

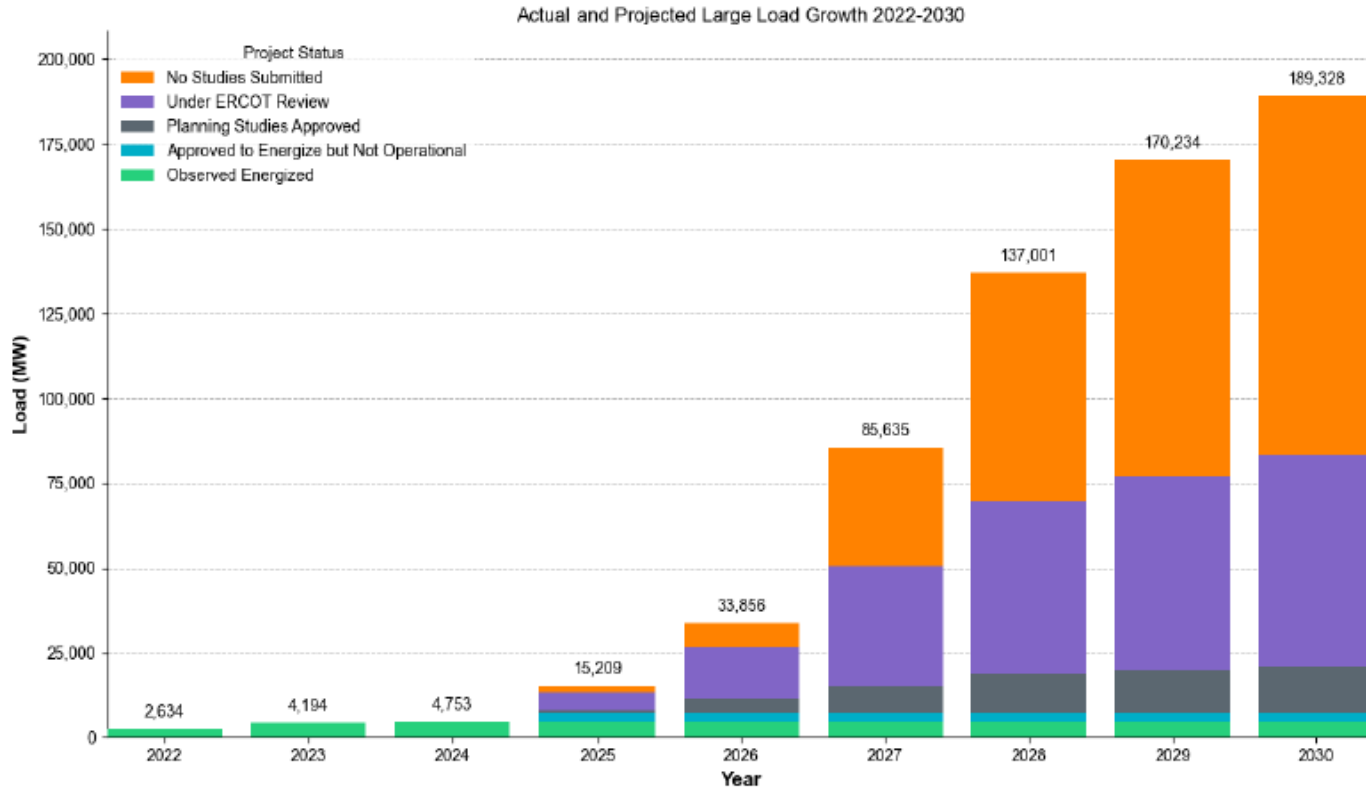


Large Electronic Loads in ERCOT

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NASPI Large Electronic Loads Panel
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ERCOT Large Load Queue

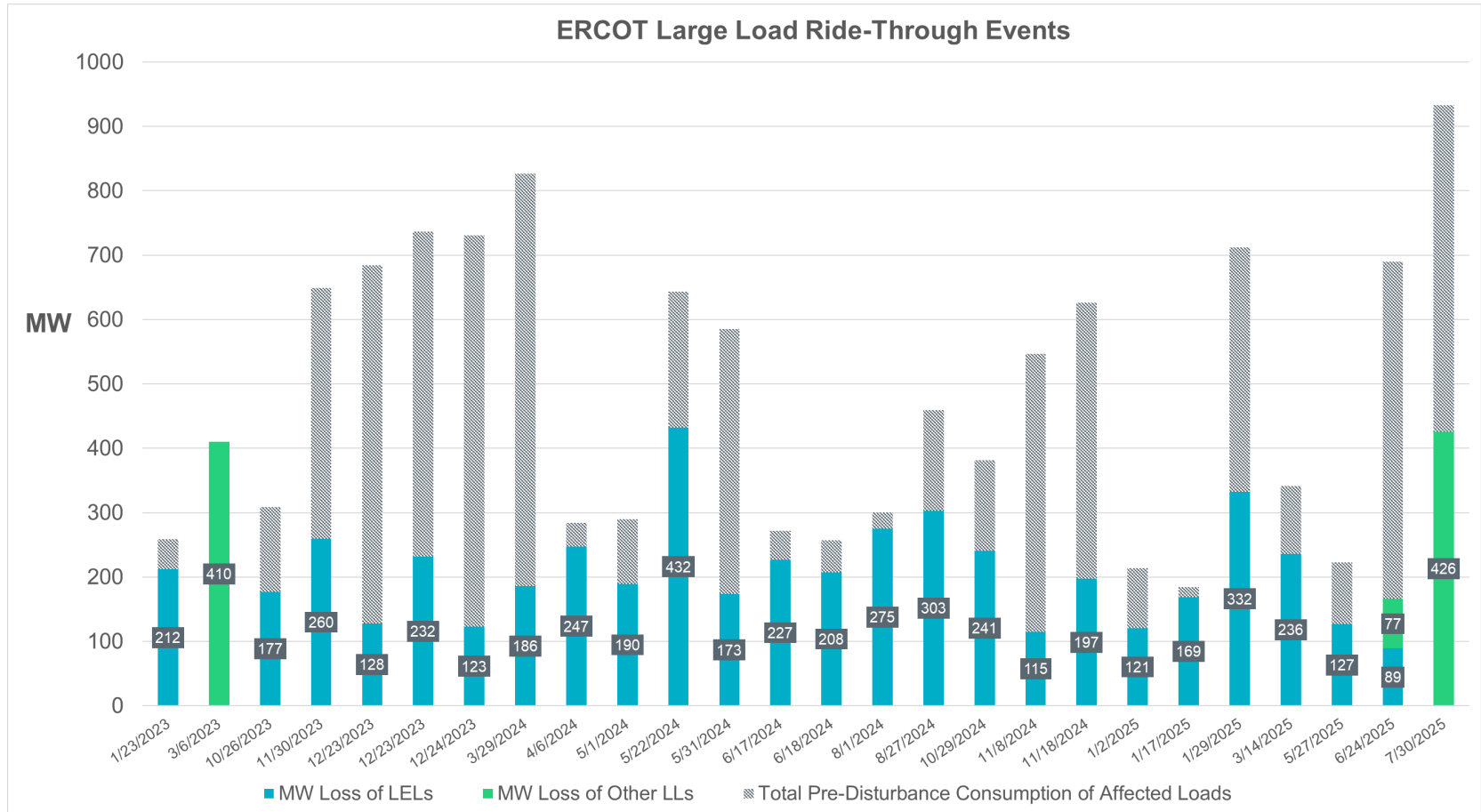


- **7,502 MW** – Large Load that has received Approval to Energize (A2E)
- **4,616 MW** – Peak non-simultaneous observed consumption of approved loads
- **3,733 MW** – Peak simultaneous observed consumption of approved loads
- **~20,000 MW** – Combined Planning Studies approved, A2E, or operational
- **85,508 MW** – ERCOT all-time peak demand record (Aug. 10, 2023)
- Over 90% of approved/energized Large Load is data center/crypto currency mining

System Impacts

- ERCOT has observed many events in which large electronic loads (LEL) immediately reduce consumption during a system fault
 - LELs are more voltage-sensitive than traditional large industrial loads
 - Concern that large load ride-through events could increase in magnitude causing system frequency and voltage instability issues
 - Possible need for Fast Frequency Response down type service
- ERCOT continues to observe fast ramping of LELs in response to energy prices, sometimes resulting in near exhaustion of regulation services
 - Difficult for ERCOT Operations to predict when LELs will ramp and conflicts with periods of BESS charging
 - E.g., Prices are low – BESS charging and high LEL load may drive prices back up causing a cyclical behavior
- Most operational LELs are currently cryptocurrency facilities
 - price responsive or “Flexible”; ERCOT has no control over this flexibility
- Many large non-flexible data centers, or hyperscalers, in the queue
- ERCOT has observed only one significant oscillation from an LEL, to date
 - Concern that oscillations are undetected or will increase as more LEL connects

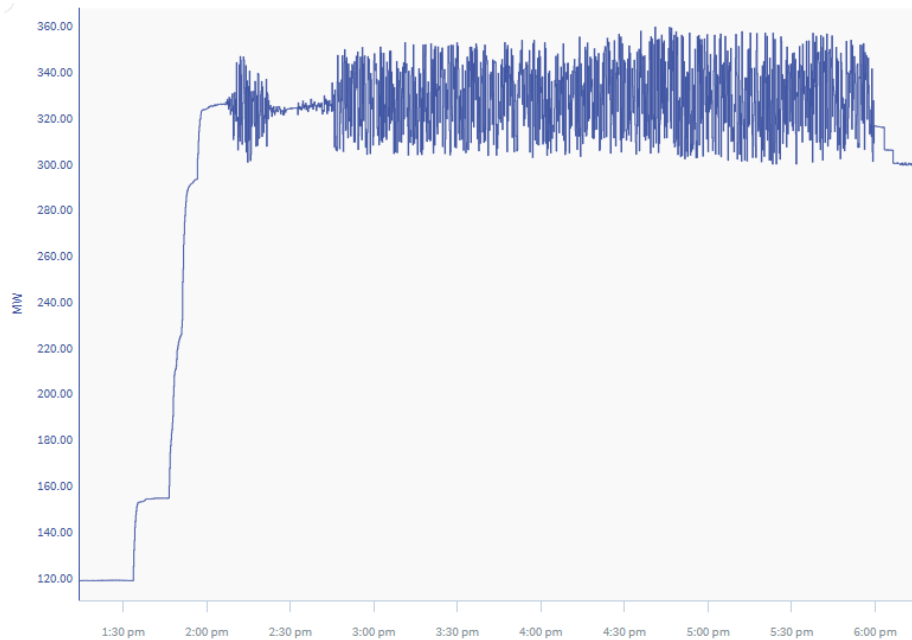
Large Load Ride-Through Events (2023 – Present)



- All events involve one or more Large Load reducing consumption from the transmission grid during a system fault
- All loads LELs involved in events are cryptocurrency mining facilities
 - to the best of ERCOT's knowledge

Large Load Oscillation Event

- Oscillation seen in real-time telemetry of large crypto load
- Needed to configure PMU/DFR at POI to verify oscillation and characteristics
- Found 23 Hz oscillation with peak-peak magnitudes >50 MW
- Load directed to reduce consumption to mitigate oscillation
- Discovered firmware issue was root cause of the oscillation
- Updated firmware to mitigate oscillation and is back to full consumption



Existing Tools for Monitoring Large Loads

- Telemetry required for loads in the Large Load Interconnection process to receive approval to energize from ERCOT
 - 2 second scan rate required for Load Resources
 - 10 second scan rate for Large Loads that are not Load Resources
- ERCOT may require TSP to install/configure PMU/DFR to monitor Large Loads >75 MW from POIB
 - Data **is not** required to be streamed, local storage only and data provided to ERCOT upon request
 - ERCOT has requested streaming for many
- ERCOT has ~275 PMUs from 3 TSPs streaming real-time data
 - PMUs spread out across the system, but some areas have limited visibility
 - **No PMU streaming requirements in ERCOT (voluntary only); only local storage required for certain locations**
- ERCOT uses real-time PMU data to detect oscillations and system faults
- ERCOT uses in-house tools to identify oscillation source and Large Loads or Generation Resources that reduce consumption/output during a fault

Existing Practices, Limitations, and Improvements

- Ability to detect and mitigate oscillations dependent on location of streaming PMUs being electrically close to the source
 - ERCOT may only request additional PMUs to be streamed
 - TSPs are concerned about potential CIP compliance violations
 - ERCOT requires system upgrades to increase PMU visibility
- Tools designed to detect oscillation source from generation units
 - New/modified tool needed to identify Large Loads as possible source (in progress)
- ERCOT has capability to reduce generation output to mitigate oscillations within short time window
 - Large Loads are not registered entities; ERCOT must communicate with TSP who then needs to contact Large Load operator to reduce consumption
- Recent rule requires breaker under remote control of TSP to disconnect load with an instruction from ERCOT
 - Some existing loads may not have this configuration; rule not retroactive
 - ERCOT leveraging this rule to install PMU/DFR to monitor LL directly



Questions?