De-Carbonization / DER Report for NYSRC Executive Committee Meeting 5/13/2022

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The April 2022 edition of the De-Carbonization / Distributed Energy Resources (DER) Report includes the following items:

- NERC April Newsletter
  - NERC Lesson Learned: DER Performance During a Disturbance
  - IRPWG Webinar: Utilizing BPS-Connected Inverter-Based Resources for Frequency Support
  - NERC / WECC Report: Multiple Solar PV Disturbances in CAISO
  - IEEE-PES Report on T&D Grid Modernization to Mitigate Impacts from Climate Change
- NYSERDA Announcement – DPS Approves Contracts for CHPE and CPNY
- NYISO Blog: Grid Reliability Needs and How to Resolve Them, Keeping the Lights On (Video)
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / Co-located Storage

Highlights from the April NERC Monthly Newsletter (Link)

NERC Lesson Learned: DER Performance During a Disturbance

This Short Report recounts an incident in which a three-phase-to ground fault resulted in two 500 kV circuits being removed from service. This led to a net loss of approximately 1,300 MW of voltage-sensitive loads as well as at least 300 MW of supply from distributed energy resources. At the time of the occurrence, the weather conditions were mild, demand was low, and DERs were only delivering at 30% of capacity when the fault occurred, limiting the impact of the event. Note the location of this event was not disclosed in the report.

The report goes on to observe that DERS without smart inverters generally do not have adequate ride-through capability and can exacerbate the impact of a power system event by tripping off due to a voltage or frequency transient. It was recommended that:

- Performance requirements for DERs need to be such that they are better able to cope with and endure disturbances on the electricity grid.
- There is a need to understand how distribution system connected generation and loads will behave and how they can accurately be modeled under expected system contingencies.
- Entities should know the behavioral characteristics of DER inverters on their system (both new and old) as well as their number, capabilities, and locations and then report that information to their Balancing Authorities and Reliability Coordinators so their models can be accurate.

Among other measures, the TOP updated their performance requirements to ensure that future DERs are better able to remain connected during system events and support voltage.

IRPWG Webinar: Utilizing BPS-Connected Inverter-Based Resources for Frequency Support

The Inverter-Based Resource Performance Working Group (IRPWG) posted a Webinar and Slide Presentation entitled *Utilizing Excess Capability of BPS-Connected Inverter-Based Resources for Frequency Support*, held on April 19th. Additional information can be found in this White Paper.

Inverter-based resources operating at their maximum contractual agreement, also referred to as the Steady-State Interconnection Limit (SSIL), may be able to support the grid during underfrequency events beyond their SSIL. This situation is most likely to occur in ac-coupled hybrid plants (i.e., the combination of battery energy storage and wind or solar PV) or in standalone wind, solar PV, and battery energy storage plants where additional capacity is available but not presently utilized due to the SSIL constraints imposed by interconnection agreements.

By establishing a Short-Term Interconnection Limit (STIL) in interconnection agreements, inverter-based resources with excess active power capability beyond the Steady-State Interconnection Limit (SSIL) can use this capability to better support the grid frequency. However, once the system frequency recovers to nominal, the MW output of the plant should return to a value equal to or below SSIL.

In an effort to advance this concept, the NERC IRPWG has developed a set of recommendations and identified the applicable entities within the industry that would need to act upon these recommendations to enable this capability:

- The pro forma Large Generator and Small Generator Interconnection Agreements (LGIA and SGIA) should be amended to specify conditions under which the SSIL and STIL of the facility would complement each other to enable the facility to respond to underfrequency events and provide Primary Frequency Response (PFR) or Fast Frequency Response (FFR) rto the BPS for the duration until the frequency is restored.

- Transmission Owners (TOs), in coordination with their Transmission Planner (TP) and Planning Coordinator (PC), should update local interconnection requirements per NERC FAC-001 to permit operation of all newly interconnecting inverter-based resources, to provide PFR and FFR while operating at their SSIL up to their STIL. Primary Frequency Response and Fast Frequency Response requirements should focus on the required performance - droops, dead-bands, response times, and reaction times.

- TPs and PCs should evaluate and enhance their interconnection study processes per NERC FAC-002 to ensure the added provision of FFR and PFR from inverter-based resources does not adversely affect BPS reliability or stability. Adequate simulations are needed to ensure all system operating limits are met with these capabilities enabled.

    - TPs and PCs should review, amend, and file their pro forma interconnection agreements and procedures to clarify SSIL and STIL to support PFR or FFR whenever excess capability is available.

    - TPs and PCs should also ensure any transmission planning studies including PFR or FFR from these types of resources are appropriately modeled in underfrequency load shedding (UFLS) studies per the latest effective version of NERC PRC-006.

- Equipment manufacturers, developers, Generator Owners (GOs), and Generator Operators (GOPs) of BPS-connected inverter-based resources that have excess capabilities and able to provide additional active power (above SSIL) to support frequency response should utilize the STIL established by interconnection agreements or requirements.

- Reliability Coordinators (RCs) and Transmission Operators (TOPs) should ensure the additional active power generated by resources that have exceeded their SSIL up to their STIL to provide PFR or FFR would not cause any adverse impacts to reliability and stability of the BPS during real-time operations. This includes ensuring that operational planning assessments and real-time assessments are reflective of these additional capacities from inverter-based resources.

    - Balancing Authorities (BAs) should ensure awareness of the on-line FFR and PFR capabilities to ensure sufficient reserves to support BPS frequency immediately following sudden loss of generation or sudden increase in load events.

NERC / WECC Report: Multiple Solar PV Disturbances in CAISO (Link)
This report contains the ERO analysis of four BPS disturbances with widespread reductions of solar PV output that occurred in the California Independent System Operator (CAISO) footprint between June and August of 2021. Each disturbance involved widespread reductions of active power output from solar PV resources in the Southern California area. Two of these events also involved tripping of synchronous generating resources, and three involved some degree of distributed energy resource (DER) tripping or reduction. The table below provides an overview of the four disturbances analyzed by NERC and WECC:

Disturbance and Name	Initiating Fault Event	Description of Resource Loss*
June 24, 2021 "Victorville"	Phase-to-Phase Fault on 500 kV Line	Loss of 765 MW of solar PV resources (27 facilities) Loss of 145 MW of DERs
July 4, 2021 "Tumbleweed"	Phase-to-Phase Fault on 500 kV Line	Loss of 605 MW of solar PV resources (33 facilities) Loss of 125 MW at natural gas facility Loss of 46 MW of DERs
July 28, 2021 "Windhub"	Single-Line-to-Ground Fault on 500 kV Circuit Breaker	Loss of 511 MW of solar PV resources (27 facilities) Loss of 46 MW of DERs
August 25, 2021 "Lytle Creek Fire"	Phase-to-Phase Fault on 500 kV Line	Loss of 583 MW of solar PV resources (30 facilities) Loss of 212 MW at natural gas facility Loss of 91 MW at a different natural gas facility

Brief descriptions of the causes of solar PV reduction observed in these four disturbances are described below. Note that in many cases, the report describes the inverters as "legacy" models, either no longer supported or manufactured. Many of these issues would not recur in future installations, as a result of new features and/or compliance with IEEE 2800 guidelines and requirements.

- Momentary Cessation and Plant Controller Interactions: Momentary cessation continues to be a notable cause of BPS-connected solar PV reduction in the California region. This is primarily driven from solar PV facilities with legacy inverters that cannot eliminate momentary cessation or modify settings. NERC did note that a number of the facilities that tripped due to inverter protection (e.g., ac overcurrent protection) also stated that they have momentary cessation controls enabled; these are relatively large, newer facilities with these controls enabled that seems to conflict with existing interconnection requirements. Similarly, plant controller interactions with the inverters appear to be elongating the expected dynamic response from these resources based on the programmed ramp rates in the plant controller. This precludes the inverters from quickly returning to pre-disturbance output levels and degrades system stability. Some interactions slowed the plant recovery by many seconds while other slowed the recovery to many minutes. These issues are easily identifiable using various data sources (even Supervisory Control and Data Acquisition (SCADA) data) and should be mitigated immediately.

- Slow Dynamic Response: A number of facilities originally identified in the brief report as reducing power output actually responded dynamically (with dynamic voltage support) to the disturbance. However, the fault cleared in around 50 ms and voltage recovered immediately, yet the recovery of active power to pre-disturbance levels extended many seconds or minutes beyond the recommendations specified in NERC reliability guidelines. These inverters are specifically programmed with momentary cessation disabled and some form of reactive current injection (e.g., K-factor control) enabled.

- Cause Unknown: A number of facilities that reduced output in these disturbances were unable to provide any useful information for root cause analysis. The inability of the facility owner to retrieve disturbance analysis data precludes the analysis team from conducting root cause analysis and prohibits the development of any possible mitigations or solutions to the issues observed.

- DC Voltage Imbalance: Inverters from one manufacturer exhibited an imbalance in dc voltage conditions when the dc positive and negative voltages relative to the midpoint dc voltage exceeded a pre-defined threshold. The inverter manufacturer has stated that this may be attributable to the transient occurring during the fault or unstable negative sequence voltage plus the solar PV input at low power.

- AC Overcurrent: Across multiple facilities and three inverter manufacturers, ac overcurrent protection appeared in these disturbances. The issue was more pronounced for one particular inverter manufacturer; however, they have stated that this issue appears to be from some of their older inverter models and appears to not be an issue for newer inverters. Most commonly, the protection is set to 110–150% of rated inverter ac current (instantaneous peak).

- DC Overcurrent: At one large solar PV facility with legacy inverters, dc overcurrent protection tripped most inverters. These inverters have parallel-connected inverter insulated-gate bipolar transistor (IGBT) bridges (dc in, 3-phase ac out) and all parallel bridges initiated a dc overcurrent trip in most cases. This issue was identified in the Blue Cut Fire and led to this specific inverter manufacturer disabling fast dc current protection for all newer inverters; however, legacy inverters require the fast dc overcurrent protection remain enabled.

- Uninterruptible Power Supply Unit Failure: A few inverters tripped on uninterruptible power supply failure and remained off-line for the rest of the day. The plant owner was able to restore the inverters to service upon manual inspection; however, no additional details were provided regarding the failure.

- Inverter Frequency Tripping: Two facilities exhibited frequency-related tripping. One facility had inverters trip on over-frequency (61.7 Hz for 1 ms), and the other had inverters trip on underfrequency (59.3 Hz for 20 ms). Both trips involved a near-instantaneous trip timer that led to false tripping caused by spikes in calculated frequency during voltage phase angle jumps at the time of the fault. NERC recommended that the plant owner work with the inverter manufacturer to expand settings to given equipment capabilities. NERC also recommended the inverter manufacturer proactively update settings at all existing facilities that may be prone to this spurious tripping.

- AC Undervoltage: Inverters at two facilities tripped on ac undervoltage protection. In particular, one non-BES facility had ac undervoltage protection set within the PRC-024-3 voltage boundaries and tripped due to the relatively tight settings. NERC recommended that the facility owner extend those undervoltage trip settings, if possible, to help ensure resource ride-through for BPS faults.

The table below shows each of the causes of solar PV reduction, along with the magnitude of reduction for each event. Note the significant contributions from momentary cessation and slow active power recovery.

Cause of Reduction	June 24 [MW]	July 4 [MW]	July 28 [MW]	August 25 [MW]
Slow Active Power Recovery	111	193	184	91
Momentary Cessation	310	120	192	447
Cause Unknown	103	103	112	24
Inverter DC Voltage Unbalance	-	77	15	4
Inverter AC Overcurrent	49	74	17	13
Inverter DC Overcurrent	98	9	47	3
Inverter UPS Failure	-	4	-	-
Inverter Overfrequency	-	-	43	18
Inverter Underfrequency	14	-	-	-
Inverter AC Undervoltage	100	-	16	-
Total	**785**	**566**	**626**	**600**

IEEE-PES Report on T&D Grid Modernization to Mitigate Impacts from Climate Change

NERC has Announced the publication of a new report on climate change Impacts to the Grid, which can be found along with a summary presentation at the IEEE PES Resource Center (Free for IEEE PES members). The report is entitled "*Importance of T&D Grid Modernization to Mitigate Impacts from and Adapt to Climate Change*". The report underscores the significance for a modern, resilient grid as the foundation for a clean energy future, and obtains input from global energy experts on practical solutions to enable stakeholders to meet the emerging challenges associated with climate change.

The table below highlights the key contributions from Inverter-Based Resources:

Addressing Reliability with IBRs

Key Considerations	System Aspects
Power ramping	• High up and down intermittent power ramps can affect control area performance
Low system inertia	• High rate-of-change of frequency following a large loss causes resources to trip due to reduced synchronizing torques • Under-frequency relays respond to low frequency by tripping load • Speed of system events faster than ability of protection system
Low reserves	• Renewables generally operate at max power tracking and do not leave a headroom for reserves
Low fault-current levels	• Ability of protection systems to detect faults
Low short-circuit ratio (weakened grid)	• Instability in inverter controls (phase-locked loop synchronization and low frequency oscillations) • Challenges to inverter ride-through and islanding • Voltage flicker (especially in distribution feeders) • Difficulty of voltage control due to voltage sensitivity (dV/dQ) • Difficulty in energizing large power transformers
Low damping of system oscillations	• Synchronous machines have rotor dampers • Use of grid forming inverters and inverter control settings to mitigate
Power flow and voltage fluctuations	• Intermittent renewables cause fluctuations is system voltages especially when the grid short circuit strength is low • Ensure compliance with IEEE 1453 standard for flicker
Black start	• Ability to restart a system with predominantly inverter-based resources

NYSERDA Announcement – DPS Approves Contracts for CHPE and CPNY (Link)

On April 14th, NYSERDA and Governor Hochul announced that the New York State Public Service Commission has approved contracts with Clean Path New York for its Clean Path NY project (CPNY) and H.Q. Energy Services Inc. for its Champlain Hudson Power Express (CHPE) project to deliver clean, renewable solar, wind and hydroelectric power from upstate New York and Canada to New York City.

As the largest transmission projects contracted for New York State in the last 50 years, these projects will reduce the city's reliance on fossil fuel-fired generation by more than 50 percent in 2030. Today's announcement accelerates progress to exceed New York State's goal for 70 percent of the state's electricity to come from renewable sources by 2030 on the path to a zero-emission grid by 2040 as outlined in the Climate Leadership and Community Protection Act.

The selected projects are expected to deliver 18 million megawatt-hours of clean energy per year, or more than a third of New York City's annual electric consumption, from a diverse and resilient clean generation portfolio including onshore wind, solar, and hydroelectric power, backed by energy storage, from upstate New York and Quebec. Current estimates anticipate the CHPE project to become operational in 2025, and the CPNY project in 2027.

NYISO: Announcements on the Blog Page of the NYISO Website:
Features from the [Blog Page]() of the [NYISO Website]() are as follows:

[Posting: Grid Reliability Needs and How to Resolve Them]()
The posting seeks to explain the basic processes used by the NYISO to identify reliability challenges and implement solutions. Two methods were described below:

Four times a year, the NYISO performs a Short-Term Assessment on Reliability (STAR), which focuses on identifying reliability needs up to five years out. This helps to quickly evaluate changes to the system, such as generator deactivations, changes to the transmission system, or changes in demand that could affect reliability.

For a longer-term approach, the NYISO performs a Reliability Needs Assessment (RNA), looking 10 years out. This process cycle runs every two years and begins with the development and publishing of the RNA report. The RNA looks at both the adequacy of energy resources and limitations of the transmission grid to determine whether the grid will be able to supply enough power to meet demand.

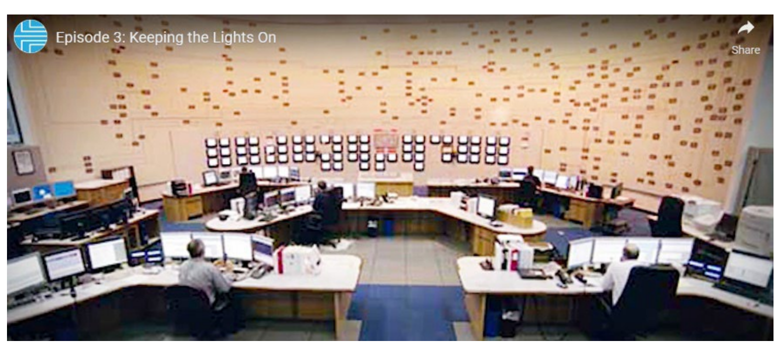
In response to the state's "Peaker" rules creating more stringent emission limits, a series of deactivations of fossil fuel plants in New York City and Long Island will further reduce the available generation to meet demand on days when is most needed, such as a multi-day heat wave.

Once a need is identified, solution strategies include:
- Solicit a developer to implement in new energy resources, transmission, or demand reduction
- Solicit a utility for backstop transmission solutions when market solutions can't be built in a timely manner
- Gap solutions such as transmission and demand response
- Establish Reliability Must Run (RMR) agreements with one or more generators

There are currently over 400 proposed supply, transmission, and load projects in the Interconnection Queue.

[Video: Keeping the Lights On]()
In this third installment in the series [Grid of the Future](), Rick Gonzales, Zach Smith and former FERC Commissioner Colette Honorable take a look at lessons learned from previous outages, impacts of major weather-related events, and how we can avoid similar events from happening in the future.

A short history of the formation of the NYISO provided images of some of the founding members with a backdrop of the original control center. A statement at the end of the presentation reinforced the necessity of maintaining fossil-fuel type generation for reliability needs until such time as there are sufficient renewable and storage resources to satisfy this responsibility.



NYISO Press Releases:

April 5th: New York Energy Storage Interconnection Queue Reaches 12 GW, Double the state's 2030 Target

The Department of Public Service (DPS) has issued its third 'State of Storage' annual report detailing the state's progress in meeting its 2030 deployment goal, which was doubled in January from 3,000MW to 6,000MW.

Table 1: Total Energy Storage in New York

TOTAL ENERGY STORAGE IN NEW YORK (Deployed and Contracted/Awarded)	
NYSERDA Bridge Incentive Program	879 MW
Bulk 550 MW	
Commercial Retail 320 MW	
Long Island 9 MW	
Utility Bulk Storage Dispatch Rights Procurement	120 MW
Renewable Energy Standard	101 MW
NYPA North Country Project	20 MW
Utility Demonstration and NWA Projects	56 MW
Other Projects	54 MW
2021 TOTAL	**1,230 MW**
Percentage of 2025 Goal	82%
Percentage of 2030 Goal	41%

Source: NYSERDA and DPS Staff

The Bridge Incentive Program offers financial incentives to build 5 MW-plus systems participating in wholesale markets, commercial retail projects up to 5 MW, and single-family residential systems paired with PV on Long Island.

Sixty-four out of the 77 commercial retail projects awarded Bridge incentives are there to time shift the renewable energy dispatch to times with a more valuable distribution grid value under Value of Distributed Energy Resource (VDER) compensation. The Long Island projects are paired with solar to help the local grid relieve demands during peak summer days under the Long Island Power Authority's Dynamic Load Tariff.

Many of the Bulk projects provide or will provide wholesale services in the NYISO market. Some 14 projects comprising 550MW/1,835MWh have been awarded $115 million in NYSERDA (New York State Energy Research and Development Authority) incentives for projects targeting downstate capacity or ancillary services revenues in the wholesale market.

April 5th: New York Reaches Record Solar Production Peak of 2,328 MW (S&P Global), and
March 29th: State Sets New Record for Behind the Meter Solar Production

The New York Independent System Operator said March 29 that about 750 MW of incremental behind-the-meter solar power capacity has been added over the past year, helping the state recently set a record high of 2,328 MW of BTM meter solar output.

Natural gas accounted for 47% of the NYISO's power generation stack in 2021 and S&P Global analysts expect that figure will grow slightly to 48% for 2022, according to the latest North American Electricity Five-year Forecast. By 2026, S&P Global anticipates gas-fired generation will decline to 36% of overall market share.

According to the forecast, incremental wind capacity will lead to wind generation to increase from 4% of the share in 2021 to 13% by 2026. Similarly, new solar additions will quickly lift solar from only 1% of total generation in 2021 to 8% over the next five years.

New York ranked 11th in the US in 2021 in terms of installed solar capacity, according to the trade group Solar Energy Industries Association.

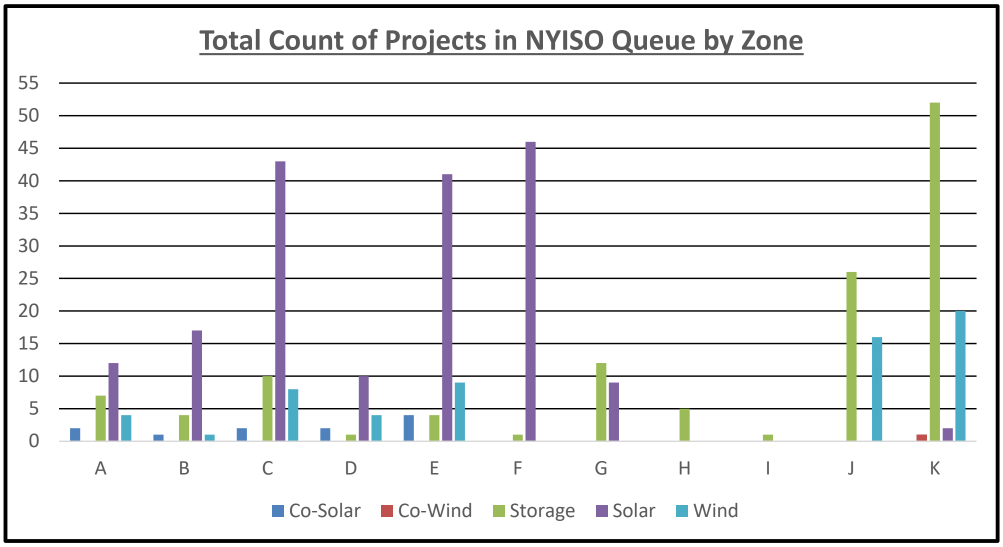
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

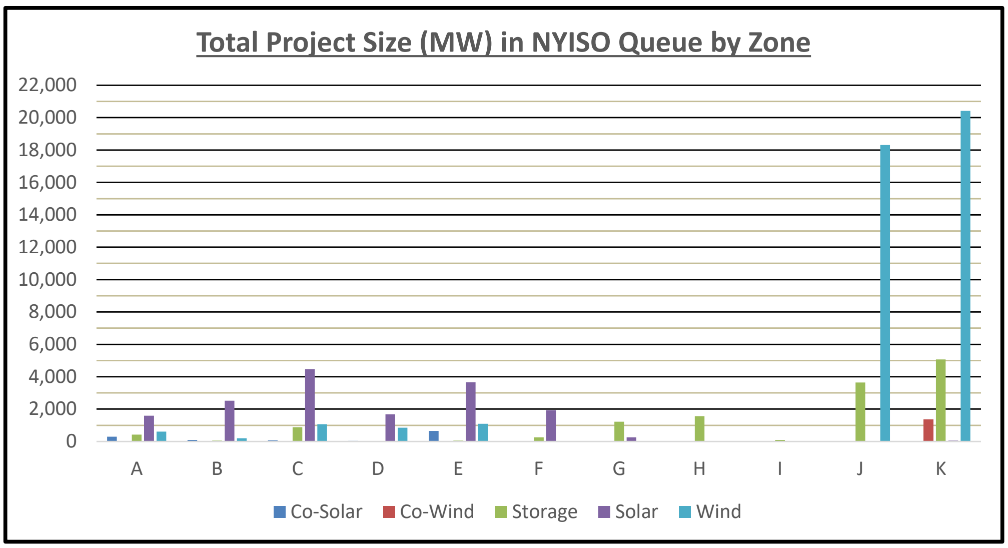
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (Solar and Wind now in separate categories) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on April 21st, and representing the Queue as of March 31st. Note that 18 projects were added, and 11 were withdrawn during the month of March. Results are tabulated below and shown graphically on the next page.

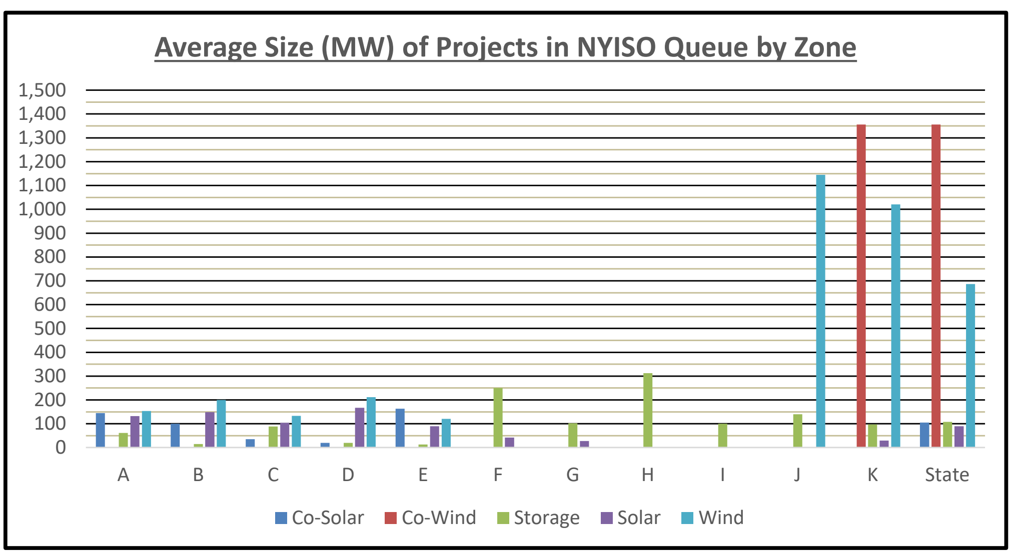
Total Count of Projects in NYISO Queue by Zone					
Zone	**Co-Solar**	**Co-Wind**	**Storage**	**Solar**	**Wind**
A	2		7	12	4
B	1		4	17	1
C	2		10	43	8
D	2		1	10	4
E	4		4	41	9
F			1	46	
G			12	9	
H			5		
I			1		
J			26		16
K		1	52	2	20
State	11	1	123	180	62

Total Project Size (MW) in NYISO Queue by Zone					
Zone	**Co-Solar**	**Co-Wind**	**Storage**	**Solar**	**Wind**
A	290		430	1,590	615
B	100		61	2,521	200
C	70		888	4,472	1,062
D	40		20	1,674	847
E	654		52	3,663	1,087
F			250	1,937	
G			1,223	250	
H			1,560		
I			100		
J			3,641		18,312
K		1,356	5,071	59	20,418
State	1,153	1,356	13,296	16,166	42,541

Average Size (MW) of Projects in NYISO Queue by Zone					
Zone	**Co-Solar**	**Co-Wind**	**Storage**	**Solar**	**Wind**
A	145		61	132	154
B	100		15	148	200
C	35		89	104	133
D	20		20	167	212
E	163		13	89	121
F			250	42	
G			102	28	
H			312		
I			100		
J			140		1,145
K		1,356	98	29	1,021
State	105	1,356	108	90	686


Total Count of Projects in NYISO Queue by Zone
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
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
1,500
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
Co-Solar
Co-Wind
Storage
Solar
Wind