Attachment #8.1
Return to Agenda

De-Carbonization / DER Report for NYSRC Executive Committee Meeting 4/14/2023

Contact: Matt Koenig (koenigm@coned.com)

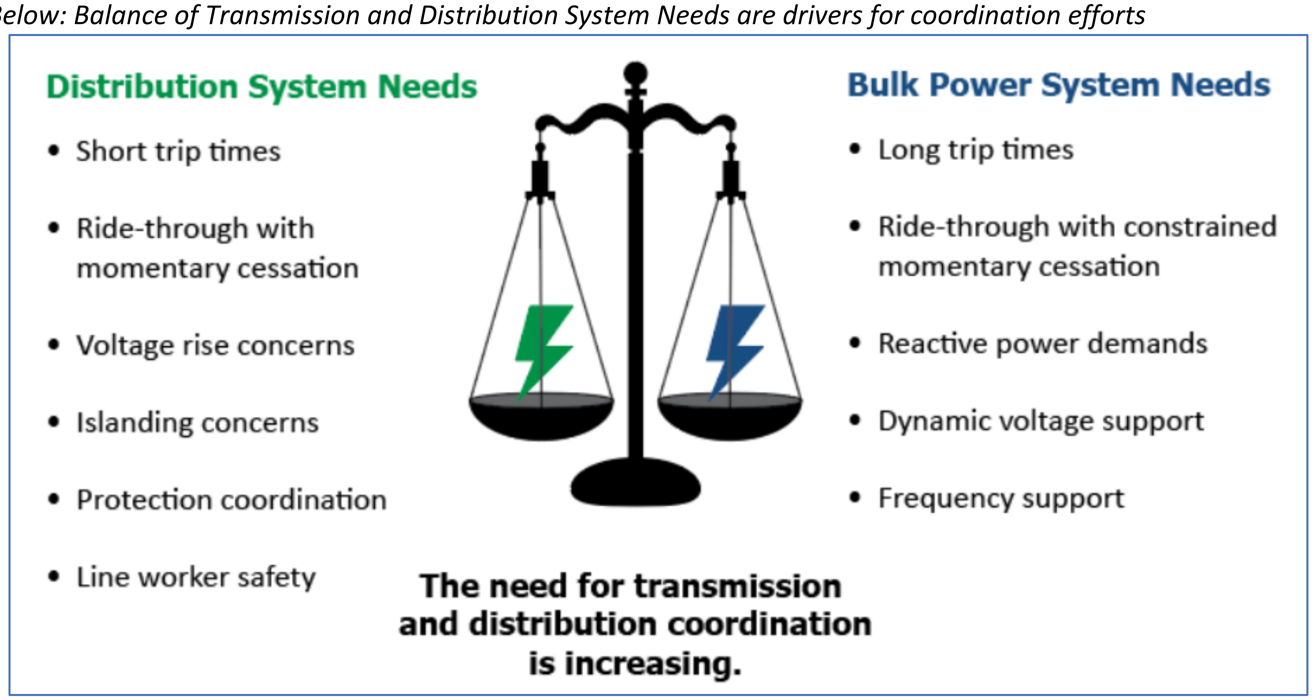
The April 2023 edition of the De-Carbonization / Distributed Energy Resources (DER) Report is primarily focused on NERC-related activities, and includes the following items:

- NERC RSTC Approves Reliability Guideline on Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018
- NERC Issues Level 2 Alert on Inverter-Based Resource Performance Issues for Generator Owners
- NERC MRC/BOT Meeting Technical Session – Recap of Inverter-Based Resource Panel
- Article: Advancing New York's Clean Energy Future with NYISO'S New Class Year
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / Co-located

NERC RSTC Approves Reliability Guideline on Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018

The SPIDER (System Planning Impacts from DER) Working Group has updated the reliability guideline, which was approved by the Reliability and Security Technical Committee (RSTC) on March 22. The document is entitled: Reliability Guideline: Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018 and can be found on the Reliability Guidelines Page. It provides high-level guidance and BPS reliability perspectives that should be considered during the adoption and implementation of IEEE 1547-2018. Specifically, this guideline focuses on issues that pertain to DERs that have been identified by NERC SPIDERWG as potentially having an impact on the BPS. This reliability guideline addresses key clauses in IEEE 1547-2018 in detail to ensure that BPS reliability perspectives and recommended considerations are made clear. These include the following: voltage and frequency mandatory trip settings, ride-through capability, DER enter service and return to service operation, DER controls configuration, interoperability, and local DER communication interface considerations.

Below: Balance of Transmission and Distribution System Needs are drivers for coordination efforts

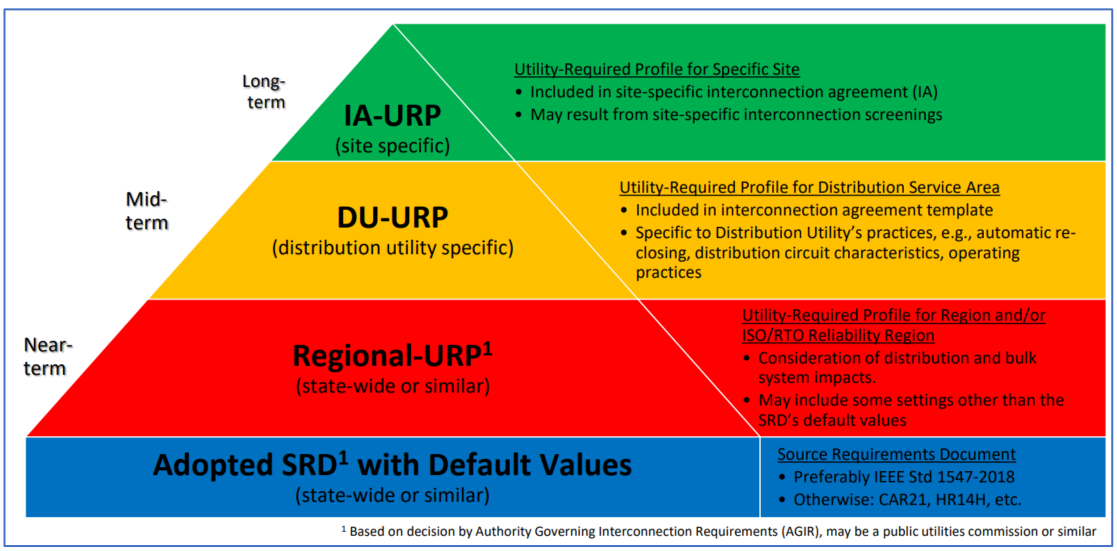


The document introduces the concept of the "Authority Governing Interconnection Requirements" or AGIR: It is defined as a cognizant and responsible entity that defines, codifies, communicates, administers, and enforces the policies and procedures for allowing electrical interconnection of DER to the area Electric Power System (EPS). An AGIR can be a state regulator, a municipal governing board, or a cooperative governing board. DPs should be aware that a high degree of technical involvement is necessary for successfully implementing IEEE 1547-2018. Additionally, coordination across many stakeholders is also necessary. RCs, Planning Coordinators (PCs), Transmission Planners (TPs), Transmission Owners (TOs), Transmission Operators (TOPs), BAs, state regulatory agencies, manufacturers, and developers will likely all have a stake in how IEEE 1547-2018 is implemented for each local jurisdiction. Collaboration at the state-level and regional-level are encouraged to engage all necessary stakeholders. The goal is that involvement from all interested stakeholders will lead the state regulatory entities and DPs to the successful selection of appropriate settings within IEEE 1547-2018 and appropriate enforcement of the standard across all DERs connecting to their grid.

Adoption of IEEE 1547-2018 requires entities to make decisions regarding how to implement the standard. Learnings from ongoing regional adoption suggest including selection of the following:

- Normal operating condition reactive power-voltage regulation (IEEE 1547-2018, Clause 5)
- Abnormal voltage and frequency ride-through performance categories (IEEE 1547-2018, Clause 6)
- Voltage and frequency regulation settings (IEEE 1547-2018, Clauses 5 and 6)
- Selection of standardized communication protocols (IEEE 1547-2018, Clause 10)

The figure below illustrates the various levels of DER functional settings with regional settings expected in the near-term and site-specific settings in the long-term.



BPS Perspectives and Recommendations – General Remarks

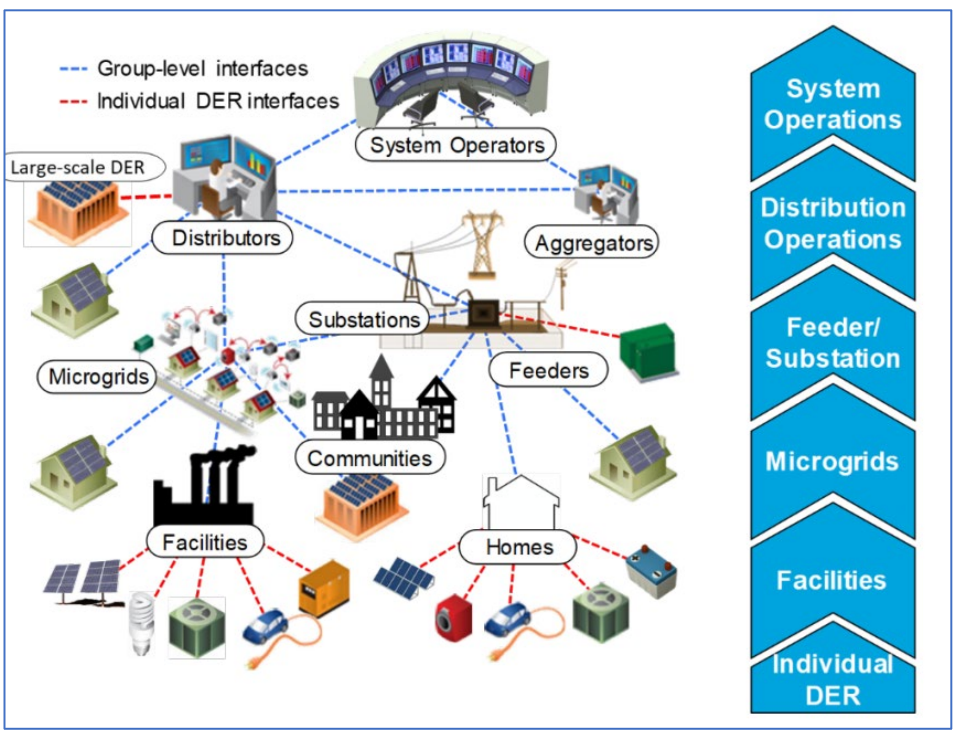
- Decisions related to ride-through capability and trip settings should be addressed in the near-term because the aggregate impact from undesired choices will accumulate over time, and large-scale reconfiguration or retrofit of DERs could be challenging and costly. AGIRs should look to begin proceedings for the adoption of IEEE 1547-2018 and start with decisions on ride-through capability to mitigate the potential need to retrofit DERs.
- Default settings have been chosen to "do no harm" for BPS reliability. However, each of these default settings should be reviewed and coordinated between the DP and RC to ensure that they do not have any conflicts with BPS, regional, and distribution system reliability and safety criteria.

- Any modifications to the default settings should consider the range of allowable settings as specified in IEEE 1547-2018, and the AGIR (in coordination with all stakeholders, particularly the RC) should make appropriate modifications within the ranges of adjustability that best suits each jurisdiction. The RC should be informed of settings that differ from established defaults to ensure the DERs are accurately modeled in reliability studies

Additional summaries cover the following areas of concern:

- Clause 6.4.1 Mandatory Voltage Tripping Requirements
- Clause 6.4.2 Mandatory Voltage Ride-Through Requirements
- Clause 6.5.1 Mandatory Frequency Tripping Requirements
- Clause 6.5.2 Frequency Disturbance Ride-Through Requirements
- Clause 6.4.2.7 Restore Output
- Clause 6.5.2.7 Frequency Droop
- Clause 6.5.2.7.1 Frequency Droop Capability
- Clause 6.5.2.7.2 Frequency Droop Operation
- Clause 6.5.2.8 Inertial Response
- Clause 6.5.2.6 Voltage Phase Angle Change Ride-Through
- Clause 6.6 Enter Service and Return to Service
- Clause 8.1 Unintentional Islanding
- Clause 8.2 Intentional Islanding
- Clause 10 Interoperability, Information Exchange, and Protocols

The figure below illustrates one of many communications interface models that could be utilized and that should be considered by each AGIR as needed. Coordination between system operators and DER aggregators/operators could be essential as DER are enabled to provide services to wholesale markets, transmission, and distribution systems. Lack of coordination could limit quantities of DER, reduce grid asset utilization, reduce the accuracy of studies, and compromise safety and reliability.



NERC issues Level 2 Alert Focused on Inverter-Based Resource Performance Issues for Generator Owners

On March 14th, NERC issued the [Inverter-Based Resource Performance Issues Alert](), which is a 9 page document being distributed to Generator Owners (GOs) of Bulk Electric System (BES) solar photovoltaic (PV) generating resources. This alert comes after NERC analyzed multiple large-scale disturbances involving widespread loss of inverter-based resources (IBRs), which resulted in abnormal performance across several BES solar PV generating resources. These resources have exhibited systemic performance issues that could lead to potential widespread outages if they persist.

Note: This alert pertains specifically to solar PV resources, however, the recommendations may be applicable to BPS-connected battery energy storage systems (BESS). This alert does not pertain to wind resources as the observed performance issues are different.

As a Level 2 Alert, this document contains recommendations for specific actions that should be taken, and entities registered under the GO function are required to acknowledge receipt and respond to a series of questions. Responses are due by midnight Eastern on June 30, 2023. NERC strongly recommends that registered GOs also adopt the recommendations and supply data for their non-BES solar PV facilities so that NERC can more comprehensively assess potential BPS reliability risks in this area. While entities other than GOs are not required to submit a response, NERC also advises that all registered entities assess the content of the alert for applicability to their operations and incorporate recommendations where possible.

The alert also seeks to gather data from solar PV asset owners to understand whether additional actions are necessary to mitigate possible BPS performance risks. Applicable GOs are strongly encouraged to consult their inverter- and plant-level controller manufacturers, review inverter settings and controls currently installed in the field, implement the recommendations, and review this information with the associated Generator Operators (GOPs) as applicable. NERC registered entities had to acknowledge receipt of these recommendations by March 21st and are required to report on the status of their activities related to these recommendations by June 30th.

GOs of all BPS-connected solar PV resources who are receiving this Industry Recommendation are strongly encouraged to adopt the following recommendations:

- **Recommendation 1:** Coordinate with inverter manufacturers to ensure that inverter protection settings are set using the following principles:
    - Expand AC voltage protection settings as widely as possible within the inverter equipment capability. Eliminate or minimize the use of inverter instantaneous AC voltage tripping (e.g., zero or near-zero3 time delay using instantaneous peak measurements)
    - Inverter frequency protection should be set based on equipment capability. Frequency protection should operate on a filtered frequency measurement over a time window.4 Eliminate or minimize the use of inverter instantaneous frequency tripping.
    - Inverter instantaneous AC overcurrent protection should be set based on maximum inverter capability. Inverter phase lock loop loss of synchronism and/or phase jump protection should be set as widely as possible (or eliminated, if possible) to maximize ride through capability while still preventing equipment damage or degradation.
    - Inverter dc bus protection should be configured to prevent equipment damage or degradation and to avoid any inadvertent tripping in response to BPS faults, particularly unbalanced faults.
    - Document all inverter AC and DC protections, including technical basis as well as the inverter capability curves (particularly for items a–e above).
    - Inverter reconnection settings (voltage and frequency levels and time delay) should be coordinated with inverter protection settings and the requirements established by the Balancing Authority (BA).

- **Recommendation 2:** Ensure that all collector systems and substation protection settings at the facility are set using the following principles:
  - Protection settings should be based on the equipment they are intended to protect
    - Eliminate or minimize the use of instantaneous voltage tripping
    - Eliminate or minimize the use of instantaneous frequency tripping. Frequency protection should operate on a frequency measurement over a time window
  - Protection settings should be coordinated with inverter- and plant-level protection and controls.
  - Protection settings in the power plant controller should generally be disabled.

- **Recommendation 3:** Coordinate with inverter manufacturers to document and mitigate known causes of inadvertent protection system operation during normally cleared BPS faults. Inverter hardware or firmware updates should be completed for all inverters supplied by manufacturers that have observed inadvertent operations of protection systems including, but not limited to, the following:
  - Instantaneous voltage protection settings
  - Instantaneous frequency protection settings
  - Instantaneous overcurrent protection settings
  - DC bus protection functions and settings
  - Phase lock loop protection settings

- **Recommendation 4**: Coordinate with inverter manufacturers and power plant controller manufacturers to ensure that facility control modes, fault ride through modes and parameters, and protections are set and coordinated according to the following principles:
  - Inverter- and plant-level fault ride through controls should be set and coordinated to ensure maximum ride through capability and the provision of essential reliability services.
  - Fault ride through parameters should be set to maximize active current delivery during the fault and post-fault periods unless otherwise limited by its current limit or reactive power priority mode. Reactive power priority modes should be set to minimize reductions in active current, while providing and prioritizing a strong and appropriate reactive current response.
  - All protection settings should be set to maximize ride through performance, while still preventing damage to or degradation of the equipment.
  - Facility output returns to pre-disturbance active power levels as soon as possible without any artificial ramp rate limit or delay imposed by the power plant controller. Ramp rates established by the BA for dispatch should not impede plant recovery of active power post-fault

- **Recommendation 5:** Coordinate with inverter manufacturers in instances where IBRs fail to ride through BPS faults to proactively determine and implement potential corrective actions.

- **Recommendation 6:** Coordinate with inverter manufacturers and power plant controller manufacturers to not artificially limit dynamic reactive power capability delivered to the point of interconnection during normal operations and BPS disturbances. Power plant controllers should not hinder the full utilization of available dynamic reactive capability during or following BPS faults. 9 For example, plant dynamic reactive power capability should not be artificially limited to ±0.95 power factor across the full range of active power capability (e.g., a triangular capability curve).

- **Recommendation 7:** Provide the findings from this alert with respective TO, TP, PC, TOP, RC, and BA. These findings include the Data Submission Worksheet and any information regarding deficiencies in ride through performance. Any potential changes to equipment installed in the field should be coordinated with these entities, as required by NERC Reliability Standards.

NERC MRC/BOT Meeting Technical Session – Recap of Inverter-Based Resource Panel

NERC launched a Technical Session at its February 2023 Member Representatives Committee/Board of Trustees meetings, with a panel dedicated to the challenges faced by BPS-connected inverter-based resources. The discussion noted that essential reliability services must be provided, and future grid conditions studied if reliability is to be maintained. Key takeaways from the panel discussion included:

- **Paradigm Shift for Inverter Technology:** The previous "get out of the way" strategy is not acceptable under rapidly increasing penetrations of IBRs. BPS-connected inverter-based resources must provide essential reliability services, support the BPS during normal and disturbance conditions, and provide sufficient information and data to ensure transmission entities can reliably and effectively operate the grid. It is imperative that both the inverter and plant controllers be configured in a way that supports grid reliability.
- **ERO Enterprise Forensics and Technical Leadership:** Developing mitigating measures, working with asset owner/operators and equipment manufacturers, and sharing lessons learned widely with industry stakeholders has been paramount to BPS reliability to-date. However, reliance on recommendations and guidance has proved insufficient for mitigating these risks moving forward.
- **Interconnection Requirements:** The lack of uniformity, clarity, consistency, enforcement, and detail in the interconnection requirements and processes has led to unreliable operation of BPS-connected inverter-based resources and the widespread abnormal performance of resources during grid disturbances. These unexpected grid disturbances have grown in likelihood and magnitude for more than seven years.
- **Reliance On and Challenges with the FERC Interconnection Agreements and Procedures:** The facilitation of the interconnection queue needs to be differentiated (and possibly bifurcated) from the establishment of performance requirements that define BPS reliability. The focus to date has been on the Transmission Owner having interconnection requirements (FAC-001) and the Transmission Planner and Planning Coordinator conducting reliability studies (FAC-002) during that process. However, all entities will have those requirements and conduct those studies per the FERC interconnection process. The requirements must be updated to ensure that the "interconnection customer" actually comply with the established performance and modeling requirements throughout the process, otherwise face explicit corrective actions to address any shortcomings prior to the interconnecting customer's planned commercial operation date.
- **Reliability Due Diligence during the Interconnection Process:** BPS reliability must be given due diligence during the interconnection process; however, those activities may conflict with legal and financial pressure during the interconnection process as well as political pressure related to renewable energy targets. Ensuring an effective and efficient interconnection process that gives credence to adequately studying and mitigating possible BPS reliability issues is paramount to a sustainable electricity delivery system of the future.
- **Equipment Standardization:** Lack of equipment standards have challenged the interconnection of inverter-based resources. IEEE 2800-2022 outlines minimum performance specifications and is based on state-of-the-art IBR capabilities. Development and implementation of this standard is necessary but not sufficient to address ongoing reliability risk issues in this area. Implementation of this standard solely for newly interconnecting resources ("grandfathering" existing facilities) will not address systemic risks posed to BPS reliability today. Furthermore, many of the procedural challenges that occur during the interconnection and commissioning processes cannot be addressed solely by reliance on IEEE 2800-2022 adoption.
- **Changing Needs for Modeling and Reliability Studies:** The need for more detailed and accurate modeling while performing reliability studies during interconnection studies and annual planning assessments are challenging Transmission Planners and Planning Coordinators. Namely, the necessity for conducting detailed electromagnetic transient (EMT) studies in many areas is problematic for many entities as there is limited expertise in this area and significant computational requirements.

- **Enhanced Commissioning Practices Needed:** There are currently no commissioning requirements within the NERC reliability standards for newly interconnection resources. However, the ERO Enterprise has observed numerous situations in which the facility commissioned does not match the model provided and used for studies throughout the interconnection process. This results in the system being operated in an unknown operating state. Non-compliance with interconnection requirements or NERC standards are generally only identified after a major event occurs rather than proactive auditing and study.
- **Agile Modernization of NERC Reliability Standards:** There are numerous existing NERC standards projects underway to modernize the NERC reliability standards to ensure applicability, clarity, and consistency for inverter-based technologies. FERC has also issued a Notice of Proposed Rulemaking regarding NERC standards enhancements to address inverter-based resource risks raised by the ERO.
- **Risk-Based Compliance Enhancements:** ERO Enterprise Compliance Monitoring and Enforcement Program (CMEP) activities will need to account for the significantly elevated risk that IBRs pose to BPS reliability and take necessary actions to assure entities are adequately complying with all associated NERC standards.
- **Registration Focus:** Industry is increasingly challenged with addressing reliability issues for unregistered inverter-based resources, and those resources are reaching critical mass in some parts of the country. The lack of requirements currently imposed on those resources creates local and regional reliability risks to the BPS in aggregate. NERC will strengthen its advocacy, particularly with State regulators and the National Association of Regulatory Utility Commissioners (NARUC). Furthermore, NERC has submitted a work plan to FERC to address registration of inverter-based resources more comprehensively.
- **Cyber Security Concerns:** Cyber security continues to be a top concern for industry, particularly with an increasing amount of generation that is not subject to the NERC Critical Infrastructure Protection (CIP) standards. Concerns include:
    - The growing level of DERs often connected directly to the Internet as well as unregistered inverter-based resources on the BPS that are also not subject to the NERC CIP Standards
    - The introduction of DER Aggregators, their control of many DERs across a large footprint, and their lack of applicability to the NERC CIP Standards
    - The prevalence of vendor/manufacturer remote access and potential cross-border control center operations
    - Securing the overall electricity ecosystem for this vastly changing resource mix.

  As part of the Security Integration Strategy, NERC is supporting industry with advances in DER cyber security and recommended security practices for unregistered inverter-based resources on the BPS.
- **Looking to the Future:** It is imperative that industry not let the challenges of today (e.g., fundamental and reliable provision of essential reliability services from inverter-based resources) deter from the focus of system integration and interoperability issues ahead. Example topics include:
    - The need for system strength and stability measures (e.g., identifying the need for "grid forming" inverter technology, synchronous condensers, etc.)
    - Impacts to BPS protection systems, rapid growth of offshore wind
    - Resourcing large-scale EMT studies.

  Beyond the engineering, design, planning, and operation of these resources, changes to resource and energy adequacy due the variable nature of these resources (mostly renewable energy resources) also pose BPS reliability risks that must be adequately addressed moving forward.

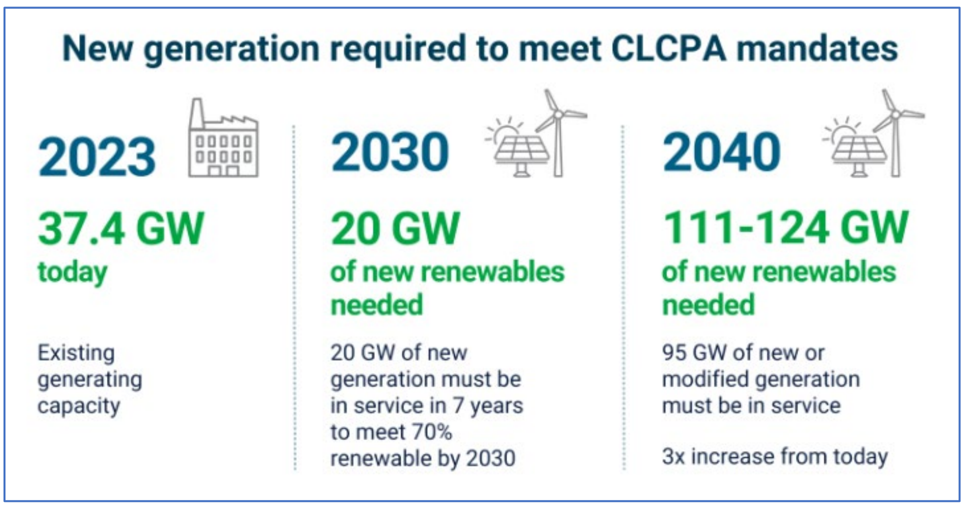
Reference Links from the report:

Link Long Term Reliability Assessment – December 2022
Link 2022 Odessa Disturbance Report
Link Compliance Guidance
Link Major Event Analysis Reports
Link ERO Enterprise Registration Procedure
Link IEEE SA: Standard IEEE 2800-2022
Link Reliability Guidelines, Security Guidelines, Technical Reference Documents and White Papers
Link Dept. of Energy E Library – RM22-12-000: Reliability Standards to Address Inverter-Based Resources

NYISO: Announcements on the Blog Page of the NYISO Website:
Features from the NYISO Blog Page include the following:

Article: Advancing New York's Clean Energy Future with NYISO'S New Class Year
The NYISO has announced the launch of the 2023 Class Year, one month after the completion of the previous process. It is projected that approximately 80-90 projects will be included in the 2023 Class Year. In the prior Class Year, the NYISO completed study of 53 projects, 27 of which included wind, solar, energy storage, and transmission that selected to move forward to the next step in the interconnection process. There has been an unprecedented increase in the number of projects seeking to connect to the bulk power system since the passage of the CLCPA in 2019. This increase, which is attributable to public policy mandates, has increased workloads and the time necessary to complete required reliability studies. The interconnection process involves coordinating multi-stakeholder involvement to complete the necessary studies for each project.

The graphic below was included to show both the current levels and future CLCPA requirements for renewables in the state.



In an effort to make the Class Year process more efficient and encourage the development of renewable energy, the NYISO is pursuing reforms under three broad categories:

- Improved and more transparent communication with Developers
- Efficient administration and coordination between parties
- Revised scope and structure of the interconnection process to make the Class Year Study and entire process more efficient.

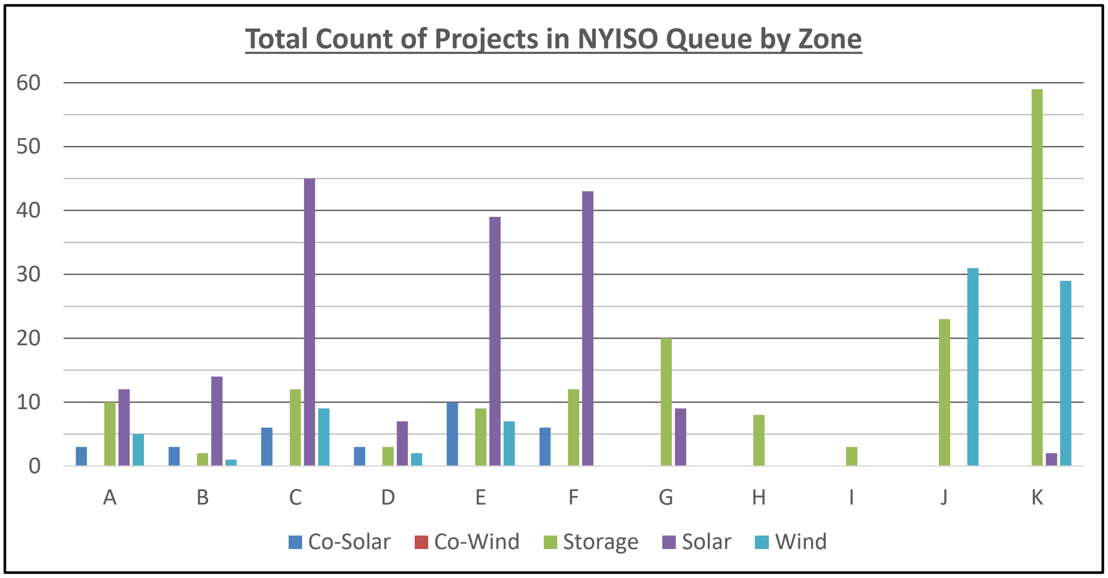
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

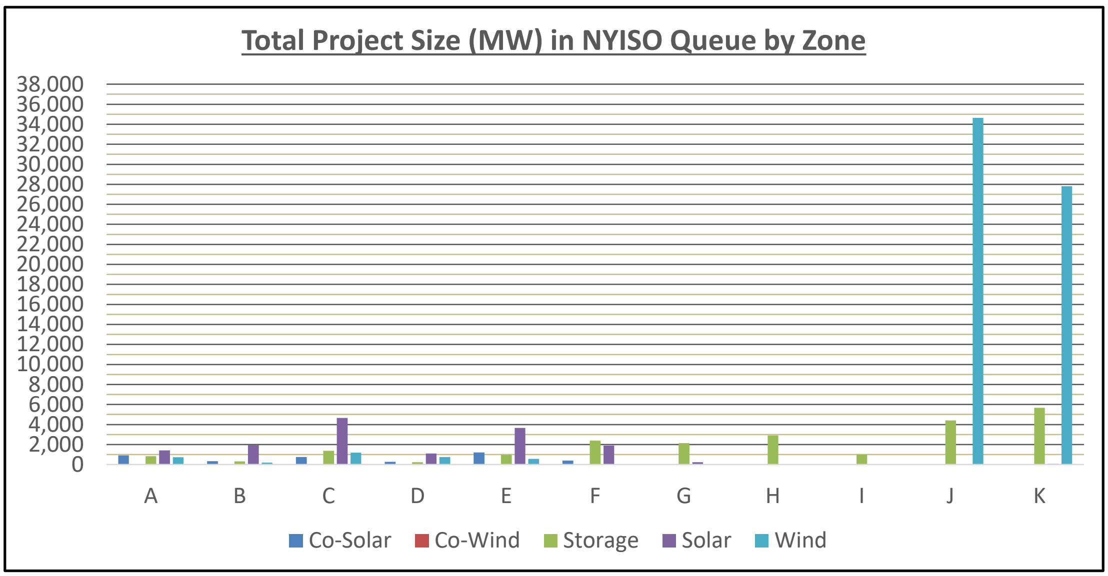
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (Solar and Wind now in separate categories) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on March 20th, and representing the Interconnection Queue as of February 28th. Note that 18 projects were added, and 14 were withdrawn during the month of February. A new Co-located Wind Project was added in Zone J, so the column was restored in the tables and graphs. Results are tabulated below and shown graphically on the next page.

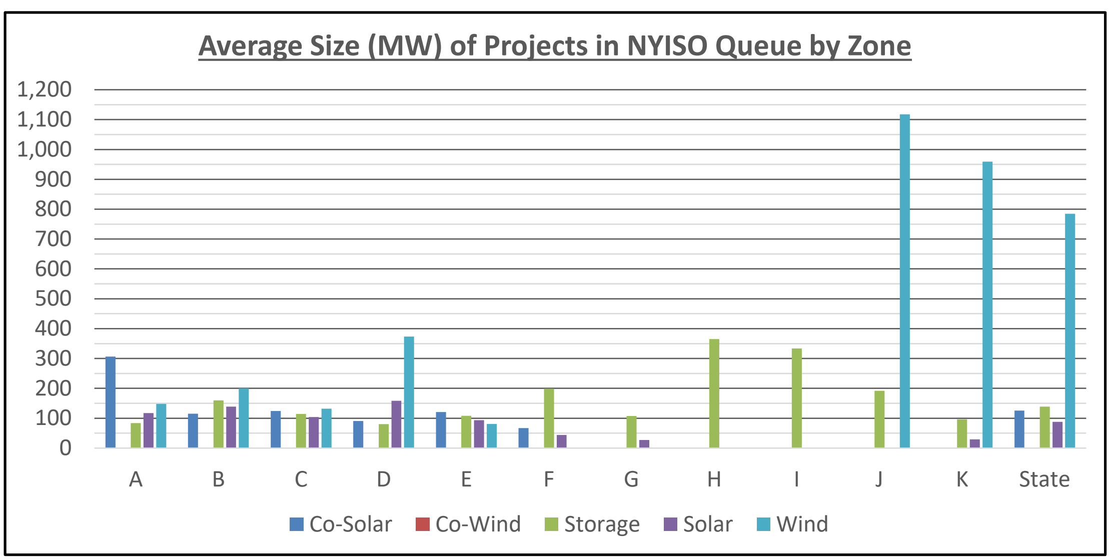
Total Count of Projects in NYISO Queue by Zone					
Zone	**Co-Solar**	**Co-Wind**	**Storage**	**Solar**	**Wind**
A	3		9	13	5
B	3		2	14	1
C	6		13	47	10
D	3		2	7	2
E	11		11	38	7
F	6		12	43	
G			27	9	
H			6		
I			3		
J		1	25		31
K			62	2	29
State	32	1	172	173	85

Total Project Size (MW) in NYISO Queue by Zone					
Zone	**Co-Solar**	**Co-Wind**	**Storage**	**Solar**	**Wind**
A	920		801	1,508	738
B	346		320	1,945	200
C	745		1,284	5,036	1,259
D	60		220	1,107	747
E	1,393		1,444	3,551	565
F	400		2,523	1,891	
G			3,823	243	
H			2,450		
I			1,000		
J		1,400	4,942		35,908
K			6,952	59	29,124
State	3,863	1,400	25,760	15,339	68,542

Average Size (MW) of Projects in NYISO Queue by Zone					
Zone	**Co-Solar**	**Co-Wind**	**Storage**	**Solar**	**Wind**
A	307		89	116	148
B	115		160	139	200
C	124		99	107	126
D	20		110	158	374
E	127		131	93	81
F	67		210	44	
G			142	27	
H			408		
I			333		
J		1,400	198		1,158
K			112	29	1,004
State	121	1,400	150	89	806


Total Count of Projects in NYISO Queue by Zone
60
50
40
30
20
10
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
38,000
36,000
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
0
A
B
C
D
E
F
G
H
I
J
K
Co-Solar
Co-Wind
Storage
Solar
Wind


Average Size (MW) of Projects in NYISO Queue by Zone
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