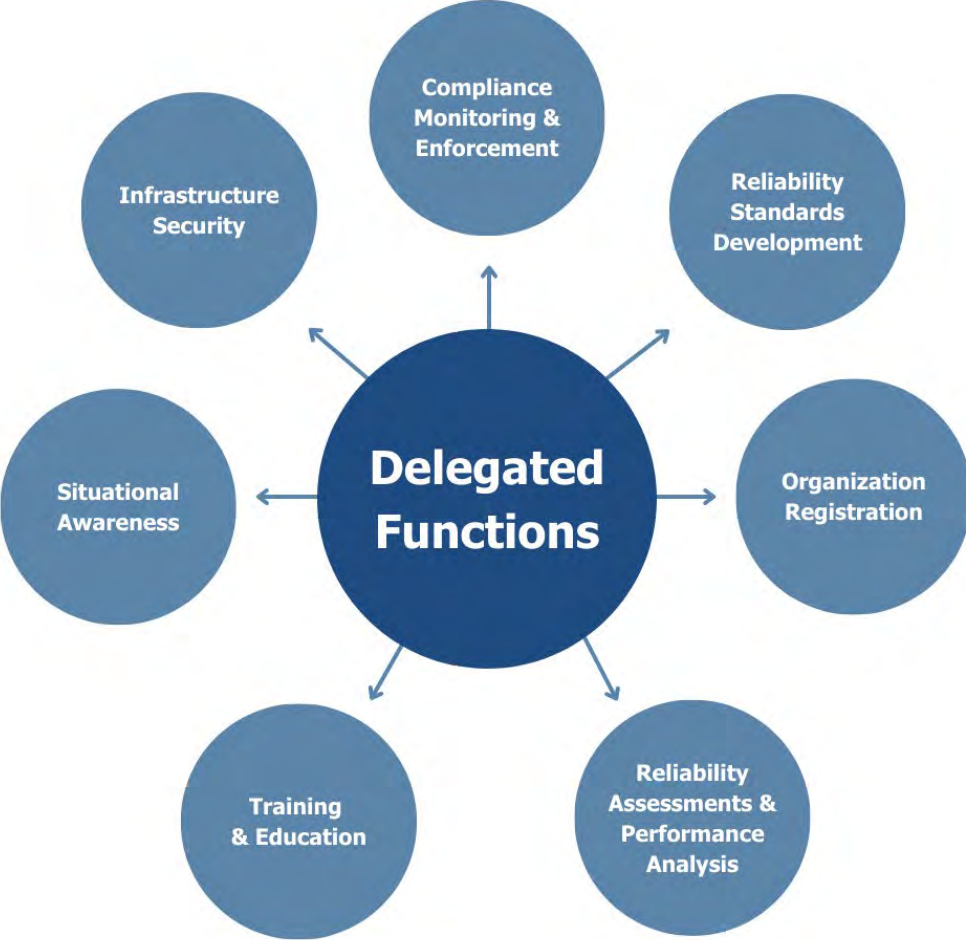
SERC Reliability Corporation (SERC)

Texas Reliability Entity, Inc. (Texas RE)

WECC

Regional Entities Support

- NERC provides delegated authority to the Regional Entities
- Regional consistency is key for transparency and predictability.





Registration



Standards



Compliance and
Enforcement

Registration

- Creates criteria that establishes whether NERC can register an entity
- Notifies entities they must follow applicable Reliability Standards
- Exceptions based on risk

Standards

- Specify who is supposed to perform an action
- Specify what they are required to do

Compliance and Enforcement

- Ensures registered entities comply with Reliability Standards
- Corrective actions
- Potential sanctions for violations based on risk

Why?

- Identify those impactful to reliability
- Notify those who must comply
- After registration, applicable Reliability Standards apply

Who?

- Criteria to be determined after workshop
- Exception process available

When?

- After criteria developed in NERC Rules of Procedure
- After approval by FERC in the United States

How?

- Day to day delegated to Regional Entities

Standards Framework



Mandatory and enforceable to Registered Entities



Reliability Standards define the reliability requirements for planning and operating the North American BPS



Requirements organized by topic areas (for example, transmission operations, transmission planning, coordination, communication, system protection, and cybersecurity, etc.)



Reflect a results-based approach that focuses on performance, risk management, and entity capabilities



Process includes opportunity for regional variances where necessary

Compliance Foundations

Compliance Monitoring and Enforcement Program (CMEP)

- Outlines compliance monitoring processes
- Provides guidance and requirements for each monitoring method

CMEP also addresses:

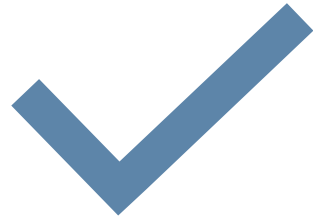
- Enforcement actions
- Mitigations of violations
- Remedial Action Directives
- Data retention and confidentiality

Compliance Tools

- Compliance Monitoring Methods
 - Compliance Audits
 - Self-Certifications
 - Spot Checks
 - Self-Reports
 - Periodic Data Submittals
 - Complaints
 - Compliance Investigations



Registration Benefits



For registered entity

- Clear delineation of responsibility
- Accurate representation
- Reliability of the world's largest machine
- Access to BPS alerts



For BPS/NERC

- Ensure reliability
- Standards compliance
- Increased data access
- Deeper collaboration

Preliminary Findings from the Level 2 NERC Alert

JP Skeath, NERC

About NERC Alerts

As part of its normal course of business, NERC often discovers, identifies, or is provided with information that is critical to ensuring the reliability of the bulk power system (BPS) in North America. To effectively disseminate this information, NERC utilizes email-based “alerts” designed to provide concise, actionable information to the industry, as defined in its Rules of Procedure, there are three levels of alerts.



Level 2 Alert Background

- Gives guidance on ensuring reliable integration of **Large Loads**
 - **Large Loads** as defined in the LLTF *White Paper Characteristics and Risks of Emerging Large Loads*
 - **Interconnection Requirements and Process**
 - **Planning Studies and Models**
 - **Operations**
- Aligned with LLWG Initial White Paper and LLAP
- To collect data and analyze conditions
 - Registered Entities are required to respond
 - Large Load owners and operators are encouraged to collaborate with their Transmission Owners



LLTF First White Paper: Prioritization of Risks

HIGH

Long-Term Planning

- Resource Adequacy

Operations/Balancing

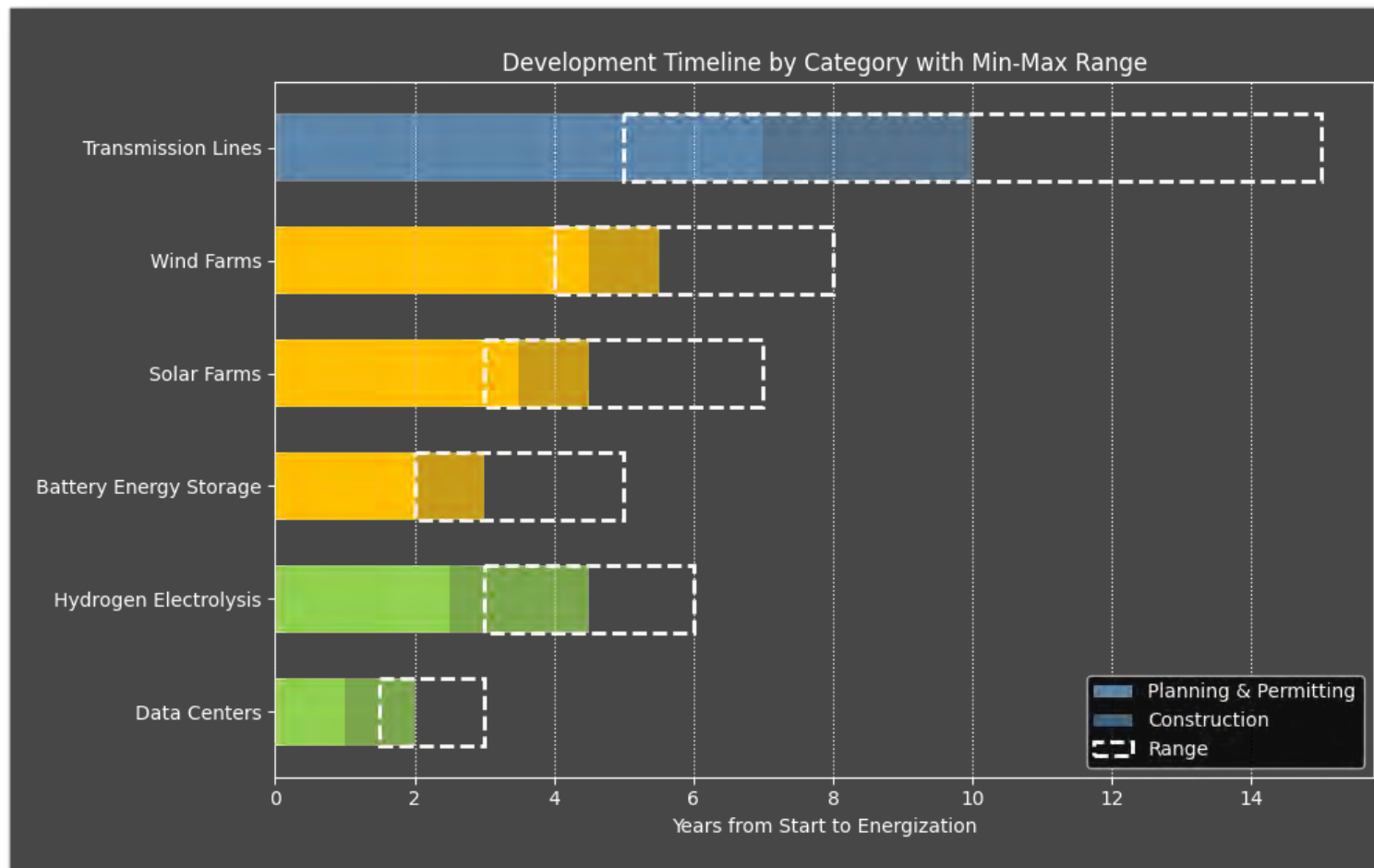
- Balancing and Reserves

Resilience

- Automatic UFLS Programs

Stability

- Dynamic Modeling
- Frequency Stability
- Oscillations
- Ride-through
- Voltage Stability



Sources:

https://www.2035report.com/wp-content/uploads/2024/04/GridLab_2035-Reconducting-Technical-Report.pdf

https://emp.lbl.gov/sites/default/files/2024-04/Queued%20Up%202024%20Edition_R2.pdf

LLTF First White Paper: Prioritization of Risks

HIGH

Long-Term Planning

- Resource Adequacy

Operations/Balancing

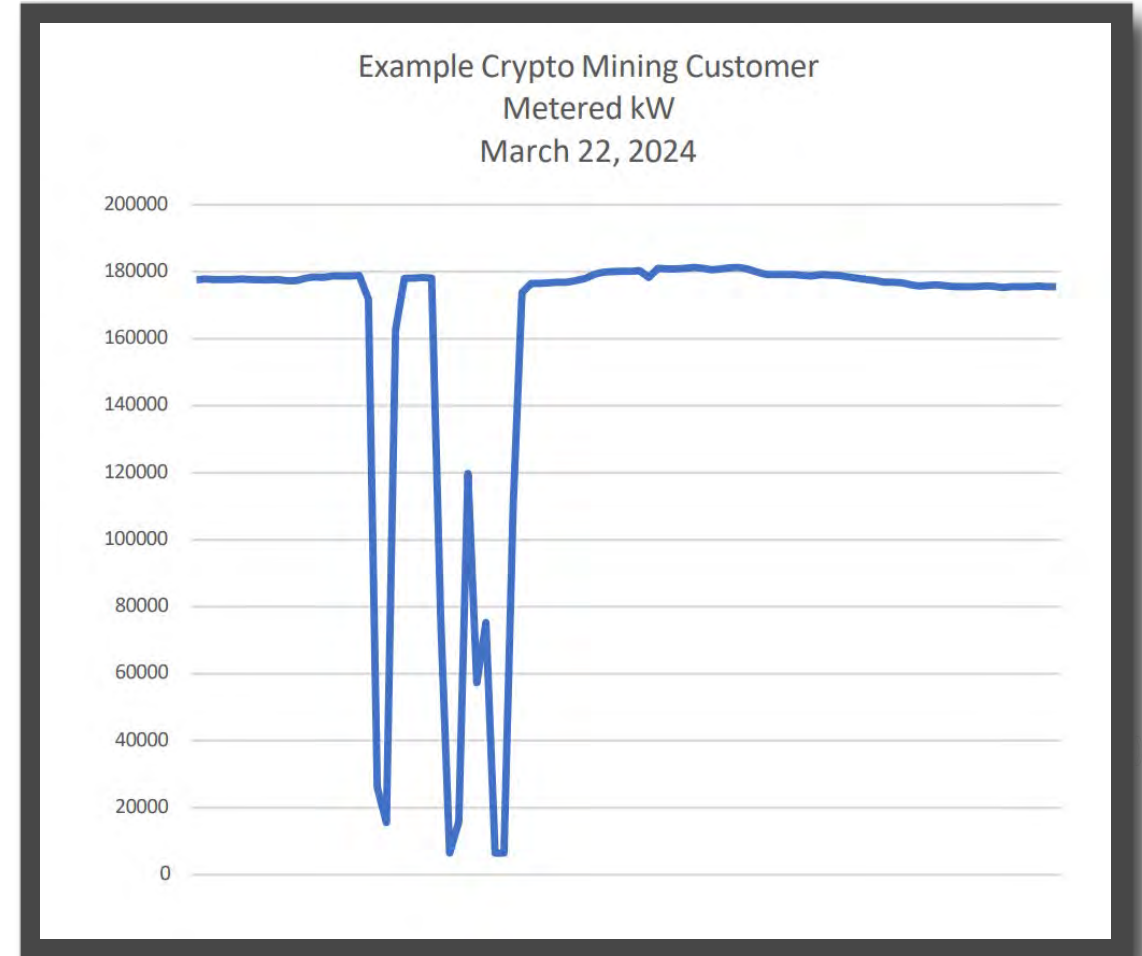
- Balancing and Reserves

Resilience

- Automatic UFLS Programs

Stability

- Dynamic Modeling
- Frequency Stability
- Oscillations
- Ride-through
- Voltage Stability



Source: AEP presentation on October 8, 2024, LLTF Kickoff Meeting:
https://www.nerc.com/comm/RSTC/LLTF/LLTF_Kickoff_Presentations.pdf

HIGH

Long-Term Planning

- Resource Adequacy

Operations/Balancing

- Balancing and Reserves

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- Automatic UFLS Programs

Stability

- Dynamic Modeling
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- Oscillations
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- Voltage Stability

PRC-006-5 — Automatic Underfrequency Load Shedding

A. Introduction

1. **Title:** Automatic Underfrequency Load Shedding
2. **Number:** PRC-006-5
3. **Purpose:** To establish design and documentation requirements for automatic underfrequency load shedding (UFLS) programs to arrest declining frequency, assist recovery of frequency following underfrequency events and provide last resort system preservation measures.

Source: <https://www.nerc.com/pa/Stand/Reliability%20Standards/PRC-006-5.pdf>

UFLS design assessment frequency: every 5 years

Emerging large load time to connection: <2 years

LLTF First White Paper: Prioritization of Risks

HIGH

Long-Term Planning

- Resource Adequacy

Operations/Balancing

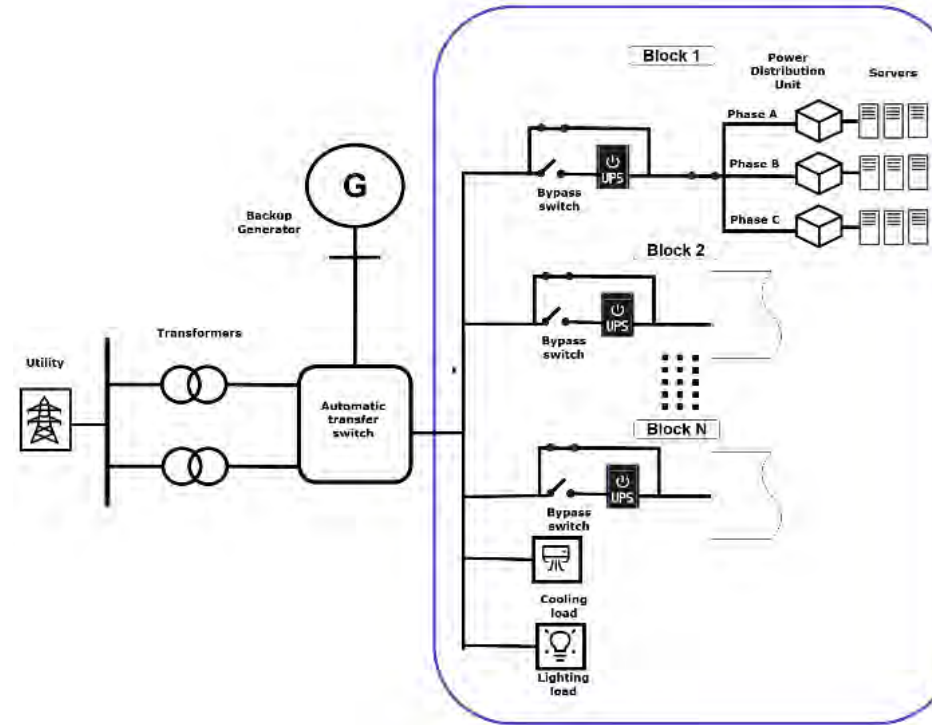
- Balancing and Reserves

Resilience

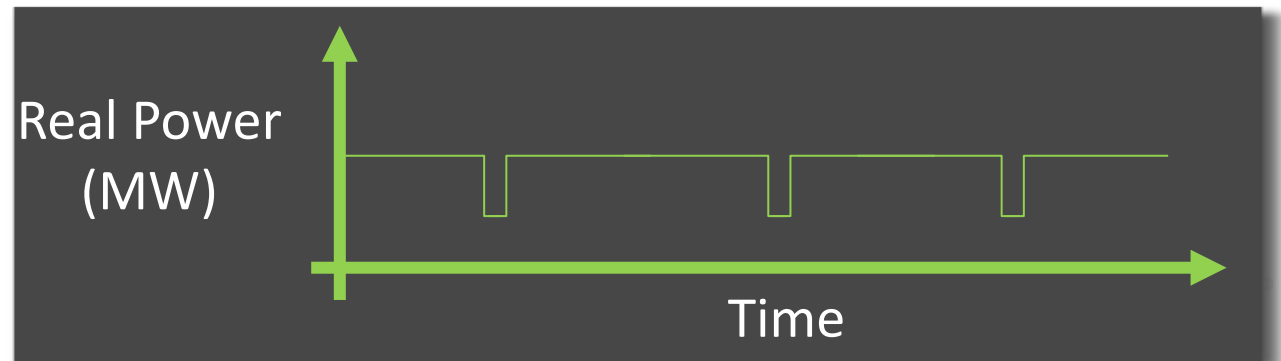
- Automatic UFLS Programs

Stability

- Dynamic Modeling
- Frequency Stability
- Oscillations
- Ride-through
- Voltage Stability



Source: EPRI



LLTF First White Paper: Prioritization of Risks

HIGH

Long-Term Planning

- Resource Adequacy

Operations/Balancing

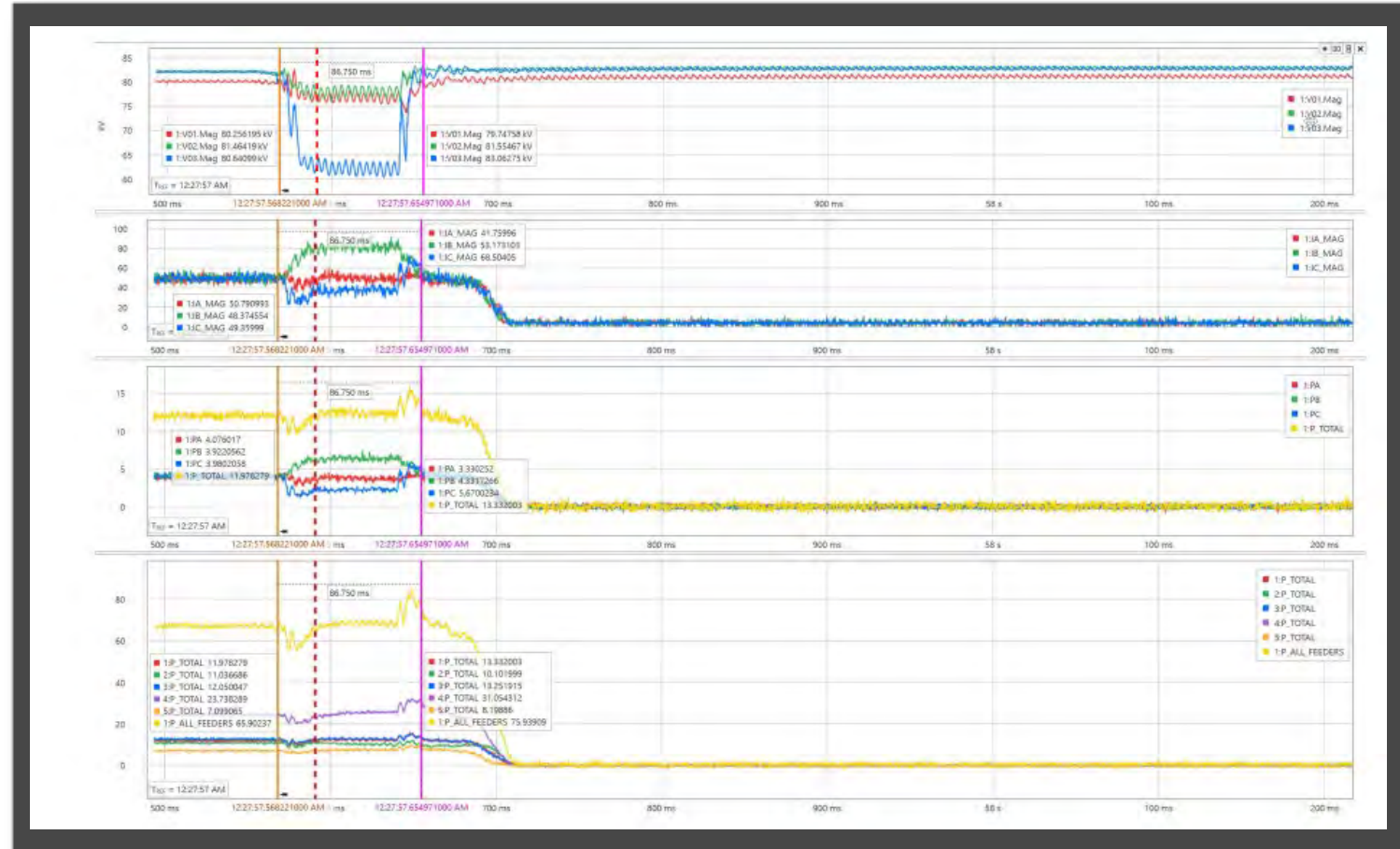
- Balancing and Reserves

Resilience

- Automatic UFLS Programs

Stability

- Dynamic Modeling
- Frequency Stability
- Oscillations
- Ride-through
- Voltage Stability



Source: AEP presentation in April 10, 2025 LLTF Meeting and Workshop:

https://www.nerc.com/comm/RSTC/LLTF/LLTF_April_Meeting_&_Technical_Workshop_Presentations_.pdf

Level 2 Alert Overview

- Issued September 9th, 2025
- 5 Industry Recommendations
 - Clear facility design and performance criteria
 - Interconnection and system-wide study process
 - Commissioning activities
 - Establish operating protocols
 - Inclusion into planning horizon Demand forecasts
- Additional worksheet for TOs and DPs
- Additional request for modeling files

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Industry Recommendation

Large Load Interconnection, Study, Commissioning, and Operations

Initial Distribution: September 9, 2025

The purpose of this alert is to address the risks observed from the analyzed large load behavior and to assess the status of industry preparedness in relation to large loads.

NERC, Regional Entities, and NERC registered entities have analyzed a series of disturbances that occurred on the bulk power system (BPS) resulting in widespread and unexpected customer-initiated load reduction of large loads. These disturbances involved multiple events during which 1,000+ MW of unexpected Large Loads output reduction occurred, with most events occurring in 2024 or 2025. The increase of Large Loads-related events coincides with an increase in Large Load penetration across the BPS.

To better understand the reliability impact(s) of emerging large loads on the BPS, NERC established the Large Loads Task Force (LLTF) in August 2024. In July 2025, NERC published a white paper titled *Characteristics and Risks of Emerging Large Loads*¹ that highlights characteristics of Large Loads such as rapid fluctuations in demand and cyclical ramping. That paper includes the following high-priority categories of risks: Long-Term Planning, Operations/Balancing, and Stability.

For this Alert, the term "Large Load" is consistent with the definition in the LLTF white paper referenced above:

Large Load - "Any commercial or industrial individual load facility or aggregation of load facilities at a single site behind one or more point(s) of interconnection that can pose reliability risks to the BPS due to its demand, operational characteristics, or other factors. Examples include, but are not limited to, data centers, cryptocurrency mining facilities, hydrogen electrolyzers, manufacturing facilities, and arc furnaces."

Rapid, major swings in load, experienced both in typical operations as well as in response to grid disturbances, can impact the BPS's ability to maintain frequency, regulate transmission voltage, and otherwise maintain stability. The comparatively large size, unique end-use operational characteristics, unique facility design, and unique operational performance of Large Loads necessitate enhancements to interconnection processes, BPS planning studies and models, validation of installed facility equipment, and operational communication with these customers. Accurate,

¹ "White Paper: Characteristics and Risks of Emerging Large Loads," NERC, Jul. 2025. Available: https://www.nerc.com/comm/BSTC_Reliability_Guidelines/Whitepaper%20Characteristics%20and%20Risks%20of%20Emerging%20Large%20Loads.pdf

RELIABILITY | RESILIENCE | SECURITY

Level 2 Alert Overview - Recommendation 1

- **Primary Actor(s)** – TOs, where relevant, DPs
- Consulting with TPs, PCs, RCs, TOPs, and BAs
- Model data, parameters, settings for studies
- Integrate operational requirements
- Include performance-based Disturbance recovery requirements
- Mitigate oscillations
- Monitoring and data capture
- Periodic review

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NORTH AMERICAN ELECTRIC
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RELIABILITY | RESILIENCE | SECURITY

Level 2 Alert Overview

Recommendation 2

- **Primary Actor(s)** – TPs and PCs
- Model data collection at interconnection
- Conduct periodic planning studies focusing on Large Loads
- Screening studies or process for when “special assessments” are needed (e.g., EMT)

Recommendation 3

- **Primary Actor(s)** – TOs
- Consult with RCs, TOPs, and BAs for commissioning practices
- Model verification and validation process during commissioning
- Performance validation process during operations

Level 2 Alert Overview

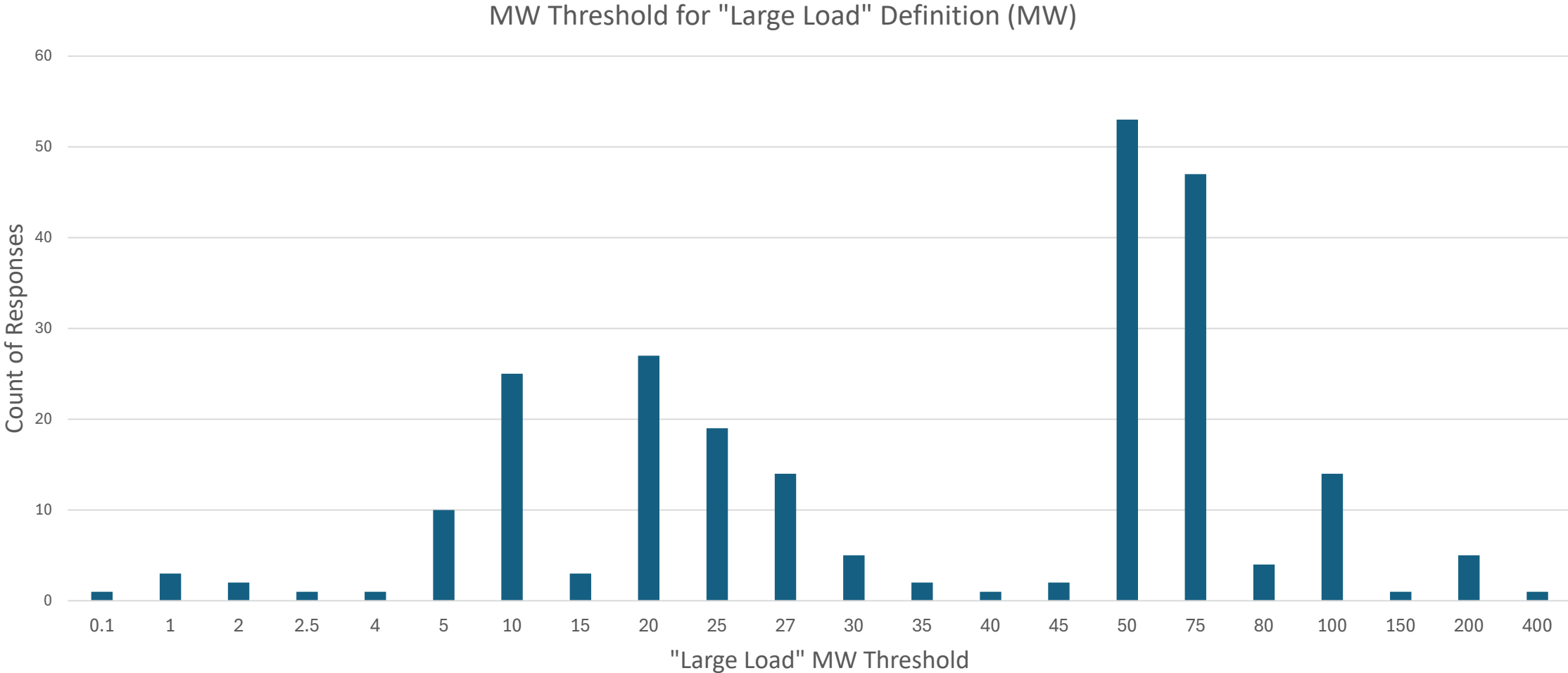
Recommendation 4

- **Primary Actor(s)** – TOs
- Establish necessary communication protocols with Large Loads
- Coordination post-Disturbance
- Collection of Disturbance recordings for event analysis
- Coordinate with TOPs to ensure situational awareness

Recommendation 5

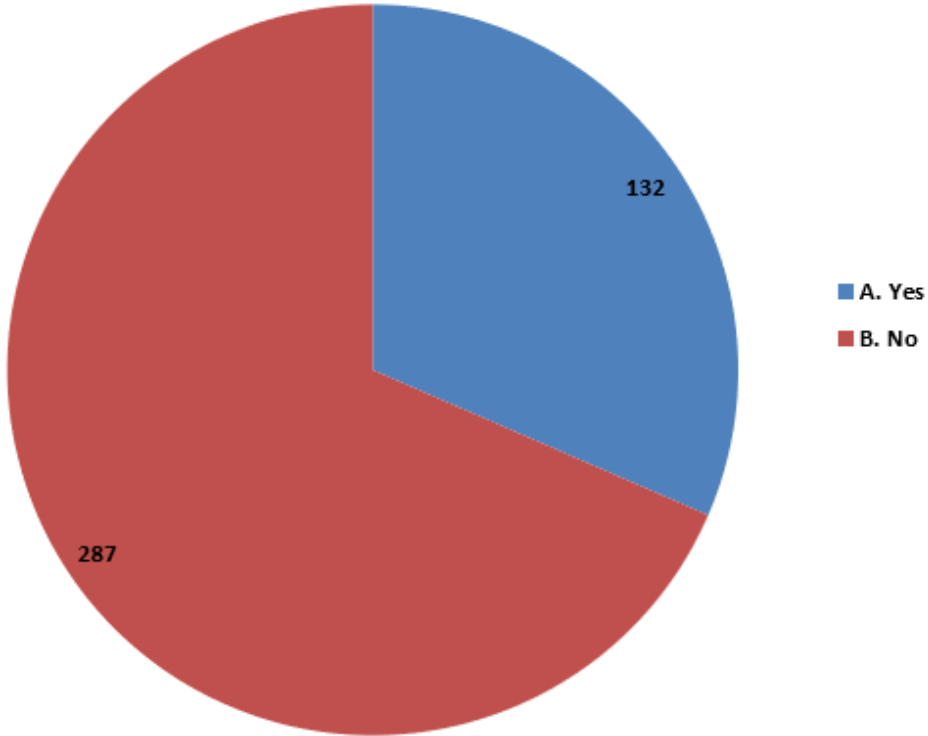
- **Primary Actor(s)** – TPs, RPs, and PCs
- Process for Near-Term Transmission Planning Horizon Demand forecast (1-5 years)
- Process for Long-Term Transmission Planning Horizon Demand forecast (5-10 years)

Preliminary Analysis Definitions



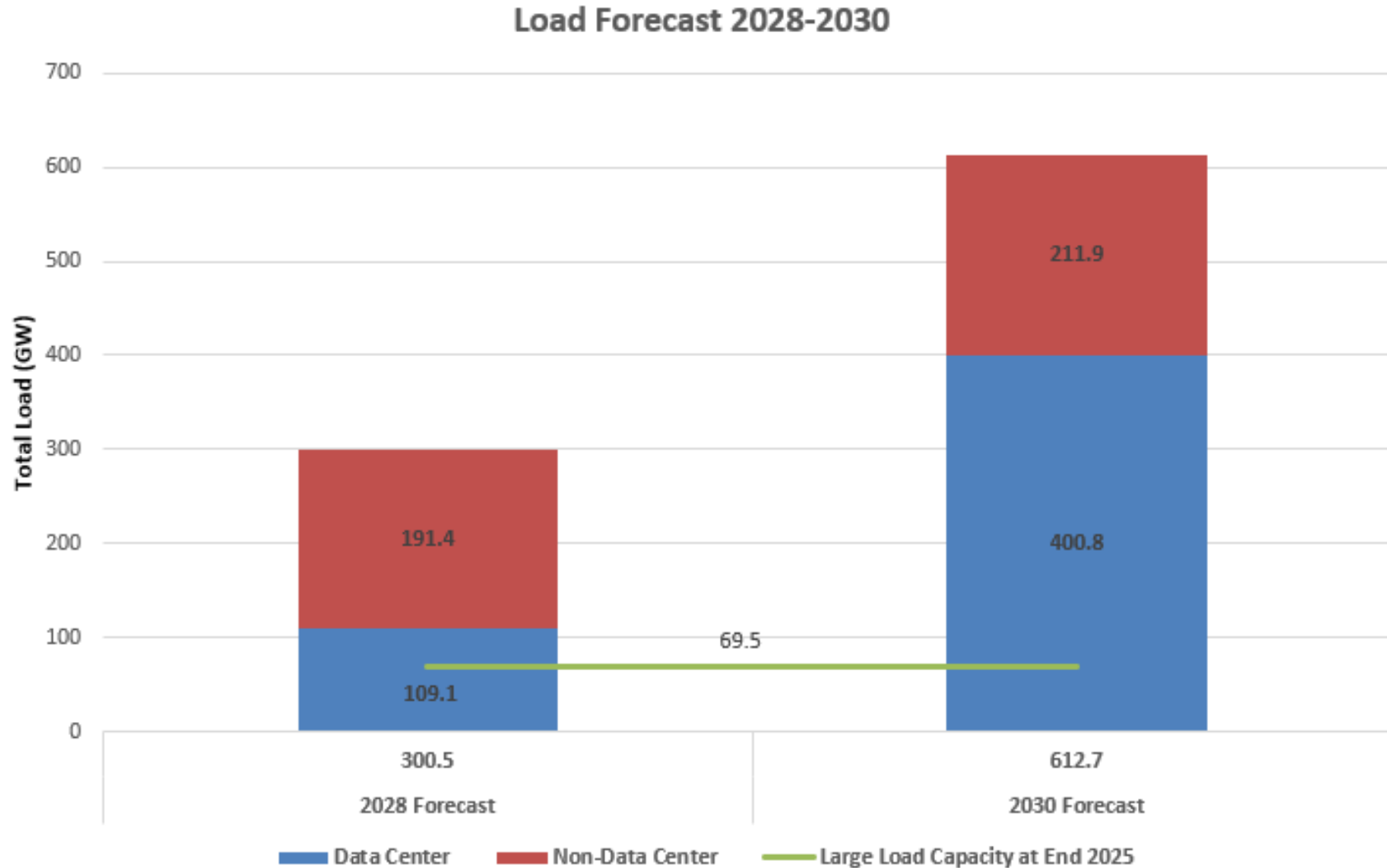
Preliminary Forecast Analysis

- Most entities don't have or expect to have Large Loads come onto their System
 - Some regional variance
- Entities that do have significant capacities



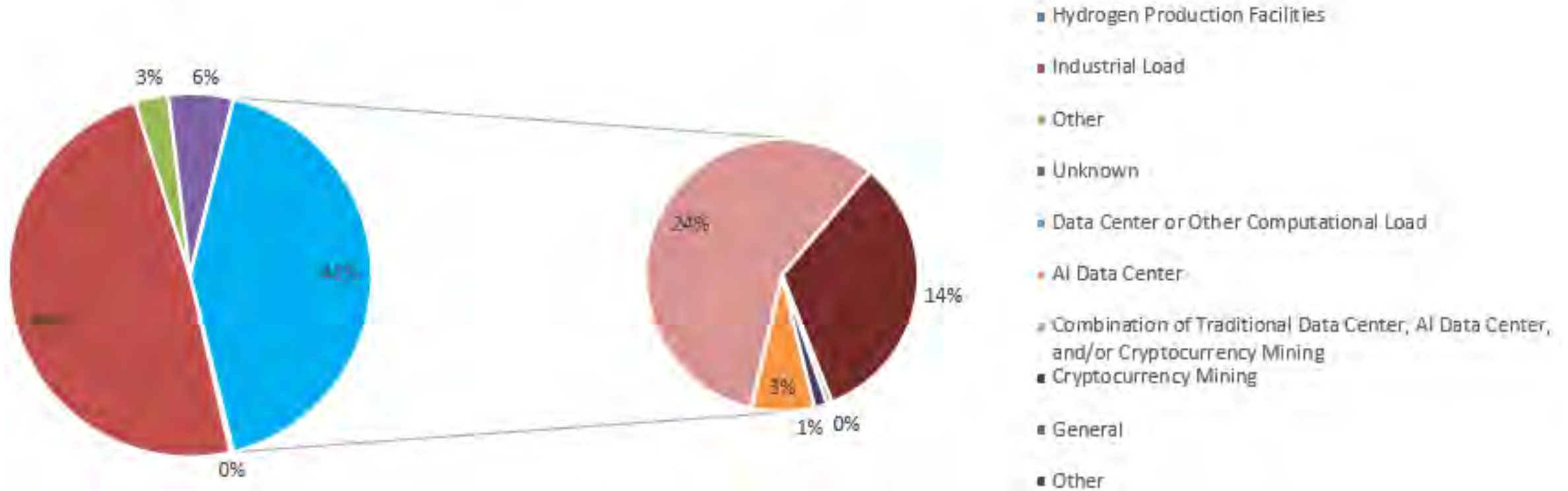
Answer	Total	Percentage	MRO	NPCC	RF	SERC	TRE	WECC
A. Yes	132	31.5%	31	5	26	27	14	29
B. No	287	68.5%	54	46	35	70	16	66
Total	419	100.0%	85	51	61	97	30	95

Preliminary Forecast Analysis



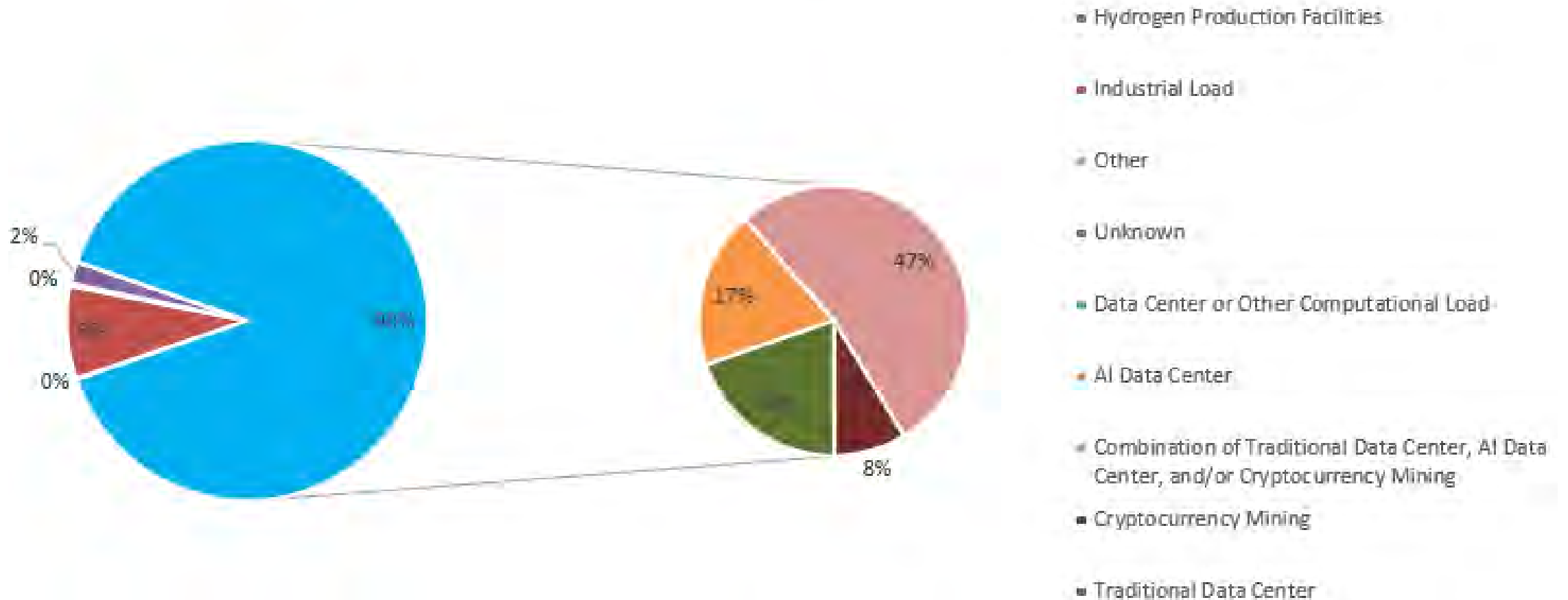
Preliminary Electrical Size Analysis - 2025

Composition of In-Service Large Load by Year End 2025



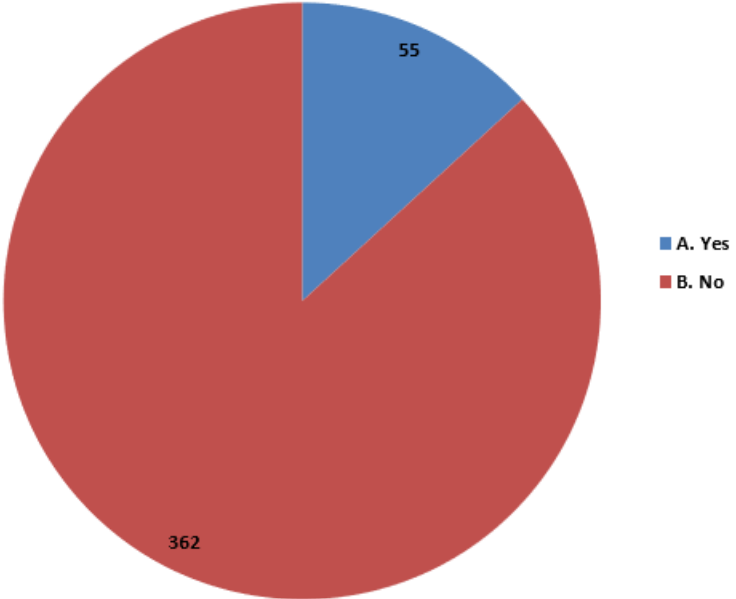
Preliminary Electrical Size Analysis - 2027

Composition of In-Service Large Load by Year End 2027



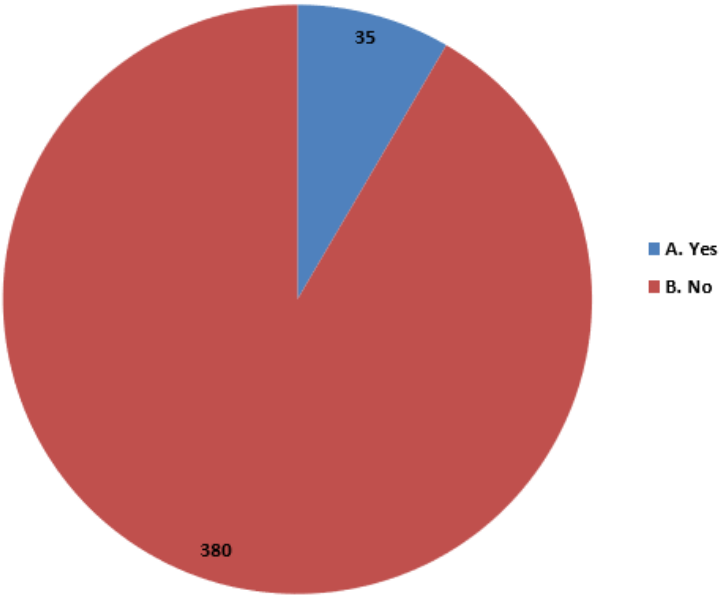
Preliminary Findings on Alert Responses

Clear Facility Performance Criteria



Answer	Total	Percentage	MRO	NPCC	RF	SERC	TRE	WECC
A. Yes	55	13.2%	8	1	13	13	9	11
B. No	362	86.8%	76	50	48	83	21	84
Total	417	100.0%	84	51	61	96	30	95

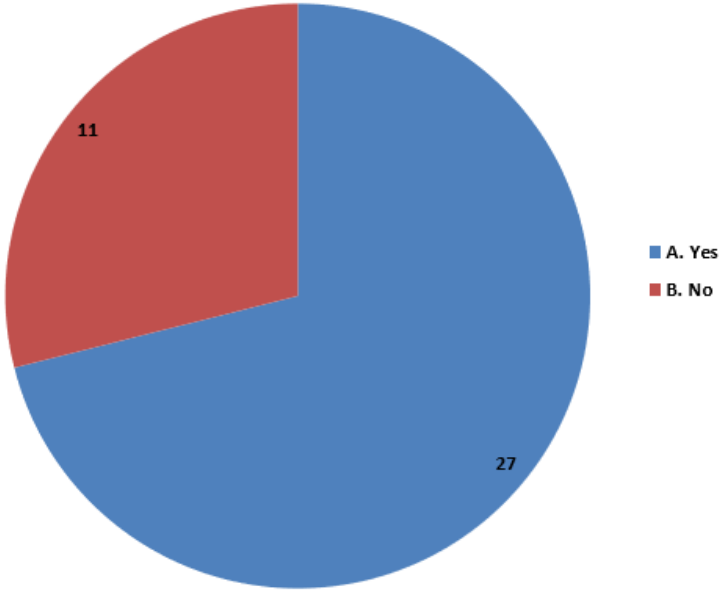
Commissioning Practice



Answer	Total	Percentage	MRO	NPCC	RF	SERC	TRE	WECC
A. Yes	35	8.4%	8	1	8	7	5	6
B. No	380	91.6%	76	50	52	89	25	88
Total	415	100.0%	84	51	60	96	30	94

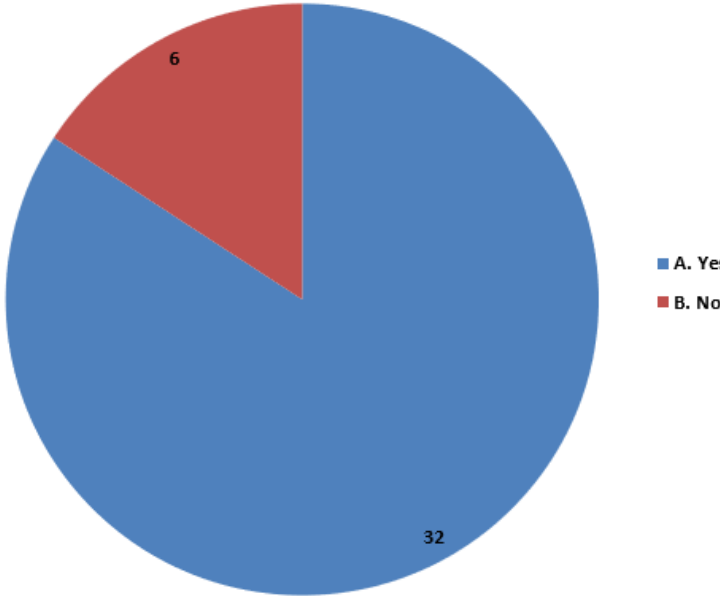
Preliminary Findings on Alert Responses

Update Model during Normal Operations



Answer	Total	Percentage	MRO	RF	SERC	TRE	WECC
A. Yes	27	71.1%	6	3	9	5	4
B. No	11	28.9%	4	2	2	1	2
Total	38	100.0%	10	5	11	6	6

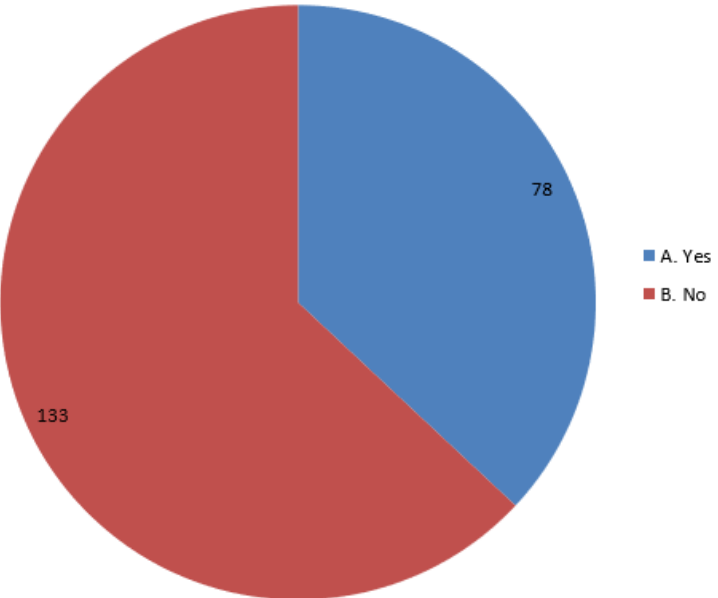
Update on Qualified Change



Answer	Total	Percentage	MRO	RF	SERC	TRE	WECC
A. Yes	32	84.2%	9	5	9	5	4
B. No	6	15.8%	1	0	2	1	2
Total	38	100.0%	10	5	11	6	6

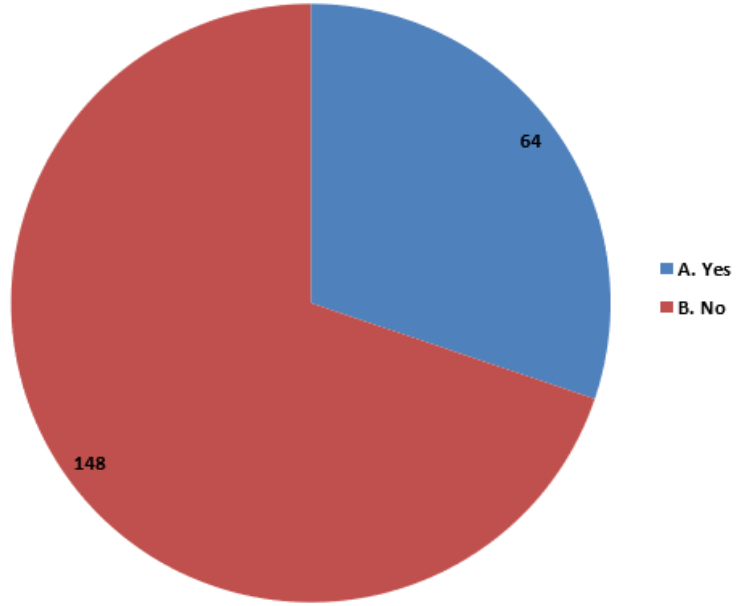
Preliminary Findings on Alert Responses

Contains Unknown Model Performance



Answer	Total	Percentage	MRO	NPCC	RF	SERC	TRE	WECC
A. Yes	78	37.0%	19	6	8	16	8	21
B. No	133	63.0%	27	10	6	28	18	44
Total	211	100.0%	46	16	14	44	26	65

System Studied using Steady-State Data



Answer	Total	Percentage	MRO	NPCC	RF	SERC	TRE	WECC
A. Yes	64	30.2%	14	5	6	14	14	11
B. No	148	69.8%	31	11	8	31	12	55
Total	212	100.0%	45	16	14	45	26	66

Preliminary Findings of Alert Responses - Open Text

- Many entities expressed that they did not or do not expect in the next two years to interconnect any large loads.
- Many entities highlighted concerns with the “theoretical” load that burdens their processes.
- Many entities stated that they defer to the independent system operator (ISO) or regional transmission organization (RTO) for additional work and implementation of the Alert Recommendations.
- Entities reiterated that they have limited experience with these loads.

Preliminary Key Findings

- Many entities at the time of this Alert do not have specific procedures to handle the unique challenges associated with large loads
 - Models
 - Commissioning Practices
 - Operational Readiness
 - Near-term and Long-term planning
- Many entities do not have a process to coordinate with TOs and DPs to establish protection coordination requirements for large loads.
- Many entities report waiting on or coordinating with a separate entity, primarily their ISO or RTO.

Immediate Next Steps for Addressing Emerging Large Load Reliability Risks

Soo Jin Kim, Vice President, Standards and Registration, NERC



NERC

Discussion