WECC

BESS Events in the West

March 14, 2025

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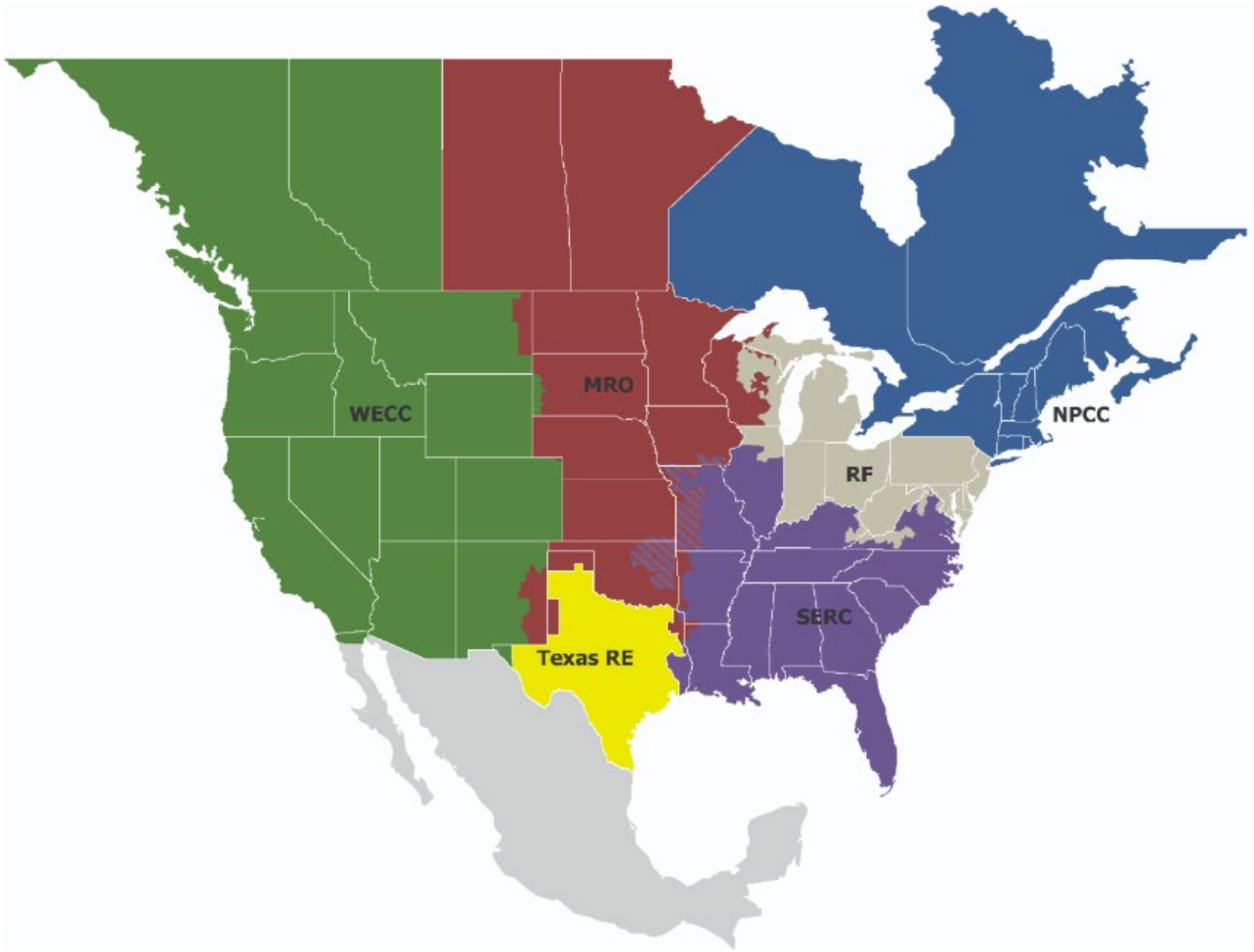
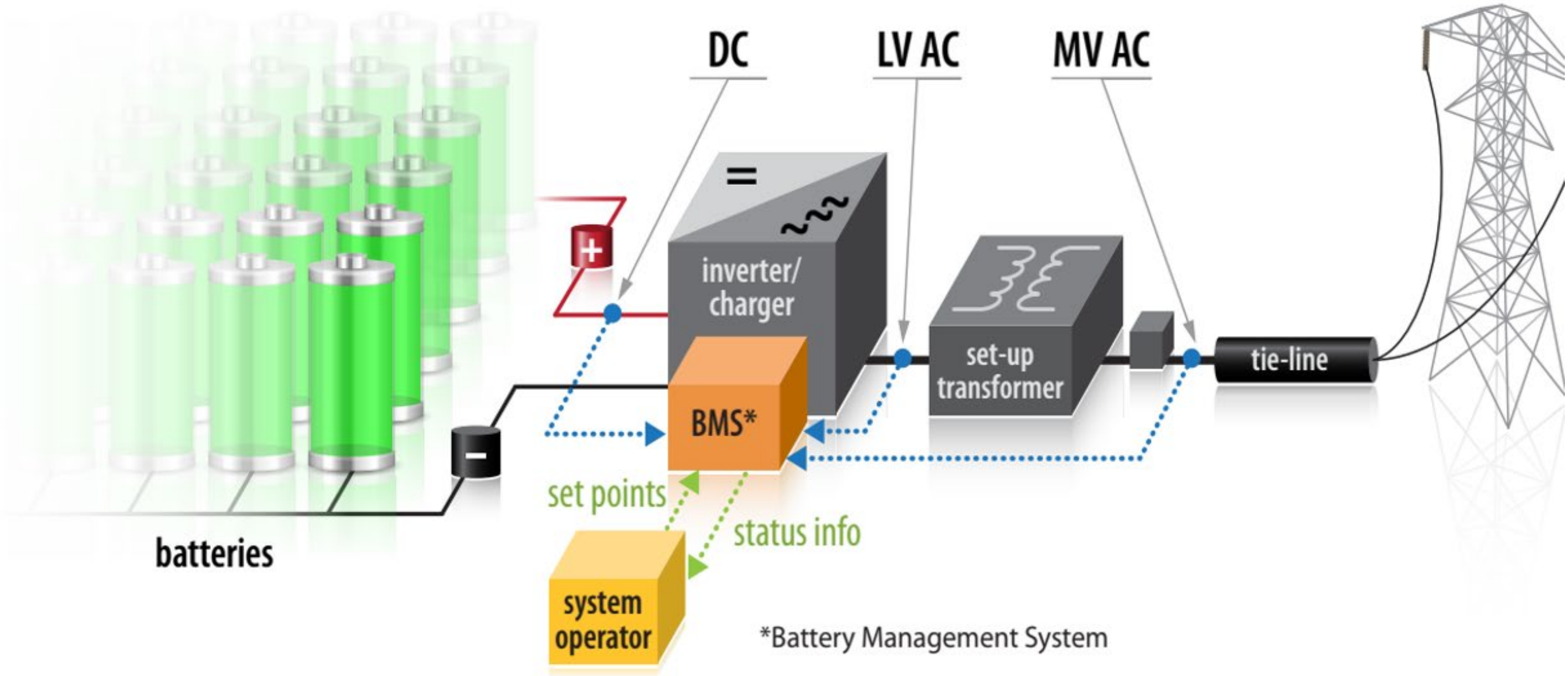
NERC Regional Entities



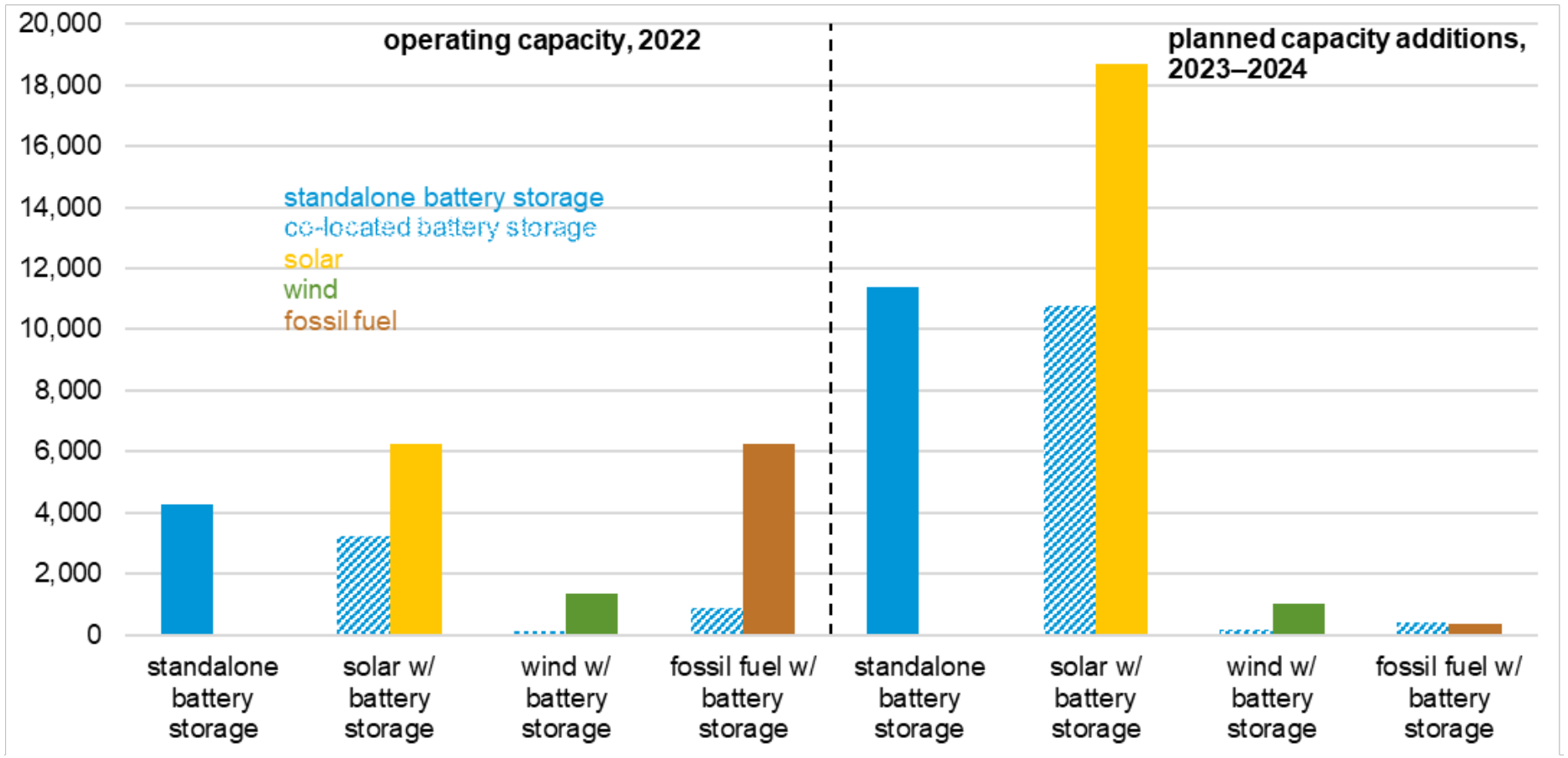
Electric Storage Resource

The Federal Energy Regulatory Commission's (FERC) regulations define an electric storage resource as "a resource capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid."



Key components of BESS interconnected at the transmission substation level. LV AC represents a low-voltage AC connection, while MV AC represents a medium-voltage AC connection. *Source: Denholm (2019)*

Figure 7. Large-scale battery storage power capacity, standalone and co-located (2022–2024)



Data source: U.S. Energy Information Administration, *2022 Form EIA-860 Early Release, Annual Electric Generator Report*
Note: Solid yellow, green, and brown bars indicate generating total capacity of solar, wind, and fossil fuels that have battery storage on-site.

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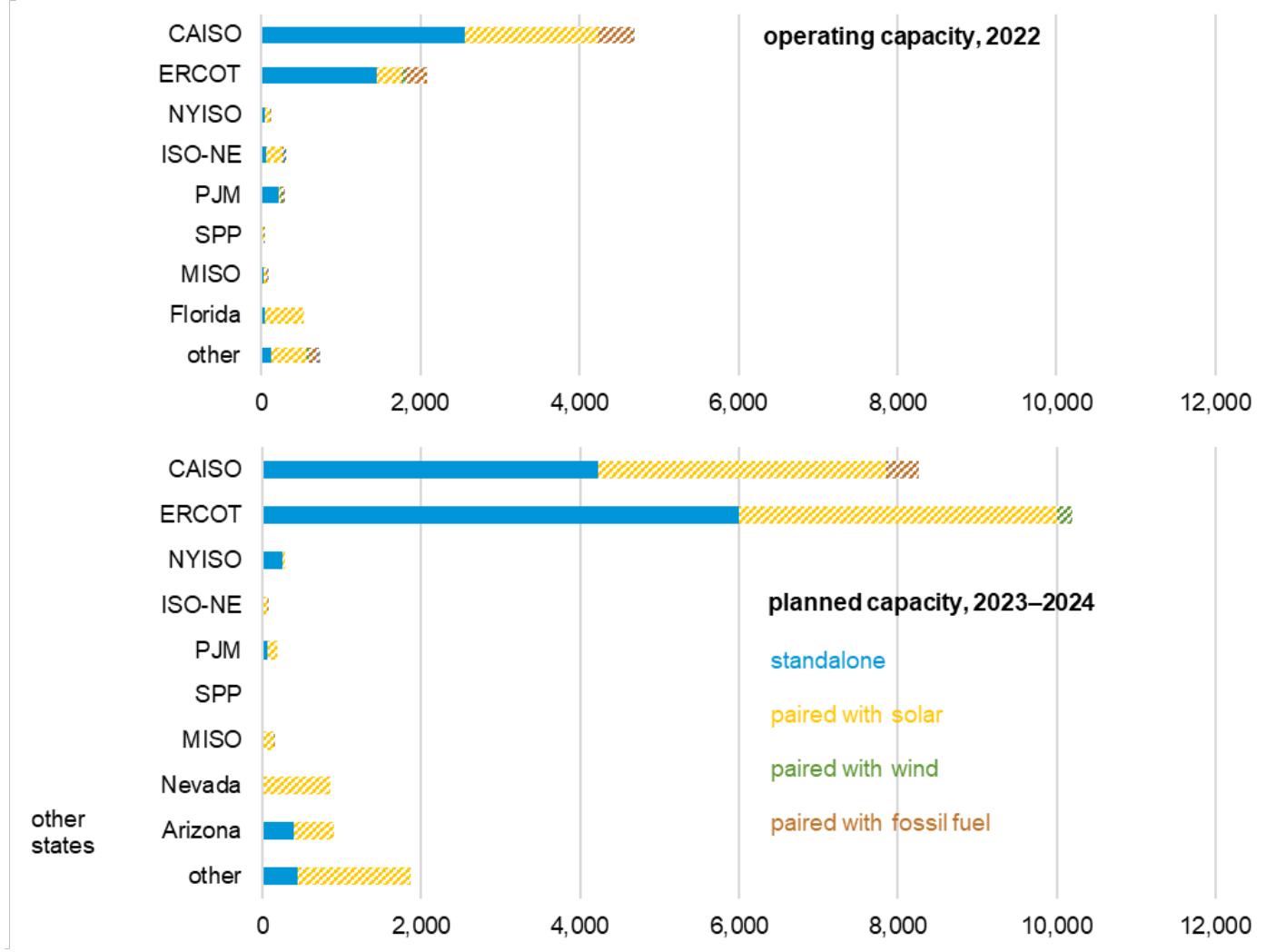
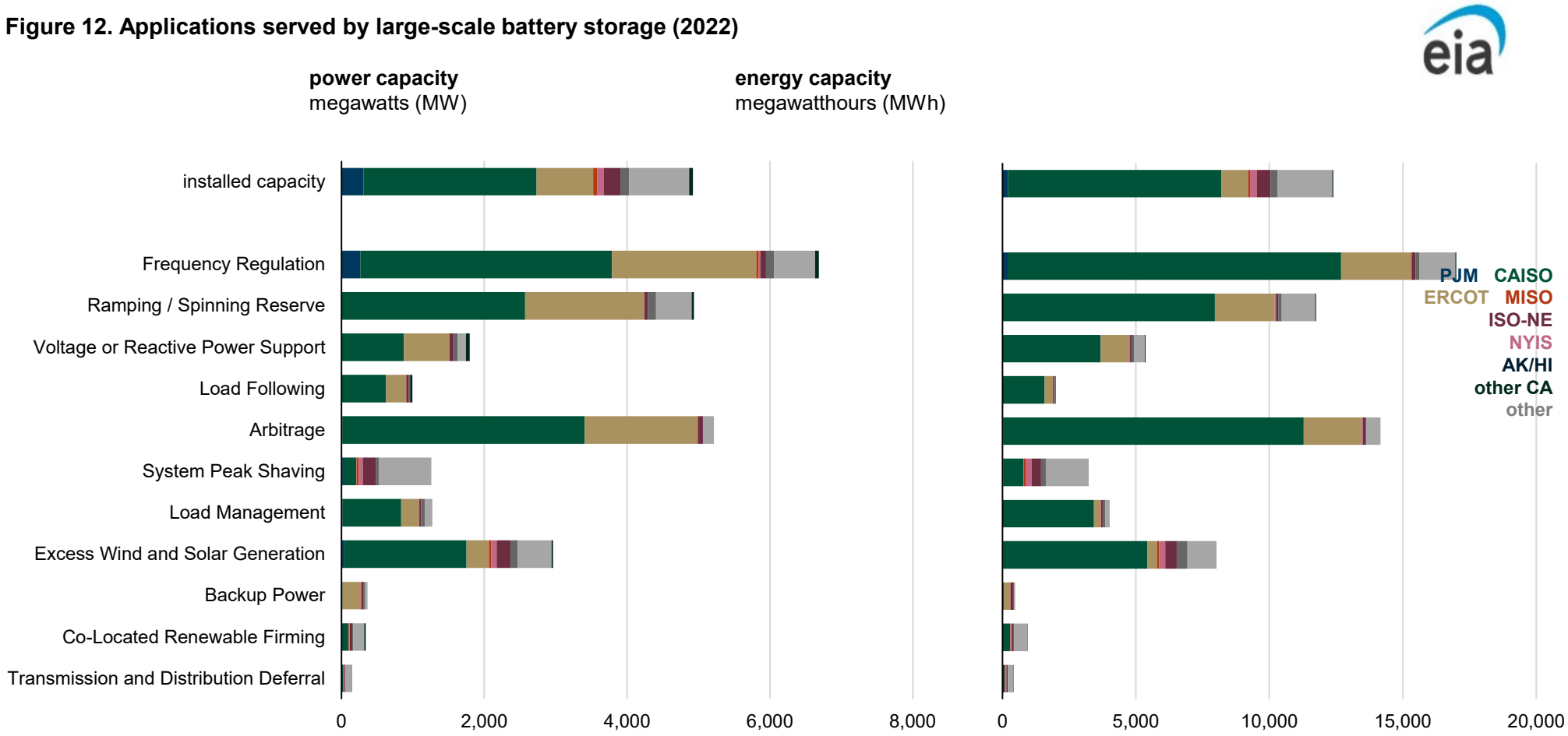
Figure 8. Large-scale battery storage power capacity by region and co-located generator operating and planned (2022–2024)



Data source: U.S. Energy Information Administration, *2022 Form EIA-860 Early Release, Annual Electric Generator Report*

BESS Usage

Figure 12. Applications served by large-scale battery storage (2022)



Data source: U.S. Energy Information Administration, *2022 Form EIA-860 Early Release, Annual Electric Generator Report*

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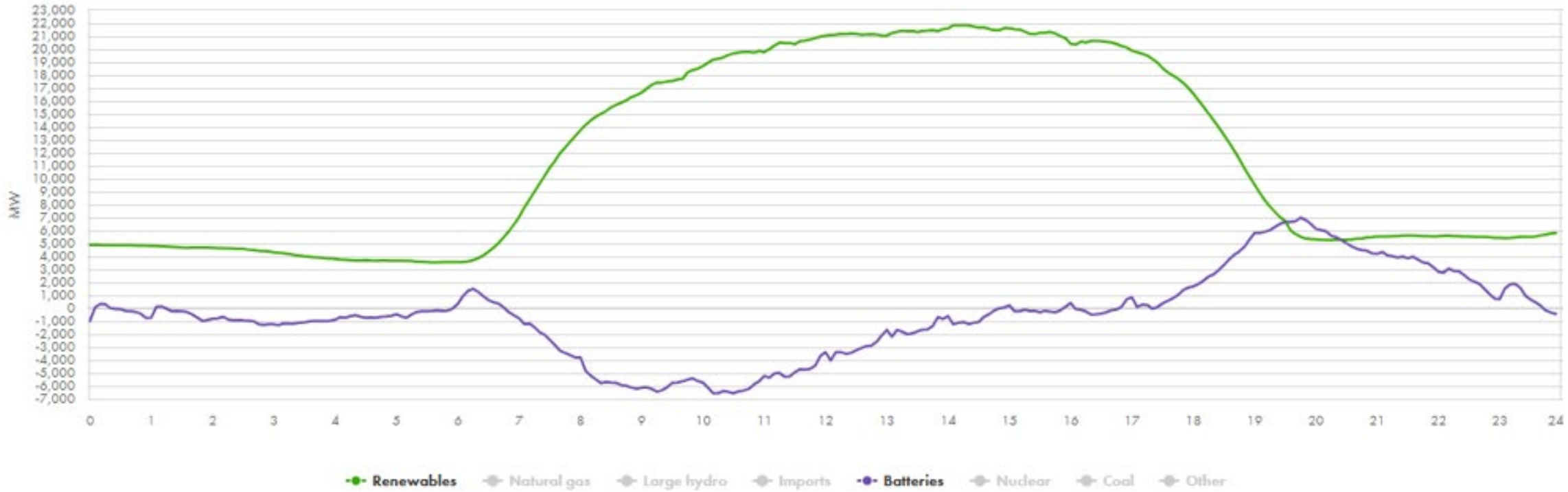
BESS Usage

Supply trend

Energy in megawatts broken down by resource in 5-minute increments.



BESS Usage

During cold weather in January 2024, one WECC entity declared an EEA 3 and reported they had requested Reserve Sharing assistance and were consuming Energy Storage for reserves

Later, as the Reserve Sharing and Energy Storage were exhausting, they sent out an Emergency Alert for consumer assistance in reducing load

2022 California BESS Disturbances

This report assesses two widespread losses of BESS caused by normally cleared faults in the Western Interconnection that occurred on March 9 and April 6, 2022

These events are unique in that they are the first major events involving BESS facilities

These events highlight the need to consider BESS in the same light as any other inverter-based resource, such as solar PV, for their systemic reliability risks

2022 California BESS Disturbances

BESS may have the same systemic performance problems as solar PV resources

All BESS facilities experienced partial plant tripping caused by inverter protection, failing to ride through normally cleared single-line-to-ground grid faults

The affected inverters tripped on both new causes and causes previously reported associated with solar PV resources

2024 Cat 1i events

Four submitted Brief Reports within WECC with loss of generation at BESS facilities including one event at 9:10 p.m.

In one Category 0 event, a BESS went from producing to consuming power for a total change of -514 MW

LL20240501

Incorrect IBR Primary Frequency Response (PFR) Logic Caused Negative ACE

On May 15, 2023, a sustained low-frequency (59.93 Hz) event lasting approximately 10 minutes—during which numerous intermittent renewable resources (IRR) and energy storage resources (ESR) were operational—occurred in the interconnection

Although the ISO was able to restore the grid frequency to the nominal 60 +/- 0.036 Hz, the frequency spiked to above 60.036 Hz for a short time due to anomalous behavior from some ESRs connected to the transmission system

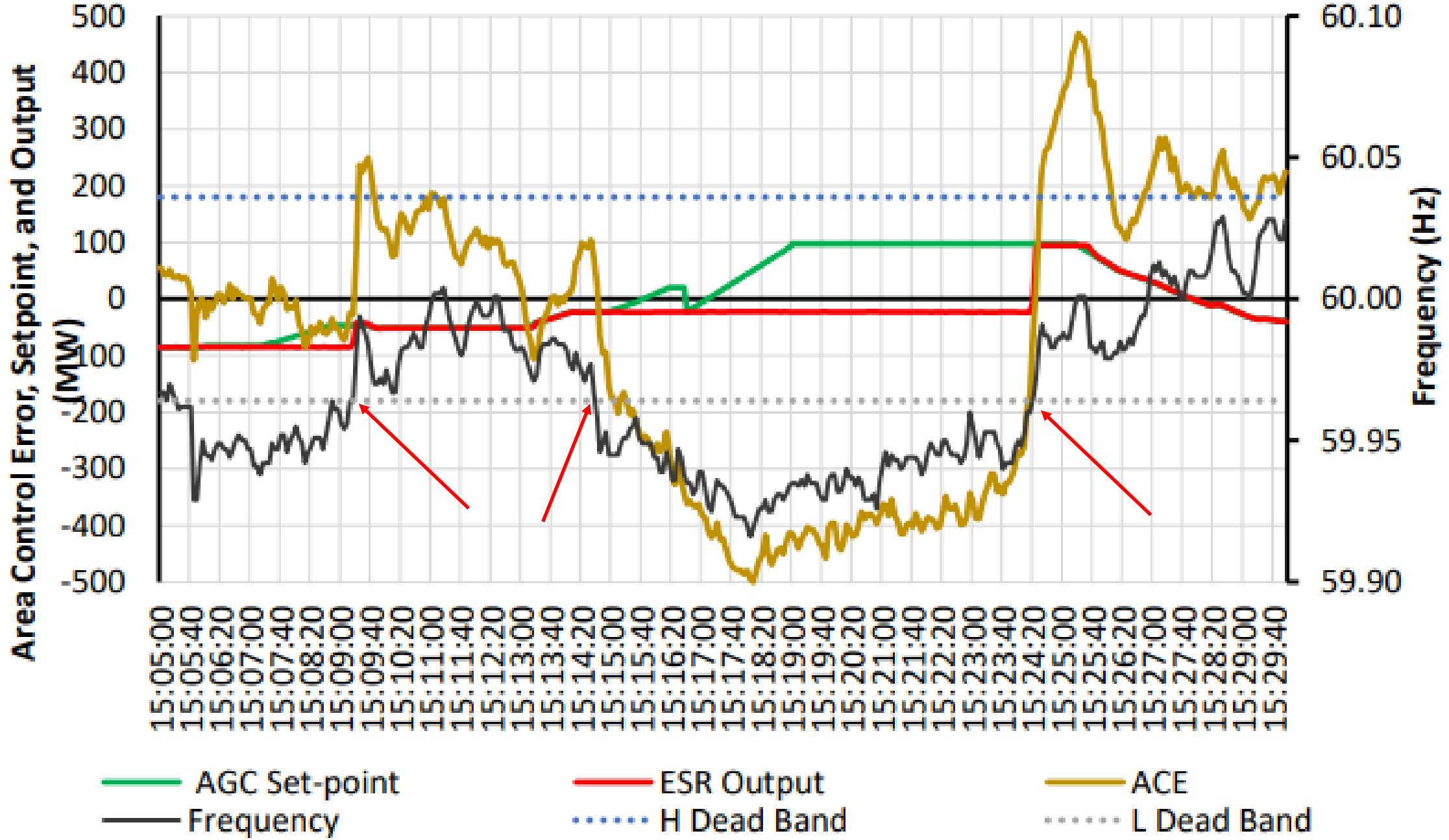


Figure 2: AGC Setpoint, ESR Output, ACE, and Frequency during the Event

LL20240501

ESR that do not have controller logic set in a manner that applies the PFR droop offset as “additive” to the dispatch setpoint may produce anomalous responses

The need to provide industry-wide awareness for specific PPC logic for IRRs and ESRs remains

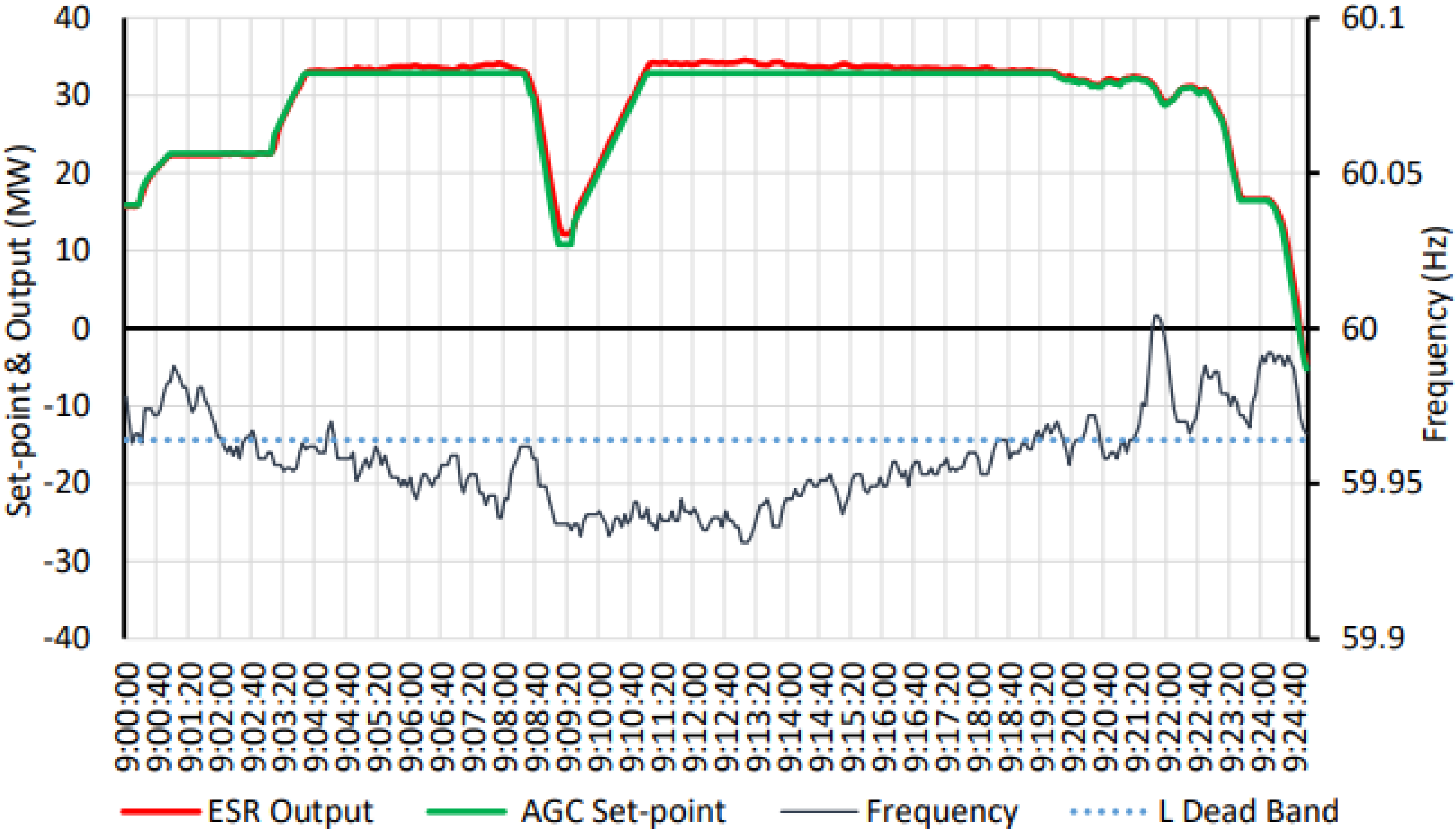


Figure 3: AGC Setpoint, ESR Output, and Frequency during a Later Event

WECC Oscillation Modes

Summary of mode properties.

Mode	Freq. (Hz)	Shape	Interaction Path(s)	Controllability	Grade	Comments
NSA	0.20–0.30	Alberta vs. System	Alberta–BC (Path 1) Northwest–CA (Path 3)	Alberta	Well understood	Well understood from 2014 report. Analysis for 2021 report confirms 2014 conclusions. An Alberta disconnect causes this mode to disappear.
NSB	0.35–0.45	Alberta vs. (BC + N. U.S.) vs. S. U.S.	COI (Path 66)	Widespread, incl. PDCI	Well understood	The most widespread mode in the system. An Alberta disconnect causes mode frequency and damping to decrease.
EWA	0.35–0.45	(Colorado + E. Wyo.) vs. System	Wyoming–ID (Path 19) Colorado–UT (Path 30) Colorado–NM (Path 31)	Colorado area	Marginally understood	Close in frequency to the NSB mode. Extensive new knowledge in 2021 report.
BCA	0.50–0.72	BC vs. N. U.S. vs. S. U.S.	Unknown	Unknown	Not understood	Model studies hypothesize two BC **modes**. Need improved PMU coverage in western BC (e.g., Kemano).
BCB	0.60–0.72	W. edge vs. System vs. E. edge	Unknown	Unknown	Not understood	(See above.)

BESS Oscillations

During Hybrid BESS+PV site commissioning, controller integration challenges caused two IBR site batteries to create three large interconnection-wide oscillations and led to instances of required utility reliability disconnection of IBRs and evaluation of controller integration improvements for future IBR interconnections

The frequency of all forced oscillations (0.25 Hz) was close to that of NS-A mode frequency causing the Mode meter to trigger alerts for apparent NS-A mode critical damping ratio

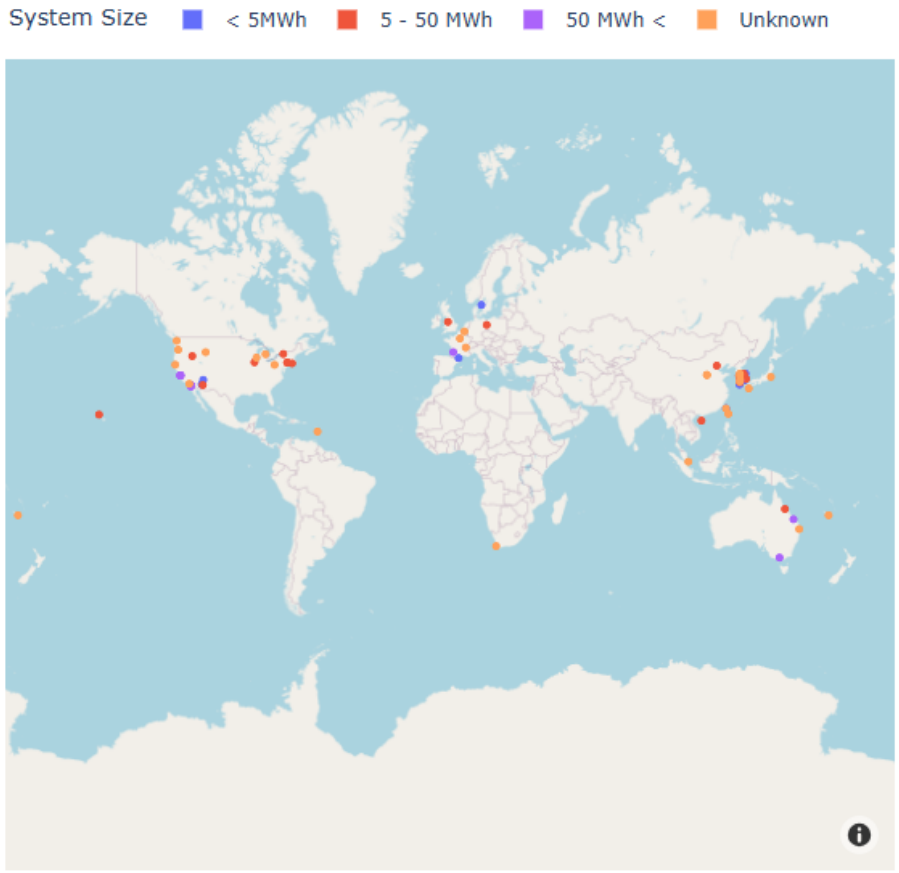
BESS Oscillations

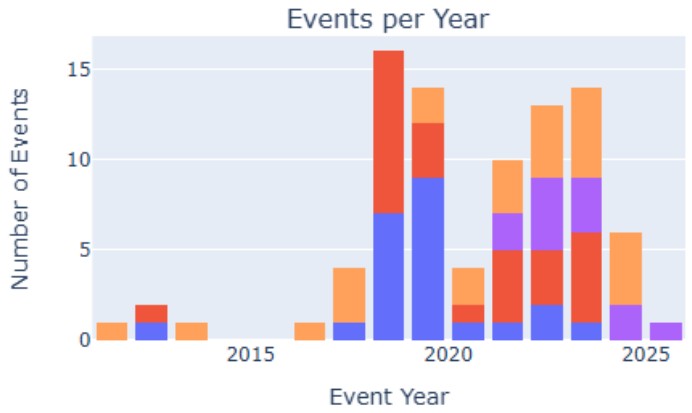
The utility has identified that more rigorous testing of IBR controllers is critical to ensure reliable commissioning and operation of IBR sites including:

Potential interconnection requirement to perform Hardware in the Loop (HIL) testing and either provide a report on the results (what gaps in the controller logic were found and how were they fixed) or provide an opportunity for the utility to witness the HIL testing

Established requirements for commissioning test procedures and test reporting

BESS Fires





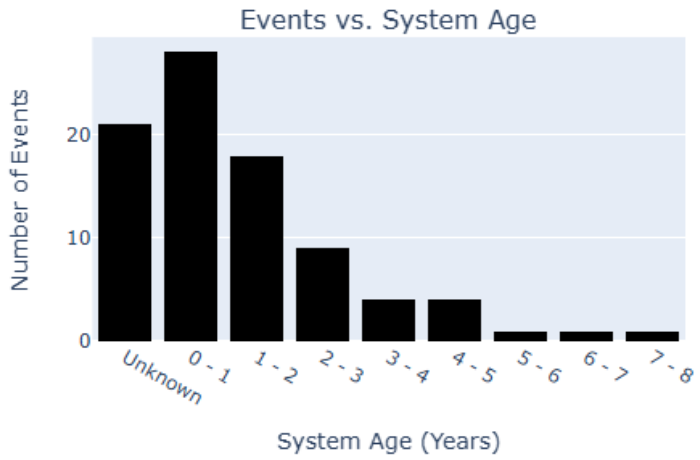


Figure 1. A breakdown of the stationary energy storage failure events from the above table.

https://storagewiki.epri.com/index.php/BESS_Failure_Incident_Database

BESS Fires

There have been 26 battery fires in the U.S. from 2012 to 2025.

22 of these fires have occurred since 2019.

The EPRI BESS Failure Incident Database presently has 95 entries.

LL20210301—Battery Energy Storage System Cascading Thermal Runaway

BESS Resources

- Grid-scale Battery Storage: https://www.nrel.gov/docs/fy19osti/74426.pdf
- EPRI BESS Failure Incident Database: https://storagewiki.epri.com/index.php/BESS_Failure_Incident_Database
- McMicken Report: APS.com/mcmicken
- LL20210301 Battery Energy Storage System Cascading Thermal Runaway

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Electric Reliability and Security for the West

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