De-Carbonization / DER Report for NYSRC Executive Committee Meeting 11/10/2022

Contact: Matt Koenig (koenigm@coned.com)

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

- NPCC: Four Presentations from the DER October 13th Workshop
- NYISO Blog: The Outlook: Transmission Must Expand to Avoid Renewable Generation Pockets:
  Blog: 2022 Peak Load Day Highlights Challenges and Opportunities for New Resources on a Changing Grid
  Podcast: Zach Smith on Unprecedented Investment Needed to Meet Energy Goals
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / Co-located Storage

NPCC DER Workshop

The workshop included four presentations, all of which can be viewed from this Video Recording Link, and the Presentation File containing all of the material can be found here.

Presenters and topics included the following:

- Hydro One: Operational Challenges of DER Integration at Tx/Dx interface
- ISONE: ISO New England Planning Initiatives to Support Transmission Grid in 2040 & 2050
- Ontario IESO: Leveraging Existing Planning Processes to Prepare for the Energy Transition
- ESIG: Transmission – A Key Enabler

Hydro One presented on Operational Challenges of DER Integration at Tx/Dx interface. The Company's drivers for Decarbonization and Electrification are shown below:

Decarbonization – Canadian government energy policy targets:

- By 2030, power indigenous remote & rural communities with clean reliable energy
- By 2035, produce ~100% of electricity from non-emitting sources and 100% of light-duty vehicles sales must be ZEVs (zero emission vehicles).
- By 2040, establish leading hydrogen & full cell technology cluster
- End goal, by 2050 achieve net zero emissions

Energy Transition/Electrification – drivers identified by the Ontario Independent Electric System Operator (IESO)

- EV (electric vehicles) becoming mobile energy storage units. EV grid infrastructure
- Electric Arc Furnaces (steel ind.) transitioning from blast fossil fuel furnaces to electric arc furnaces.
- Building Space and Water Heating (residential/commercial) shifting from natural gas to electric heating.
- Public Transportation systems (fleet - TTC, train - Metrolinx, ferry – OPG/MTO)

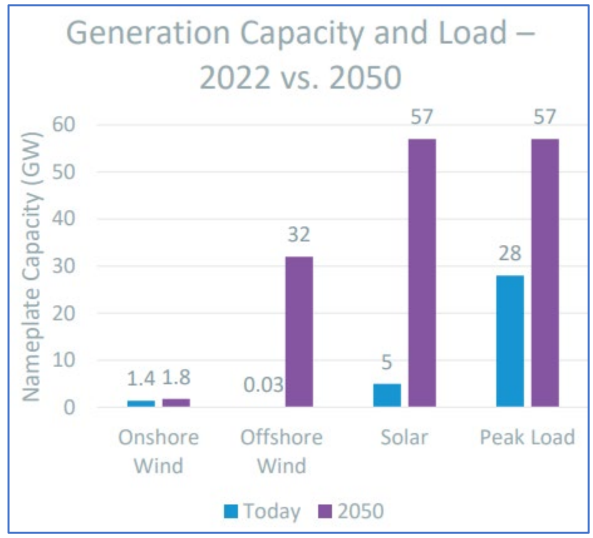
Hydro one also discussed their unique sub-transmission system, in which major portions can be reconfigured as necessary to redirect power from alternative transmission substations. While allowing for greater flexibility of transmission support, sudden changes in this configuration can result in new operating conditions impacting pre-dispatch, other connected customers, DERs, sub-transmission assets, and distorting market signals.

ISO-NE presented on their Planning Initiatives to Support the Transmission Grid in 2040 & 2050. Triggers for these studies can be seen in the two charts shown below:

Left: Various State Goals within the New England region impacting ISO-NE

Right: Comparing Generation Capacity and load for current vs. forecasted for 2050. Assumptions for this chart include development of significant new renewable generation capacity, retirement of all existing coal and oil generation, transmission and Heating electrification, and new transmission to Quebec and New York

≥80% by 2050	Economy-wide greenhouse gas reductions: MA, CT, ME, RI, and VT (mostly below 1990 levels)
Net-Zero by 2050 80% by 2050	MA emissions req't MA clean energy standard
90% by 2050	VT renewable energy req't
100% by 2050 Carbon-Neutral by 2045	ME renewable energy goal ME emissions req't
100% by 2040	CT zero-carbon electricity req't
100% by 2030	RI renewable energy req't



Note that background information for the charts can be found in this report: Energy Pathways to Deep Decarbonization: A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study.

At the request of the New England states, ISO-NE began the 2050 Transmission Study (authorized access required) in late 2021 to analyze the transmission system in more detail. Key questions to be answered include:

- Where will the transmission system be deficient in serving load in 2035, 2040, and 2050?
- What conceptual transmission upgrades could resolve these deficiencies?
- Approximately how much will these upgrades cost?

Assumptions include:

- Development of significant new renewable generation capacity
- Retirement of all existing coal and oil generation
  - Some natural gas units retained, with decreased capacity factor
- Transportation and heating electrification
- New transmission to Quebec and New York

Preliminary results showed that approximately half of the total Pool Transmission Facility (PTF) line miles in New England (~4,200 miles out of ~9,000 miles) are overloaded in 2050. Furthermore, approximately 90 PTF transformers (of about 150 total) are also overloaded in 2050

The vast majority of these overloads occur in the Winter Evening Peak due to electrified heating. These overloads were spread throughout all six New England states, with New Hampshire and Maine having higher amounts due to high North-South transfers driven by new resource assumptions.

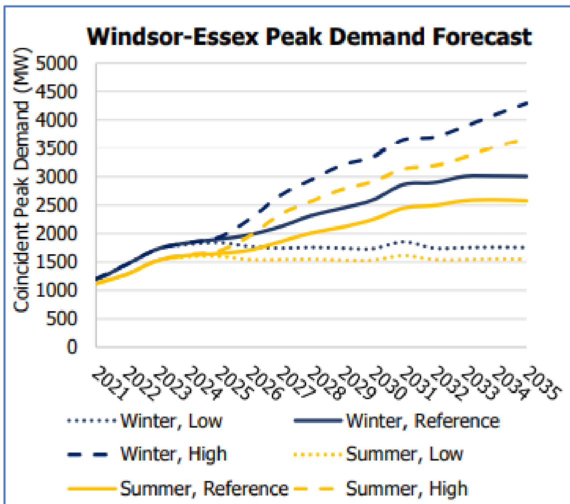
Sensitivity Analysis showed that reducing winter peak loads significantly reduces transmission concerns. Specifically, a ~10% reduction in load causes roughly a 35% reduction in overloaded transmission miles, assuming that decreased load is offset by decreased northern New England generation.

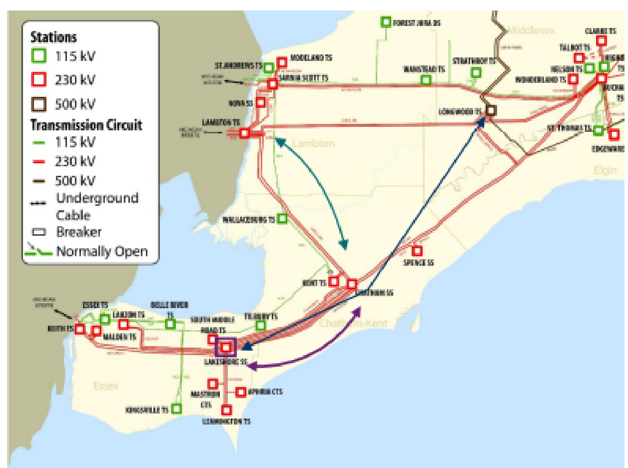
Based on the conditions studied, key takeaways from the 2050 study so far include:

- Winter peak is a major driver of transmission concerns in the long term
- Generator interconnection locations are critical
  - Interconnecting in southern New England rather than northern New England tends to reduce transmission needs
- Additional 345/115 kV transformer capacity is required
  - Serving peak load from remote renewable resources requires long-distance transmission at high voltage, and then transformation to reach local substations
  - Generator interconnections directly to the 115 kV network may help, but often require upgrades on the 115 kV system instead
- Outside of dense urban areas, many concerns can be resolved through incremental upgrades rebuilding/reconductoring existing lines)

Work is expected to continue throughout late 2022 and early 2023. Studies will initially focus on the “primary solution set,” and then address intermediate years and the original 57 GW winter peak. The results will Include development of order- of-magnitude cost estimates for solution components. The final 2050 Transmission Study report is expected to conclude in 2023

<u>The Ontario Independent Electric System Operator (IESO)</u> presented on Leveraging Existing Planning Processes to Prepare for the Energy Transition. The graphics below pertain to the Windsor-Essex area of Canada (adjacent to Detroit in the USA). The chart on the left shows the wide variation of forecasts for both Winter and Summer seasons looking out to 2035. The map on the right shows the bulk transmission configuration for the region.





Factors considered for long-term recommendation include:

- Cost
- Ability to meet future demand
- Land use – transmission corridor
- Land use – stations
- Resiliency
- Operational flexibility
- Interchange with Michigan
- Transmission losses
- Community preferences

<u>The presentation from the Energy Systems Integration Group (ESIG)</u> covered the transmission grid as the key enabler for future success with renewable energy. The report starts out by stating that the USA would need 1 TW or more of new wind and PV capacity to reach 100% clean electricity goals (which is five times greater than current wind/PV capacity). Furthermore, Decarbonizing the entire US energy economy may require twice that.

The presentation notes that the best land-based wind and solar capabilities are far from load, with 88% of the capacity located in 15 central states. To recover the energy would require a regional exchange configuration to balance all energy requirements with high penetration. It was further noted that as conventional generators continue to retire, system inertia will decline, and the overall transmission grid becomes weaker.

The presentation provided arguments in favor of building out more transmission:

- Enables greater Resource Adequacy (Smooths all time scales of weather vulnerability)
- Supports system balancing (maximizing flexibility)
- Steady State Reliability
- Storage-only solutions can be more expensive and may not address all of the issues
- Transmission supports energy transfer for higher levels of DERs (Vibrant Clean Energy Report)

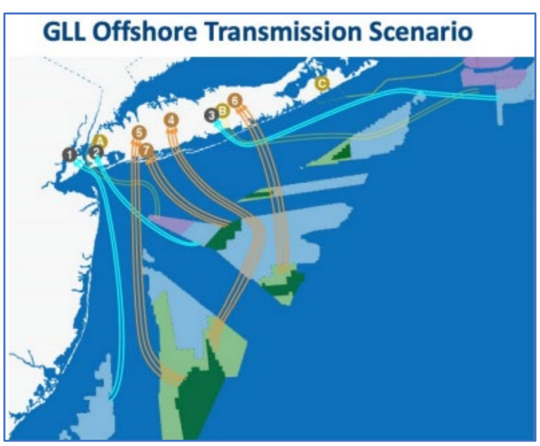
The presentation contained multiple references to previous Anbaric / Brattle presentations supporting networked Offshore Wind grids:

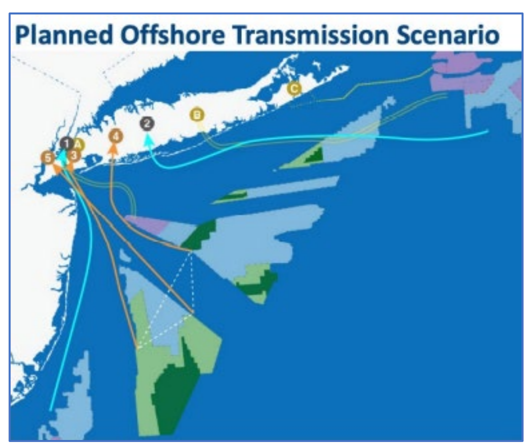
- Offshore Transmission in New England: The Benefits of a Better Planned Grid
- Link to Anbaric / Brattle Presentation: Offshore Wind Transmission: An Analysis of Options for New York
- New York's Evolution to a Zero Emission Power System

The Anbaric / Brattle New York study was highlighted briefly in the presentation. In that study, two approaches were compared with regards to developing offshore transmission and associated onshore upgrades to reach New York's offshore wind (OSW) development goals:

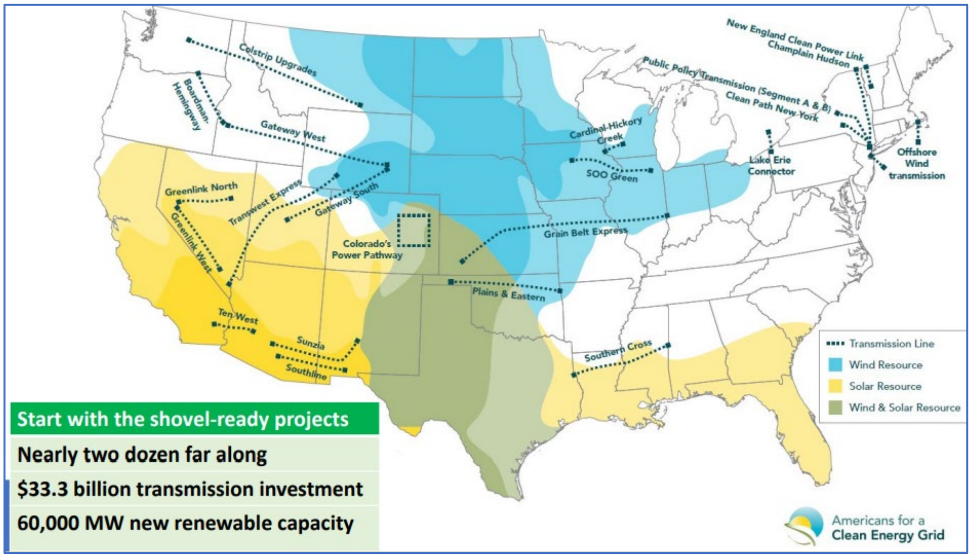
- The "generator lead line" approach wherein OSW developers compete primarily on cost to develop incremental amounts of offshore generation and associated project-specific generator lead lines (GLLs). The "GLL" approach reflects current trends in how and where OSW developers interconnect to the onshore grid, selecting the least-cost option available for each incremental project

- An alternative "planned" approach wherein transmission is developed independently from generation. Offshore transmission and onshore upgrades are planned to minimize overall risks and costs of achieving the state's offshore wind and clean energy goals The alternative "planned" approach reflects a more optimized outcome that is unlikely to occur without an explicit planning process



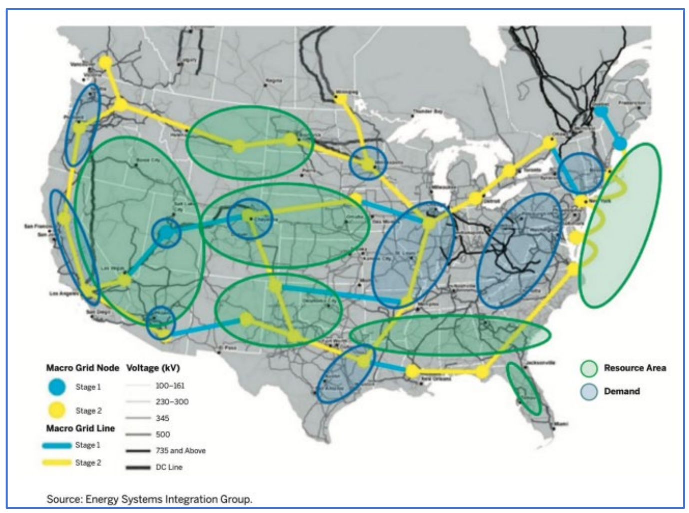


ESIG strongly recommends a coordinated national planning process to leverage national and regional capabilities, which would include regional planners, utilities, and governments, and enable the construction of multi-regional transmission grid. The map below shows projects already under construction which could be considered as the first steps leading to the foundation for that grid.



A fundamental transformation of the grid and the resource mix is needed:

- Incrementalism likely won't achieve this.
- Top-down optimization can show us the end game and improve bottom-up efforts.
- Macrogrid design would be based on sound transmission planning principles but may require some new approaches.
- HVDC allows for controllability to coordinate across regional system operators
- VSC-HVDC supports stability with high levels of inverter-based resources
- HVDC allows for long distances transfers at low cost with limited right-of-way



ESIG's concluding recommendations are:

- Create a national transmission planning authority that conducts ongoing national transmission planning
- Identify renewable energy zones
- Work collaboratively with the regional transmission planning processes

Supporting documentation can be downloaded from these ESIG Summary pages:

- Transmission Planning for 100% Clean Electricity
- Multi-Value Transmission Planning for a Clean Energy Future
- Design Study Requirements for a US Macrogrid
- Proactive Planning for Generator Interconnection – report to be published

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

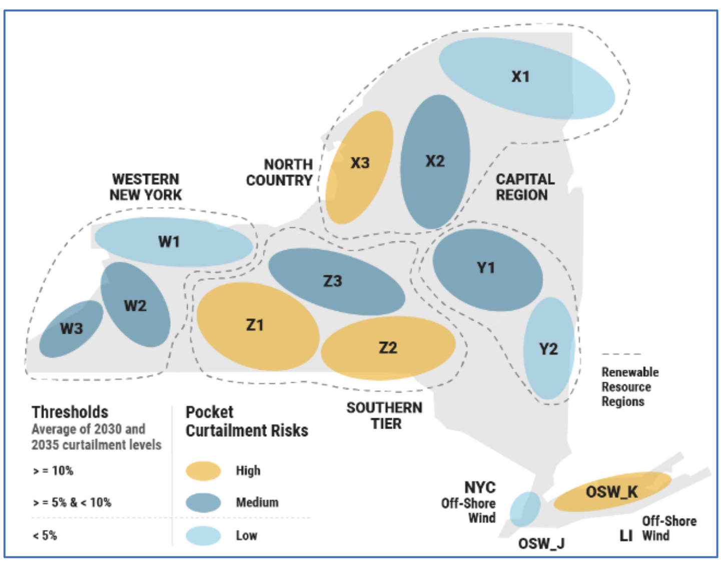
Features from the NYISO Blog Page include the following:

Findings from the Outlook: Transmission Must Expand to Avoid Renewable Generation Pockets:
The NYISO takes a second look at the report entitled 2021-2040 System & Resource Outlook, this time with the concern that while unprecedented investment in renewable generation will be necessary to meet future demand, we will also need to invest in transmission capabilities to get that power delivered reliably and efficiently.

To accomplish this, the report focuses on two important elements: energy deliverability and curtailment. Energy deliverability refers to the ability to move electricity from a generator to consumers. At times, congestion or limitations on the transmission system can restrict the amount of electricity that can flow from one area of the state to another, potentially resulting in curtailment of generation. The report determined that future renewable energy production in several regions of the state may not be deliverable to consumers due to constraints on the transmission system.

These expected transmission constraints, if left unaddressed, lead to “generation pockets,” in which renewable energy production must be limited, or curtailed to avoid overloading the transmission system. Curtailment is often necessary during periods of high renewable energy production but low consumer demand for electricity, such as windy overnight periods.

The map below identifies 13 regions in the state where renewable generation pockets are expected to form due to transmission constraints. High curtailment pockets represent transmission needs that must be addressed to achieve the public policy targets of the CLCPA. Four pockets will particularly benefit from transmission expansion in the near-term: Finger Lakes (Z1), Southern Tier (Z2), Watertown (X3), and Long Island.



The Finger Lakes/Southern Tier renewable generation pockets (Z1, Z2) represent regions where the land and natural resource availability (wind and solar) are expected to attract renewable generation buildout. Transmission expansion from these pockets is necessary to deliver renewable energy to the bulk grid where it would benefit New York consumers statewide.

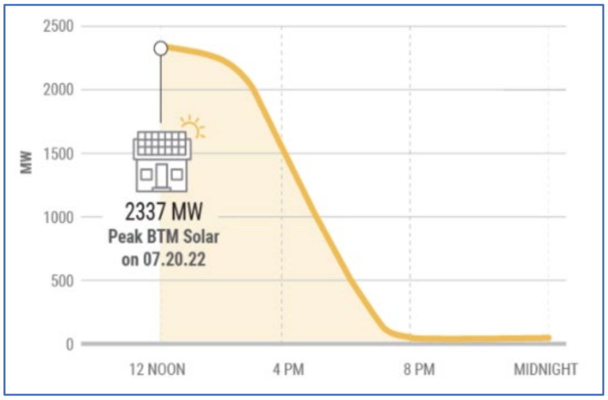
The Watertown/Tug Hill Plateau renewable generation pocket (X3) is driven largely by constraints on the 115 kV network that are expected to limit the availability of wind and solar generation in this area. Additional transmission is necessary to provide the resources access to the bulk grid.

The Long Island need is driven by offshore wind development and the need to export that generation from Long Island to the rest of New York State. NYISO is currently evaluating proposals to significantly reduce the expected congestion in Long Island. However, offshore wind resource additions of up to 20 GW that are under discussion may necessitate additional transmission to deliver offshore wind energy to New Yorkers.

[2022 Peak Load Day Highlights Challenges and Opportunities for New Resources on a Changing Grid](),
The blog highlights a two major examples of the way grid operators are managing new resources. First, the Empire State Line is a new 20-mile-long transmission line, which has improved access to renewable hydroelectric energy from the Niagara Power Plant.

Second, behind-the-meter (BTM) solar production (solar panels on rooftops and community solar projects) provided 2,337 MW at the noon hour of the peak load day (30,505 MW) of the year. During the 5PM hour, when the overall system energy demand peaked, those resources were still providing roughly 1,045 MW.

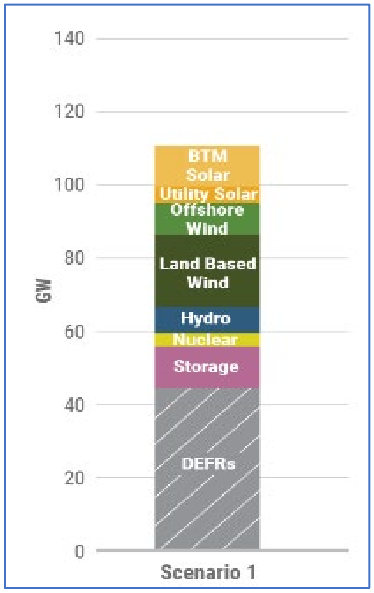
By contrast, on last year's peak day, June 29, 2021, system demand reached 30,919 MW at 5 PM. At that time, BTM solar produced 695 MW, indicating that BTM solar production has increased by about 800 MW, or 50% since last year.



[Podcast #22: Zach Smith on Unprecedented Investment Needed to Meet Energy Goals]()
NYISO Vice President of System & Resource Planning, Zach Smith, explains the potential impacts of the changing resource mix on the needs of the electric grid to maintain reliability. State policies, like the Climate Leadership and Community Protection Act of 2019 (CLCPA), are having profound impacts on the electric system and decisions for system investments to keep the lights on.

Some key findings include:

- State climate mandates are driving the need for unprecedented levels of new generation capacity to achieve decarbonization and maintain system reliability.
- Electrification of buildings and transportation driven by state policies is one of the largest factors driving rapid increases in peak and annual energy demand.
- Significant increases in new resource and transmission development will be required to achieve CLCPA targets.
- Dispatchable Emission-Free Resources (DEFRs) must be developed and deployed at scale well before 2040 to achieve an emission-free grid.



Zach stressed that DEFR technologies are not yet commercially viable but must be developed and added to the system at scale to reliably serve demand when intermittent generation from wind and solar is unavailable and supply from storage resources is depleted. The lead time necessary for research, development, permitting, and construction of DEFR supply will require action well in advance of 2040 if state policy mandates under the CLCPA are to be achieved.

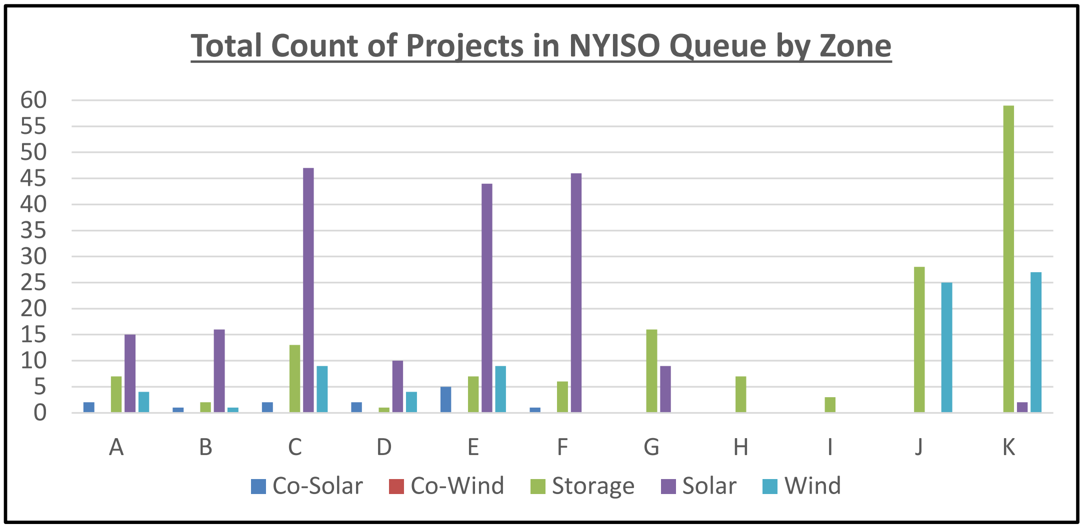
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

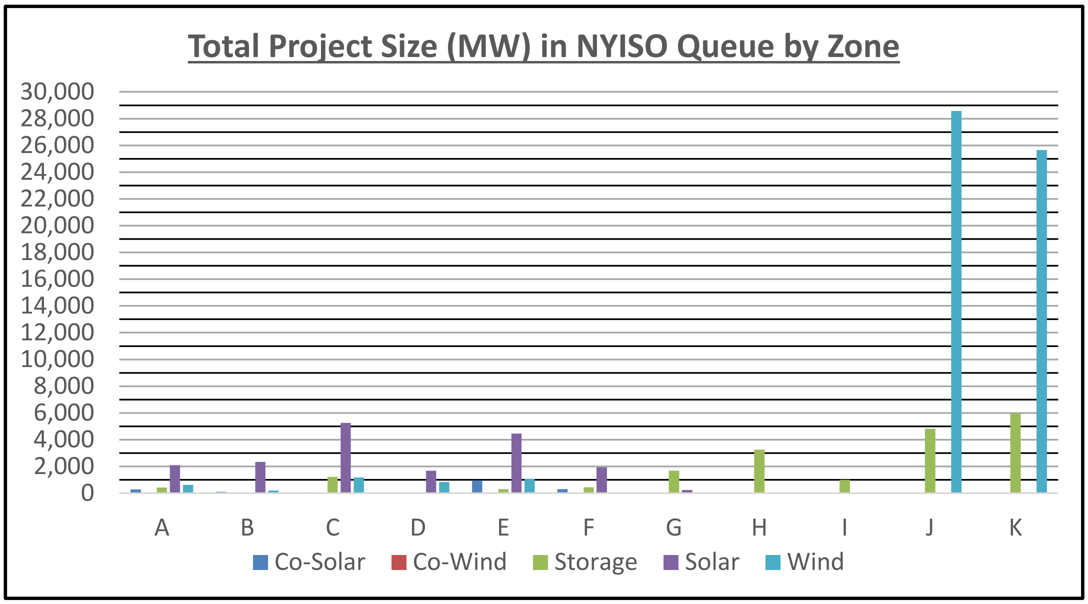
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (Solar and Wind now in separate categories) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on October 21st, and representing the Queue as of September 30th. Note that 18 projects were added, and 6 were withdrawn during the month of September. Results are tabulated below and shown graphically on the next page.

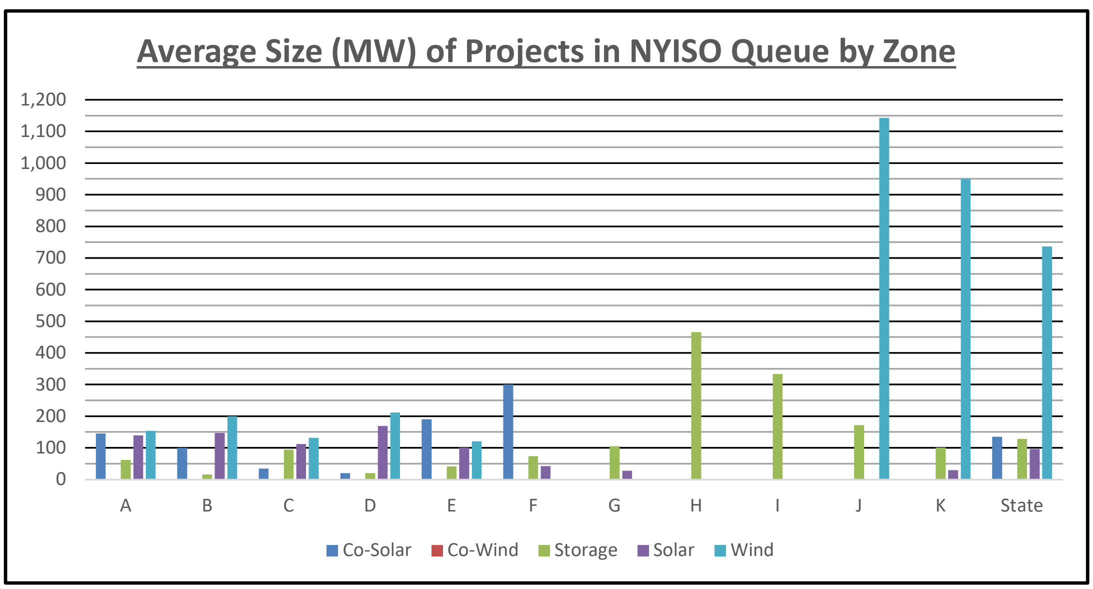
Total Count of Projects in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	2		7	15	4
B	1		2	16	1
C	2		13	47	9
D	2		1	10	4
E	5		7	44	9
F	1		6	46	
G			16	9	
H			7		
I			3		
J			28		25
K			59	2	27
Grand Total	13		149	189	79

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		31	2,347	200
C	70		1,223	5,254	1,184
D	40		20	1,689	847
E	954		292	4,452	1,087
F	300		440	1,937	
G			1,686	250	
H			3,260		
I			1,000		
J			4,815		28,576
K			5,968	59	25,658
State	1,753		19,166	18,078	58,168

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		16	147	200
C	35		94	112	132
D	20		20	169	212
E	191		42	101	121
F	300		73	42	
G			105	28	
H			466		
I			333		
J			172		1,143
K			101	29	950
State	135		129	96	736


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
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