NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Agenda
NERC Quarterly Technical Session

August 14, 2024 | 2:45-5:15 p.m. Pacific

In-Person
Hyatt Regency Vancouver
655 Burrard St.
Vancouver, BC V6C 2R7, Canada

Conference Room: Regency A/B/C

Virtual Attendees
Webcast Link: Join Meeting
Webcast Password: Day108142024ATT (32910815 when dialing from a phone)
Audio Only: +1-415-655-0002 US Toll | +1-416-915-8942 Canada Toll | Access code: 2311 130 8233

Introductions and Opening Remarks

NERC Antitrust Compliance Guidelines

Agenda Items

1. **CISA Extreme Weather Outreach – Impacts to Transmission Systems* – Update**
2. **Real-Time System Operations Artificial Intelligence* – Update**
3. **System Performance – May 2024 Solar Storm* – Update**
4. **Interregional Transfer Capability Study Report* – Review**
5. **Closing Remarks and Conclude Session**

*Background materials included.

CISA Extreme Weather Outreach – Impacts to Transmission Systems

Action
Update

Summary
Recent experience has shown the impacts on the availability of current and evolving resource mix. Climate change driven weather patterns can have far reaching impacts on weather patterns, water availability and diversity, and environmental conditions. The ability to forecast these short and long-term impacts will help industry prepare for and harden their systems to provide higher levels of reliability and resilience. This presentation will focus on the changing climate and resulting weather patterns that can impact the reliable operation of the bulk power system.

Real-Time System Operations Artificial Intelligence

Action
Update

Background
While Artificial Intelligence (AI), Machine Learning (ML), and Data Science have been studied and developed for decades, recent major technological growth and public attention has ballooned. This has led to a tremendous amount of research and new solutions in the marketplace, affecting nearly every aspect of work and personal life. Innovations and discourse continue to evolve rapidly as excitement, investment, and research continue to branch into new areas.

Within the realm of real-time electric power operations, there is also the recognition of the increasing complexity and complicatedness of the bulk power system (BPS), as many aspects change, with several new use cases that stretch the assumptions of the system (e.g., increasing concerns around cyber aspects, excess solar back flowing onto the transmission system, significant load growth for electric vehicle charging, growing power requirements for AI/ML, mining, and other data center operations).

When this translates to control room operators working to manage the real-time realizability of the system, the amount of cognition, attention, vigilance, knowledge, and abstract reasoning required of those dedicated system operators continues to rise, which invariably leads many to consider new AI/ML solutions. Because the BPS is the most Complex Sociotechnical System on the planet (complex humans and complex systems with complex interactions between them), many considerations are necessary to minimize the risks to the system.

There are also several aspects of the intersection of electric power operations and AI/ML that the Real-Time System Operations Intelligence Whitepaper does not contemplate. For example, AI/ML technologies as a rapidly growing load on the BPS, or on the intersection of AI/ML and cloud technologies are outside the scope of this document.

The whitepaper is currently divided into several sections:

- An overview of the technologies currently within the “AI/ML” space and distinctions between the different types.
- An overview of the human factors associated with real-time control room operators working alongside these new technologies and the kinds of preparations that are needed to increase the probabilities of desirable outcomes.
- An overview of an anonymized survey and interviews from decision makers within the industry to provide a snapshot of the kinds of use cases and considerations these entities are investigating.
- An overview of AI/ML technologies and the roles they can play in real-time operations
- An overview of cybersecurity concerns that these emergent technologies bring to the reliable real-time operations of the BPS.

After an internal review the Whitepaper will be posted for a 45-day comment period for the ERO Enterprise and RSTC membership. The whitepaper is tentatively scheduled to be published on October 21, 2024.

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Real-Time System Operations Artificial Intelligence

Darrell Moore, Director, Situation Awareness and Personnel Certification
NERC Quarterly Technical Session
August 14, 2024

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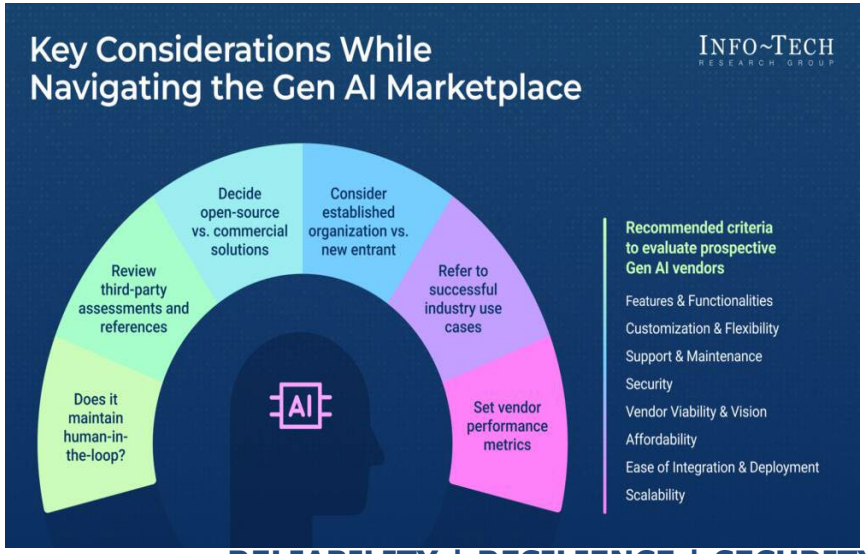
Whitepaper Outline

- Core materials – other references (e.g., DOE, NIST, DHS)
- Overview of AI/ML Technologies
- Human Factors in using AI/ML
- ERO Survey Results on AI/ML Technologies
- AI/ML in System Operations
- Cybersecurity Issues Related to AI/ML

Survey and Interview Results

- Significant “hype” around AI/ML, but often misunderstood
- Vendors
- Major challenges in the tools



Survey Results

- Many organizations contemplating or implementing policies and solutions across the industry
- Most implemented use cases

By Use Case

- The survey provided insight in some use cases that entities are engaged.
- Use varies across the industry, with particular focus on predicting.

Risk

- Ensure AI/ML Systems Designed with Humans in the Loop
- Vendor Transparency
- Outdated Models
- Confidentiality of Information
- Cybersecurity Understanding/Identifying Unique Risk Posed by AI
- Software Supply Chain Vulnerabilities
- Intellectual Property Rights
- Hallucinations

Core Recommendations

- Operators need time to review/monitor the applications of AI/ML systems on the BPS
- Expert/experienced operators need to continuously vet
- Advanced Training needed

Next Steps

Real-time Operations

Collaborate

Critical Tools & Training

Questions and Answers

System Performance – May 2024 Solar Storm

Action
Update

Background
During the weekend of May 10-12, 2024, earth experienced the largest geomagnetic disturbance (GMD) in over two decades when multiple coronal mass ejections from the sun passed earth's atmosphere. Extreme space weather like the May 2024 event can affect the reliable operation of electric grids by inducing quasi-dc currents in transmission lines that can degrade power transformer performance and cause system harmonics that interfere with relay, protection, and control functions. Over the past decade NERC and the industry have committed to initiatives that reduce the risks from GMD through reliability standards, research to support planning and operating tool development, and data collection.

The bulk power system (BPS) remained stable throughout the May 2024 GMD Event, though high levels of geomagnetically-induced currents (GIC) were observed across North America. NERC staff will provide a summary of the preparatory actions taken by BPS operators and the observed impacts from the GMD event. Staff will also provide an overview of the after-action review that NERC, industry, and research collaborators are conducting to support continued improvement to planning and operating tools for reducing risk to the BPS from severe GMD events.

Click here for: May 2024 GMD Event Review Plan
Click here for: NERC Rules of Procedure Section 1600 Data Collection Webpage for GMD Data

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System Performance-May 2024 Solar Storm

Darrell Moore, Director, Bulk Power System Awareness
Mark Olson, Manager, Reliability Assessment
NERC Quarterly Technical Session
August 14, 2024

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May 2024 GMD Event

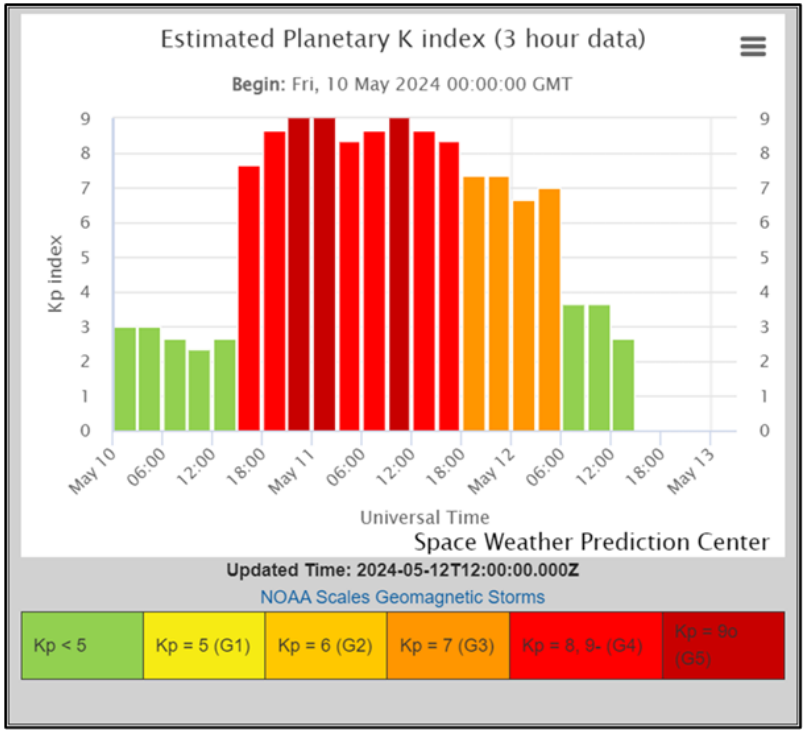
- From May 10-12 strongest geomagnetic disturbance (GMD) in over two decades
- Reliability Coordinators (RC) received early warning from the U.S. Space Weather Prediction Center (SWPC)
- The bulk power system (BPS) remained stable while some impacts were observed
- NERC and industry are collaborating on an after-action review

Geomagnetic Storms

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
G 5	Extreme	**Power systems:** Widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. **Spacecraft operations:** May experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. **Other systems:** Pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).	Kp = 9	4 per cycle (4 days per cycle)
G 4	Severe	**Power systems:** Possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. **Spacecraft operations:** May experience surface charging and tracking problems, corrections may be needed for orientation problems. **Other systems:** Induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).	Kp = 8, including a 9-	100 per cycle (60 days per cycle)
G 3	Strong	**Power systems:** Voltage corrections may be required, false alarms triggered on some protection devices. **Spacecraft operations:** Surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. **Other systems:** Intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).	Kp = 7	200 per cycle (130 days per cycle)
G 2	Moderate	**Power systems:** High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. **Spacecraft operations:** Corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. **Other systems:** HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).	Kp = 6	600 per cycle (360 days per cycle)
G 1	Minor	**Power systems:** Weak power grid fluctuations can occur. **Spacecraft operations:** Minor impact on satellite operations possible. **Other systems:** Migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).	Kp = 5	1700 per cycle (900 days per cycle)

Early Action

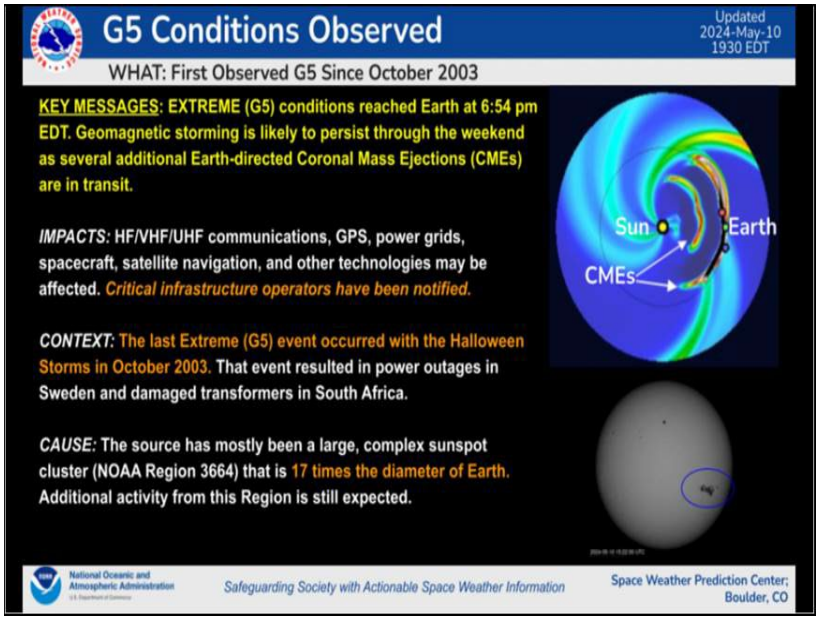
- SWPC initiated voice notification to RCs six hours prior to onset of GMD event using NERC hotline
- System operator actions:
  - Implementing GMD Operating Procedures and 'Conservative Operations' protocols
  - Scheduling additional generation
  - Cancellation of some transmission maintenance
  - Increased monitoring of system geomagnetically-induced currents (GICs) and system performance



The K index characterizes the magnitude of GMD events. SWPC alerts RCs prior to GMD events that are expected to be K7 and stronger

Summary of BPS Impact

- Operation of the interconnected transmission system largely unaffected
- Unites States Northeast, Mid-Atlantic, and Western Canada observing impacts to power system equipment
- Reports of limited GMD-related effects on the BPS:
  - Operator alarms for high GIC and temperatures at power transformers
  - Tripping of transmission lines and voltage support equipment
  - Voltage oscillations at some inverter-based resources



After Action Review

- Analyze event grid conditions to improve GMD tools and operating procedures
- Analyze NERC data collection systems and industry feedback
  - Impact of GIC on equipment
  - Validation of models used for GMD Vulnerability Assessments
  - Effectiveness of operating mitigations
- Collaborative industry and researchers review – early 2025

NERC Data Sources include GMD Data System, Transmission Availability Data System (TADS), and Generator Availability Data System (GADS)

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Questions and Answers

Interregional Transfer Capability Study (ITCS)

Action
Update

Background
Congress passed the Fiscal Responsibility Act of 2023[1], which included a provision for NERC to conduct a study on the reliable transfer of electric power between neighboring transmission planning areas. NERC, in consultation with the Regional Entities and industry stakeholders, is conducting transfer capability studies for regional transmission areas in the United States and recommend prudent additions to transfer capability needed for reliability.

Who: NERC, in consultation with each Regional Entity and each transmitting utility[2] in a neighboring transmission planning region.

What: A study of total transfer capability between transmission planning regions.[3] In accomplishing this work, the study should include:

1. "Current total transfer capability, between each pair of neighboring transmission planning regions."[4] [5]
2. "A recommendation of prudent additions to total transfer capability between each pair of neighboring transmission planning regions that would demonstrably strengthen reliability within and among such neighboring transmission planning regions"; and
3. "Recommendations to meet and maintain total transfer capability together with such recommended prudent additions to total transfer capability between each pair of neighboring transmission planning regions."

When: NERC must file the report with FERC within 18 months of enactment of the bill. Public comment period will occur when FERC publishes the study in the Federal Register. After submittal, FERC must provide a report to Congress within 12 months of closure of the public comment period with recommendations (if any) for statutory changes.

ERO study filing deadline: On or before December 2, 2024

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[1] H.R.3746 - 118th Congress (2023-2024): Fiscal Responsibility Act of 2023 | Congress.gov | Library of Congress

[2] "means an entity (including an entity described in section 201(f)) that owns, operates, or controls facilities used for the transmission of electric energy—(A) in interstate commerce; (B) for the sale of electric energy at wholesale." [FPA, Section 3(23)]

[3] (a) IN GENERAL.—The Electric Reliability Organization (as that term is defined in section 215(a)(2) of the Federal Power Act), in consultation with each regional entity (as that term is defined in section 215(a)(7) of such Act) and each transmitting utility (as that term is defined in section 3(23) of such Act) that has facilities interconnected with a transmitting utility in a neighboring transmission planning region, shall conduct a study of total transfer capability as defined in section 37.6(b)(1)(vi) of title 18, Code of Federal Regulations, between transmission planning regions that contains the following:" [1-3 bullets quoted above]

[4] **Total transfer capability** means the amount of electric power that can be moved or transferred reliably from one area to another area of the interconnected transmission systems by way of all transmission lines (or paths) between those areas under specified system conditions, or such definition as contained in Commission-approved Reliability Standards. [18 C.F.R. Section 37.6(b)(1)(vi)]

[5] **Neighboring transmission planning region**: implicitly means facilities connecting two adjacent systems or control areas.

Key Activities

- **Study Analysis**

  NERC's consultant for Part I "Transfer Capability Analysis" (PowerGem) has completed the transfer capability analysis for 2024 base-cases. A scope change was made to not only calculate the region-to-region transfer capability but also to calculate total simultaneous import capability into each transmission planning region. This scope change was necessary to ensure that in the Part II Prudent Additions analysis, the available transmission capability under heavy import conditions is accurately represented. The results are being reviewed by the study team for finalization. Concurrently, NERC's consultant for Part II Prudent Additions Analysis (Telos Energy) has been testing the model to run energy deficiency and prudent additions analysis which then will form the basis for recommending prudent additions to transfer capability. NERC and the Regional Entities are working to finalize the transfer capability analysis by July, 2024 and the prudent additions recommendations are expected to be finalized in September, 2024.

- **Study Reports**

  The Study Report drafts will be released in four volumes.

  1. ITCS Overview: This report provides a high-level overview of the study, the background, the approach and form foundational information for subsequent reports. The draft was published on June 27, 2024.
  2. Part I Transfer Capability: This report will cover the results from the transfer capability analysis. The report is expected to be released in August, 2024.
  3. Parts II and III Prudent Additions: This report will include recommendations of prudent additions to transfer capability as well as recommendations to meet and maintain prudent additions. The draft is expected to be ready by September, 2024.
  4. Canadian Analysis: A report covering the US to Canada exports analysis and inter-provincial analysis will be released in Q1 of 2025.

  The final submission to FERC will include reports 1-3 above and expected to be officially filed in with FERC in November, 2024.

- **Stakeholder Outreach**

  The ERO Enterprise (NERC and the Regional Entities) are executing a comprehensive stakeholder outreach plan to ensure that all North American transmitting utilities can provide input into the ITCS. Regional Entities are already working with their technical committees, which will continue throughout 2024. The study directive in Fiscal Responsibility Act requires that NERC perform the ITCS in consultation with all transmitting utilities that have facilities interconnected with a transmitting utility in a neighboring transmission planning region.
  NERC has been publishing quarterly project updates which have been posted to the NERC ITCS website.

  NERC issued a letter to all Transmission Owners, Transmission Operators, Transmission Planners and Planning Coordinators inviting them to participate in the ITCS and provide input. A future letter will be issued to the same entities in the Q3, 2024 informing them of the study progress and provide another opportunity to give input on the study.

Next Steps

The Advisory Group's next in-person meeting is scheduled for October 24, 2024 in Washington, DC. The meeting will allow for more in-depth discussion on topics including the analysis results. The Advisory Group meets remotely every month as per the schedule set throughout the lifecycle of the project.

The completion of the ITCS Framework and scoping documents for Part I and Part II of ITCS marks the end of Phase 0: Study Preparation. Phase 1: Analysis began in the first quarter of 2024 and is scheduled to be completed in August, 2024.

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Interregional Transfer Capability Study

John Moura, Director, Reliability Assessment and Performance Analysis

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August 14, 2024

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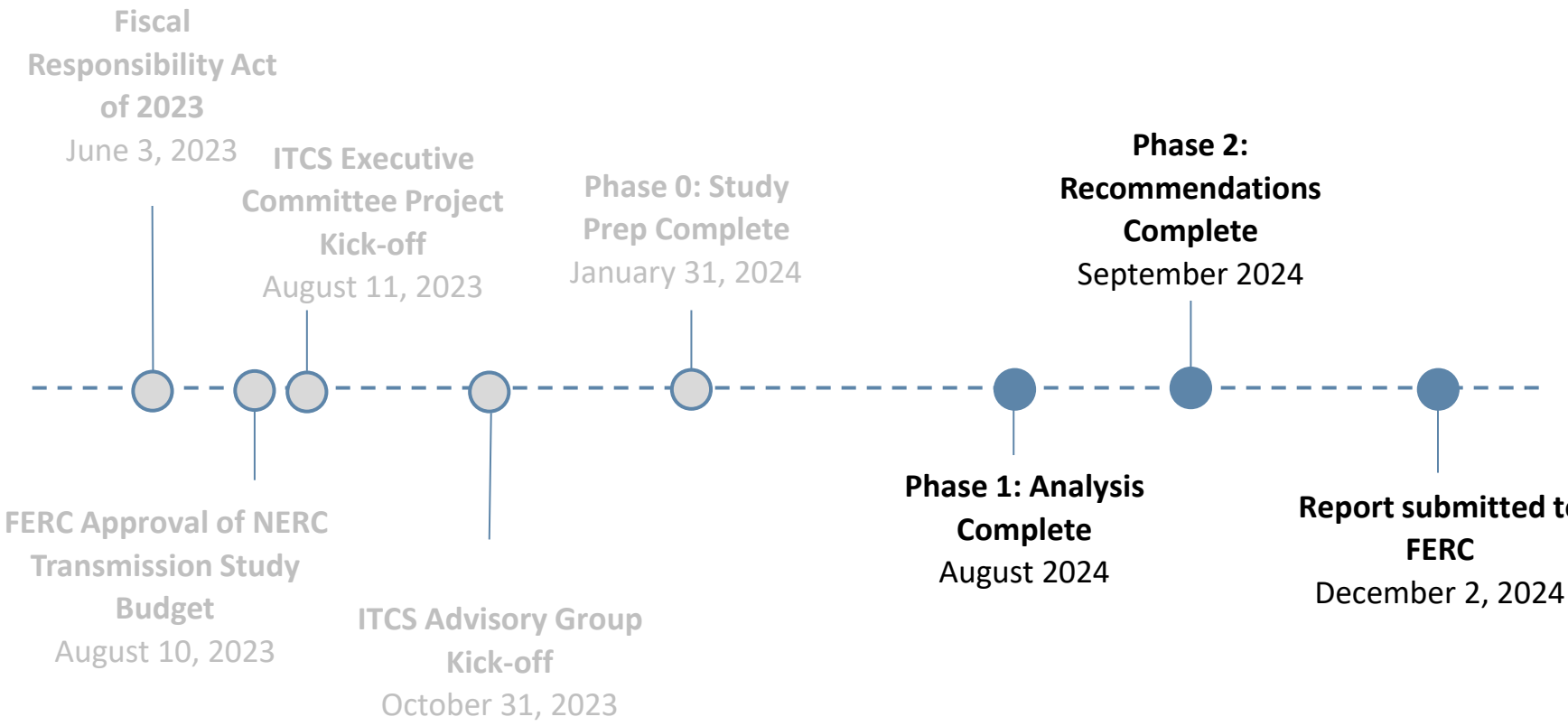
FRA of 2023: Required Study Elements

Fiscal Responsibility Act (FRA), Section 322

In consultation with the Regional Entities and transmitting utilities, NERC shall conduct a study containing three elements:

1. **Current total transfer capability,** between each pair of neighboring transmission planning regions.
2. A recommendation of **prudent additions to total transfer capability** between each pair of neighboring transmission planning regions that would demonstrably strengthen reliability within and among such neighboring transmission planning regions.
3. Recommendations on **how to meet and maintain the identified total transfer capability,** together with the prudent recommended additions in #2.

ITCS Timeline Overview



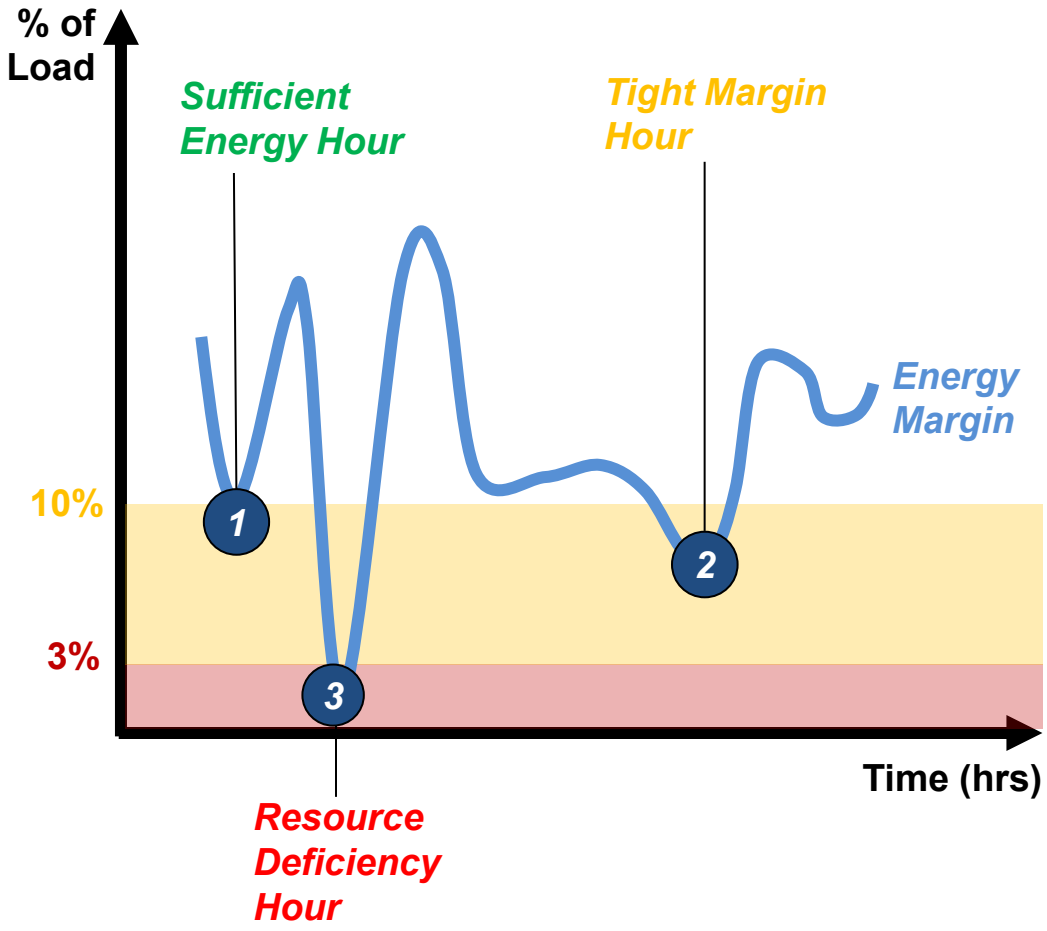
Transfer Capability Calculation Challenges

- FRA 2023 required region-to-region transfer capability
- Had to calculate simultaneous import capability
- Transfer capability is not always a single constant number
- Need more data models developed for future studies

Transfer Capability

Six-Step Prudent Addition Process

- Identify
- Quantify
- Prioritize
- Allocate
- Iterate
- Finalize



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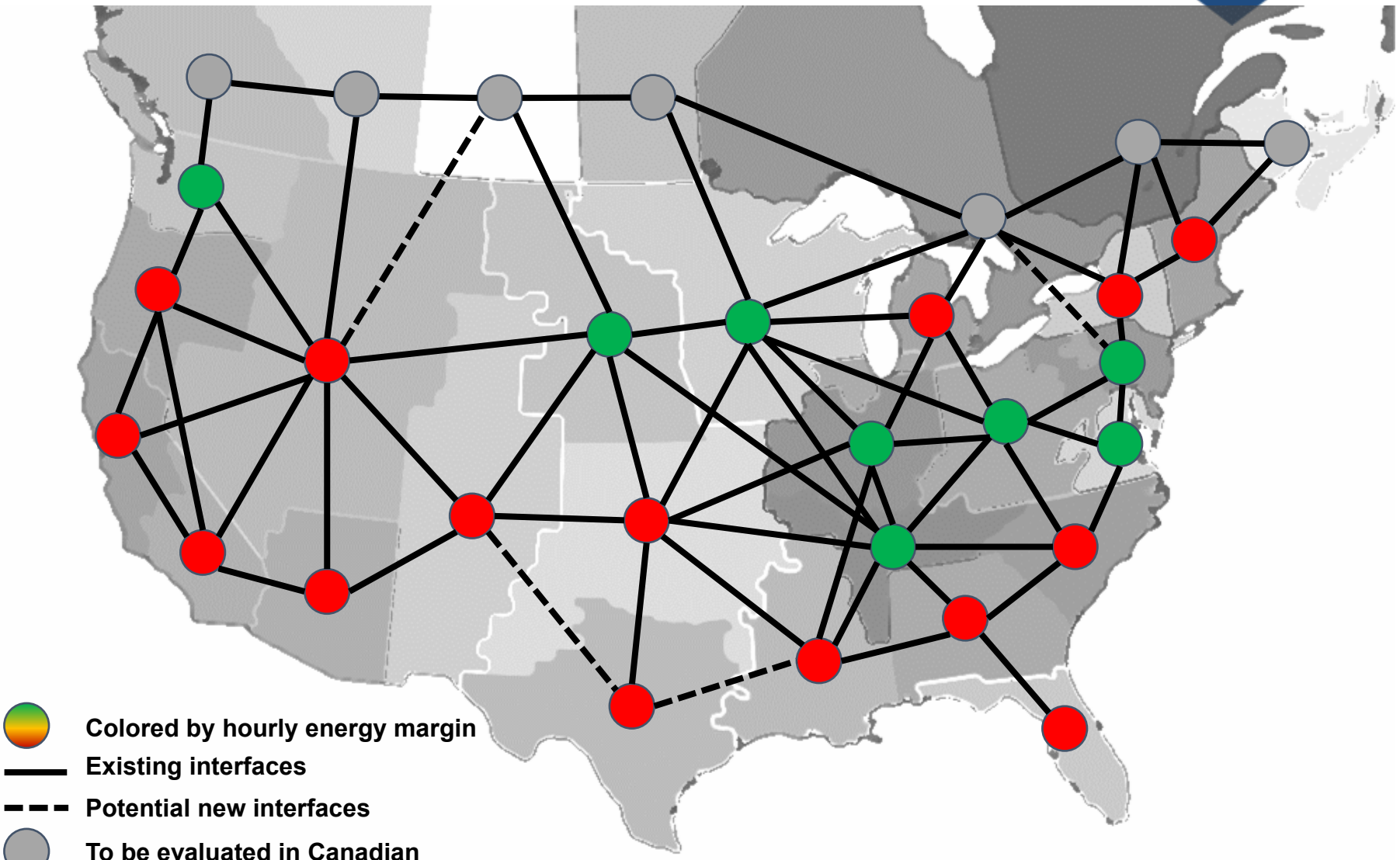
Potential Areas for increased transfer capability evaluation (Preliminary)



- Colored by hourly energy margin
- Existing interfaces
- Potential new interfaces
- To be evaluated in Canadian analysis

Part 3 Scope: Meet and Maintain

- Mandate calls for: “Recommendations to meet and maintain total transfer capability together with such recommended prudent additions to total transfer capability...”
- Measures and general actions:

Additional Analyses

Capital and Infrastructure

Grid Enhancement Technologies

Market and Regulatory

Resource Additions

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ITCS and Other Studies

	ITCS	DOE Needs Study	ESIG
Study Criteria	Reliability	Reliability, Economics, Policy	Interregional Transfer Capability % of load
Study Horizon	2024 and 2033	2030, 2035, 2040	Late 2020s
Study Regions	US and Canada (sub-divided FERC Order 1000 and other planning regions)	Roughly aligned to FERC Order 1000 regions where applicable	FERC Order 1000 regions
Resources	Existing and planned resources	Existing, planned and capacity expansion	NREL data
Transmission	Existing and planned transmission	Existing, planned and capacity expansion	Based on historical flows
Interregional Transfer Capability	Calculated	Statistical analysis of results from several studies	Based on historical flows + fixed additions

Questions and Answers

NERC Bulk Power System Awareness Update

Action
Update

Background
NERC's Bulk Power System Awareness (BPSA) group acquires and disseminates timely, accurate, and complete information regarding the current status of the bulk power system (BPS) and threats to its reliable operation, to enable the ERO Enterprise to effectively assure the reliability of the BPS. During major system disturbances, extreme weather, fires, hurricanes, physical events, and geomagnetic disturbances, etc. the BPSA facilitates effective communications between the ERO Enterprise, industry, and government stakeholders.

NERC BPSA, in collaboration with the E-ISAC and the ERO Enterprise Situation Awareness teams, maintains a near real-time situation awareness of conditions on the BPS. Notifies the Industry of significant BPS events that have occurred in one area, and which have the potential to impact reliability in other areas. Maintains and strengthens high-level communications, coordination, and cooperation with governments and government agencies regarding real-time conditions.

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Bulk Power System Awareness

Situational Awareness Q3 2024

Darrell Moore, Director Situation Awareness and Personnel Certification/Credential Maintenance, NERC

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August 14, 2024

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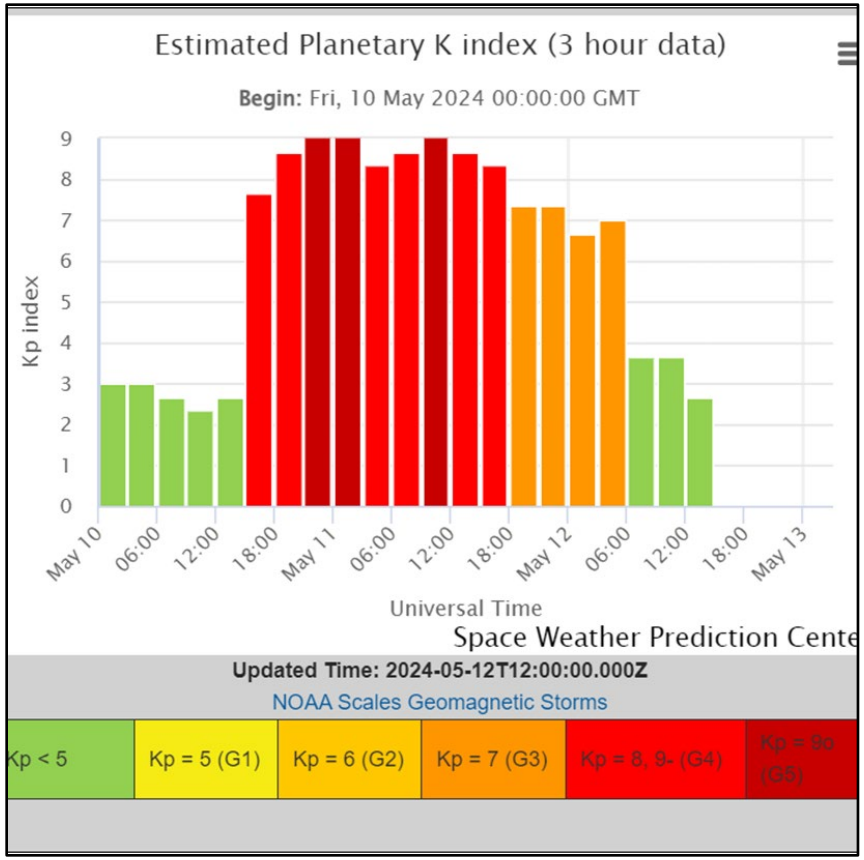
2024 Q2 Overview

- There were several Notable Weather Events
  - Geomagnetic Storm throughout weekend of May 10
  - Sever thunderstorms struck Houston, Texas on Thursday, May 16
  - Hurricane Beryl impacts Texas, July 7

Geomagnetic Storm

- Reliability Coordinators (RC) closely followed space weather conditions and vigilantly monitoring bulk power system (BPS) facilities.
- Operators postured the system to ensure reliability.
- Minor impacts were observed in northern areas.
- The NOAA Space Weather Prediction Center (SWPC) initiated multiple RC Hotline Telephone calls to keep system operators informed of conditions.

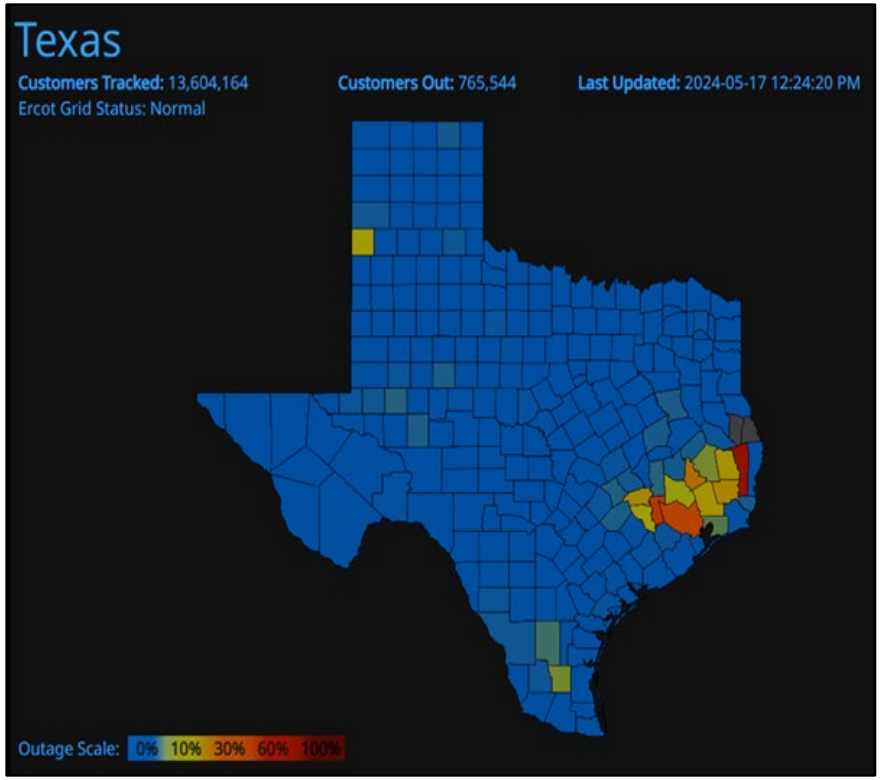
The BPS remained stable and largely unaffected in the presence of a strong to extreme geomagnetic storm throughout the weekend of May 10.



Houston Thunderstorms

- Approximately 4,100 MW of load was lost between 6:00 and 7:00 p.m. Central.
- Many transmission and distribution circuits were damaged.
- Texas distribution outages peaked at 1.05M.
- Louisiana distribution outages peaked at 218k.
- Restoration continued though Wednesday, May 22.

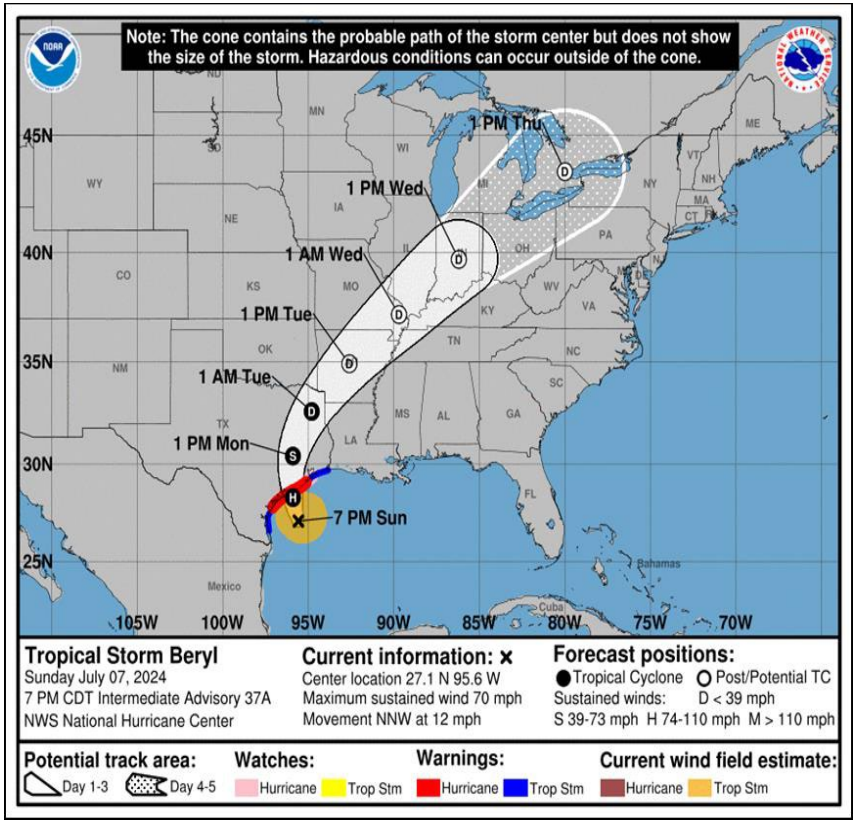
The BPS remained stable as severe thunderstorms traversed Houston, Texas on Thursday, May 16.



Hurricane Beryl

- Approximately 2.8M distribution customers were with power at the height of the storm. Most of the outages 2M in CenterPoint Energy (Houston TX).
- Entities postered their systems in response to tropical storm Beryl.
- Entities issued operating condition notices, conservative operations, and severe weather alerts.
- South Texas Nuclear Generation Station (STP) units remained online during the storm.

The BPS remained stable as tropical storm Beryl re-intensified to a Category 1 hurricane on July 8th



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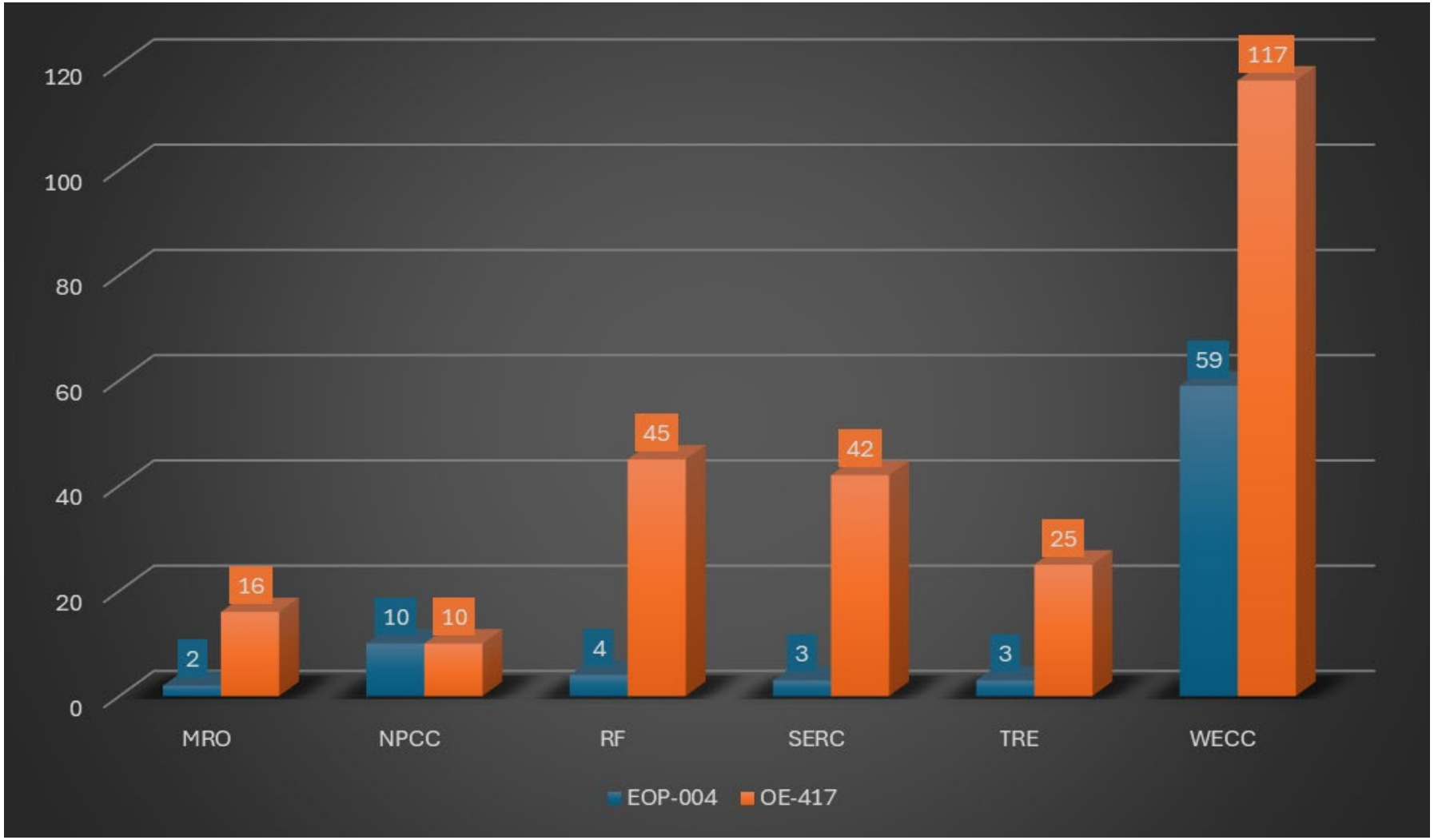
2024 YTD Mandatory Reports by Region



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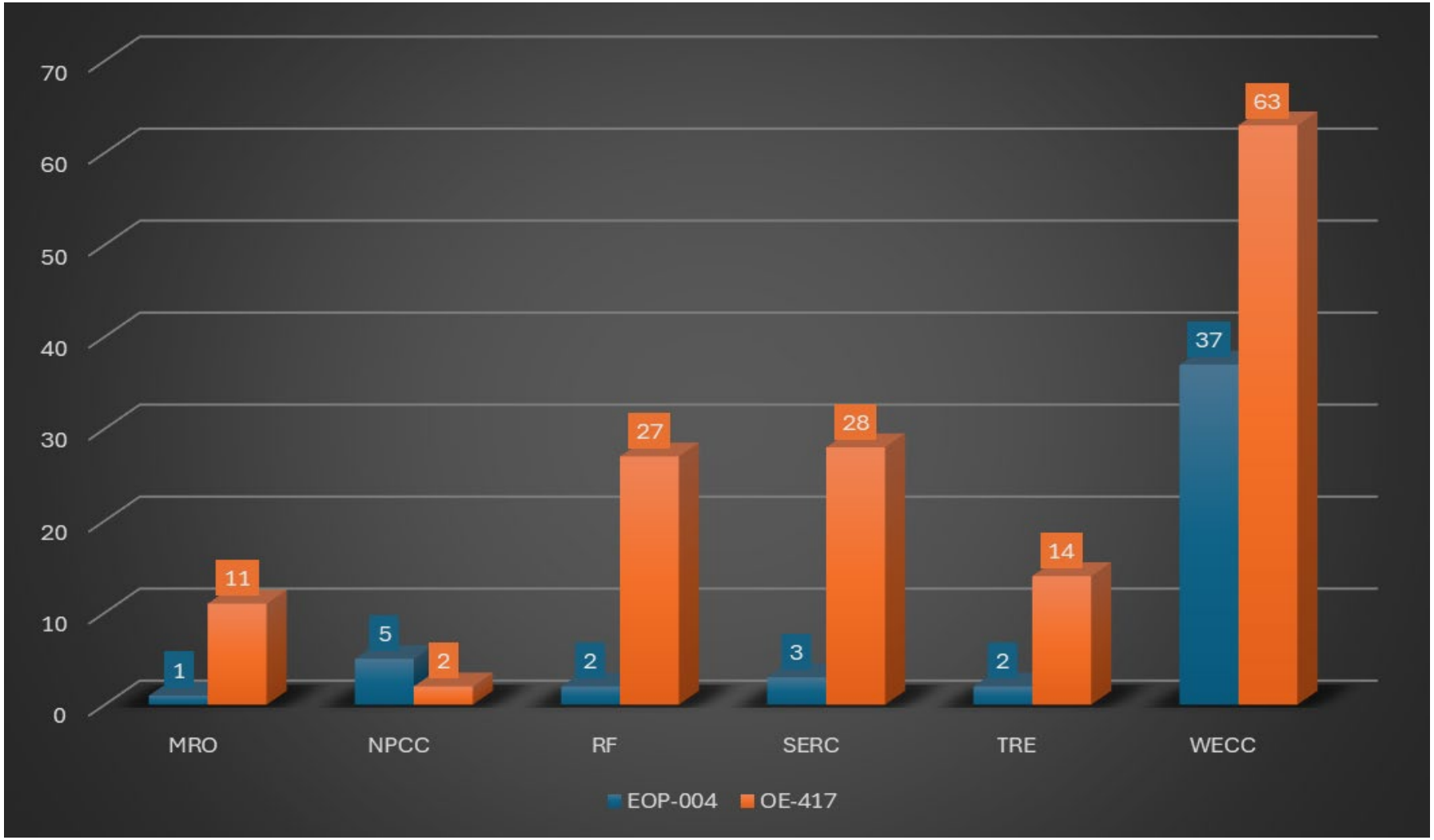
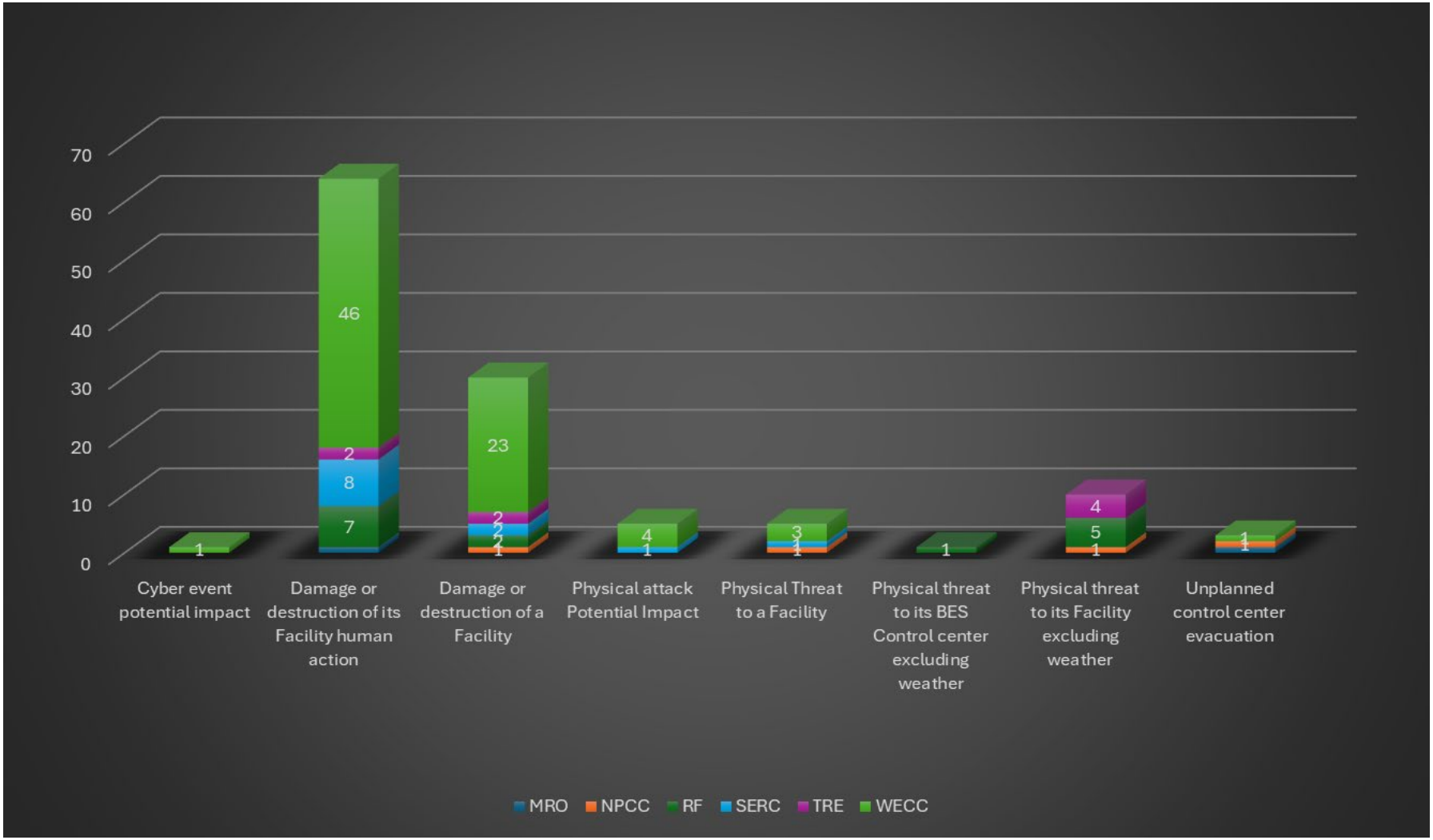
2024 Q2 Mandatory Reports by Region



2024 Q2 Cyber and Physical Security Reports by Region



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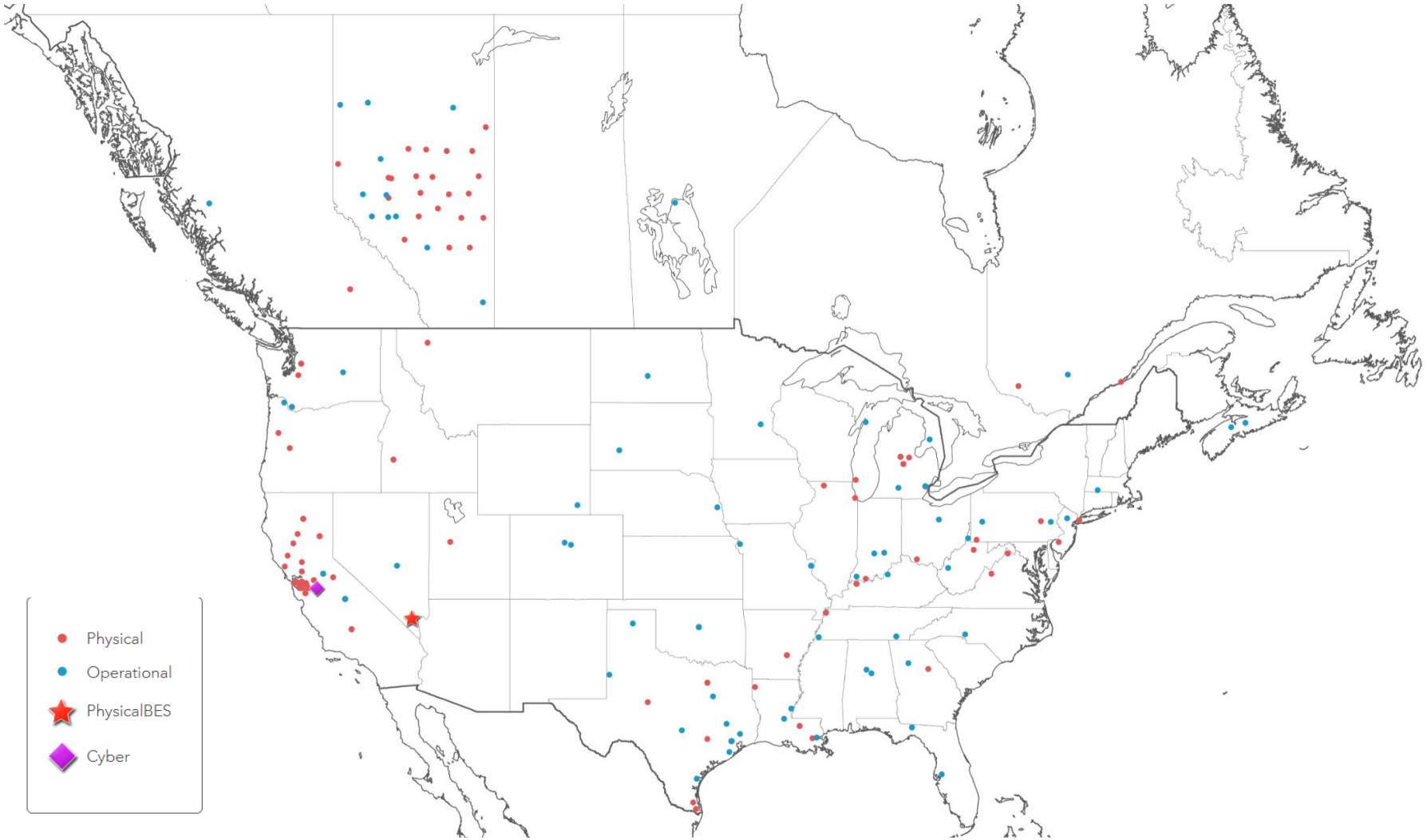
2024 Q2 Events
United States and Canada



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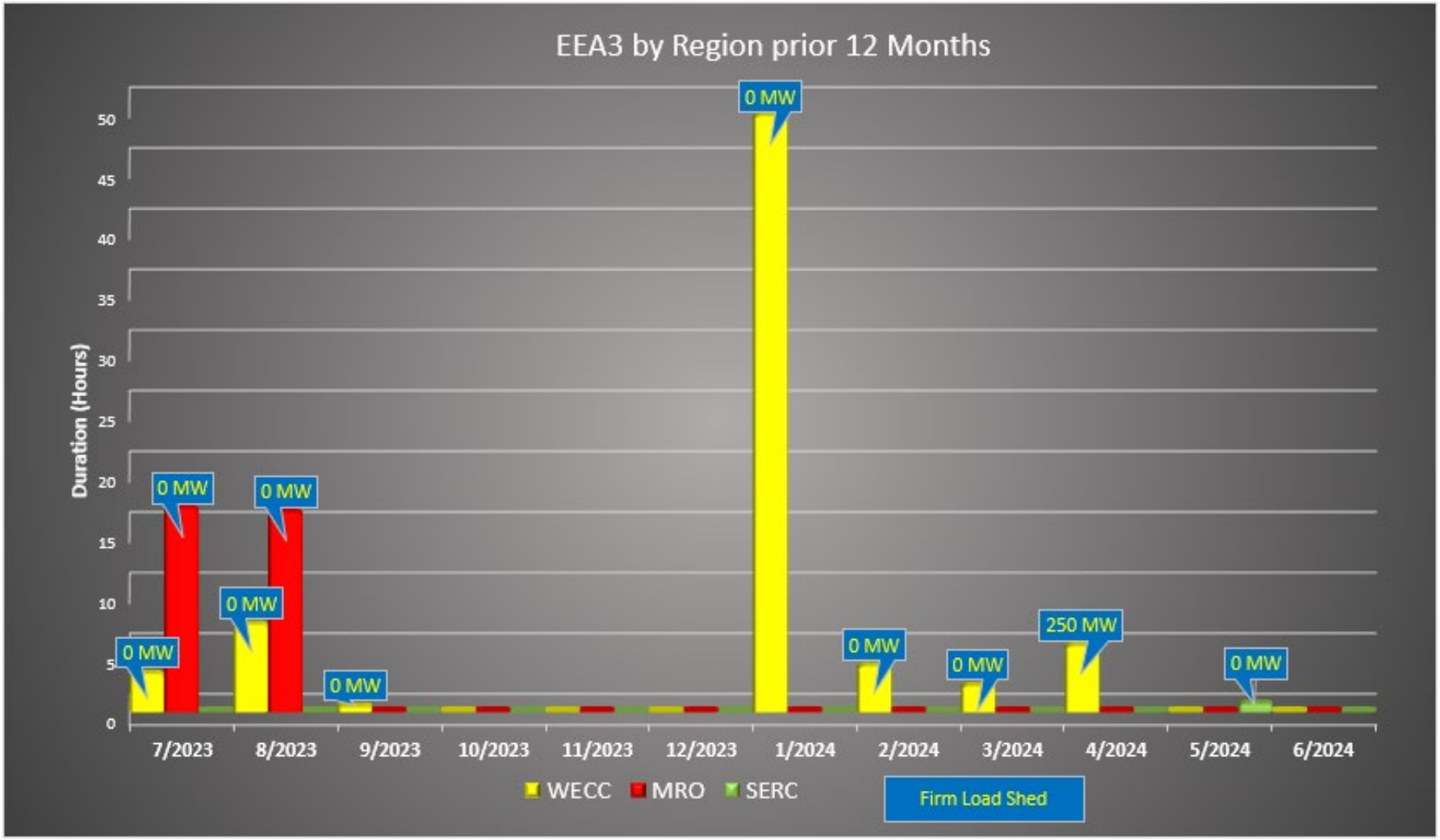
Energy Emergency Alert (EEA) 3 Reports 12 Month View



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Questions and Answers