Attachment #8.1
Return to Agenda

De-Carbonization / DER Report for NYSRC Executive Committee Meeting 5/12/2023

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

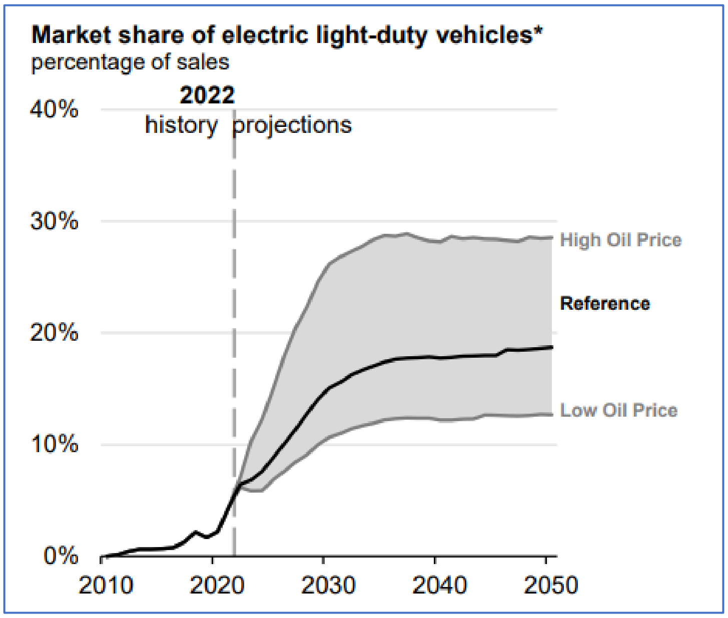
- NERC Cross-Sector Collaboration: Addressing the Potential Challenges from Electric Vehicle Grid Impacts
- CBS 60 Minutes Report: Out of Thin Air - Direct Air Carbon Capture
- New York Times Article: Is It a Lake, or a Battery? New Kind of Hydropower Is Spreading Fast
- NYISO Press Release and Blog Articles
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / Co-located

NERC Cross-Sector Collaboration: Addressing the Potential Challenges from Electric Vehicle Grid Impacts

On April 11, The California Mobility Center (CMC), NERC and WECC announced the release of their joint report, "Electric Vehicle Dynamic Charging Performance Characteristics during Bulk Power System Disturbances" to highlight the need for ongoing collaboration between electric utilities, electric vehicles (EVs), and electric vehicle equipment industries to ensure electric system reliability.

The report, undertaken as part of the joint EV Grid Reliability Working Group, focuses on EV charging behavior during infrequent disturbances that originate from the high-voltage bulk power system. These events last no more than a few seconds, but if left unchecked they have the potential to cause catastrophic consequences for electric system reliability such as cascading blackouts and widespread power interruptions.

The adoption of EVs is projected to grow rapidly over the coming decades (see Figure at right). To support this growth, the U.S. Energy Information Administration forecasts that electricity consumption by the transportation sector will increase by more than a factor of 12 between 2021 and 2050 (from 12 billion kWh in 2021 to more than 145 billion kWh in 2050). Considering all forms of electrification across North America, the Energy Research Consulting Company Woods Mackenzie projects that electricity consumption in 2050—by transportation and building electrification after subtracting projected increases in on-site generation (e.g., rooftop solar PV)—will represent a 66% increase over total electricity consumption in 2022.

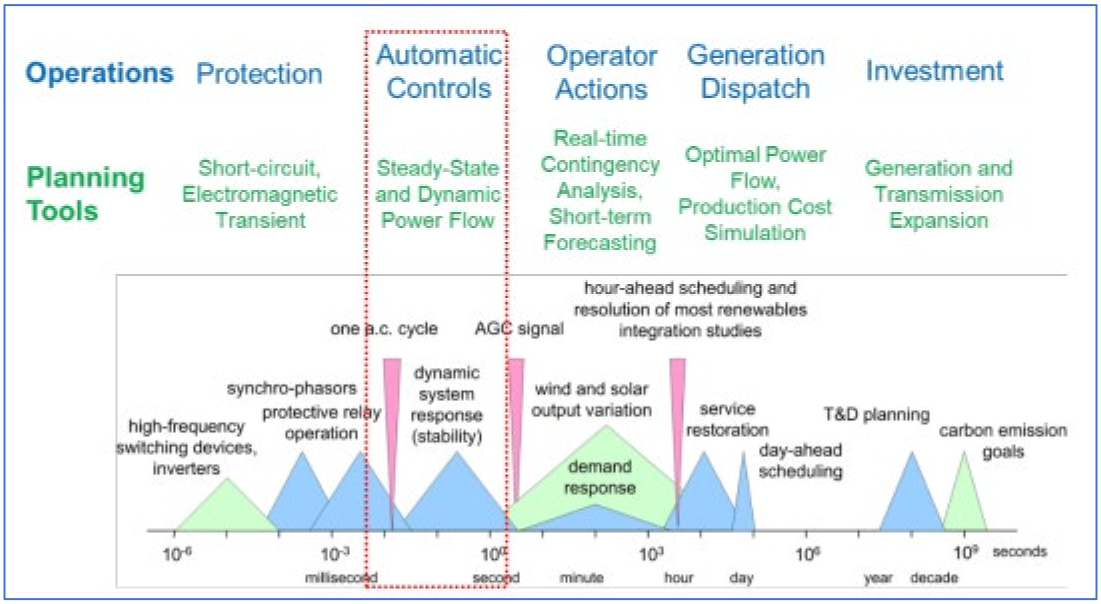


Preliminary testing has confirmed that some EV chargers already appear to behave in a manner that is grid friendly during the very infrequent, short-lived times (lasting no more than seconds) when the grid is under stress. This is encouraging because it suggests that only modest changes might be required to make all EV charging and Electric Vehicle Supply Equipment (EVSE) technologies operate in a grid-friendly manner.

The Working Group expects these effects on the electric power system will only intensify as the penetration of EVs on the grid increases. These impacts must be managed to maximize the speed of adoption. Examples include, but are not limited to, the following:

- Demands on distribution providers to process EV charging load interconnection requests may increase faster than can be managed by these providers and lead to delays in new interconnections.
- Significant increase in distribution system hosting capacity and loading effects may cause operational problems in distribution systems requiring expensive, last-minute upgrades in order to accommodate EV charging demands.
- Large-scale changes to demand profiles due to unmanaged EV charging behavior, time-of-use rates, and distributed renewable energy resources (DER) may lead to resource adequacy shortfalls and create needs for short-term, emergency rationing, such as planned, rolling blackouts.
- Faster load growth than is anticipated by current demand forecasts may have unexpected negative consequences for capacity and energy resource plans.
- The need for flexible ramping resources and reserves carried by BPS balancing authorities (BA) and transmission operators (TOP) may grow faster than that which has been anticipated in current long-term planning and operational planning studies.
- Increasing variability and uncertainty in distribution and transmission system demand patterns may lead to unexpected operational challenges and the need for emergency demand rationing (i.e., rolling blackouts).
- Negative effects on distribution system and transmission system protection system operations may lead to unplanned power interruptions.
- Effects of grid dynamics, controls, and system stability due to the power electronic behavior of the EV charging loads may create new risks of widespread, cascading blackouts.

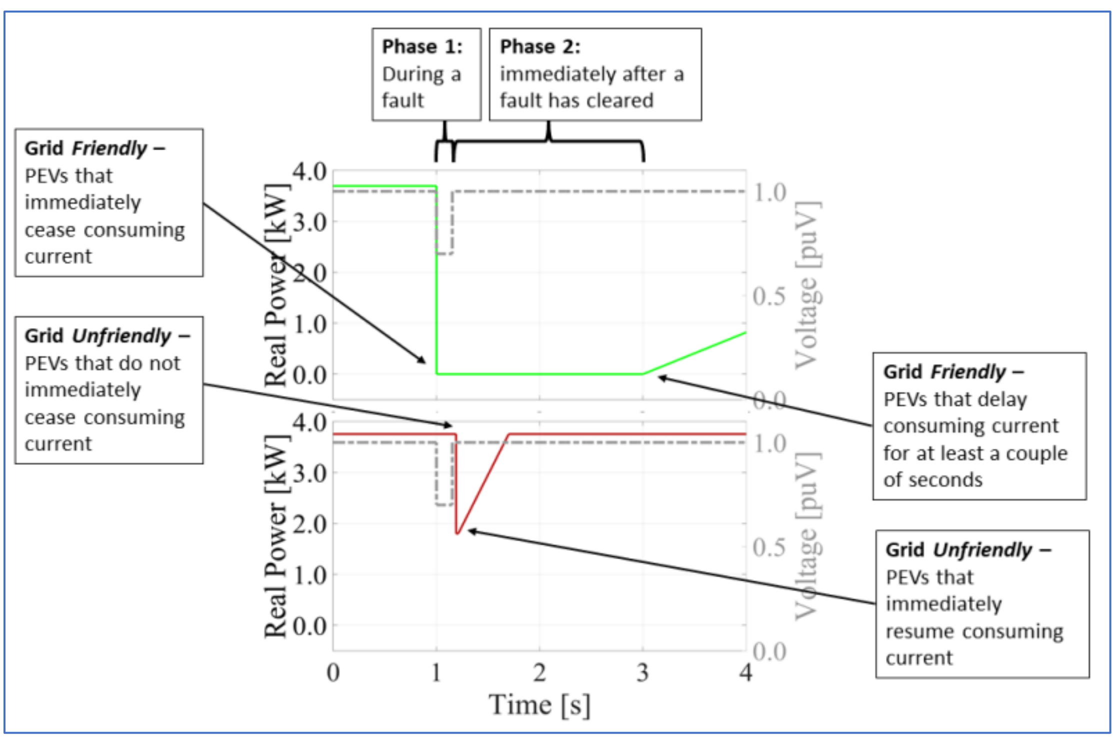
This document focuses on the dynamic system with respect to BPS reliability. The time frames involved range from milliseconds (one thousandth of a second) to seconds. In this time frame, automatic and autonomous (i.e., independent) controls and protections must operate quickly in a pre-coordinated manner to ensure the safety and reliability of the power system. Dynamic stability simulation tools must be relied upon to study and pre-plan the automatic actions that grid equipment must take to ensure that the BPS will remain stable and reliable during large grid disturbances. To consider all possible scenarios, hundreds or even thousands of distinct "what if" simulations are necessary.



Evaluations and recommendations of Grid-Friendly and Unfriendly EV Charging Dynamic Behavior were made in the following categories:

- Steady-State Consumption Control:
  - EV Chargers and EVSEs should employ a steady-state control strategy that use constant current control rather than constant power level control during normal operations.
- Power Factor:
  - EV chargers and EVSEs should operate with a power factor of 0.985 or higher (leading or lagging). Power factor should be maintained for ac supply voltages from 80% to 110% of nominal voltage.
- Frequency Response (Active Power-Frequency Control):
  - EV chargers and EVSEs should have a programmable current consumption droop characteristic with a programmable range and a default value of 5%.
  - EV chargers and EVSEs should be programmed with the capability to rapidly reduce current consumption for severe frequency excursions before UFLS levels are reached.
- Ride-Through Performance: Remaining Connected during Grid Disturbances:
  - Continuous Operation: Steady-state operations or minor grid disturbances (e.g., distant faults and generator trips, line switching) where EV chargers and EVSEs should remain connected to the grid and consuming constant current
- Ride-Through Performance: Dynamic Response Times
  - EV chargers and EVSEs should dynamically control current consumption, with any ceasing (or ramping down) and resumption (or ramping up) of current in a manner that supports grid reliability.
- Ride-Through Performance: Voltage Characteristics
  - The dynamic response of active current consumption during ride-through operation should be proportional to measured terminal voltage. The response time to changes in voltage should be less than 20 milliseconds (or approximately one cycle) to support BPS reliability.

Examples of Grid Friendly and Unfriendly Charging Behaviors are shown in the image below:

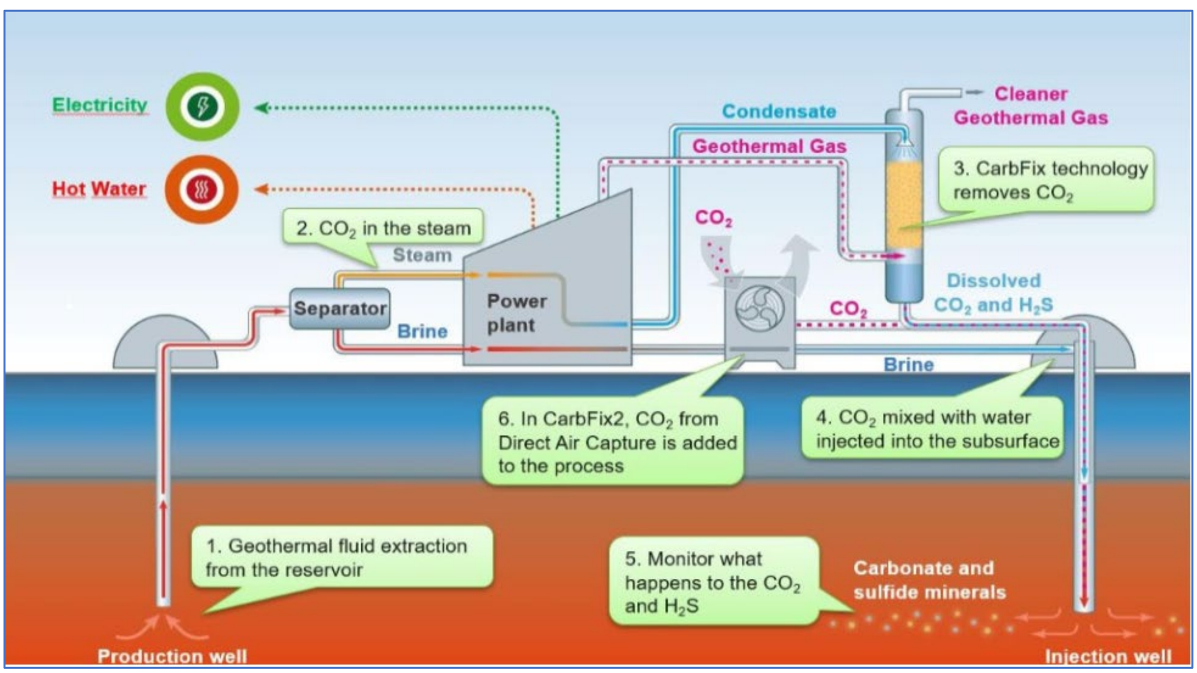


CBS 60 Minutes Report: Out of Thin Air: Direct Air Carbon Capture

On Sunday, April 30th, CBS 60 Minutes presented a segment covering a new direct air carbon capture facility that has been established and is currently operational in Iceland. The project began in 2012 when researchers and engineers began sequestering carbon into basalt rocks at the Hellisheidi geothermal power station in southwest Iceland.

The CarbFix project – a collaboration between utility company Reykjavik Energy, the University of Iceland, France's National Centre for Scientific Research (CNRS) and Columbia University in the US, with funding from the European Union – has been capturing and injecting about a third of the CO2 and three-quarters of the hydrogen sulfide emitted from the geothermal plant.

Iceland has enormous geothermal resources that can be harnessed to produce clean energy. Heating and hot water for most Icelandic homes and more than a quarter of the nation's electricity comes from geothermal energy. The Hellisheidi facility is located on the Hengill volcano, on top of a layer of basalt rock. Water underneath the volcano is pumped up to run six turbines, which provide electricity and heat to the capital city as a part of the CarbFix project.



Through than energy produced from fossil fuels, geothermal plants emit some CO2, as well as the hydrogen sulfide contained in steam. The CO2 from the steam is captured and dissolved in large amounts of water. The fizzy water is pumped to the injection site and is pushed over a mile a deep into basaltic rock, where it solidifies to rock in about 2 years. Trapped in the rock, the CO2 cannot leak out of the ground and into the atmosphere.

Basalt formations are found around the world and the CarbFix team believe their model could be repeated elsewhere. The process does, however, require a large amount of desalinated water (about 25 tonnes of water per tonne of stored CO2), so they are working on adapting it to saltwater.

The technology relies on basalts, where the carbonated water reacts with elements such as calcium, magnesium and iron, forming carbonates that fill up empty spaces in the rocks underground. Carbfix is also working with research institutions on making the technology applicable for other types of rock.

The study found that over 95% of the CO2 injected into the CarbFix site in Iceland had mineralized to carbonate minerals in less than 2 years. This result contrasts with the common view that the immobilization of CO2 as carbonate minerals within geologic reservoirs could take hundreds to thousands of years. The results demonstrated that the safe long-term storage of anthropogenic CO2 emissions through mineralization can be far faster than previously postulated.

Potentially, basalt could solve all the world's CO2 problems. The storage capacity is such that, in theory, basalts could permanently hold the entire bulk of CO2 emissions derived from burning all fossil fuel on Earth. It can also go to other uses, as well. Energy companies can mix the carbon dioxide with hydrogen to make fuel. Farmers can feed their plants with it. Soda manufacturers can use it to fizz their drinks - something a Swiss customer of Climeworks did a few years ago when there was a carbonation shortage.

Challenges include:

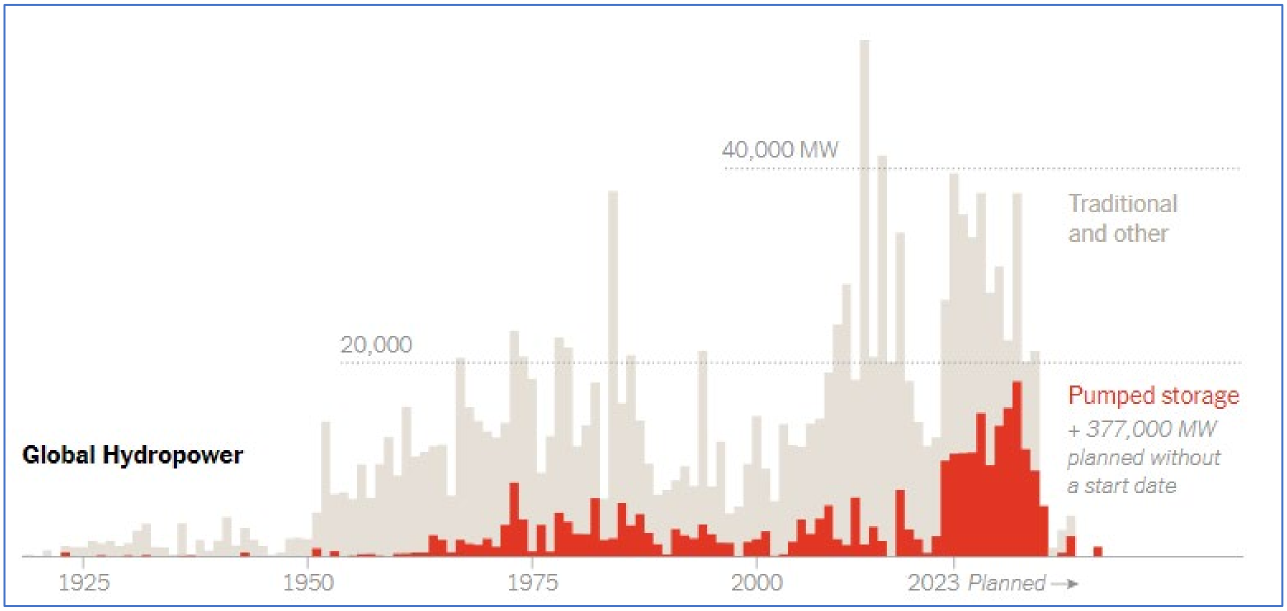
- This approach requires substantial water and the presence of reactive rocks, which are not available in all localities.
- The nearby Hengill volcano, generated a swarm of low magnitude earthquakes resulting from pumping water without the CO2, with 250 quakes being reported on September 13th, 2011.
- There have been earthquakes reported due to the injection of wastewater in the area. Proceedings at the 2010 World Geothermal Congress reported that reinjection at Hellisheiði had induced seismic activity.

Supporting information can be found at these links:

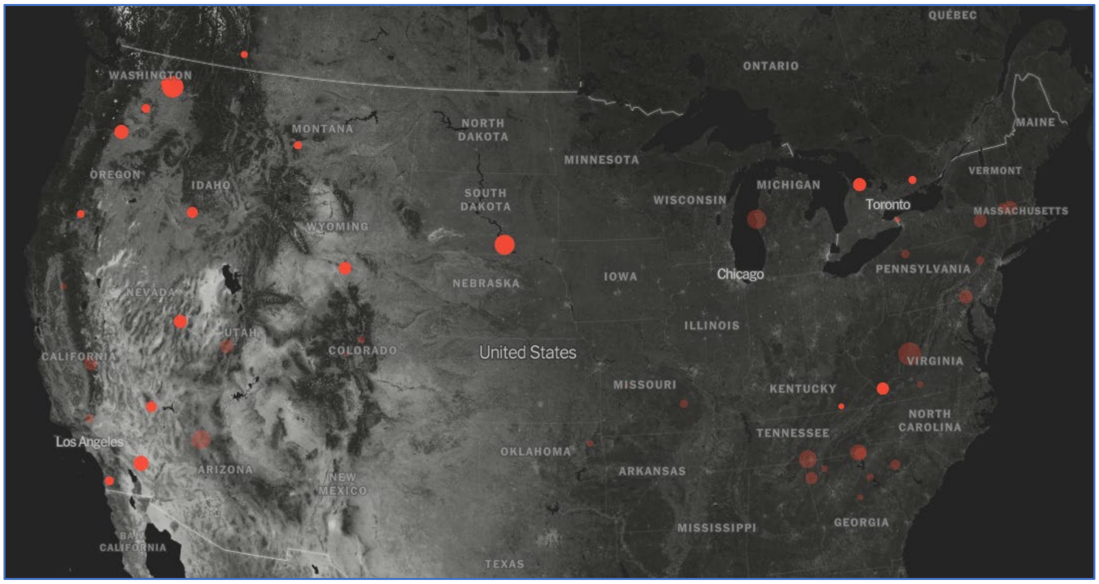
CBS 60 Minutes	Video Report: Out of Thin Air	April 30, 2023
Climeworks Video	Orca, The World's First Direct Air Capture and Storage Plant	April 2022
Fortune Magazine	This startup has unlocked a novel way to capture carbon - by turning the fouling gas into rock sink	March 6th, 2021
World Economic Forum	How Iceland's Carbfix Project is turning carbon dioxide into rock	May, 2019
BBC News	Turning carbon dioxide into rock - forever	May 18th, 2018
The Journal Science	Rapid carbon mineralization for permanent disposal of anthropogenic carbon dioxide emissions (Subscription required)	June 10th, 2016

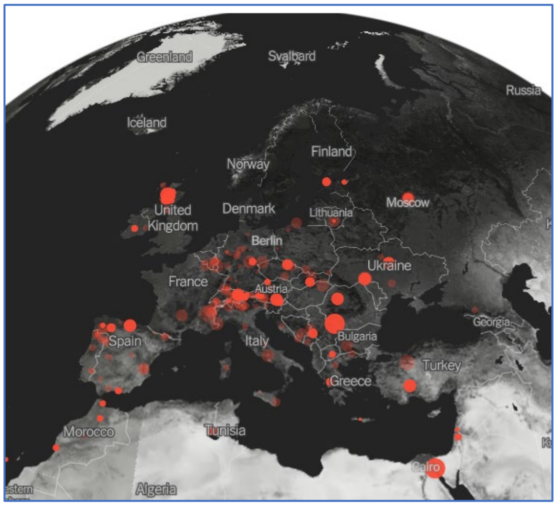
New York Times Article: Is It a Lake, or a Battery? New Kind of Hydropower Is Spreading Fast

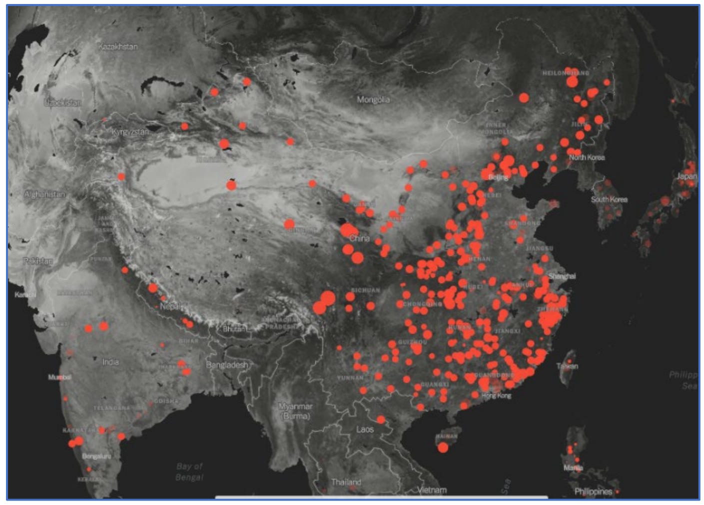
This New York Times Article highlights new research released Tuesday by Global Energy Monitor reveals a rapidly expanding transformation underway in hydroelectric projects using pumped storage technology. Pumped storage is undergoing a renaissance in countries where wind and solar power are also growing, helping allay concerns about weather-related dips in renewable energy output. The graphic below shows the historic and planned growth in global pumped storage vs. traditional hydropower.



The maps below and on the following page show the geographic locations for worldwide existing (pink) and planned (red) pumped storage facilities in the United States, Europe, and Asia. The small dots are <=500 MW, with larger dots representing up to 2000MW in capacity.







The data shows that pumped storage is growing much faster than conventional dams. The trend is most pronounced in China, which accounts for over 80 percent of planned projects worldwide. China's pumped storage strategy won't directly equate to a reduction in coal use. China has stopped financing coal projects abroad, but at home last year it approved the building of more coal plants than ever before. And it is already by far the world's biggest user of coal, a particularly dirty fuel.

China now leads the world in wind, solar and hydroelectric power capacity. As renewables contribute more and more to China's grid, the country is seeking ways to ensure that fluctuations in wind and solar output don't leave the grid in the lurch. Some of that insurance comes from continued growth in fossil fuels, especially coal, which China has in abundance. Pumped storage represents a viable cleaner alternative and has been critical in making the business case for renewable energy in China, as their national grid is not prepared to take on 100 percent of the wind and solar energy in the pipeline. Some of it will have to be stored if it isn't to be wasted.

Global Energy Monitor data shows another kind of hydroelectric technology becoming prevalent, particularly in mountainous places like Nepal. So-called run-of-river facilities are located, as the name suggests, on rivers, but don't create giant reservoirs behind them. Without the reservoir, power generation is dependent on seasonal water flows but is less environmentally damaging and less prone to catastrophic failures in tectonically active zones like the Himalayas. Hundreds of run-of-river facilities have been built or are in the pipeline across the world, though they tend to produce smaller amounts of power.

It was noted that pumped storage may not be entirely environmentally friendly. Hydroelectric reservoirs can also release considerable methane, a potent greenhouse gas, from microbes that thrive in these environments and as vegetation decomposes in flooded areas. Reservoirs could be the source of 3 to 7 percent of methane emissions caused by humans.

Features from the NYISO Press Release Page include the following:

Announcement: NYISO Releases Short-Term Assessment of Reliability Report

The New York Independent System Operator (NYISO) today released its quarterly assessment of reliability of the bulk electric system, which examines changes during the grid in transition. The Short-Term Assessment of Reliability (STAR) studied the period of January 15, 2023, through January 15, 2028, and found that reliability margins in New York City could become deficient in 2025.

Looking closely at reliability in the New York City area, the STAR report found that reliability margins will continue to narrow due to the planned retirement of certain generators in compliance with the New York State Department of Environmental Conservation's "Peaker Rule." Those findings are consistent with the NYISO's 2022 Reliability Needs Assessment which was published in November 2022.

Features from the NYISO Blog Page include the following:

The Capacity Market's Role in Grid Reliability: Frequently Asked Questions

The State's climate and clean energy mandates are adding to the challenge of ensuring sufficient supply is available to the grid. With an increased reliance on intermittent resources such as solar or wind power, the system must maintain sufficient capacity to provide energy when the sun is not shining, or the wind is not blowing, which increases the reserve margin. This blog looks to answer many common questions regarding the process, characteristics, and functionality that drive New York State's capacity market.

How the Installed Reserve Margin (IRM) Supports Reliability in New York

The IRM is based on updated load, resource, and transmission models. The IRM study evaluates changes in forecasted demand, supply performance capabilities, and transmission system constraints. In years past, most energy on the grid came from dispatchable resources capable of operating on-demand, with a high level of availability. However, with the state moving to a grid increasingly reliant on clean energy, the IRM will also change (while remaining critical to system reliability). Solar and wind are intermittent resources don't respond on demand. As a result, these resources have lower capacity factors. While energy storage, like batteries and pumped hydro, help meet unexpected demands for power, these technologies can only run for a limited number of hours. New "on-demand" resources will be necessary to supplement the intermittent nature of wind, solar and storage.

Forecasting Future Heating: How Electrification Challenges Future Grid Planning

Only 10% of New York's homes rely on electricity for heat today. That is expected to grow to 90% by 2050, with electric heat pumps considered the leading technology to convert fossil-fuel-based furnaces and boilers. As heat pump technology proliferates, peak demand on New York's grid is expected to shift from summer to winter. The NYISO teamed with the Electric Power Research Institute (EPRI) on a study to model how demand in individual homes is likely to change with the conversion to heat pumps. Specifically, the study examined how air source heat pumps with supplemental electric resistance heating equipment will impact peak demand and overall energy use. For more information about how the NYISO forecasts demand on the grid, please click here.

Staying Cool in the Deep Freeze: How NYISO's Forecasters Performed During Winter Storm Elliot

This post reviews the accuracy of NYISO's weather and electric system forecast and the resiliency of the grid during Winter Storm Elliott. That intense storm system rolled through the United States in late December, bringing cold temperatures, strong winds, and massive snowfall totals. New York was especially hard-hit from December 23 through December 27. "Despite severe weather, we were able to maintain electric service in New York State in large part because many of our generating units are able to switch fuels during times of high demand and stress on the gas system," said Aaron Markham, the NYISO's Vice President of Grid Operations. "Our diverse resource mix provides a significant reliability benefit."

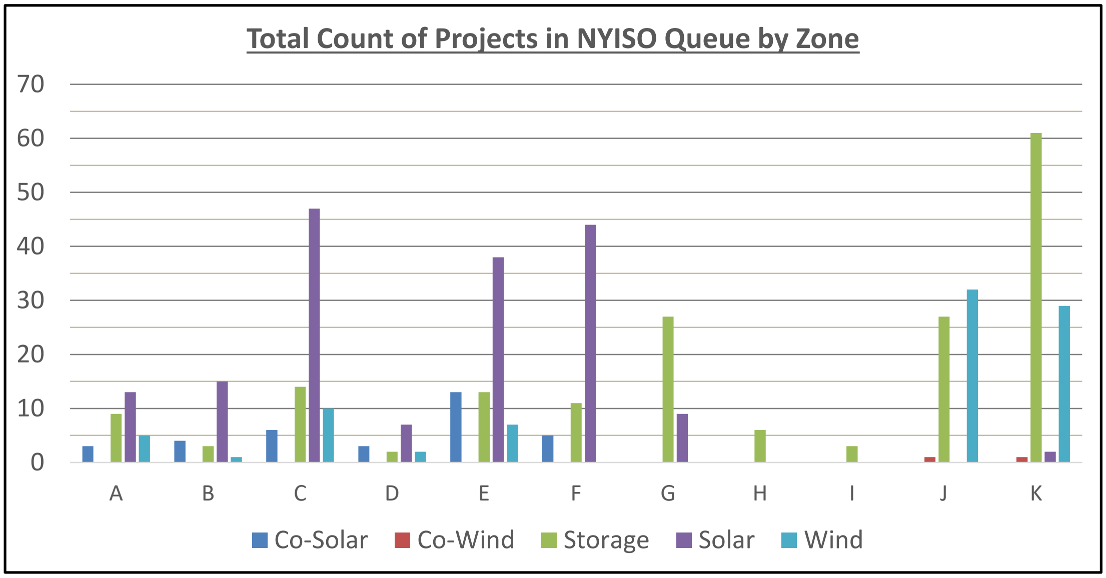
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

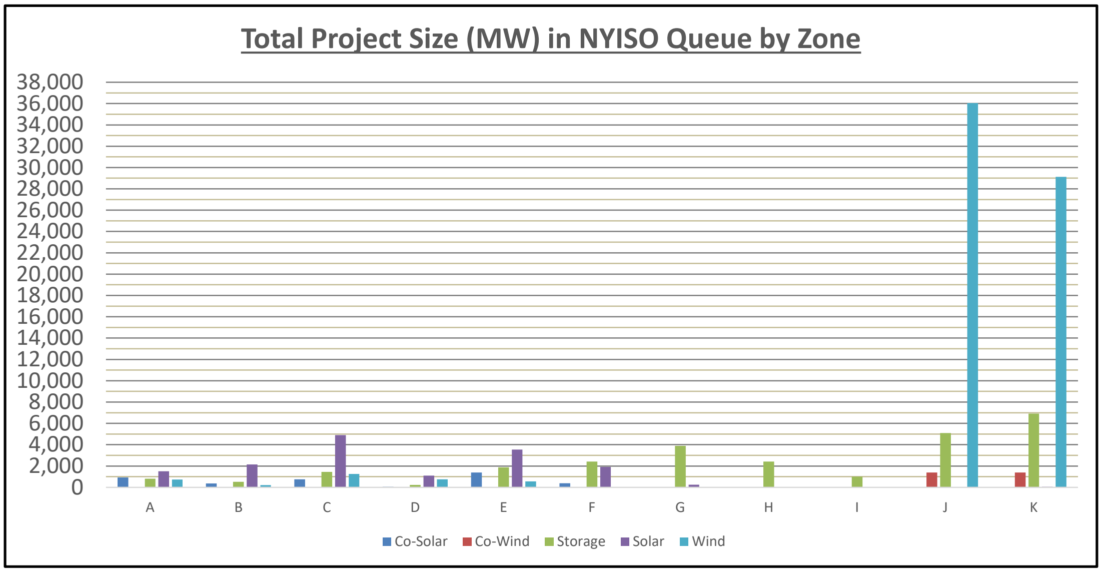
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (Solar and Wind now in separate categories) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on April 20th, and representing the Interconnection Queue as of March 31st. Note that 17 projects were added, and 16 were withdrawn during the month of March. There are now 2 Co-located Wind Projects from Bay Wind, one each in Zone J and K. Results are tabulated below and shown graphically on the next page.

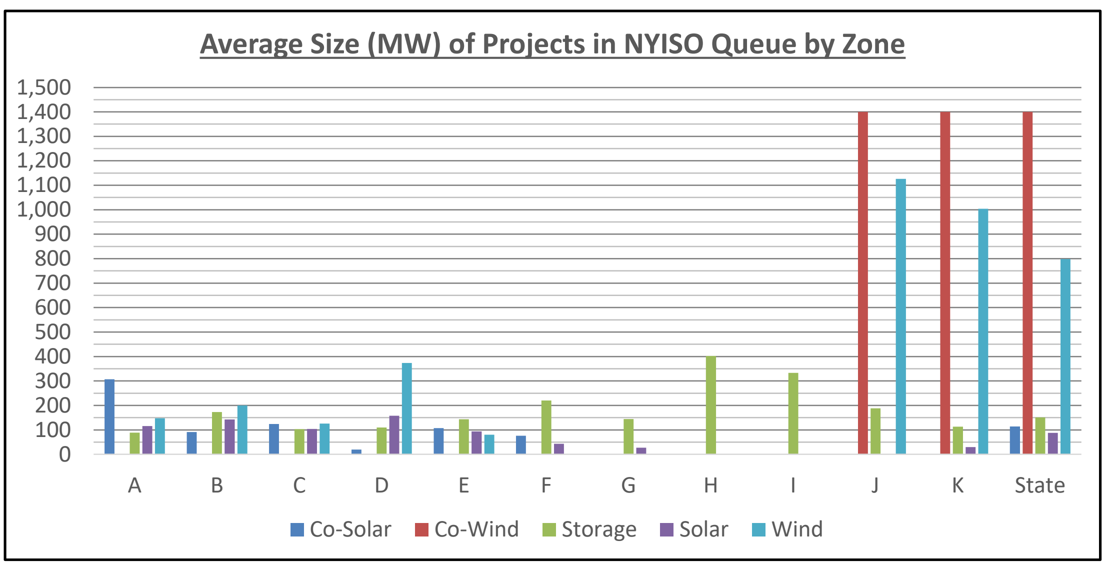
Total Count of Projects in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	3		9	13	5
B	4		3	15	1
C	6		14	47	10
D	3		2	7	2
E	13		13	38	7
F	5		11	44	
G			27	9	
H			6		
I			3		
J		1	27		32
K		1	61	2	29
State	34	2	176	175	86

Total Project Size (MW) in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	920		801	1,508	738
B	366		520	2,145	200
C	745		1,449	4,891	1,258
D	60		220	1,107	747
E	1,396		1,869	3,551	565
F	380		2,425	1,921	
G			3,900	243	
H			2,416		
I			1,000		
J		1,400	5,092		36,036
K		1,400	6,912	59	29,124
State	3,867	2,800	26,605	15,424	68,669

Average Size (MW) of Projects in NYISO Queue by Zone					
Zone	Co-Solar	Co-Wind	Storage	Solar	Wind
A	307		89	116	148
B	92		173	143	200
C	124		104	104	126
D	20		110	158	374
E	107		144	93	81
F	76		220	44	
G			144	27	
H			403		
I			333		
J		1,400	189		1,126
K		1,400	113	29	1,004
State	114	1,400	151	88	798


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
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