De-Carbonization / DER Report for NYSRC Executive Committee Meeting 1/13/2023

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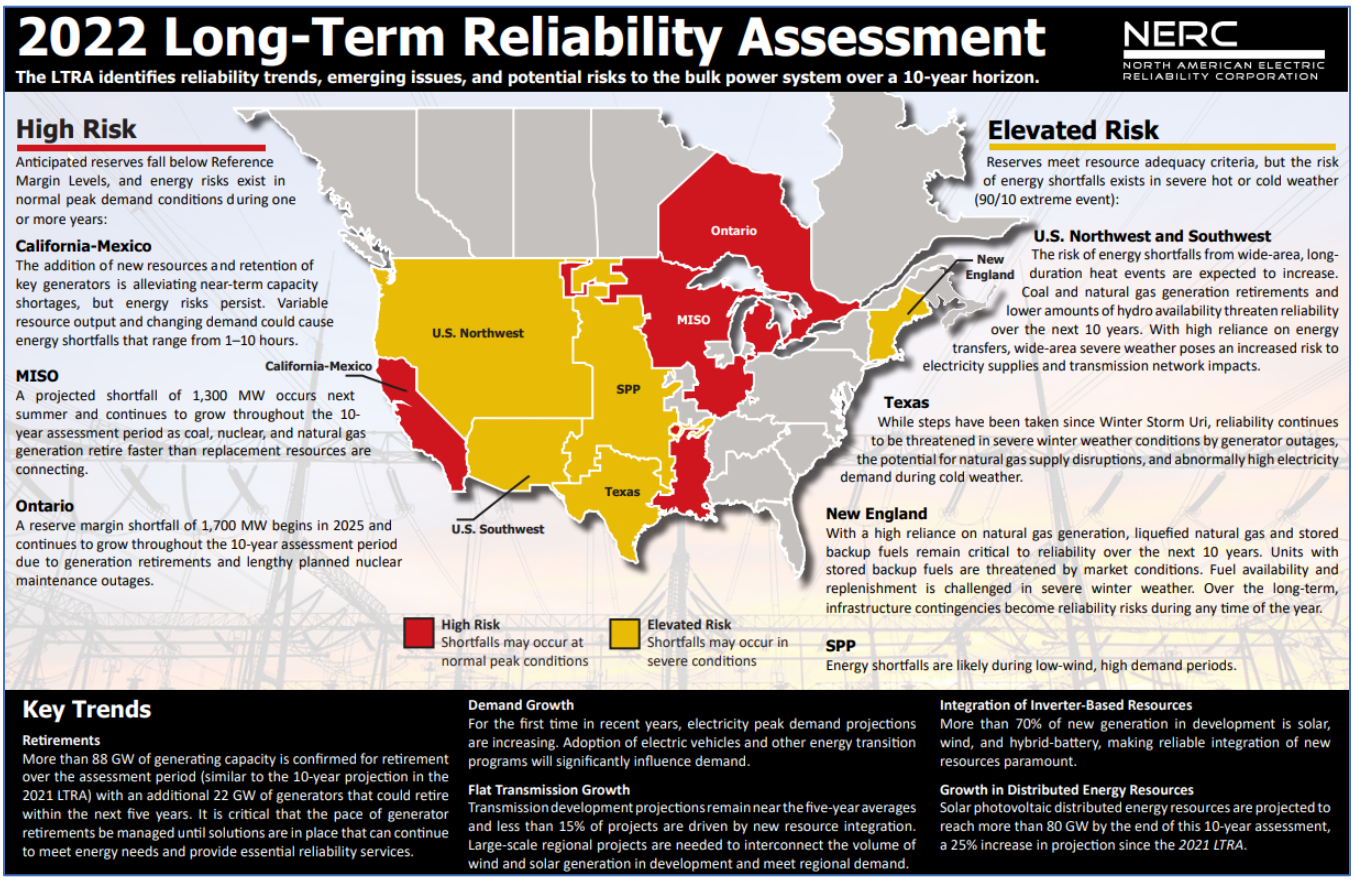
The January 2023 edition of the De-Carbonization / Distributed Energy Resources (DER) Report includes the following items:

- NERC Updates
  - NERC publishes 2022 Long-Term Reliability Assessment (LTRA) Report
  - NERC and Texas RE publish Joint Disturbance Report
- CAISO Adopts New Energy Storage Rules
- EPRI Energy Storage Briefing: 2022 Industry Trends and Research Activities
- NYISO Blog - RNA Report: Reliability Findings Hinge on Key Assumptions
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / Co-located Storage

NERC 2022 Long-Term Reliability Assessment (Announcement / Report / Infographic)
This report identifies energy and capacity risks that underscore the need for reliability to be a top priority for resource and system planners in North America as the energy transition unfolds. The assessment concludes that planners and operators of the grid must increasingly account for different characteristics and performance of resources being brought online during the energy transition.

The Infographic is shown immediately below:



The LTRA highlights five trends: integration of inverter-based resources (IBRs), growth in distributed energy resources (DERs), generation retirements, flat transmission growth and increased demand growth that, without careful planning, could negatively impact the ability of the bulk power system to service the energy needs in North America over the next 10 years.

While most areas are projected to have adequate electricity supply resources to meet demand forecasts associated with normal weather, reserves in some areas do not meet resource adequacy criteria, and more firm resources are needed. The areas forecast to be at high risk of shortfall in peak conditions are:

- Midcontinent Independent System Operator (MISO): A projected shortfall of 1,300 MW occurs next summer and continues to grow throughout the 10-year assessment period as coal, nuclear and natural gas generation retire faster than replacement resources are connecting.
- Ontario: A reserve margin shortfall of 1,700 MW begins in 2025 and continues to grow throughout assessment period due to generation retirements and lengthy planned nuclear maintenance outages.
- California: The addition of new resources and retention of key generators is alleviating near-term capacity shortages, but energy risks persist. Variable resource output and changing demand could cause energy shortfalls that range from 1 to 10 hours.

Extreme weather-related events, like Winter Storm Uri in 2021 and recent wide-area heat waves in the West, have and will continue to strain electricity resources over major parts of North America — even those where traditional resource adequacy criteria are met. Scenarios and probabilistic analyses performed indicate that the U.S. Western Interconnection, Texas, New England and the Southwest Power Pool area are at elevated risk of shortfall in extreme conditions.

Recommendations are aimed at promoting actions that are capable of controlling the pace of the resource transition and are effective for identifying reliability risks and delivering solutions. The assessment recommends:

- Reducing the Risk of Insufficient Energy: Industry and regulators should be mindful of all-hours energy availability analyses when evaluating and establishing resource adequacy and include extreme condition criteria in integrated resource planning and wholesale market designs.
- Planning and adapting for IBRs and DERs: Industry should increase its focus on the technical needs for the bulk power system to reliably operate with increased amounts of DERs. Increased DER penetrations can improve local resilience at the cost of reduced operator visibility into loads and resource availability.
- Addressing the Reliability Needs of Interdependent Electricity and Natural Gas Infrastructures: ERO and industry planners should enhance guidelines for assessing and reducing risks through system and resource planning studies and develop appropriate Reliability Standards requirements to ensure corrective actions are put in place.

Conclusions and additional recommendations include:

- Manage the pace of generator retirements until solutions are in place that can continue to meet energy needs and provide essential reliability services
- Include extreme weather scenarios in resource and system planning
- Address IBR performance and grid integration issues
- Expand resource adequacy evaluations beyond reserve margins at peak times to include energy risks for all hours and seasons
- Increase focus on DERs as they are deployed at increasingly impactful levels
- Mitigate the risks that arise from growing reliance on just-in-time fuel for electric generation and the interdependent natural gas and electric infrastructure
- Consider the impact that the electrification of transportation, space heating, and other sectors may have on future electricity demand and infrastructure.

NERC and Texas RE publish Joint Disturbance Report

NERC and Texas RE jointly published the December 2022 Odessa Disturbance Report, which provides a comprehensive assessment of the June 4, 2022, Odessa disturbance, in which a widespread loss of solar photovoltaic (PV) and synchronous generation was caused by a fault in the Texas Interconnection. This event, which occurred just over a year after NERC and Texas RE analyzed a nearly identical event at the same location, illustrates the need for immediate industry action to ensure reliable operation of the bulk power system with the ever increasing penetrations of inverter-based resources (IBRs).

The 2022 Odessa disturbance was a Category 3a event in the NERC Event Analysis Process, and the combined loss of generation nearly exceeded the Resource Loss Protection criteria for ERCOT as designated in the NERC Standard BAL-003-2: Frequency Response and frequency Bias Setting. This concurrent and unexpected tripping of synchronous generation, in conjunction with the abnormal reduction of power from many solar PV facilities, poses a significant risk to bulk power system reliability. Note that many of the underlying causes of abnormal performance are systemic in nature and cannot be mitigated in a timely manner. This impact covers a wide range of resources and should be captured in system planning assessments or interconnection studies.

The report provides several key findings and recommended actions for NERC and industry:

- Generator owners, especially those affected in this event, should mitigate abnormal performance issues in the Texas Interconnection.
- The IBR performance issues risk profile should be elevated, and immediate ERO Enterprise risk-based compliance activities are needed.
- NERC standards should be enhanced to address IBR performance issue identification, analysis and mitigation.
- A performance-based, comprehensive ride-through standard is needed.
- Level 2 NERC alert(s) should be issued to understand the extent of IBR performance issues and modeling deficiencies.
- NERC should develop Electromagnetic transient (EMT) modeling requirements and accurate EMT models for all bulk power system-connected IBRs.
- The ERO Enterprise and industry should conduct a comprehensive model quality review.
- Updates to the FERC pro forma generator interconnection agreements and procedures should be reiterated.
- Improvements to commissioning practices for IBRs are needed.
- NERC should include these key findings and recommendations in its comments to FERC on the Notice of Proposed Rulemaking directing NERC to enhance the NERC Reliability Standards for IBR issues.

While IBRs present new opportunities in terms of grid control, they also introduce potential risks to the system, as documented by NERC in multiple disturbance reports and related NERC reliability guidelines. In addition, FERC's recent action - Order RD22-4, directing NERC to submit a work plan to register certain IBRs, along with the above-mentioned RM22-12 Notice of Proposed Rulemaking, reinforces the activities and plans presently underway related to IBR registration and NERC standards enhancement.

Refer to NERC Quick Reference Guide: Inverter-Based Resource Activities for more information on work in this area.

CAISO Adopts New Energy Storage Rules

The material below was obtained from: Energy Storage News - California ISO adopts energy storage-friendly Market Reforms (December 22, 2022)

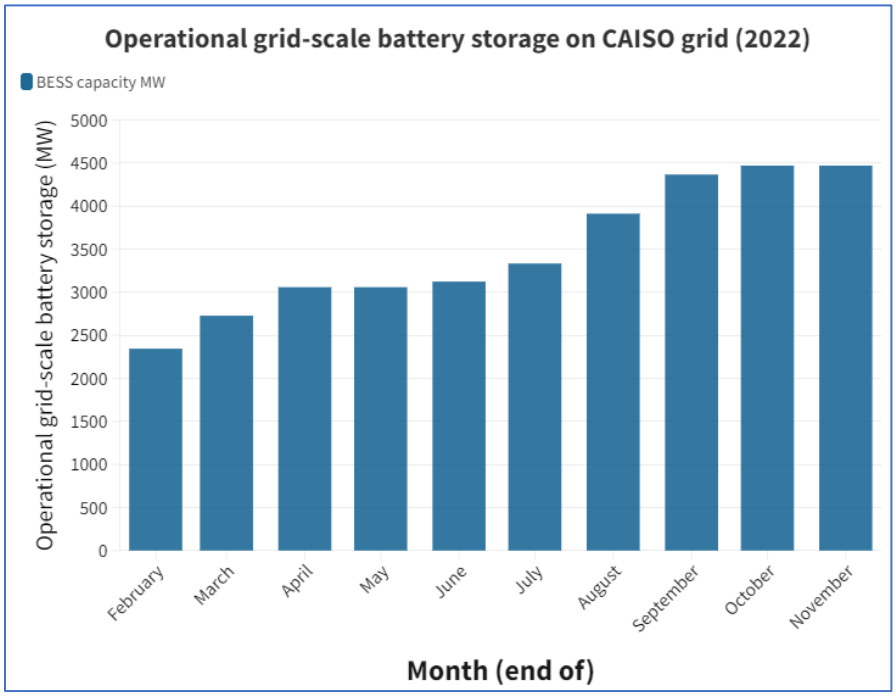
The California Independent System Operator (CAISO) has enacted market rule changes to make it easier for energy storage to provide grid ancillary services and help grid reliability. The Energy Storage Enhancements Final Proposal was adopted by CAISO's governing entities on December 16th, and will be implemented by summer 2023, when extreme heat threatens the stability of the grid.

The rules will make it easier for battery storage systems to provide grid ancillary services, specifically 'regulation up' and 'regulation down' (the other two CAISO procures are spinning reserve and non-spinning reserve). It will do this by making sure that battery systems' energy is accurately priced and that the systems are fully charged when needed by the grid. It also includes provisions to make it easier for co-located energy storage resources to charge from the grid, something many contracts do not allow.

The proposal's first major change looks to enhance the State of Charge equation that governs charging state of storage, in order to improve the alignment of the predicted state of charge with the actual state of charge, when battery systems are providing regulation up and regulation down.

The second major change requires that scheduling coordinators for energy storage resources must submit economic energy bids to charge when awarded 'upward' ancillary services, or economic bids to discharge when providing regulation down. This will ensure that, should a storage resource deviate from its anticipated state of charge, it will still have the ability to charge or discharge if it is in danger of not meeting requirements for providing ancillary services. These changes will apply to both the real-time and the day-ahead markets.

As shown below, its operational capacity over 2022 so far has nearly doubled to just under 5GW as of the end of November. With most systems now four-hour duration, that equates to nearly 20GWh online today.



A helpful overview presentation on the CAISO's Day Ahead Market concepts can be found here.

EPRI Energy Storage Briefing: 2022 Industry Trends and Research Activities

This EPRI Presentation provides a high-level overview of the current state of the energy storage market There is a $15,000 charge for this presentation to non-members or EPRI members who are not funding this program. Refer to product #3002024256 on the EPRI website if interested. A summary of the presentation follows.

Energy storage deployments for this decade are expected to exceed 1 TWh globally, excluding pumped storage hydro. Rapid growth in energy storage will impact all utilities whether they are owning, operating, procuring services, or accommodating through interconnection. Therefore, having knowledge of the current energy storage landscape will support development of utility energy storage strategies and programs.

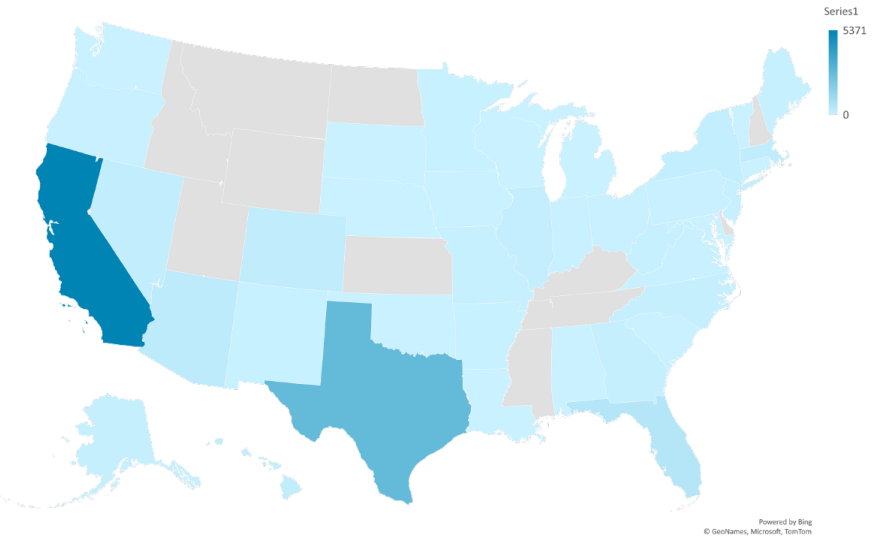
The presentation focuses are these areas:

- Policy impacting energy storage deployment
- Barriers to energy storage deployment
- Trends in energy storage siting, sizing, technology selection, and ownership models
- Market accommodations
- Insights to be gained from evaluating energy storage in interconnection queues, utility integrated resource plans, and other energy storage studies
- Status of energy storage technology development and future outlook

The Graphic below shows Operational Energy Storage in both tabular and graphic format. Both California and Texas have established significant and impactful levels of energy storage.

U.S. Battery Energy Storage in Operation, 2022

State	MW	# Plants
California	5,371	141
Texas	2702	67
Florida	548	13
Arizona	295	15
Massachusetts	249	88
Colorado	235.2	6
Nevada	200	5
Hawaii	182.9	11
New York	149.5	27
Illinois	133	133
Alaska	91.7	5
North Carolina	87	26
Georgia	82	5
Missouri	51.5	51.5
Maine	50	7
West Virginia	48	2
New Jersey	43	6
Indiana	36	36
Oregon	35	2
Pennsylvania	34.6	3



U.S. Energy Information Administration, "Preliminary Monthly Electric Generator Inventory (Form EIA-860M) – July 2022," Accessed September 2022; other sources.

Most energy storage resources are located within organized wholesale electricity markets operated by an ISO/RTO. Some battery projects were developed to provide only one type of market product (e.g., frequency regulation), whereas others provide multiple products.

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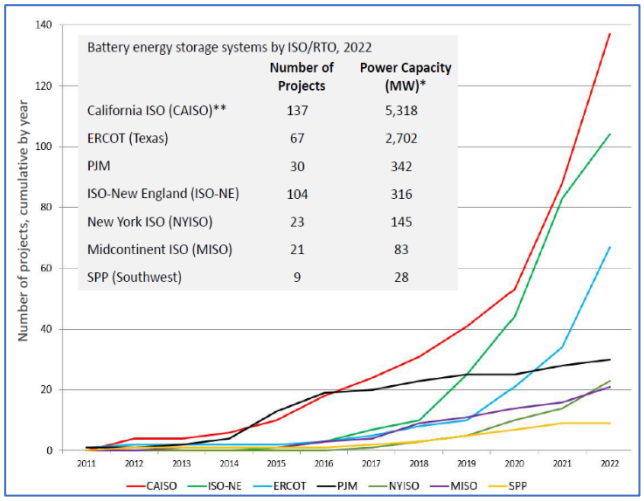
With the exception of SPP, over 2021-22, each ISO/RTO is experiencing an increased pace of installed capacity and number of installations of cumulative energy storage systems, which is expected to continue and accelerate for the rest of the decade.

CAISO had the largest expansion, which dramatically increased the pace of interconnection and had close to 5 GW installed in this period (between stand-alone and hybrid projects), all due to state policy drivers. RCOT's expansion was also significant, with over 2 GW, all due to wholesale market value. The other ISO/RTO regions had much smaller expansions, in total about 150 MW in 2021 and a little over 200 MW in 2022, mostly in ISO-NE and NYISO, also primarily due to state policies.

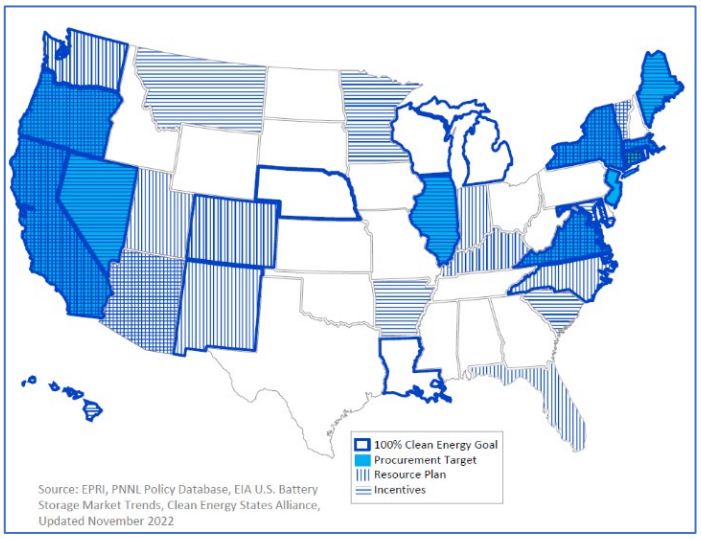


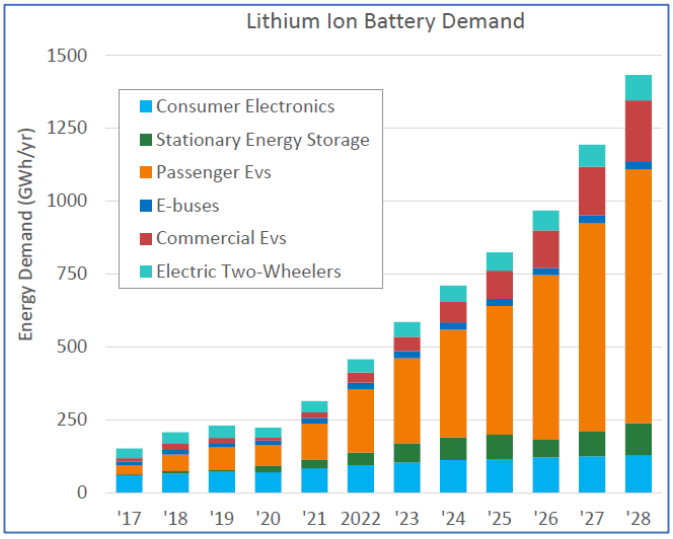
There are several indicators that inform storage forecasts and trends, including:

- Interconnection queues which are commercial indicators of the types and characteristics of projects in different stages of development.
- Capacity expansion modeling/resource planning which are typically associated with utility or state regulator integrated resource planning (IRP), but also in long-term resource portfolio studies by EPRI, national labs, other entities.
- Decarbonization studies which develop resource portfolios for full decarbonization scenarios by 2040-2050 and may influence current resource planning
- Other studies such as storage-specific assessments (typically by states and utilities) or renewable integration studies.

Below Left: U.S. State policies driving energy storage include Clean Energy goals, Procurement Targets (as set by regulators or legislation-based utility requirements), State or internally directed Resource Plans, and state incentives.

Below right: Projected Demand for Lithium Ion Batteries, by industry category. It is anticipated that large battery purchases from EV manufacturers will constrain supplies and create competition for stationary storage providers.





With respect to operations, CAISO has the largest battery fleet operating in the energy markets in the U.S. The batteries on the CAISO system are discharging at between 2-3 GW during peak hours. The batteries in the CAISO system are providing increasing quantities of ancillary services, particularly frequency regulation. During some hours in the middle of the day, the batteries are providing all the Regulation Down requirements.

The table below compares Energy Storage projects within the Interconnection Queues for each ISO / RTO.

Battery Storage in U.S. ISO/RTO Interconnection Queues

Active stand-alone and hybrid battery energy storage projects in the queues as of November 1, 2022

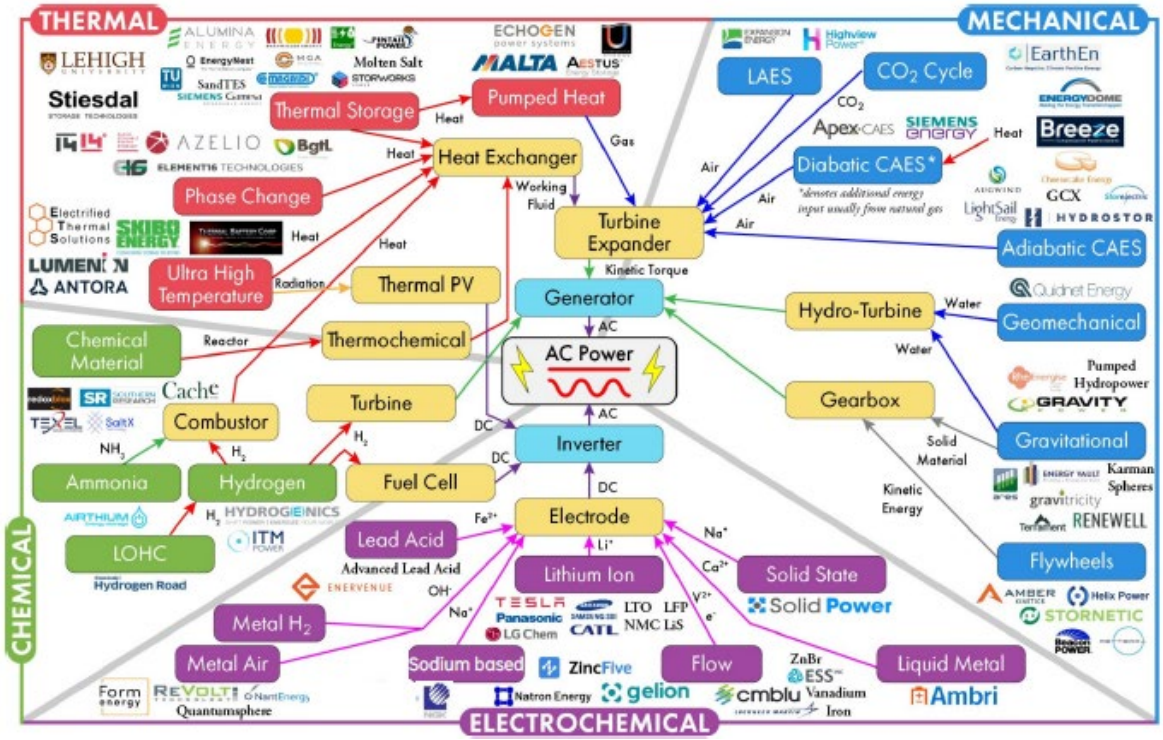
	Number of Battery Projects				Battery capacity (MW)			
	Stand-alone Battery	Solar-Battery	Wind-Battery	Other Hybrid	Stand-alone Battery	Solar-Battery	Wind-Battery	Other Hybrid
CAISO (1)	263	255	8	3	66,512	70,044	3,316	155
ERCOT (2)	254	154	4	6	42,481	19,220	182	816
ISO-NE (3)	113	115	10	7	14,478	2,224	1,081	32
MISO (4)	342	190	4	15	43,403	34,367	1,400	2,210
NYISO (5)	99	4			10,647	928		
PJM (6)	642	385	1		102,085	28,714	150	
SPP (7)	123	36	1		14,634	8,388	110	
Total	1,836	1,139	28	31	29,4240	163,885	6,239	3,213

Differences in queue data conventions make some comparisons not precise. Some key notes are: (1) Solar hybrid includes 7 solar-wind hybrid projects, "Other Hybrid" includes natural gas, geothermal; (2) "Other Hybrid" includes natural gas; (3) "Other Hybrid" includes hydro; (4) Solar hybrids include 5 solar-wind hybrid projects, "other" hybrids unspecified; (5) Hybrids not specified by technology, a few identified by name of project; (6) Capacity is based on Maximum Facility Output, which may overstate some project sizes; (7) Includes as solar hybrids 16 projects which are listed as hybrid and solar but do not specify storage.

Interconnection Queue Source

Battery energy storage projects in the queues have increased significantly since 2020, but there have been withdrawals in some ISOs since 2021

The graphic below shows about 90 different Energy Storage technologies that are currently tracked by EPRI, categorized according to their methodology (Thermal, Mechanical, Chemical and Electrochemical) and arranged according to the pathway for conversion towards AC electrical power.



NYISO: Announcements on the Blog Page of the NYISO Website:

Features from the NYISO Blog Page include the following:

RNA Report: Reliability Findings Hinge on Key Assumptions
The Reliability Needs Assessment (RNA) forecasts system conditions over the next ten years to determine whether the grid will have sufficient generating capacity and transmission capability to meet expected demand. If it does not, a reliability need is declared and the NYISO takes action to resolve it. The identification of reliability needs through this assessment is guided by mandatory reliability rules set by independent reliability organizations or accepted by regulators, including the North American Electric Reliability Corporation, the Northeast Power Coordinating Council, the New York State Reliability Council, and the Federal Energy Regulatory Commission.

While this year's RNA did not identify a reliability need and concludes that the power grid is expected to meet all applicable reliability criteria through 2032, the report emphasizes that already-thinning reliability margins could be eliminated altogether based on identified risk factors. Increased system demand, delayed implementation of planned transmission and generation projects, additional generator deactivations or unplanned outages, and extreme weather are among the risk factors discussed.

In addition to examining the future performance of the grid under expected conditions, the RNA examined multiple scenarios to inform interested parties of other potential reliability risks. In one scenario, the Champlain Hudson Power Express transmission line, which is expected to be in service in the first half of 2026, was assumed to be delayed. As a result of this hypothetical delay, reliability needs could arise on the system beginning in 2028.

To further consider extreme weather, the RNA examined the impact of conditions that are more extreme than the expected weather baseline conditions, such as heatwaves and cold snaps. The system is expected to meet most extreme winter conditions through the study period, though problems could arise as early as the winter of 2028-29 if the 1-in-100 year extreme cold coincides with gas pipeline constraints that limit the availability of gas generation. 1-in-100-year extreme heat wave conditions could cause reliability concerns as early as 2023.

Another scenario modeled the possibility of unanticipated generator retirements by removing the oldest generators from the system until the system could no longer be operated reliably. This scenario concluded that the system would likely need to retain at least 17,000 MW of fossil fuel generating capacity in 2030 to maintain reliability.

The RNA did not identify any reliability needs that would require the NYISO to take action to implement solutions. However, it did reinforce findings from earlier studies that show reliability margins are thinning to concerning levels. And, by analyzing multiple scenarios the RNA identified several risks that could erode or eliminate these thin margins.

This Two-Page Datasheet highlights risks to future reliability in the state, which are presented in greater detail in the 2022 RNA Full Report. Out-takes from the page are shown below:

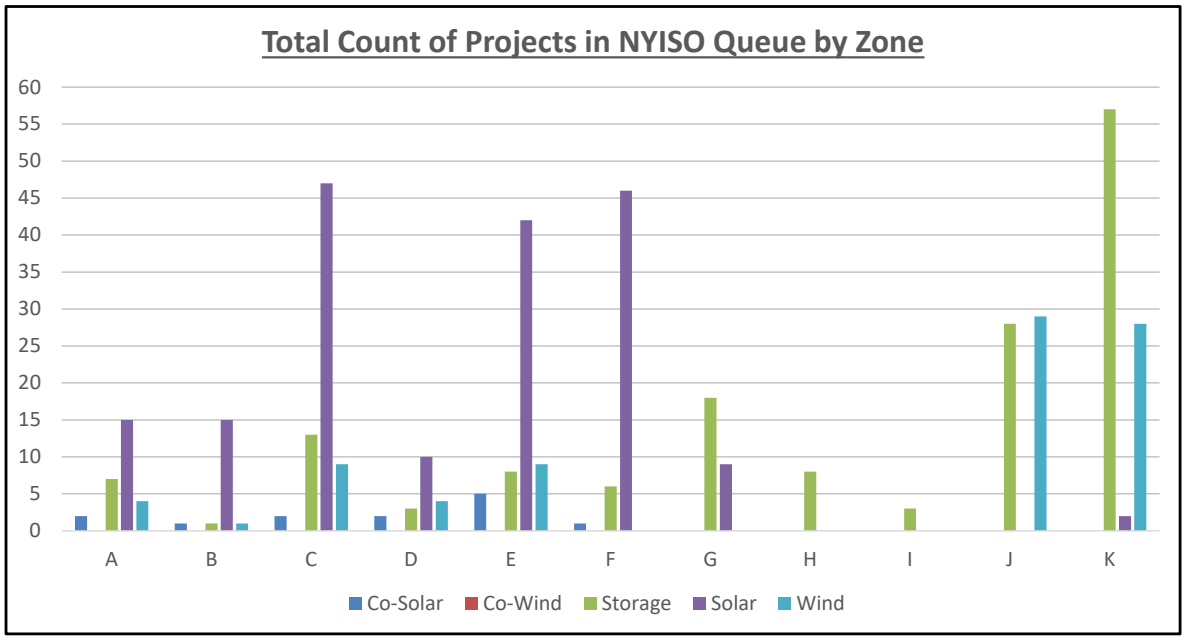
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

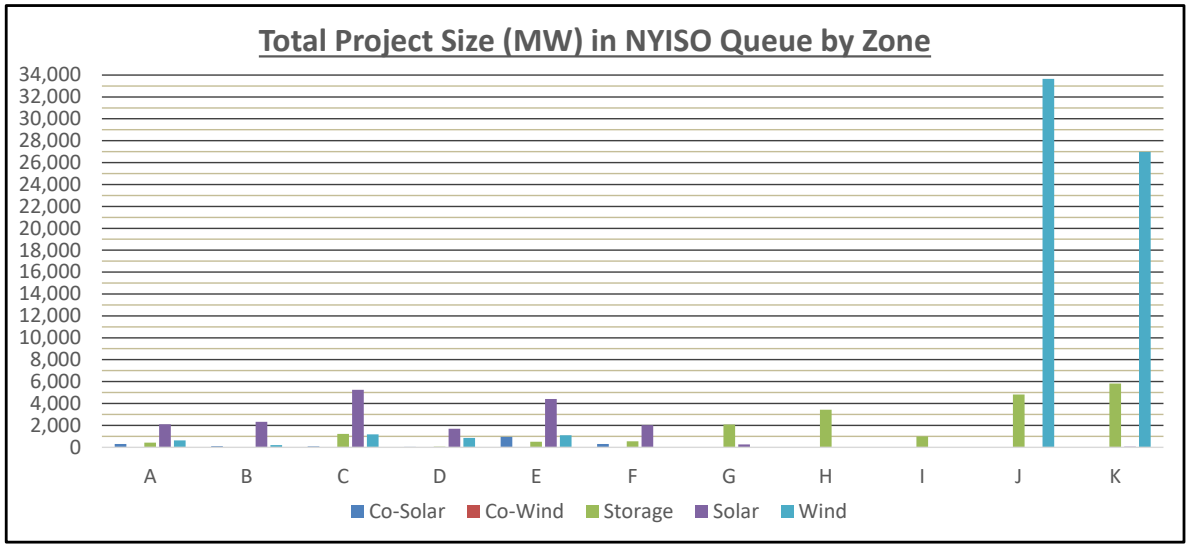
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (Solar and Wind now in separate categories) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on December 20th, and representing the Queue as of November 30th. Note that 23 projects were added, and 5 were withdrawn during the month of November. Results are tabulated below and shown graphically on the next page.

Total Count of Projects in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	2		7	15	4
B	1		1	15	1
C	2		13	47	9
D	2		3	10	4
E	5		8	42	9
F	1		6	46	
G			18	9	
H			8		
I			3		
J			28		29
K			57	2	28
State	13		152	186	84

Total Project Size (MW) in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	290		430	2,090	615
B	100		20	2,327	200
C	70		1,223	5,254	1,184
D	40		60	1,689	847
E	954		492	4,413	1,087
F	300		545	2,024	
G			2,086	250	
H			3,423		
I			1,000		
J			4,815		33,646
K			5,812	59	26,988
State	1,753		19,906	18,104	64,568

Average Size (MW) of Projects in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	145		61	139	154
B	100		20	155	200
C	35		94	112	132
D	20		20	169	212
E	191		62	105	121
F	300		91	44	
G			116	28	
H			428		
I			333		
J			172		1,160
K			102	29	964
State	135		131	97	769


Total Count of Projects in NYISO Queue by Zone
60
55
50
45
40
35
30
25
20
15
10
5
0
A
B
C
D
E
F
G
H
I
J
K
Co-Solar
Co-Wind
Storage
Solar
Wind


Total Project Size (MW) in NYISO Queue by Zone
34,000
32,000
30,000
28,000
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
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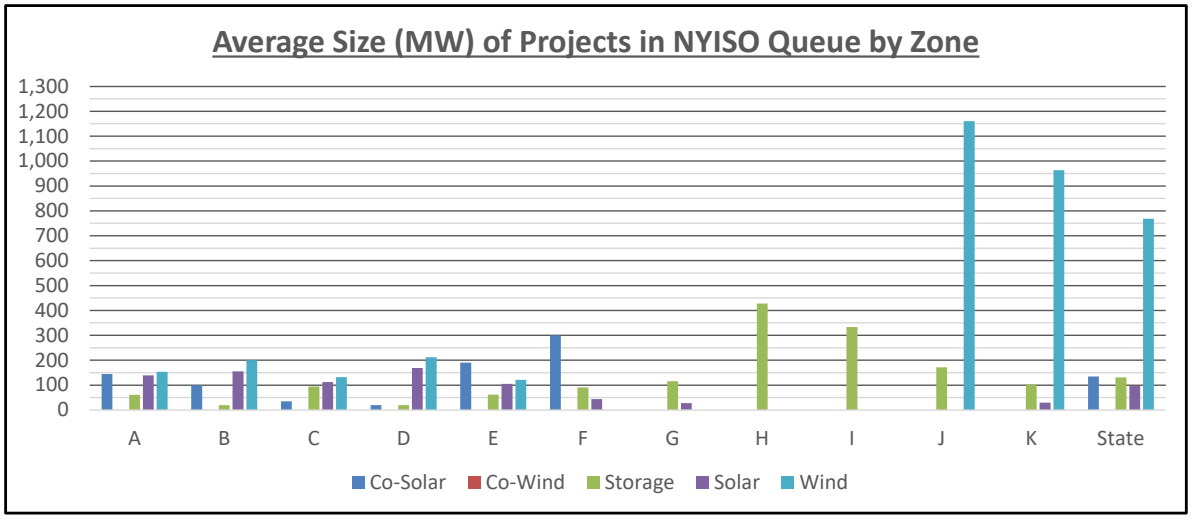
Co-Solar
Co-Wind
Storage
Solar
Wind


Average Size (MW) of Projects in NYISO Queue by Zone
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
A
B
C
D
E
F
G
H
I
J
K
State
Co-Solar
Co-Wind
Storage
Solar
Wind