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JANUARY 23-25, 2024
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DESTINATION 2050 >>>

ISO Trio:
The future of storage with America's 3 most dynamic grid operators

ORGANIZED BY CLARION ENERGY

2:00-3:00pm
Tuesday, Jan. 23
Room 213

Speakers:
Mike DeSocio (Luminary Energy)
Sai Moorthy (ERCOT)
Danny Johnson (CAISO)
Jay Dauenhauer

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LUMINARY ENERGY


Mike DeSocio
Founder and CEO
Luminary Energy
www.luminary.energy

Luminary Energy specializes in providing clients with insights into wholesale electricity market design and grid operation, supporting the assessment of changing policies, regulations, and electricity market rules to provide a fulsome understanding of the evolving energy landscape.

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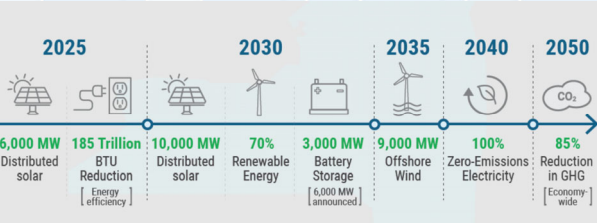


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New York has great aspirations for Energy Storage growth

- There are roughly 90 MW of energy storage in operation in New York
 - 60 MW of batteries; 20 MW of flywheels; and 10 MW of non-market storage
- There are roughly 35,226 MW of energy storage in the NYISO interconnection queue
 - The NYISO peak load is roughly 30,000 MW
 - Electrification efforts will lead to load growth
- New York State's Climate Leadership and Community Protection Act (CLCPA) has established a 3,000 MW energy storage goal for 2030
 - New York announced increasing this to 6,000 MW but has not ratified that




2025	2030	2035	2040	2050
6,000 MW Distributed solar	10,000 MW Distributed solar	9,000 MW Offshore Wind	3,000 MW Battery Storage <small>[6,000 MW announced]</small>	85% Reduction in GHG <small>[Economy-wide]</small>
185 Trillion BTU Reduction <small>[Energy efficiency]</small>	70% Renewable Energy	100% Zero-Emissions Electricity		

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There is tremendous opportunity in New York

- There are many opportunities for energy storage in New York, but it remains difficult to develop a new project for several reasons:
 - Interconnection Queue is long and changing with Order 2023
 - Retail participation treats energy storage charging like native load
 - New York is becoming more capacity-constrained
- There is a bright side, however:
 - New York is considering a storage credit to help close the revenue gap
 - New York is considering a more holistic cap and trade program (Cap and Invest)
 - New York is also making large procurements of renewable fleets

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Storage resource participation in the CAISO – POWERGEN 24

Danny Johnson, Market Design Sector Manager
Market Policy Development – California ISO




January 23, 2024

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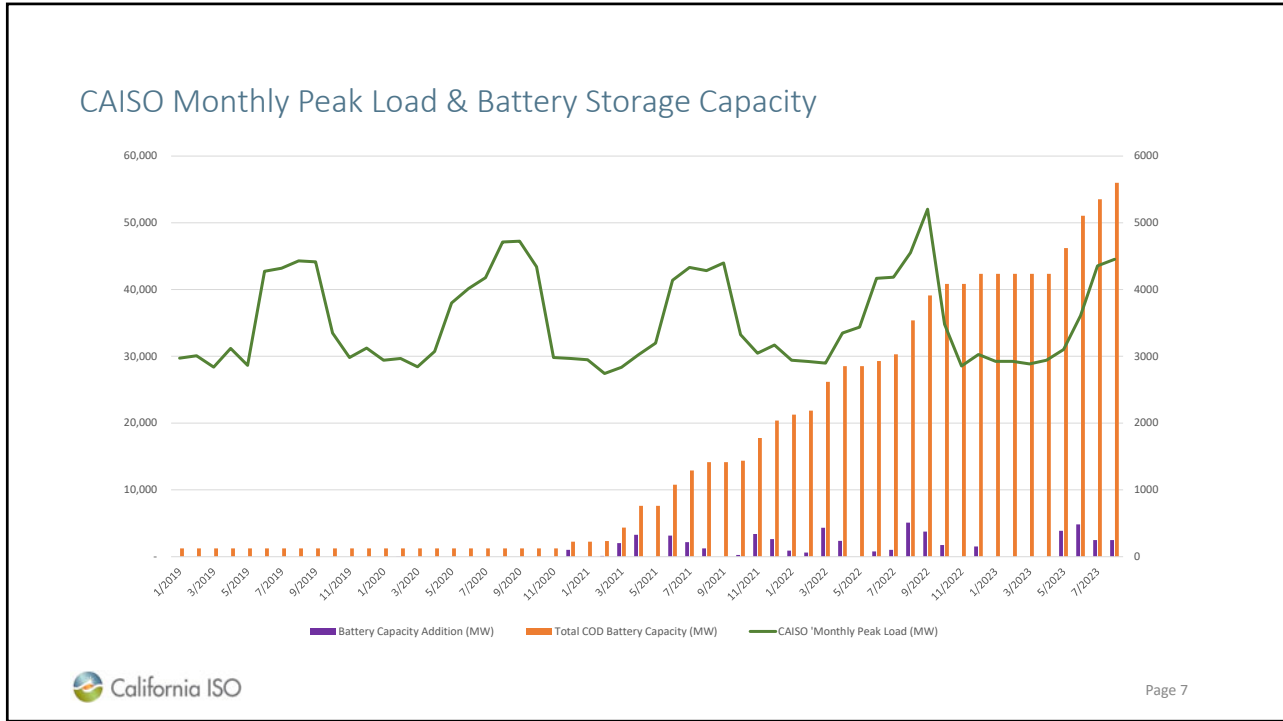
Storage is a significant and growing technology within CAISO's resource fleet

- Approximately 8000 MW of installed capacity; ~900 MW are part of hybrid registered resources
 - Primarily 4-hour lithium ion
- CAISO interconnection que projects significant additional development of storage resources
 - Upcoming interconnection cluster-15 received 311 applications totaling ~115 GW of storage capacity
- CAISO all-time peak load is ~52000MW



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The CAISO offers 3 different market models storage resources can use to participate

- Non-Generator Model: Full +/- biddable range, no transition times
- Hybrid Model: Single modeled resource behind a point of interconnection, comprised of variable energy resource (VER) and storage resources; CAISO market optimizes project
- Co-located Model: Multiple VER and storage resources behind single point of interconnection; scheduling coordinators separately manage bid submission for both resources

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Storage Resource Participation in the CAISO

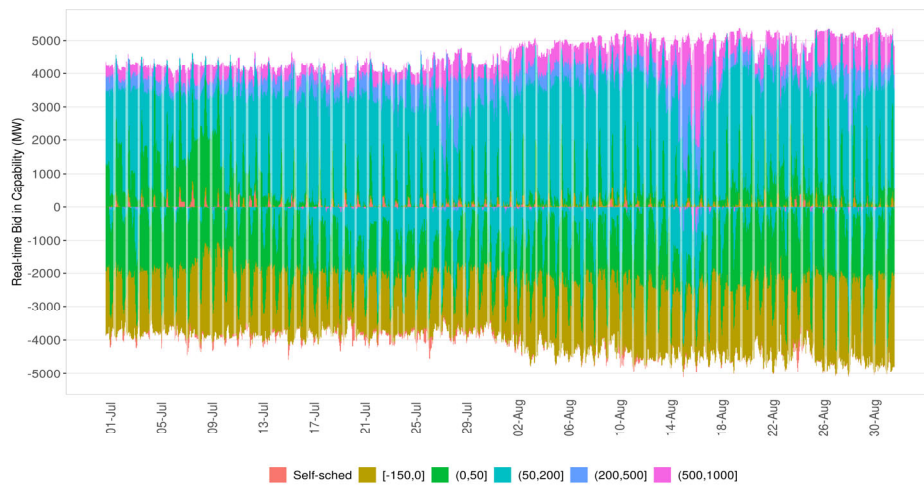
- Market revenues are purely based on price arbitrage; storage resources are eligible to receive
 - Energy awards
 - Ancillary service awards (Regulation, Spin, Non-spin)
 - Flexibility Products (Imbalance reserves, Flexible Ramping Product)

- State-of-Charge (**SOC**) parameter tracks how much energy the battery has available; is optimized by the day-ahead and real-time markets. MWh units

- CAISO utilizes a multi-interval optimization allows the market to dispatch storage based on buy/sell spreads

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Recent economic participation of storage resources is robust in the CAISO's markets




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Additional policy work is needed as storage becomes a larger part of the CAISO's resource mix

- State-of-charge management
 - Initial conditions in day-ahead time frame
 - Conversion of ancillary service or flexibility product awards into SOC
- Retaining incentive compatible dispatch within the construct of a multi-interval optimization
- Resource adequacy / forward capacity planning assumptions
 - Given the existing load profile of the CAISO, forward planning looks at both *flexible capacity* as well as peak capacity


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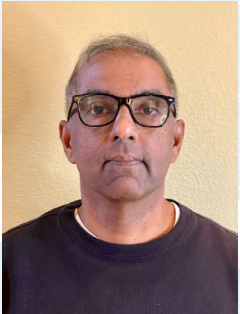
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ERCOT Energy Storage Overview


Sainath Moorthy
Principal, Market Design
ERCOT




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The Electric Reliability Council of Texas (ERCOT) is a nonprofit organization that ensures reliable electric service for 90 percent of the state of Texas. The grid operator is regulated by the Public Utility Commission of Texas and the Texas Legislature.

90% percent of Texas Load

More than **26 million** customers in the ERCOT region

75% of load is competitive choice customers — nearly 8 million electric-service IDs (premises)

1 MW of electricity can power about 200 Texas homes during periods of peak demand.

85,508 MW
All time peak demand record (August 10, 2023)

85,116 MW
Weekend peak demand record (August 26, 2023)

*Unofficial until settlements occur

2023 Generating Capacity
Reflects operational installed capacity based on November 2022 CSM report for Summer 2023.

Natural Gas: 41.8%	Wind: 28.6%	Coal: 10.8%	Solar: 11%	Hydro: 0.5%	Other*: 3.1%	Storage: 2.2%	Nuclear: 4%
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The sum of the percentages may not equal 100% due to rounding. *Other includes biomass and DC Tie capacity.


2022 Energy Use
*Other includes solar, hydro, petroleum coke (not coke), biomass, landfill gas, distillate fuel oil, net DC tie and Block Load Transfer imports/exports and an adjustment for wholesale storage load.

Natural Gas: 32.8%	Wind: 24.9%	Coal: 16.6%	Other: 6.2%	Nuclear: 9.7%
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Fact Sheet
November 2023

- 1,873+** active market participants that generate, move, buy, sell or use wholesale electricity
- 1,100+** generating units, including PUNs
- 52,700+** miles of high-voltage transmission
- 98,000+ MW** expected capacity for Summer 2023 peak demand
- 37,725 MW** of installed wind capacity as of July 2023, the most of any state in the nation
- 18,364 MW** of utility-scale installed solar capacity as of September 2023
- 4,048 MW** of installed battery storage as of September 2023
- 27,044 MW** wind generation record (May 29, 2022)
- 69.15%** wind penetration record (April 10, 2022)
- 13,811 MW** solar generation record (October 16, 2023)
- 32.93%** solar penetration record (April 30, 2023)
- \$3.3 billion** transmission projects endorsed in 2022

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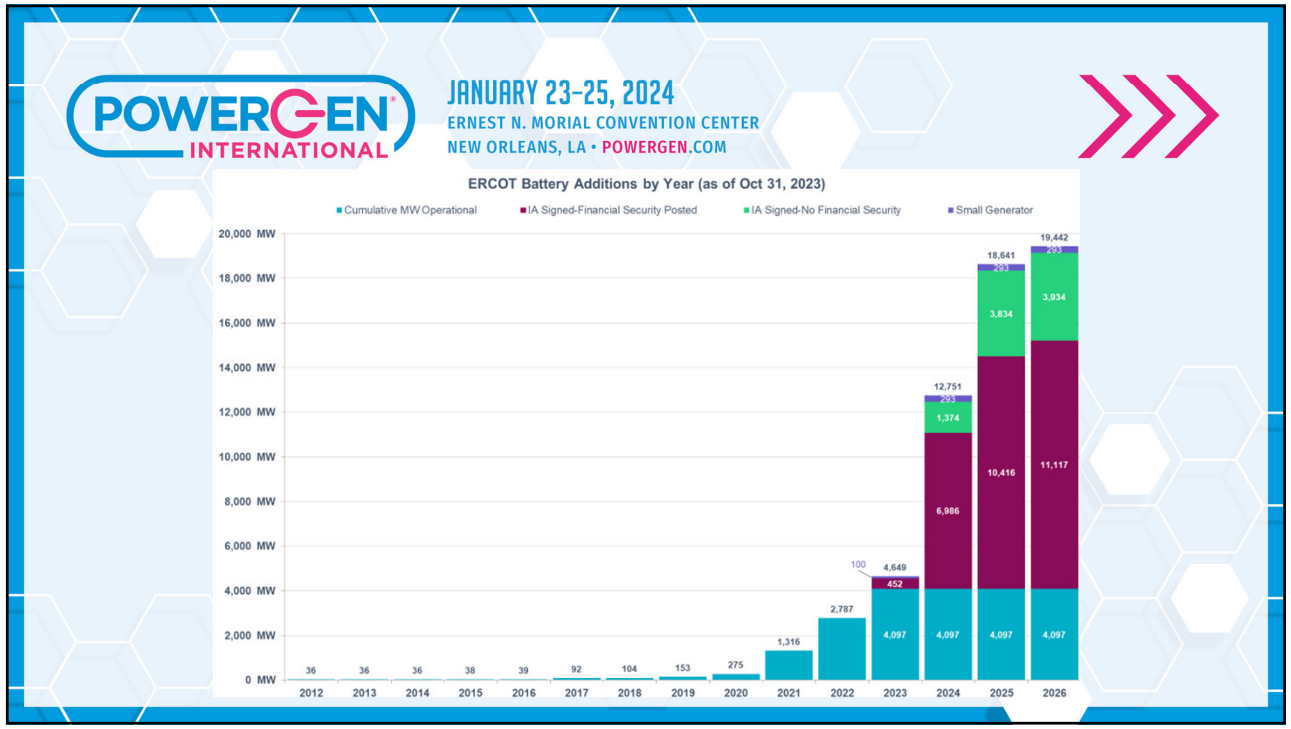
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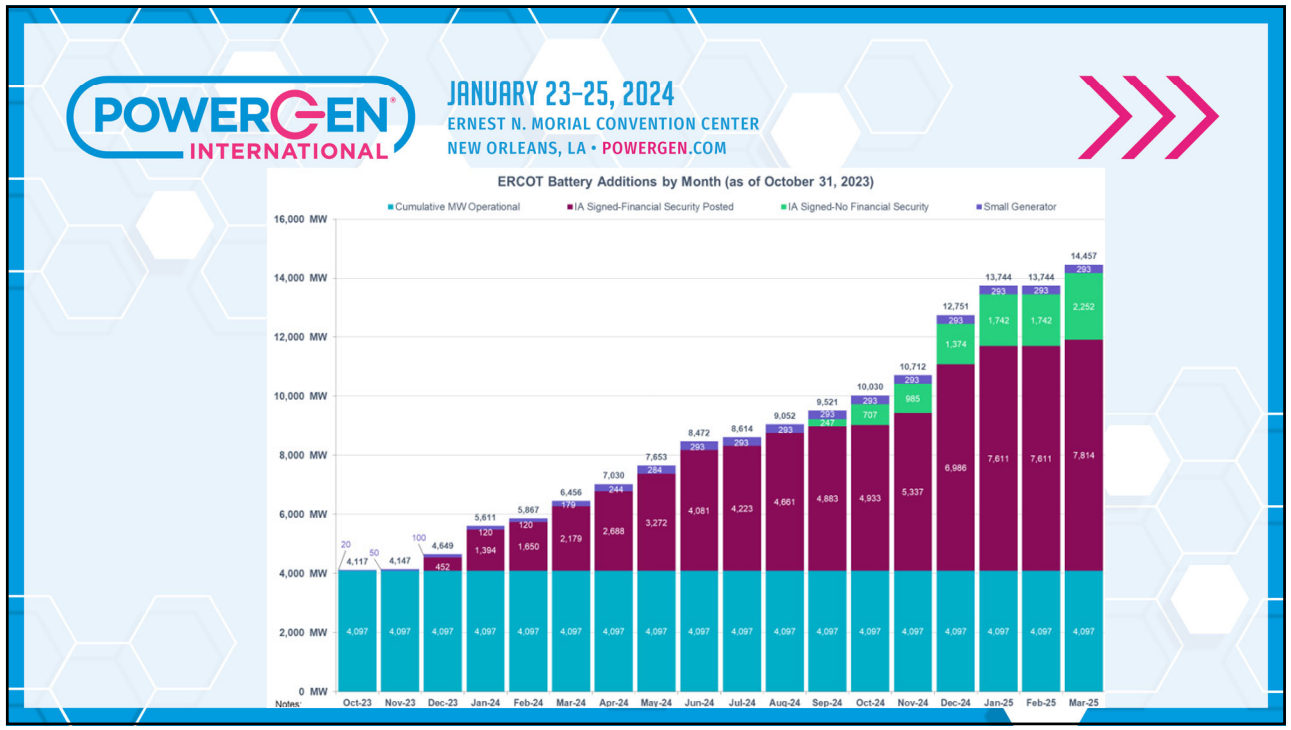
What is Interconnected and Operating as of 12/2023

- a) ESRs interconnected to the Transmission System
- b) DESRs = ESRs interconnected to the Distribution System (and participating in the market) [53 DESRs total = 500 MW]
- c) Others: Settlement Only Energy Storage Systems (SOESS) = small energy storage resources behind the meter and likely co-located with load (only one or two today) [Not seen by ERCOT Operations]
- d) Aggregate Distributed Energy Resource (ADER) Pilot [Each ADER is an aggregation of smaller batteries (residential batteries)]

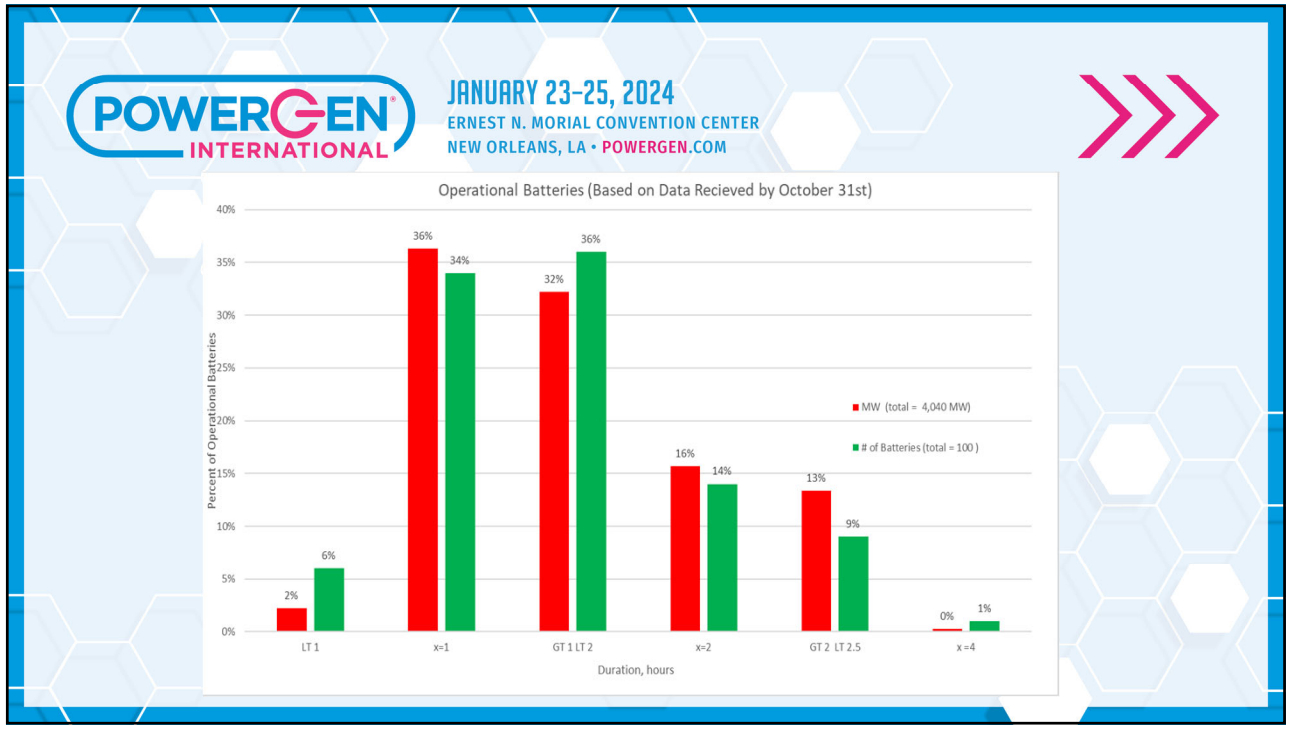
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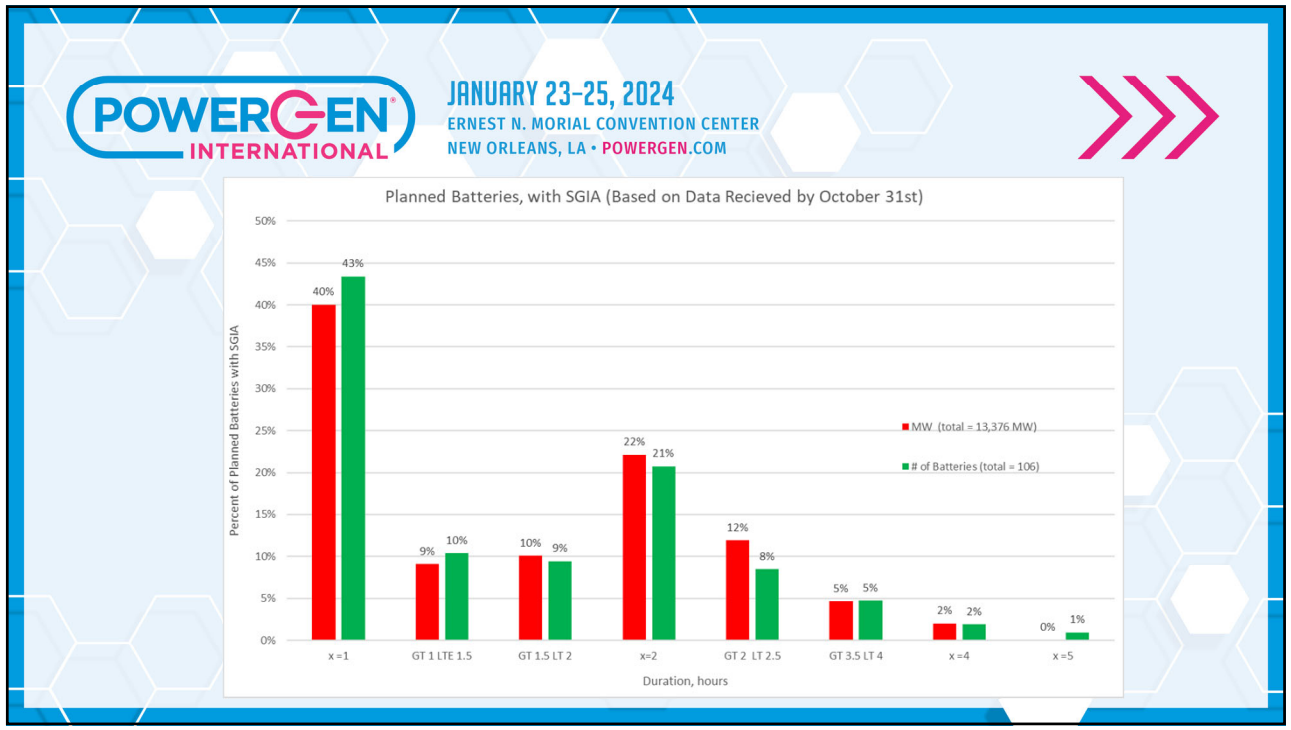
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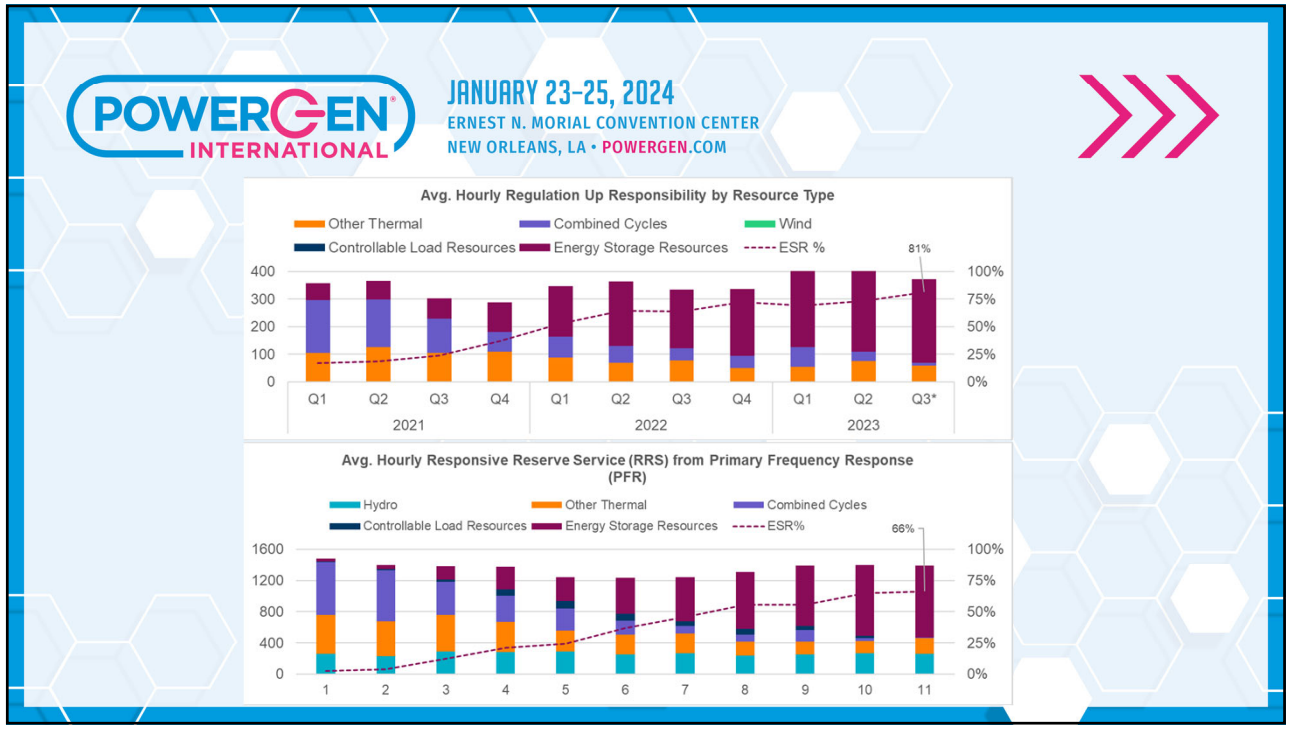
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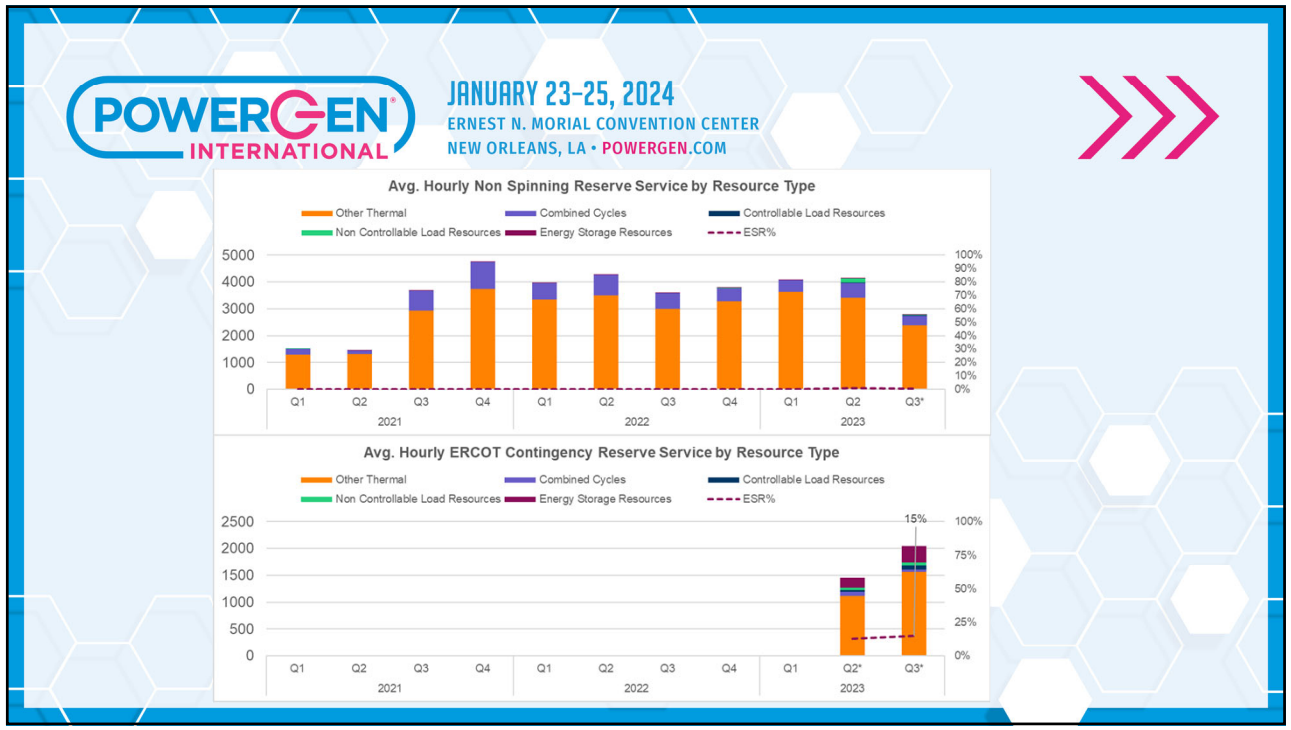
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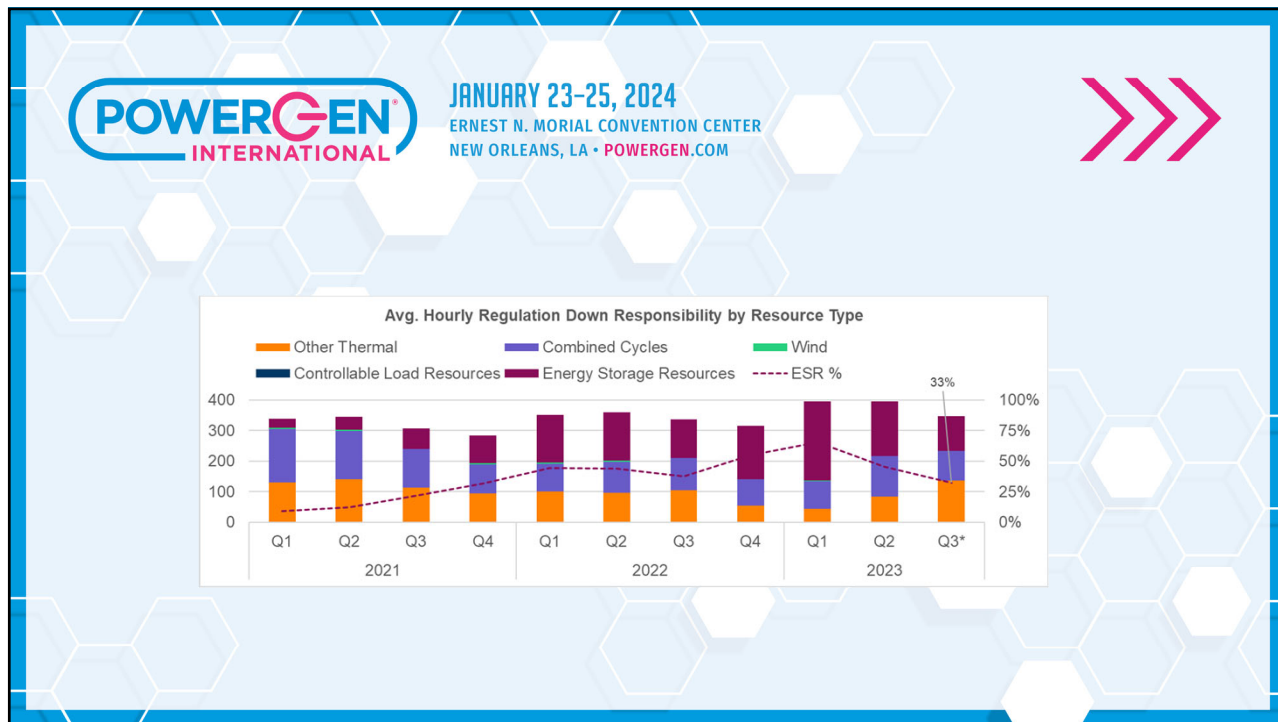
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Challenges and future work related to Energy Storage

- Current and near future planned Energy Storage Resources are predominantly short duration Resources that leads to major challenges in managing the ERCOT grid for, both:
 - Intra-day uncertainties and;
 - Multi-day events
- With increasing penetration of Energy Storage Resources, the ERCOT grid will be more reliant on storage to meet demand (i.e. less thermal generation and more storage to serve a higher load) which introduces more uncertainty. For example, how do we manage the intra-day uncertainty of forecast misses and/or forced outages to make sure we have enough energy stored to cover both these errors/uncertainties and the daily peak net load?
 - Use Case (Intra-day uncertainty): Unit trips at 2pm and Storage discharge used to make up for energy deficiency. Will there be enough energy to still meet the peak net load ramp when solar ramps down in the evening?

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