Attachment #8.1
Return to Agenda

De-Carbonization / DER Report for NYSRC Executive Committee Meeting 10/13/2023

Contact: Matt Koenig (koenigm@coned.com)

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

- NERC Releases Inverter-Based Webinar Series Recordings, FAQ, Video
- ESIG Webinar: Overview of Grid Forming Interconnection Requirements
- DOE and DOI release Action Plan for Offshore Wind Transmission Development in the Atlantic Region
- Articles:
  - NY Times: Looking to Space in the Race to Decarbonize
  - NY Times: How to Cool Down a City
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / Co-located

NERC Releases Inverter-Based Webinar Series Recordings, FAQ, Video

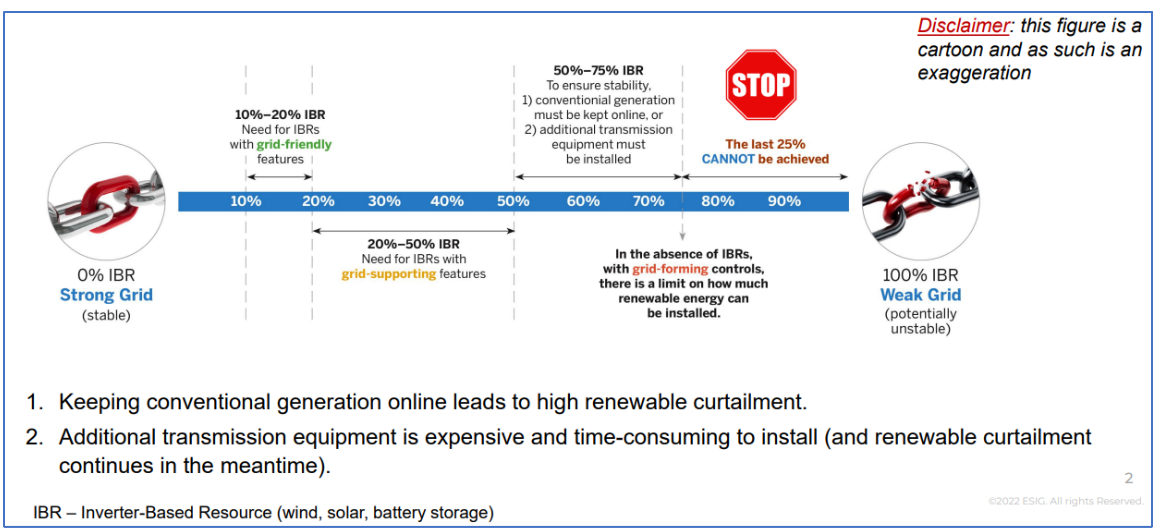
NERC has released the recordings and slides from its recent 11-part webinar series that provided a complete overview of bulk power system-connected IBRs, ranging from a fundamental understanding of the technology, to the more complex and emerging risk issues. An additional FAQ document covers general themes from the more than 1000 comments and questions received throughout the series. Additionally, NERC has produced a video featuring remarks from NERC President and CEO Jim Robb and other series highlights.

To learn more about NERC's work in this area, see the Inverter-Based Resource Activities Quick Reference Guide. All documents under the Reliability and Security Technical Committee can be found at the IRPWG Landing Page . All previous documents under the Planning Committee can be found here: IRPTF Documents.

ESIG Webinar: Overview of Grid Forming Interconnection Requirements

This presentation (Download Presentation / Webinar Video) from the Energy Systems Integration Group (ESIG) provides an overview of the functional concepts associated with Grid-Forming Inverters within the context of general Inverter-Based Resources, along with a survey of local and international efforts to develop expectations for the near-term evolution of inverters and the local / international efforts to establish guidelines and regulations for their usage.

This first slide highlights the expected impact of IBRs on transmission grids, along with the subsequent need for Grid Forming Inverters.



The presentation then identifies the fundamental aspects of Grid Forming concepts based on NERC:

- Grid Forming IBR controls maintain an internal voltage phasor that is constant or nearly constant in the sub-transient to transient time frame. This allows the IBR to immediately respond to changes in the external system and maintain IBR control stability during challenging network conditions. The voltage phasor must be controlled to maintain synchronism with other devices in the grid and must also regulate active and reactive power appropriately to support the grid.
- There are many variations of both grid-forming and grid-following controls. Both are subject to physical equipment constraints including voltage, current and energy limits, mechanical equipment constraints (on WTGs) as well as external power system limits.
- Further, performance requirements for GFL plants, will also apply to GFM inverters unless explicitly identified as inapplicable.

Note that this information can be found these sources:

- NERC, Grid Forming Technology Bulk Power System Reliability Considerations, December 2021
- ESIG, Grid Forming Technology in Energy Systems Integration, March 2022

Potential Use-Cases for Grid-Forming Controls include:

- Weak grid operation
- Damping voltage and frequency oscillations
- Response to phase-jump
- Limit initial RoCoF (substitute/supplement) inertia response
- Fast fault current (balanced and unbalanced)
- Sub synchronous control interactions
- Black start

One slide focused on NERC IRPS efforts, with reference to concepts of Grid Forming Functional Specs for BPS-Connected Battery Energy Storage Systems. The slide contents are shown below:

GFM Model Test System

- A synchronous generator with simple excitation & governor model
- A load with active & reactive components
- GFM BESS model under test
- Duplicate GFM BESS model, rated at half (MVA and MW) of the model under test

Trip synchronous machine under following conditions:

- BESSs Initially Discharging and Ends at Higher Level of Discharging: Assess GFM BESS performance when operating within limits and in discharging state.
- BESS Initially Charging and Ends Discharging: Assess GFM BESS performance when operating within limits and transitioning from charging state to discharging state.
- BESS GFM Performance at Maximum Active Power: Assess GFM BESS performance when operating at or near limits.

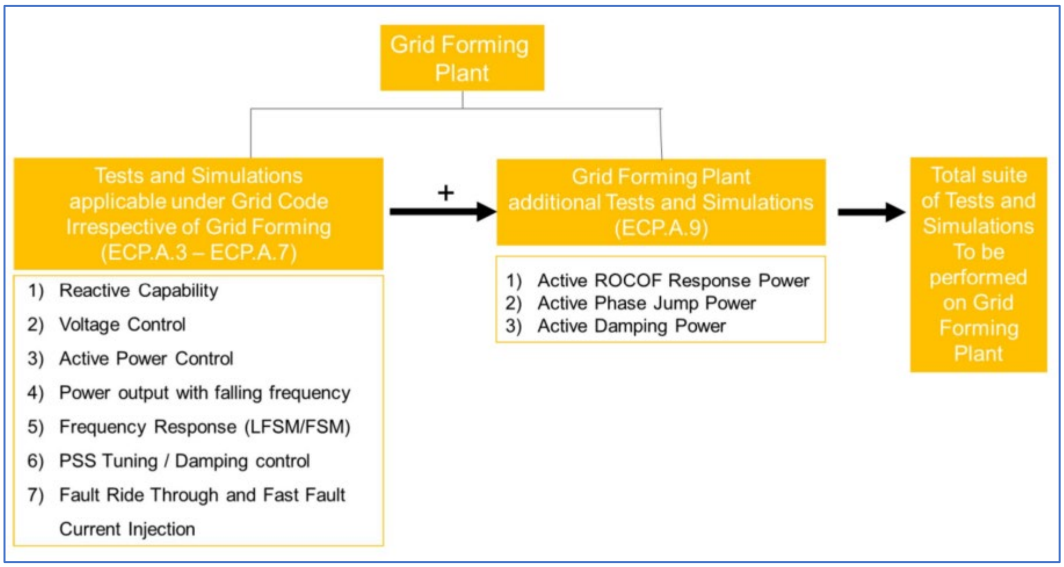
Success Criteria

- Stable initial conditions, no oscillations, within limits
- Voltage & frequency settle to stable, acceptable operating point within tolerance of droop & deadband
- Well damped, well-mannered recovery with no excessive oscillations, all oscillations settled
- Waveform distortion dissipates
- Active/reactive power settles according to demand and droop characteristic

Another slide focused on efforts at ERCOT (Info based on report entitled: Preliminary assessment of Grid Forming Inverter-based Energy Storage Resources (GFM-IBR-ESR) in the ERCOT Grid).

- Recent notable disturbance events (in 2021 and 2022) have indicated reliability risks.
- ERCOT focuses on improvements IBR capabilities and performance and strengthening of the grid – both are needed to maintain the reliable operation.
  - Adoption of NERC Reliability Guidelines, IEEE 2800 ride through requirements
  - Recommendation of synchronous condensers to strengthen West Texas grid
- ERCOT has 17.5 GW of committed batteries in the interconnection queue (out of 111.6 GW requests)
- Conducted a preliminary study on benefits of grid-forming batteries in West Texas.
- Study showed that, while GFM batteries cannot solve all the issues, but
  - Can improve system dynamic response in weak grids and support GFL IBRs in resource-rich areas
  - Still require proper control settings and coordination
- Next steps: development of grid-forming requirements for batteries including but not limited to performance, models, studies, and verification.

The slide below shows Testing and Verification process from Great Britain Grid Forming Best Practice Guide:



The Presentation concludes with these observations:

- If IBRs are built with grid-forming controls, stability can be provided by the resource itself, the need for additional mitigation can be greatly reduced, and higher share of IBRs (up to 100%) achieved.
- Grid code requirements and/or market products are needed for grid-forming IBRs to be deployed in an efficient and timely manner.
- It took 20 years in Europe to develop grid codes for present-day IBR technology, while the U.S. still does not have harmonized grid codes. We do not have another 20 years to develop requirements of grid-forming IBRs!
- There have been a number of activities in the U.S., Europe, and Australia in the past three years to accelerate the deployment of grid-forming IBRs.
- However, the challenge is broad and global. Much more work is needed to seize this window of opportunity and deploy grid-forming controls at least on BESSs next in line to be connected to the grid.

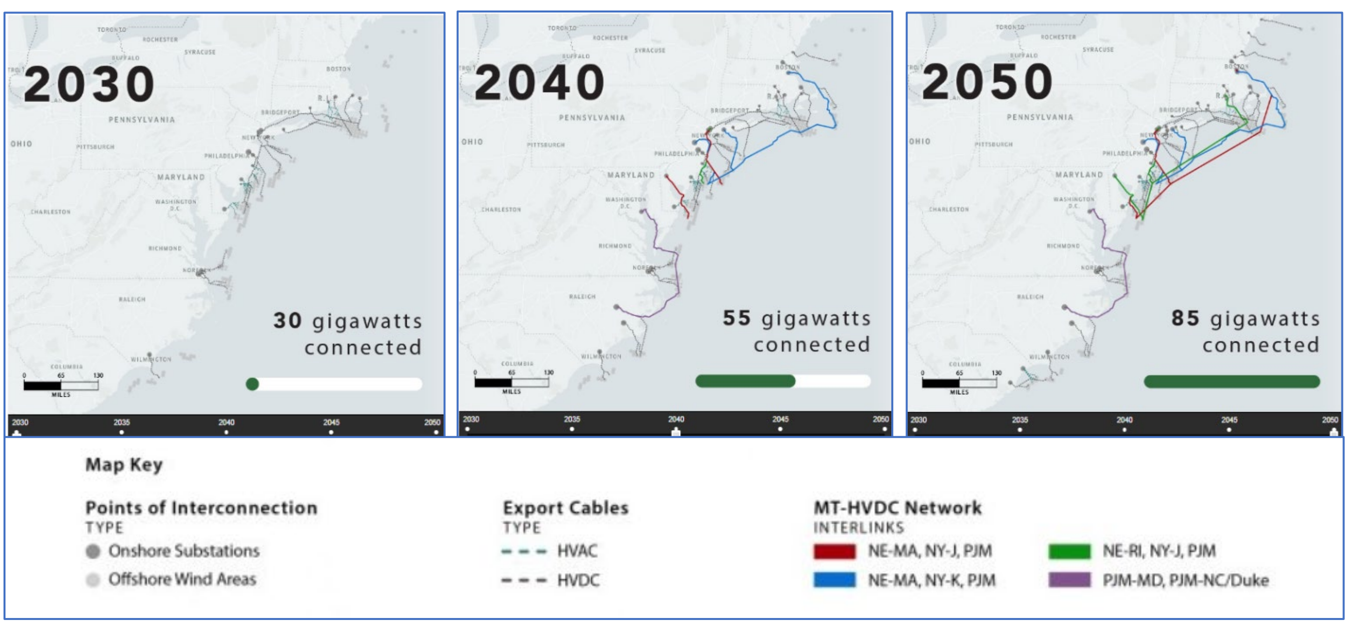
DOE and DOI release Action Plan for Offshore Wind Transmission Development in the Atlantic Region

The Department of Energy and the Department of the Interior [recently announced an Action plan]() outlining the steps needed to connect the first generation of Atlantic offshore wind projects to the electric grid, as well as to increase transmission resources over the next several decades. The full report, entitled "[An Action Plan for Offshore Wind Transmission Development in the U.S. Atlantic Region]()", which was developed by DOE's Grid Deployment and Wind Energy Technologies Offices and DOI's Bureau of Ocean Energy Management, aims to coordinate planning to speed up timelines, lower project costs, and strengthen grid reliability and resilience.

The DOE stated that increased intra-regional coordination, shared transmission lines, and an offshore network of high voltage direct current interlinks can more efficiently bring offshore energy onshore.

The recommendation include:

- Before 2025 - Establish collaborative bodies that span the Atlantic Coast region; clarify some of the building blocks of transmission planning, including updating reliability standards and identifying where offshore transmission may interconnect with the onshore grid; and address costs through voluntary cost assignments and tax credits.
- From 2025 to 2030 - Simultaneously convene and coordinate with states to plan for an offshore transmission network; with industry to standardize requirements for HVDC technology; and with federal agencies, tribal nations, state agencies, and stakeholders to identify and prioritize transmission paths on the outer continental shelf.
- From 2030 to 2040: Establish a national HVDC testing and certification center to ensure compatibility when interconnecting multiple HVDC substations to form an offshore grid network and codify updates to transmission planning through regulated interregional joint planning, transfer capacity minimums, and market monitoring.
- Sustaining actions: Improve environmental review and permitting frameworks, support strong state leadership, empower permitting agencies, develop thoughtful cost allocation practices, and consider the utilization of national corridors actions.



Together, the action plan and the tribal assistance program will advance equitable and sustainable offshore wind energy development, domestic manufacturing, and grid integration, as part of broader efforts across the Biden-Harris administration to deploy 30 gigawatts of offshore wind in the United States by 2030, unlocking a pathway to 110 GW or more by 2050.

NY Times: Looking to Space in the Race to Decarbonize

This article describes how scientists at Caltech have demonstrated space-based solar power, a clean energy technology anticipated to utilize thousands of solar panels floating in space, unobstructed by clouds and unhindered by day-night cycles, wirelessly transmitting massive amounts of energy to receivers on Earth. This year, Caltech researchers proved the concept by attaching a Caltech prototype in space that successfully converted electricity into microwaves and beamed those microwaves to receivers about a foot away, lighting up two LEDs.

The image at right shows Caltech's Space Solar Power Demonstrator mounted on a Momentus Vigoride space tug.

The prototype also beamed a tiny but detectable amount of energy to a receiver on top of their lab's building in Pasadena, Calif. The demonstration marks a first step in the wireless transfer of usable power from space to Earth — a power source that will be safer than direct sun rays, as the beam intensity is to be kept less than solar intensity on earth.

If space-based solar can be made to work on a commercial scale, such stations could contribute as much as 10 percent of global power by 2050. The idea of space-based solar energy has been around since at least 1941, when the science-fiction writer Isaac Asimov set one of his short stories, "Reason," on a solar station that beamed energy by microwaves to Earth and other planets.

In the 1970s, when a fivefold increase in oil prices sparked interest in alternative energy, NASA and the Department of Energy conducted the first significant study on the topic. In 1995, under the direction of the physicist John C. Mankins, NASA took another look and concluded that investments in space-launch technology were needed to lower the cost before space-based solar power could be realized.

The advent of Elon Musk's SpaceX has brought a steep decline in the cost of rocket launches. From 1970 to 2000, the average low-earth-orbit rocket launch cost was around $18,500 for a kilogram, or 2.2 pounds, of weight; today, the cost has plummeted to as low as $1,500 per kilogram. That reduction has helped drastically reduce estimates for building power stations beyond Earth's atmosphere. A 1980 review by NASA concluded that the first gigawatt of space-based solar power (enough energy to power 100 million LED bulbs) would cost more than $20 billion ($100 billion today). By 1997, NASA estimated that that number had dropped to about $7 billion ($15 billion today); now, it is estimated to be closer to $5 billion, according to a study conducted for the European Space Agency in 2022.

Space-based solar power requires wirelessly transmitting electrical energy across space using microwave or laser power beaming. Unlike laser beams, microwaves can penetrate clouds and rainfall, making them the prime candidate for maximizing solar capacity.

Still, there are engineering hurdles. Although this project beamed a detectable amount of energy to Earth, it did not beam enough power to Earth to convert it into a usable form. Until now, no one has demonstrated power beaming more than a few kilometers. The Caltech team are working on technologies that would enable a large array of lightweight, sail-like spacecraft, using billions of small transmitting antennas, to create a focused beam that could travel thousands of kilometers to Earth and carry megawatts worth of energy.

The scale of space-based solar power structures is also daunting. The most prominent building in space today is the International Space Station, which measures 357 feet end to end. Space-based solar power systems would be several thousand feet wide, and an army of robots would be needed to autonomously assemble the structures while in orbit.

In addition to overcoming technical challenges, researchers must also ensure the safety of wirelessly beaming power to Earth. Microwave and laser beams pose a known risk to human health when operated at certain power densities. Researchers say the power density of space-based solar would be designed to operate within limits set by international governing bodies. Still, no studies have focused on the effect of space-based beaming on human health, the environment, or the atmosphere — a critical step for public acceptance of the technology.

Then, inevitably, there will be regulatory challenges. The transmission of radio waves from orbit — including telecommunication, GPS, and weather satellites — requires licensing to prevent interference from different users. Solar-power satellites would likely need the approval of the International Telecommunications Union, a United Nations agency, to protect and license their operating frequencies.

The complexity of these challenges places the expected arrival of most space-based solar power projects in the 2030s or 2040s, should they ever get to that point. That's not stopping researchers from pressing forward with the dream of harnessing an uninterrupted, inexhaustible supply of energy from space.

NY Times: How to Cool Down a City

This article describes efforts underway in Singapore to mitigate the effects and impact of global warming. Rapid urbanization has made Singapore hotter. A big part of the problem is how almost every global city is built. Cities cut down trees and remove plants that provide shade and naturally cool the air. They cover large areas with concrete and asphalt, which absorb heat during the day and release it at night. They densely pack skyscrapers into urban canyons that limit wind flow and trap pockets of heat. And their residents expel waste heat from gas car exhausts and air conditioners, helping to transform a hot day into an unbearable one.

Preventing climate change is out of Singapore's control: The city-state emits less than 0.1% of global carbon emissions. But there is a surefire way to limit city temperatures, researchers say: Revive the natural processes that cooled the land before urbanization.

Most cities do not have Singapore's wealth and centralized political system, which allow it to move quickly to build new infrastructure. But while some of Singapore's strategies to reduce excess heat are expensive, many of them are straightforward, and cheaper than planning for, say, floods or hurricanes.

In the image on the next page, the V-shape design of this hospital funnels cool breezes from a neighboring pond, bringing cold air into the building without using air conditioning. The building integrates trees and plants in a central garden, on the rooftop, hanging from the façade. They provide shade and reduce the heat absorbed by the building from the sun. The plants also release water into the air as vapor, cooling the area down. They function like a conveyor belt moving heat from the ground high up into the air.

Researchers say that planting more trees is the most effective way to reduce a city's temperature. "If you wanted to invent the most effective kind of climate management technology from the ground up, you could spend a lot of time trying to do that. You would just engineer a tree," said Brian Stone Jr., director of the Urban Climate Lab at the Georgia Institute of Technology.

The streets around the Khoo Teck Puat Hospital are lined with trees, and the central courtyard of the building is full of dense foliage. During the day, trees shield pedestrians from the sun and prevent the sun's rays from warming the concrete sidewalk. At night, temperatures are lower, as less heat is released from the sidewalk.

In order to rely on trees to regulate climate stress, cities will need to treat them as infrastructure to ensure they are healthy and effective, according to Dr. Stone. That will come at a cost, but just a fraction of what cities spend on other environmental protections. "It's a real budget item, but it's not out of proportion to what we already spend on environmental management in cities," he said. "It's less than one percent of what we spend maintaining storm sewers in L.A. every year."

Singapore is also encouraging the integration of greenery directly into buildings by offering financial incentives for rooftop gardens and vertical green facades. The foliage works as natural blinds, shading the structure and insulating the building's material from the heat, reducing the need for air conditioning.

Singapore has used light-colored paint on the roofs of some buildings, which absorb less heat and could reduce the ambient temperature around the buildings by up to 3.5 degrees Fahrenheit, initial studies suggest. A similar program in New York City has covered more than 10 million square feet of rooftops with reflective paints since 2009, reducing the need for air conditioning and the waste heat it generates.

Simple design decisions can also have a major impact on a building's temperature. Buildings that avoid directly facing the sun result in cooler indoor temperatures. Architects are designing buildings that encourage cross-ventilation, pushing hotter air out and bringing cooler air in.

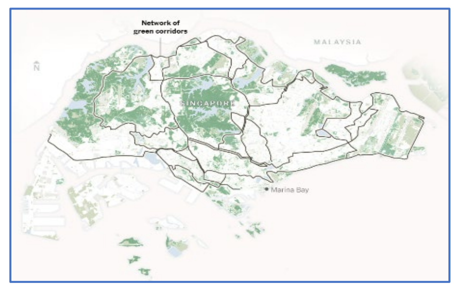
There are limits to what can be achieved by rethinking a city only one building at a time. Even the most cutting-edge buildings can negatively influence their surroundings in unforeseen ways. A new residential development with all the "bells and whistles" of efficient urban design could still make the neighborhood hotter if it blocks wind flow. To tackle the urban heat island effect, it is vital to not only improve the design of each building, but to consider its relationship with the surrounding city.

Dense skyscrapers in downtowns often limit wind flow and trap heat, but here a mix of tall, medium, and short buildings works like a sail to capture cool sea breezes and direct them to the pedestrian level. Twenty-three buildings are part of an interconnected cooling system that replaces the need for each building to use its own air conditioning.

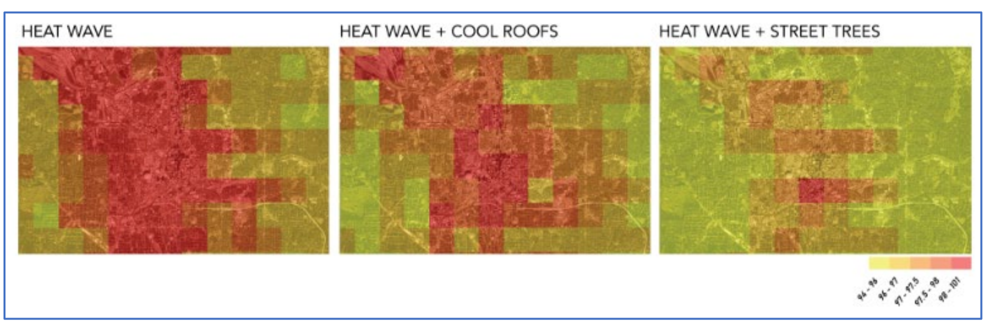
One street in Singapore, known as "air conditioner alley," demonstrates how a lot of poorly coordinated small decisions can compound to cause a big heat problem. Hundreds of air conditioning units all siphon hot air out of the apartments and businesses, onto the same narrow street. A similar dynamic plays out in most cities with hot climates. Buildings are cooled one at a time, lowering their temperature at the expense of making the environment hotter.

Instead of cooling small spaces individually, Singapore's Marina Bay, which was centrally planned, cools down many buildings at once by running chilled water through a network of insulated pipes. The district cooling network is far more efficient than multiple small A.C. units, reducing both energy consumption and waste heat.

Large green spaces like parks are a more widely practical intervention, cooling areas beyond their boundaries, researchers say. Air temperature measurements show that Singapore's 155-acre Bishan Park can be up to about 3 degrees cooler than high-density residential blocks in the middle of the city. But even parks have their limits. Singapore has built out a more systematic solution, a network of green corridors that connect green spaces together and allow cool air to flow throughout the city.



Green corridors have been successful in other cities, including in Medellín, Colombia. The city has planted more than 880,000 trees across 30 corridors, which reportedly reduced the average air temperature in the corridors by more than 8 degrees Fahrenheit. Widely planting street-level trees along sidewalks across the city is the most effective solution to reduce temperature, according to researchers at the Urban Climate Lab.



Can Singapore's efforts to reduce urban heat islands actually outpace rising global temperatures? Probably not, local officials acknowledge. But holding temperatures steady would be a huge victory. Urban planners and policymakers are recognizing that inventions to cool down cities also help in other ways. Green corridors and large green spaces support biodiversity, provide recreational spaces for residents and aid flood prevention.

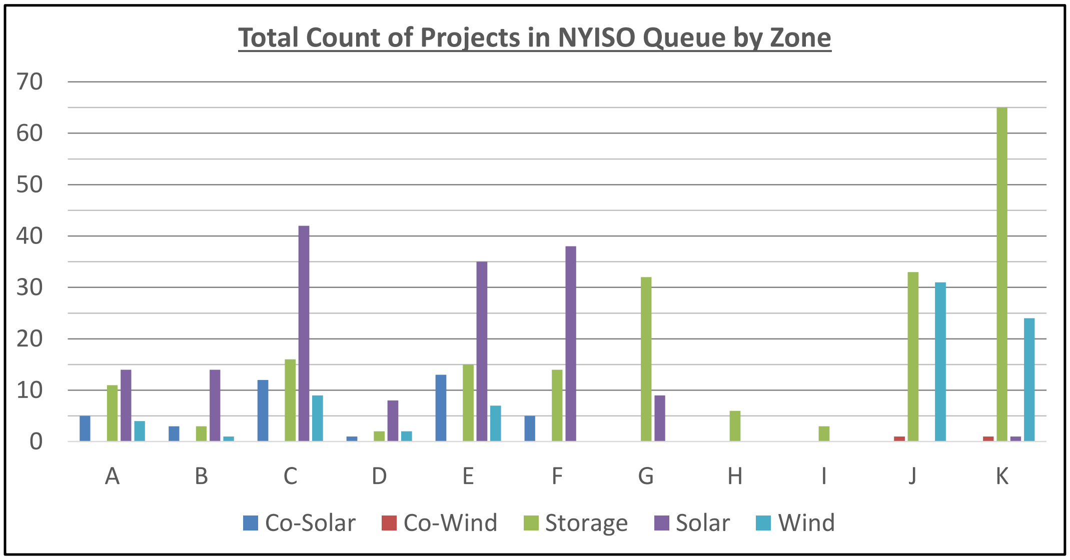
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

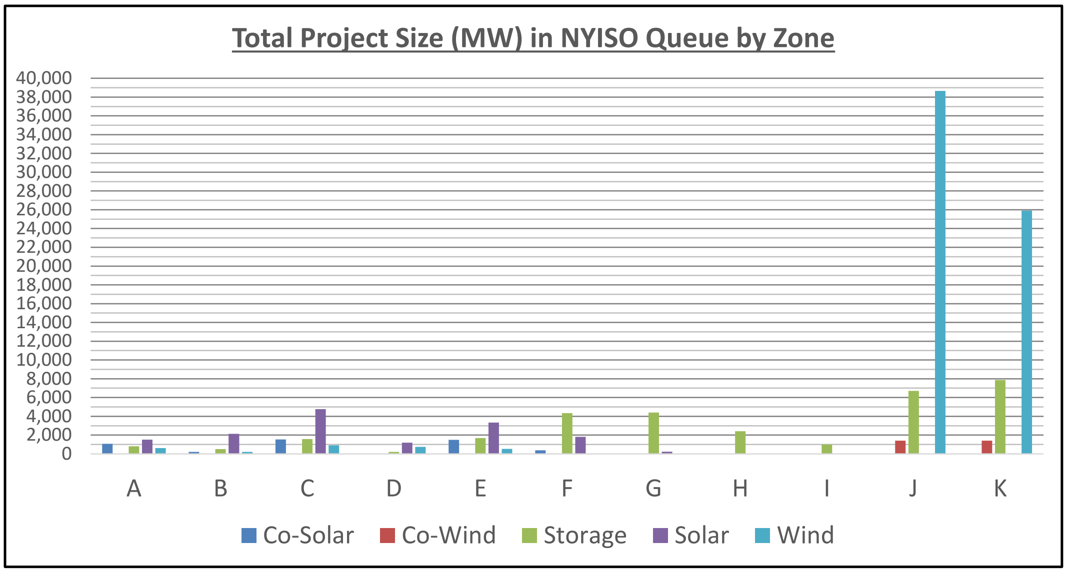
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (Solar and Wind) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on September 20th, and representing the Interconnection Queue as of August 31st. Note that 14 projects were added, and 13 were withdrawn during the month of August.

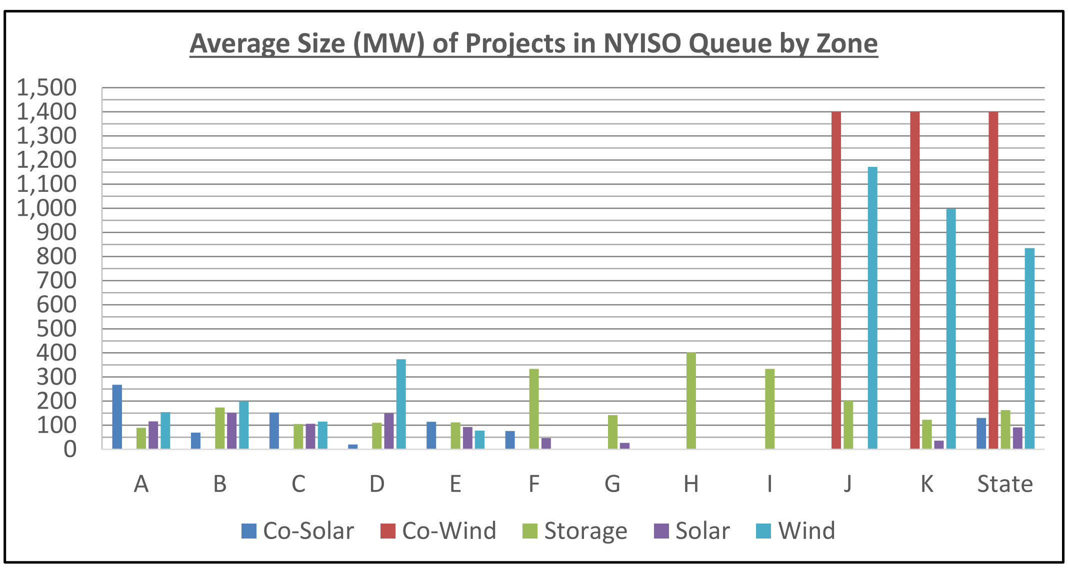
Total Count of Projects in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	5		11	14	4
B	3		3	14	1
C	12		16	42	9
D	1		2	8	2
E	13		15	35	7
F	5		14	38	
G			32	9	
H			6		
I			3		
J		1	33		31
K		1	65	1	24
Grand Total	39	2	200	161	78

Total Project Size (MW) in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	1,092		1,048	1,908	618
B	187		520	2,125	200
C	1,591		1,744	4,672	1,001
D	20		220	1,202	747
E	1,492		1,684	3,306	541
F	380		4,360	1,801	
G			4,608	243	
H			2,416		
I			1,000		
J		1,400	6,705		34,731
K		1,400	8,077	36	24,614
Grand Total	4,762	2,800	32,382	15,291	62,452

Average Size (MW) of Projects in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	218		95	136	154
B	62		173	152	200
C	133		109	111	111
D	20		110	150	374
E	115		112	94	77
F	76		311	47	
G			144	27	
H			403		
I			333		
J		1,400	203		1,120
K		1,400	124	36	1,026
Grand Total	122	1,400	162	95	801


Total Count of Projects in NYISO Queue by Zone
70
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
40,000
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
1,500
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