De-Carbonization / DER Report for NYSRC Executive Committee Meeting 9/10/2021

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The September 2021 edition of the De-Carbonization / Distributed Energy Resources (DER) Report is focused on recent publications from NERC and EPRI. This edition introduces EPRI's Energy Storage Integration Council (ESIC), an industry member group within EPRI dedicated to open technical collaboration in all aspects of Energy Storage. The Interconnection Queue has been updated to reflect the End-of-July values for CSRs (Co-located Storage Resources), energy storage, solar and wind. Topics in this newsletter are covered in the following order:

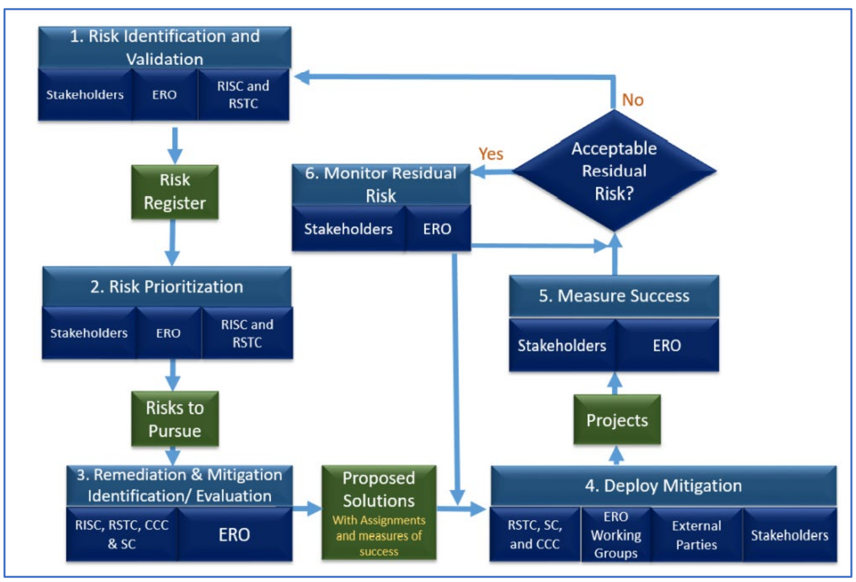
- NERC August Newsletter
  - NERC Report: ERO Reliability Risk Priorities
  - NERC Report: 2021 State of Reliability- An Assessment of 2020 Bulk Power System Performance
- EPRI Energy Storage Integration Council (ESIC)
- EPRI Report: Understanding Usable Energy in Battery Energy Storage Systems
- EPRI LCRI Report – Powering Decarbonization: Strategies for Net CO2 Emissions
- Upcoming Events:
  - NERC Annual Monitoring and Situational Awareness Technical Conference
  - NERC / NATF / EPRI – Power System Planning, Modeling and Analysis
  - EPRI Power Distribution and Utilization Conference (membership required)
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / CSRs (Co-located Storage)

The August issue of the NERC Monthly Newsletter can be found here. Highlights include two following reports:

2021 ERO Reliability Risk Priorities Report

NERC's recently released 2021 ERO Reliability Risk Priorities Report is prepared by the Reliability Issues Steering Committee (RISC), which serves as an advisory committee to NERC's Board of Trustees. The report reiterates the four key risk areas that were identified by the Committee in its previous 2019 Risk Priorities Report. These are: grid transformation, extreme natural events, security risks and critical infrastructure interdependencies. The most significant is grid transformation, which has broad implications as a catalyst for additional changes, often amplifying the impact on reliability, resilience, and security.

The following graphic provides a pictorial flow chart of the ERO's risk management process.



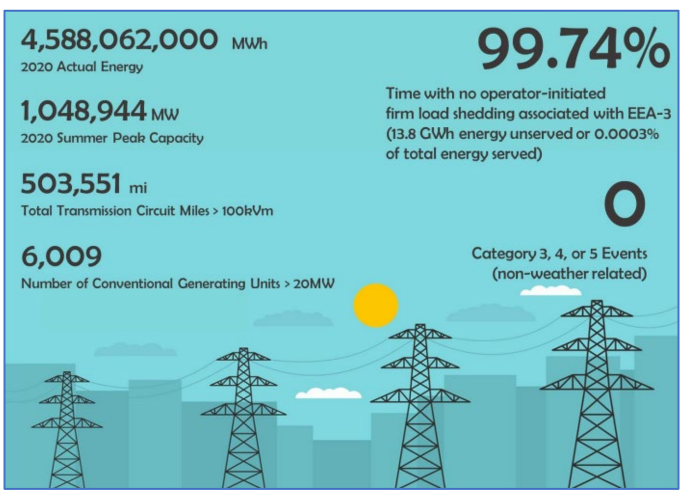
2021 State of Reliability - An Assessment of 2020 Bulk Power System Performance

This Report highlights the health of the interconnected system and the effectiveness of reliability risk mitigation activities. Outages due to human error and equipment failure continued to decline, demonstrating the success of mitigation activities focused on human performance and system maintenance. At the same time, weather events and wildfires caused more transmission outages than in previous years, highlighting the importance of continued preparedness and grid resilience. Other key findings include:

- The bulk power system remained stable in 2020; however, there was an increase in operator-initiated load shedding — a last-resort option to maintain grid stability.
- The transforming fuel mix requires more supplemental and flexible resources to balance supply and demand. More transmission is needed to access these diverse resources.
- Load shed during the summer months shows the growing vulnerability to extreme weather and highlights the energy adequacy risks.
- Supply chain risks increase the threat landscape and underscore the urgency of cyber risk response.
- Advanced planning allowed pandemic impacts to be avoided.

The report's high-level recommendations include:

- The ERO and industry should continue improving their ability to model, plan and operate a system with a significantly different resource mix.
- System planners should evaluate the need for flexibility as conventional generation retirements are considered by industry and policymakers. Retirement planning studies should consider Interconnection-level impacts and sensitivity assessments associated with the loss of critical transmission paths and the loss of local generation in larger load pockets.
- The ERO and industry should develop comparative measurements and metrics to understand the different dimensions of resilience during the most extreme events and how system performance varies with changing conditions.
- The ERO, industry and government should significantly increase the speed and detail of cyber and physical security threat information sharing, to counter the increasingly complex and targeted attacks by capable nationstate adversaries and criminals on critical infrastructure. This should be complemented by a review of cyber security standards, supply chain procurement, risk assessment as well as a review of the CIP standard's bright-line criteria between high-, medium- or low-impact assets.



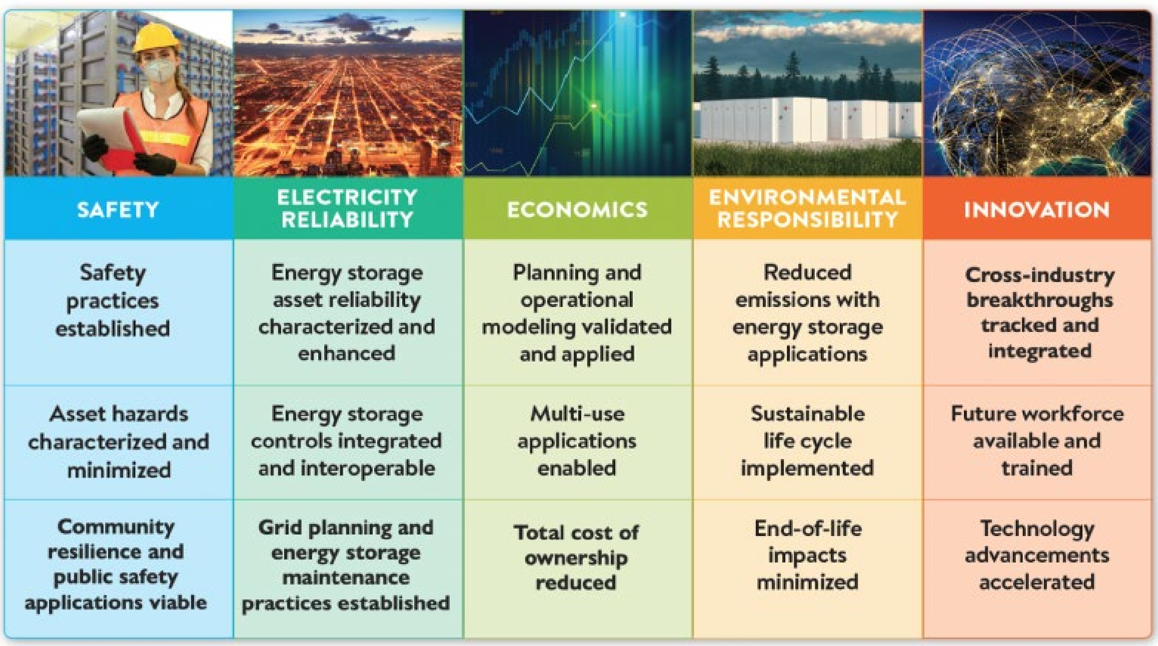
EPRI's Energy Storage Integration Council (ESIC)

ESIC was formed as a dedicated industry collaborative within EPRI, whose purpose has been to advance the deployment and integration of storage through open, technical collaboration. Most of the ESIC website material is publicly available, including all the links in this section. The ESIC Landing Page contains links to a "Wiki", which is a library containing an extensive amount of reference material, as well as a dedicated Newsletter and a tutorial section called Energy Storage 101.

An ESIC Product Overview Presentation provides a summary of the organization and its activities. There are 3 working groups within the organization, focusing on:

- Grid Services and Analysis – How to quantify value, costs, and impacts
- Testing and Characterization – How to measure and express performance
- Grid Integration – How to safely and reliably deploy storage facilities

This overview presentation provided a list of publicly available ESIC resources, which included templates for technical specifications and costs, guides for generating RFP's, testing, commissioning, along with documents relating to safety and fire hazard mitigation. A new Failure Event database has been created for public reference, and an Energy Storage Roadmap for 2025 is also available. A representation of the roadmap's matrix is shown below, with the roadmap on the website providing links for each of the topical areas in the matrix.



SAFETY	ELECTRICITY RELIABILITY	ECONOMICS	ENVIRONMENTAL RESPONSIBILITY	INNOVATION
Safety practices established	Energy storage asset reliability characterized and enhanced	Planning and operational modeling validated and applied	Reduced emissions with energy storage applications	Cross-industry breakthroughs tracked and integrated
Asset hazards characterized and minimized	Energy storage controls integrated and interoperable	Multi-use applications enabled	Sustainable life cycle implemented	Future workforce available and trained
Community resilience and public safety applications viable	Grid planning and energy storage maintenance practices established	Total cost of ownership reduced	End-of-life impacts minimized	Technology advancements accelerated

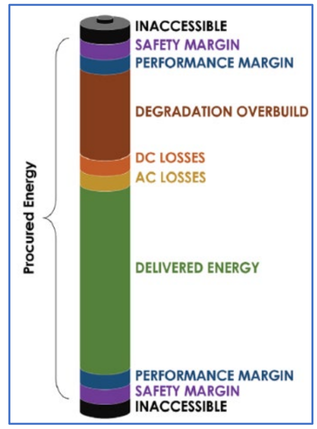
ESIC published the Energy Storage Implementation Guide, a report designed to provide a brief overview for each of the five chronological phases of the life cycle of an energy storage project, including planning, procurement, deployment, operations and maintenance (O&M), and decommissioning. Many important items are hyperlinked in this document to help users quickly navigate to specific content in the guide.

The guide also includes an appendix containing extensive list of 72 "Lessons Learned", representing a collection of information from participating utilities. In addition, a bibliography for Energy Storage Implementation provides a summary of how ESIC products can be applied throughout the implementation process, materials that the working groups have used in the development of those work products, and a list of other publicly available resources.

EPRI Report - Understanding Usable Energy in Battery Energy Storage Systems

This publicly available Report explains some of the more subtle and overlooked concepts that can have a detrimental impact on the capability and efficiency of battery storage equipment over the lifetime of their utilization. Many of these begin their impacts early on following their initiation, and consideration should be given to these factors when anticipating their level of reliability and support throughout their expected service period. The report introduces a new terminology defining Segments of Energy Capacity. These include:

- State of Charge (SOC) Window – operational envelope / voltage range
- Inaccessible – Minimum and Maximum voltage limits, beyond which irreversible damage to the battery would be incurred
- Safety Margin – margin of inaccessibility established by the manufacturer to shield exposure to min and max voltage levels
- Performance Margin – further limitations used to ensure balanced operating performance among parallel units
- Degradation Overbuild – Anticipatory design measures to compensate for degradation during operational life of units
- DC and AC Losses – a variety of impactors, including chemistry, thermodynamic effects, and material degradation.



The concept of Degradation Overbuild was of particular interest. Lithium ion BESS have shorter lifetimes than conventional utility generation and transmission and distribution assets. Lifetime expectations often range from 10–20 years (as opposed to 30–50 years for conventional equipment). BESS may experience significant degradation and energy capacity loss over time with usage. Some factors contributing to degradation are:

- Chemistry – a range of cathode, anode, electrolyte, and separator materials are employed in BESS. These different chemistries have different degradation mechanisms and durability.
- Average State of Charge – a system that spends more time at higher or lower SOC may experience accelerated degradation compared to one that rests at intermediate SOC.
- Throughput – total energy charged and discharged from the system, also sometimes referred to as "cycles", contributes to degradation.
- Depth of Discharge – a larger swing in state-of-charge per cycle typically results in faster degradation Temperature – High and low temperatures may increase degradation rates. Temperature variation within battery systems may also cause uneven wear and tear that accelerates system-level performance.
- Others – manufacturing defects, environmental anomalies, etc.

The BESS remaining energy capacity over time will depend on the application and should be considered when sizing the system. Degradation characteristics are typically provided by the supplier holding the system warranty and may be backed by extensive testing or operational data developed by the manufacturer. Developers, end users, and system planners may overbuild energy capacity to make degradation invisible to the end user, enabling delivery of rated performance for longer periods of time. Degradation overbuild can be accomplished in different ways:

- Initial overbuild—the addition of new energy during construction.
- Augmentation—the addition of new energy in out-years of the BESS service life.
- Acceptance of the degraded performance via progressive de-rating.

Each method has different tradeoffs for the capital and operating expenses of the BESS, as well as its performance. For example, a BESS with large initial overbuild may cost more than augmentation with additional batteries procured in later years. Future cost reductions in batteries and underutilization are weighed against potential upfront policy incentives, such a tax credits applied to initial capital cost, depending on the project. On the other hand, overbuild may result in lower depth of discharge during use, which can reduce degradation rate.

<u>EPRI LCRI Report – Powering Decarbonization: Strategies for Net CO2 Emissions</u>

This highly detailed Report explores scenarios for achieving net-zero emissions targets in the U.S. electric sector in the context of deep economy-wide decarbonization, considering the implications of how the target is defined, the timing of the target, the costs of the transformation, and interactions with the end-use sectors. This research addresses several key questions:

- What does "net-zero" mean, and what are the implications of alternative definitions?
- What are the roles and potential value of different low-carbon technologies?
- What pace of investment is required?
- What are the economic impacts on electricity prices and energy service costs?
- How does electric sector decarbonization enable economy-wide decarbonization?

Key findings from the report include:

- Reducing electric sector emissions up to roughly 80% below 2005 levels can be cost-effectively achieved with a combination of currently available technologies: existing nuclear, a mix of new and existing conventional natural gas, a rapid expansion of wind and solar, and battery storage, along with the retirement of existing coal.
- Achieving electric sector targets beyond 80% requires deployment of emerging low-carbon technologies, including natural gas or bioenergy with Carbon Capture & Storage (CCS), advanced nuclear, and long-duration storage such as hydrogen produced from electrolysis. The optimal combination of these technologies for achieving 100% reductions—and the associated costs—depends strongly on how the target is defined.
- If negative emissions technologies (that is, technologies that remove CO2 from the atmosphere) are allowed, a net-zero electric sector can be configured with a mix of negative and positive emissions, retaining a role for natural gas both with and without CCS and avoiding a sharp increase in electricity prices. Without negative emissions technologies, the costs of reductions near 100% rise sharply, especially if the target is met with only renewables and storage. The analysis considers three definitions of *zero emissions targets*:
  - **Net-Zero Target**: This scenario allows some negative emissions to offset a positive emissions component, allowing the most flexibility and lowest incremental cost. This analysis includes bioenergy with CCS (BECCS) as a representative negative emissions technology.
  - **Carbon-Free Target**: This scenario requires that all sources of generation must be zero-emitting, so the potential flexibility and cost savings from negative emissions technologies are excluded. No CCS technologies or conventional natural gas can contribute because of their small residual emissions.
  - **100% Renewables Target**: This scenario allows only renewable technologies such as wind, solar, hydro, and geothermal as generation sources so that existing and new nuclear are also excluded, further increasing costs. All existing thermal capacity is retired, and firm capacity is provided by Hydrogen capacity fueled by electrolysis and over 200 GW of battery storage.

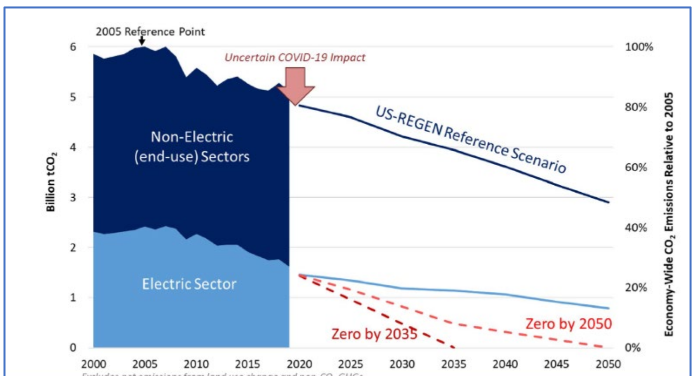


Figure 2. U.S. Economy-Wide CO_2 Emissions in Reference Scenario plus Electric Sector Targets

Upcoming Events:

NERC Annual Monitoring and Situational Awareness Technical Conference

The theme of this year's conference is "New Normal in Energy Management System." This year's conference will unite expertise from various utilities to share cutting-edge ideas and good industry practices, and to identify trends and lessons learned from events across different vendors, energy management system platforms, and Interconnections. There will be three different conference sessions to choose from:

- Session 1 - September 23, 2021 1pm-3pm Overview of the Bulk Power System Register
- Session 2 - October 7, 2021 1pm-3pm Distributed Energy Resources Register
- Session 3 - October 28, 2021 1pm-3pm Technique and Workforce Challenges Register

Joint NERC/NATF/EPRI 2021 Planning and Modeling Virtual Seminar

Join the North American Electric Reliability Corporation (NERC), the North American Transmission Forum (NATF), the Electric Power Research Institute (EPRI), and many industry experts to discuss current topics related to power system planning, modeling, and system analysis.
Planned topics include:

- Latest industry activities and NATF member experiences when planning for hybrid plants and bulk electric system storage on the bulk power system
- Integrating security into planning and modeling practices for grid resilience
- Using climate information to assess the impacts of extreme events on the bulk power system
- Latest EPRI research and uses of technology impacting the utility industry
- Insight into NERC guidelines that support Planning Coordinator and Transmission Planner activities

Day 1: Wednesday November 3, 2021	1:00 p.m. – 4:00 p.m.	Registration Link for Day 1
Day 2: Thursday November 4, 2021	1:00 p.m. – 4:00 p.m.	Registration Link for Day 2

EPRI's September Power Distribution and Utilization (PDU) Advisory Conference

This bi-annual conference will take place between September 13^{th} and 20^{th}, and will have over 100 separate sessions covering topical areas of interest, including Energy Storage, Renewables (at both the bulk power and distribution levels), Distributed Energy Resources and Management Systems, EV's, electrification, etc.

Attendance is open for most Advisory sessions, but you must have EPRI membership, and you must register in advance for each session to receive the invitation to the meeting. Use this link to start the registration process: www.epri.com/research/sectors/pdu/events.

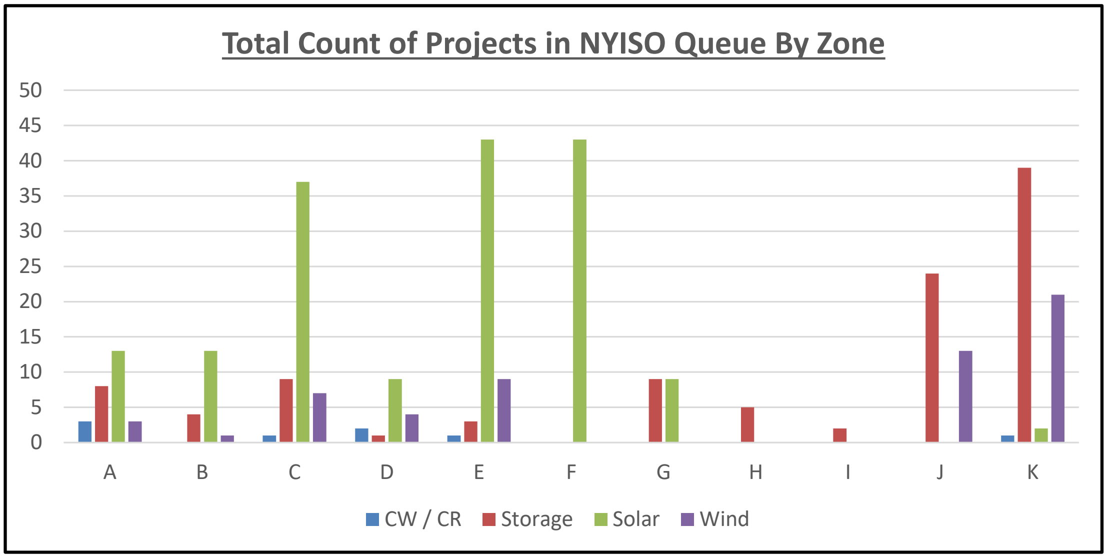
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

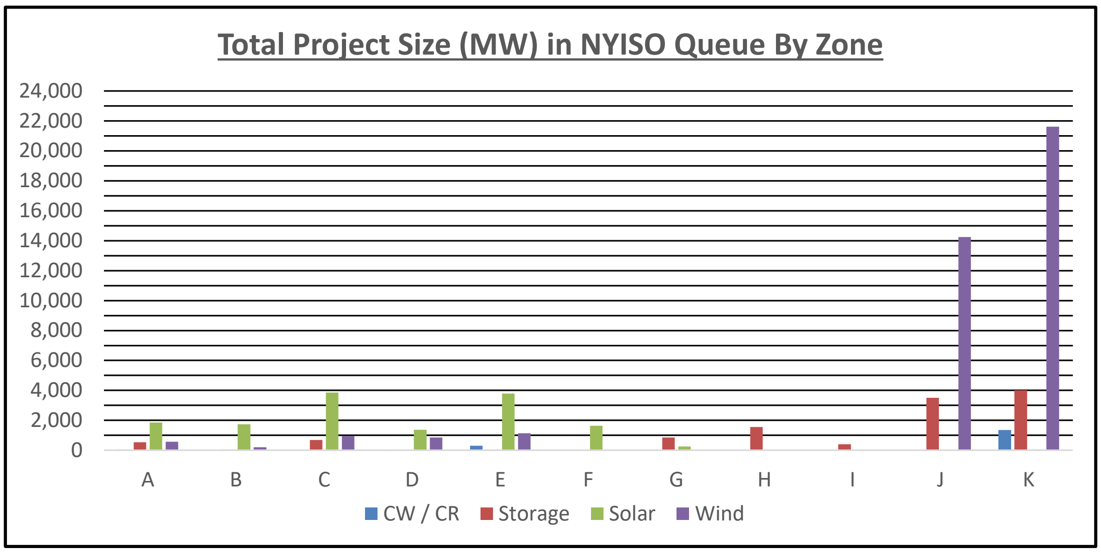
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (CW / CR) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on August 16th, and representing the Queue as of July 31st. Note that 11 projects were added and 5 were withdrawn during the month of July. Results are tabulated below and shown graphically on the following page.

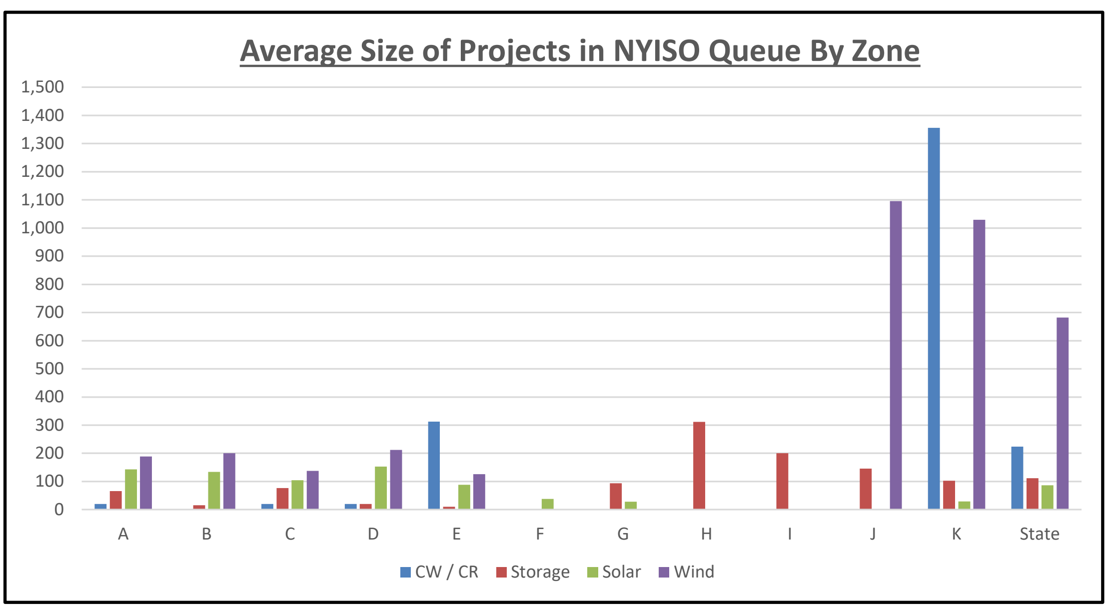
Total Count of Projects in NYISO Queue By Zone				
Zone	CW / CR	Storage	Solar	Wind
A	3	8	13	3
B	0	4	13	1
C	1	9	37	7
D	2	1	9	4
E	1	3	43	9
F	0		43	
G	0	9	9	
H	0	5		
I	0	2		
J	0	24		13
K	1	39	2	21
State	8	104	169	58

Total Project Size (MW) in NYISO Queue By Zone				
Zone	CW / CR	Storage	Solar	Wind
A	60	530	1,860	566
B	0	61	1,745	200
C	20	689	3,852	960
D	40	20	1,377	847
E	313	30	3,789	1,135
F	0		1,645	
G	0	847	250	
H	0	1,560		
I	0	400		
J	0	3,504		14,248
K	1,356	4,009	59	21,618
State	1,789	11,651	14,577	39,574

Average Size (MW) of Projects in NYISO Queue By Zone				
Zone	CW / CR	Storage	Solar	Wind
A	20	66	143	189
B	0	15	134	200
C	20	77	104	137
D	20	20	153	212
E	313	10	88	126
F	0		38	
G	0	94	28	
H	0	312		
I	0	200		
J	0	146		1,096
K	1,356	103	29	1,029
State	224	112	86	682


Total Count of Projects in NYISO Queue By Zone
50
45
40
35
30
25
20
15
10
5
0
A
B
C
D
E
F
G
H
I
J
K
CW / CR
Storage
Solar
Wind


Total Project Size (MW) in NYISO Queue By Zone
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
A
B
C
D
E
F
G
H
I
J
K
CW / CR
Storage
Solar
Wind


Average Size of Projects in NYISO Queue By Zone
1,500
1,400
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
CW / CR
Storage
Solar
Wind