Attachment #8.1
Return to Agenda

De-Carbonization / DER Report for NYSRC Executive Committee Meeting 10/15/2021

Contact: Matt Koenig (koenigm@coned.com)

The October 2021 edition of the De-Carbonization / Distributed Energy Resources (DER) Report includes multiple updates from NERC and NYSERDA. An IEEE paper illustrates the basic differences between Grid-Forming vs. Grid Following Inverters, while the latest edition of PES Magazine focuses on DER / renewables activities in Australia. The Interconnection Queue has been updated to reflect the End-of-August values for CSRs (Co-located Storage Resources), energy storage, solar and wind. Topics in this newsletter are covered in the following order:

- NERC September Newsletter
  - NERC Disturbance Report: Fault-Induced Solar PV Tripping Events in Odessa, TX
  - NERC Staff Review 2021 Winter Freeze, Recommend Standards Improvements
  - NERC Webinar on Preparation for Severe Cold Weather
- NYSERDA Announcements:
  - $11M awards for Renewables / Energy Storage projects
  - Tier 4 Awards for Two Major Transmission Projects
- DOE Announces New "UNIFI" Grid-Forming Inverter Consortium
- IEEE Paper: Comparison of Grid Following & Grid Forming inverters in High Penetration Power System
- PES Magazine - September / October Edition with focus on Australia's experience with DERs
- Snapshot of the NYISO Interconnection Queue: Storage / Solar / Wind / CSRs (Co-located Storage)

The September issue of the NERC Monthly Newsletter can be found here. Highlights include the following:

NERC Report: Odessa Disturbance (Fault-Induced Solar PV Tripping Events in Texas)

The Odessa Disturbance Report covers a disturbance within the Texas Interconnection on May 9th, 2021, in which a widespread reduction of over 1,100 MW of solar photovoltaic (PV) resources occurred following a normally cleared fault on the bulk power system (referred to as the "Odessa Disturbance"). The event involved facilities across a large geographic area of up to 200 miles from the location of the initiating fault. The report provides details regarding the initiating event, performance of the bulk power system-connected solar PV fleet during the event, and additional details around the event. Key findings from the study include:

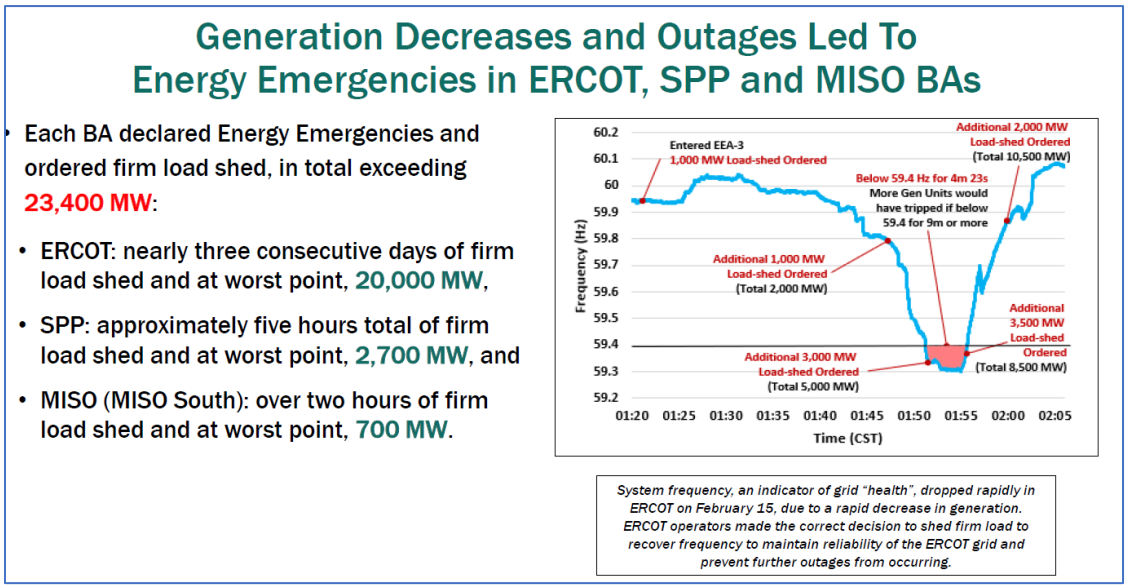
- Solar Plants are tripping incorrectly on PLL loss of synchronism
- Plant-level controller interactions with inverter response after fault events are not properly tuned with each other, leading to unreliable performance, with interactions not properly identified in the interconnection study process.
- Multiple solar PV plants tripped on inverter protection driving voltages conditions above trip settings
- Inverter logic caused excessive tripping across multiple fault events because the inverters continue to drive reactive power into the system after the fault is cleared, raising the voltage to the point of tripping
- After fault recovery, system frequency runs high, with PV resources rapidly changing active power output
- Some inverters act as a gate block rather than open the breaker, leaving associated and non-controllable capacitors in the circuit to raise the voltage
- Inconsistent return to service times following the clearing of a fault
- Majority of BPS-connecting Solar PV plant owners / operators are unaware of abnormal behavior of inverters and plant-level controller responses, until following investigation of unusual events.

February 2021 Cold Weather Grid Operations: Preliminary Findings and Recommendations

This Presentation of preliminary findings and recommendations resulting from the analysis of the February 2021 cold weather event that triggered the loss of 61,800 megawatts of electric generation, as 1,045 individual generating units experienced 4,124 outages, derates or failures to start. It severely reduced natural gas production, with the largest effects felt in Texas, Oklahoma, and Louisiana, where combined daily production declined to an estimated 20 billion cubic feet per day. This is a reduction of more than 50 percent compared to the February average.

The joint assessment points to freezing of generator components and fuel issues as the top two major causes of generator outages, derates or failures to start. The identified causes in the preliminary report affected generating units across all fuel types. Of the 1,045 generating units affected, 57 percent were natural gas fired units that primarily faced fuel-supply challenges, in part due to load shedding plans that impacted fuel pipeline pumps. The preliminary report makes nine key recommendations, including changes to mandatory reliability standards that build upon the recently approved standards developed in the wake of a 2019 joint inquiry into a prior cold weather event. Among those are:

- Revisions to require generator owners to identify and protect cold weather-critical components
- Build new or retrofit existing units to operate to specific ambient temperatures and weather based on extreme temperature and weather data
- Consider the effects of wind and precipitation in winterization plans
- Corrective action plans for generator owners that experience freeze-related outages
- Ensure the system operator is aware of the operating limitations in the generating fleet so that they can plan mitigation actions.
- Identify critical load that should not be included in load shedding and UFLS plans.

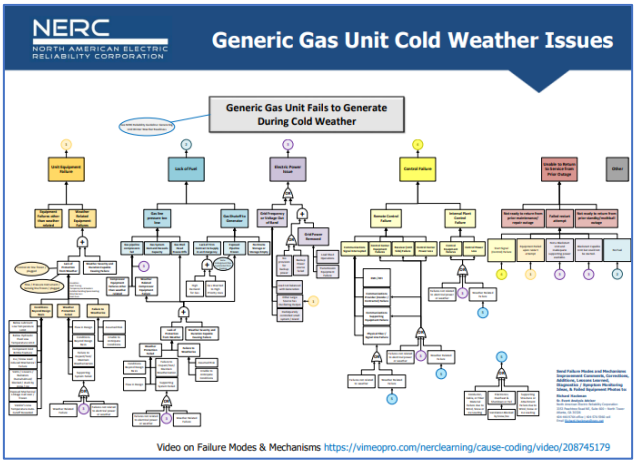


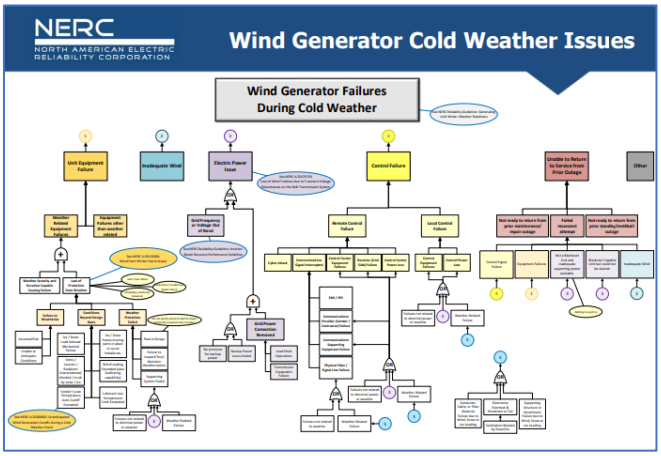
The slide above shows how System frequency, an indicator of grid "health", dropped rapidly in ERCOT on February 15th, due to a rapid decrease in generation. ERCOT operators made the correct decision to shed firm load to recover frequency to maintain reliability of the ERCOT grid and prevent further outages from occurring.

The preliminary report also recommends that generator owners be provided the opportunity for compensation and recovery of the costs of building or retrofitting to operate to a specific temperature, and that Congress, state legislatures and jurisdictional regulators require gas facilities to prepare and follow cold weather preparedness plans.

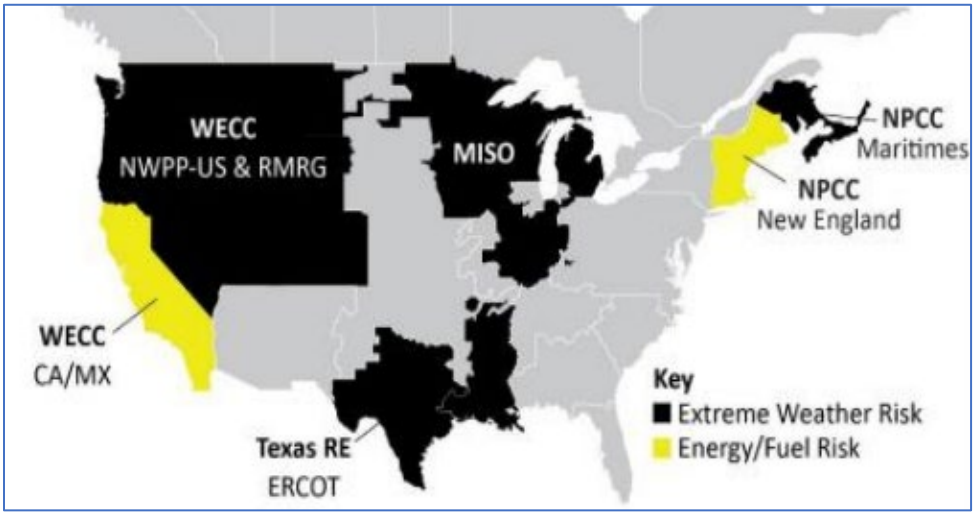
NERC Webinar on Preparation for Severe Cold Weather

NERC hosted a webinar on September 2nd on cold weather preparedness, covering both historic and projected reliability risks, along with recommended steps to be taken in anticipation as well as mitigation of these events. The webinar is available as either a 2.5 hour Video Recording or Presentation. The first part of the webinar provides additional background information on the February 2021 Cold Weather event, including a series of complex cause-and-effect diagrams showing various initiating conditions, the cascade of impacts, and the interdependencies between resources.





A summary of each region's reliability risks during Extreme Weather Events and/or Fuel Supply Disruptions is shown below:



The multiple topics in this webinar are listed below:

- Cold Weather Generator Failure Modes and Mechanisms
- NERC Winter Reliability Assessment
- Natural Gas and Electrical Operational Coordination Considerations Guideline
- Implementation of ERO Policies, Procedures and Programs for 2021/22 Winter Energy Readiness
- EOP-011 Guideline for Cold Weather Preparedness
- Cold Weather Preparations for Extreme Weather Events
- ERO Extreme Conditions for Energy Management

NYSERDA Announcement: $11 Million in Project Awards to Enhance Electric Grid Performance Projects

The New York State Energy Research and Development Authority (NYSERDA) announced nearly $11 million in awards to support projects that promote the development of a high performing smart electric grid. These projects contribute to the goals of integrating diverse renewable energy resources, enhancing grid performance and resiliency, and enabling customers to reduce their energy costs, consumption, and environmental impacts. Grid modernization supports the State's goal to generate 70 percent of the state's electricity from renewable resources by 2030, as outlined in the Climate Leadership and Community Protection Act (Climate Act).

The 12 selected projects represent solutions that facilitate connecting clean energy resources to the grid; product development; innovative data analytics development; advanced planning, operations, and forecasting tools for the modern grid. The companies and their projects are listed below:

- ConnectDER - Developing a monitoring and control device to support a secure data connection from the grid operator to solar, storage and electric vehicle chargers, with the goal of utilizing solar and storage for grid reliability and backup power during outages.
- DNV GL – Developing and validating controls for behind-the-meter energy storage systems, to advance cost-effective solutions that mitigate the risk of back-feeding power to the grid.
- Electric Distribution Design – Developing a comprehensive software system utilizing real-time situational awareness of load, solar generation, and severe weather forecasts to increase operational efficiency in the Central Hudson Gas & Electric and Orange and Rockland County service territories.
- GridEdge Networks – Developing and demonstrating a distributed network architecture featuring scalable and flexible communications that can better integrate distributed energy resources (DERs) into the grid.
- Line Vision – Demonstrating a new non-contact technology to sense power lines, allowing the line's capacity rating to be dynamically adjusted in response to current conditions, with the goal of optimizing transmission assets and relieving congestion.
- Manifold Robotics – Combining data from onboard electric and magnetic field sensors to enable aerial drones to approach and service power lines safely, reducing maintenance costs and risk to technicians.
- Quidnet - Demonstrating a system in the NYSEG/RGE (Avangrid) service territory that stores energy by pumping water into underground rock formations and returns it to the grid by using the pressurized water to generate power on demand, potentially providing an economical means of long-duration energy storage.
- Sen Engineering – Developing a new power flow controller transformer technology with potential to allow more renewable energy to be distributed in the state through existing transmission lines.
- Smart Wires – Investigating the location and sizing of electronic power flow controllers at potential sites in the state, demonstrating technology that can shift power flow from overloaded to underutilized lines to reduce congestion and allow more net power to flow in the existing system.
- Switched Source – Designing, manufacturing and field testing an electronic device that connects two power lines and safely allows power to flow in either direction between those lines, providing flexibility that can increase the amount of solar power communities can install, as well as increased redundancy to prevent power outages during extreme weather events.
- The Research Foundation for SUNY University at Albany – Enhancing predictability of weather-caused power outages using Mesonet, New York State's weather network, with the goal of enabling utilities and emergency management services to plan and deploy resources to minimize power outage impacts.
- The Standard Hydrogen Corporation – Studying development of an energy storage system using hydrogen as an energy carrier, with the goal of economical long-duration energy storage for the power grid.

NYSERDA and Governor Announce Tier 4 Awards for Two Major Transmission Projects

Governor Hochul and the New York State Energy Research and Development Authority's (NYSERDA) have announced the winners of the Tier 4 Energy Solicitation as

- Clean Path NY (CPNY): Developed by Forward Power (a joint venture of Invenergy and EnergyRe) and the New York Power Authority, and
- Champlain Hudson Power Express (CHPE): Developed by Transmission Developers, Inc. (backed by Blackstone) and Hydro-Québec

Together, the 2 projects will:

- Produce approximately 18 million megawatt-hours of upstate and Canadian renewable energy per year, enough to power more than 2.5 million homes
- Reduce greenhouse gas emissions by 77 million metric tons over the next 15 years, the equivalent of taking one million cars off the road

The projects were selected for contract negotiation as part of NYSERDA's Tier 4 renewable energy solicitation issued in January. Once finalized, NYSERDA will submit the negotiated contracts for these awarded projects to New York's Public Service Commission for consideration and approval. If the Tier 4 contract is approved, NYSERDA payments under this award will not commence for each respective project until the project has obtained all required permits and local approvals, is constructed, and delivers power to New York City, which is expected to begin in 2025 for CHPE and 2027 for CPNY.

CPNY's 174-mile transmission line will run from the Fraser Substation in Delaware County to the Rainey Substation in Queens, utilizing a buried cable using existing rights-of-way, which will mitigate potential local community impacts, avoid sensitive habitats along the Hudson River, and be more resilient than above-ground alternatives in the face of severe weather and security threats. CHPE is a permitted 339-mile buried cable, both underground and underwater, transmission line that runs from Hydro-Quebec's wind and hydropower resources in the Province of Quebec to the Astoria Energy Center in Queens.

If approved, the CPNY and CHPE projects will add to New York's existing pipeline of large-scale renewable energy, comprised of nearly 100 solar, land-based wind and offshore wind projects totaling 11,000 megawatts of clean power, when completed. NYSERDA reports that with this new commitment to green energy transmission, led by 250 miles of new major upgrades already underway, the current list of projects will result in nearly 60 percent of New York's electricity from renewable energy once operational.

DOE Announces New "UNIFI" Grid-Forming Inverter Consortium

The U.S. Department of Energy (DOE) has announced the formation of a new collaborative, designated as the Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium. UNIFI will create an extensive R&D ecosystem to evaluate and design grid-forming inverter solutions, with the goal of developing a universal set of guidelines that enable seamless integration of inverter-based resources like solar, wind, batteries, and electric vehicles.

The National Renewable Energy Laboratory (NREL) will co-lead UNIFI, along with the University of Washington and the Electric Power Research Institute. The consortium was announced under DOE's Solar Energy Technologies Office (SETO) Systems Integration and Hardware Incubator Funding Program. SETO and the Wind Energy Technologies Office are co-funding the consortium, providing $25 million over five years, alongside a partner cost-share of $10 million. Other members include technology vendors, grid operators, energy laboratories and corporations from around the world.

At the current scale of growth in renewables, these inverter-based resources are fundamentally changing the physics of the power system by substituting fast-response digital devices for traditional physical generators. Already in many locations, inverter-based resources operate in concert with traditional resources. In some locations (e.g. – Maui), inverter-based resources are even close to providing 100% of local power. Grid-forming inverters are an upcoming category of controls and coordination strategies for systems with a large proportion of inverter-based resources, and are uniquely qualified to enable renewable integration at scale with added security, resilience, efficiency, and affordability.

Over the next five years, the UNIFI consortium will build consensus on interoperability and functional requirements for grid-forming technologies by unifying research capabilities and project objectives. The consortium will demonstrate next-generation power systems using federated hardware test beds housed at partner institutions. The field demonstrations will include at least a 20-MW system featuring different manufacturer technologies and operating scenarios. From this coordinated research, the consortium will also produce training materials for the future workforce and industry-standard models and tools to facilitate growth in renewables.

Use this link for further information on the NREL Research Roadmap and Grid Forming Inverter research.

IEEE Paper: Comparison of Grid Following & Grid Forming Control for High Inverter Penetration Power System

Authors: Dinesh Pattabiraman* R. H. Lasseter T. M. Jahns - Department of Electrical and Computer Engineering University of Wisconsin - Madison,WI. *Available at the IEEE Xplore website (free for members, $15 for others)*

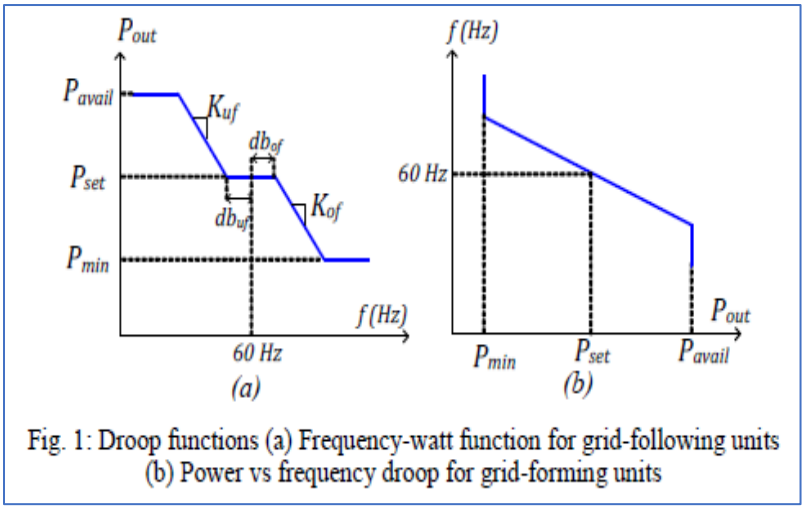


Fig. 1: Droop functions (a) Frequency-watt function for grid-following units (b) Power vs frequency droop for grid-forming units

In this work, the impact of grid-forming and grid-following inverter controllers on the system frequency dynamics is studied and compared. A simple two-source system is modeled, and the small-signal dynamic characteristics are studied at various penetration levels and varying levels of mechanical inertia. The results exhibit significant dynamic response advantages of the grid-forming inverter over its grid-following counterpart, particularly under the most demanding conditions when the penetration level of inverter-based sources reaches high levels and the available system stored inertial energy drops.

The study showed that in a simple two-source power system, there was noticeable improved dynamic performance with grid-forming (GFM) droop-controlled inverters as compared with grid-following (GFL) inverters with frequency support. Utilization of GFL inverters resulted in reduce damping and higher frequency excursions with increases in inverter penetration level, resulting in increased sensitivity of the system dynamics to inertia. On the other hand, utilization of GFM inverters resulted in increased damping and lower peak frequency excursions with higher inverter penetration, reducing the dependence of the system's frequency dynamic response on the mechanical inertia. The ability of power-limit control in a grid-forming inverter to smoothly transfer overloads to other sources while maintaining reliable system operation has also been demonstrated via simulation.

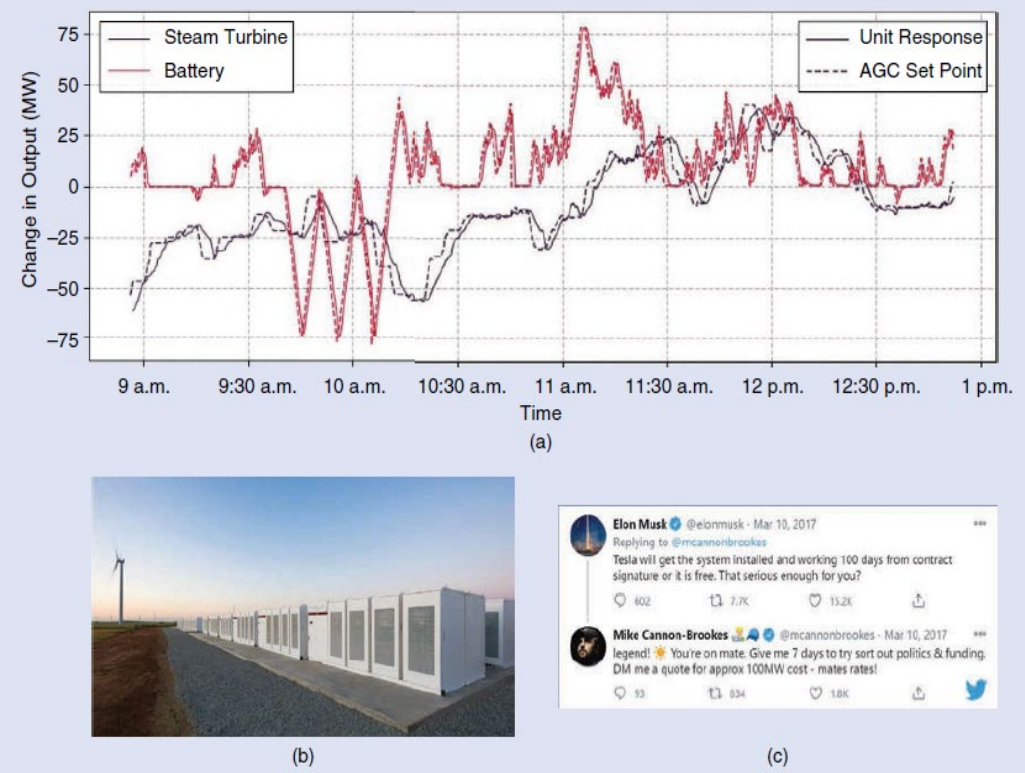
The September / October edition of the IEEE Power and Energy Magazine (IEEE PES Membership required)

The latest issue of PES Magazine is focused on "Renewables in Australia. This edition of the magazine can be found from the main page of the IEEE PES Website. Articles in the edition include:

- Achieving World-Leading Penetration of Renewables
- Essential System Services Reform (Australian Market Design for Renewable Dominated Grids)
- Power system Operation with a High Share of Inverter-Based Resources
- Renewable energy Zones in Australia
- From Security to Resilience
- Distributed Energy Resources Roadmap

The article on *Essential System Services (ESS) Reform* discusses the evolution of Australia's power market with respect to the integration of DER's and Energy Storage. One section in the article exemplified the advantages of the battery response over conventional steam turbine generation. The Hornsdale Power Reserve (HPR) facility has a capacity of 100 MW/129 MWh. The battery has been a resounding commercial success, delivering an estimated AUD$150 million in electricity cost savings to consumers in its first two years—AUD$116 million from frequency control costs in a two-week period in 2019, when South Australia was islanded from the rest of the grid (savings expressed in US dollars are approximately 25% lower).

The facility has demonstrated the potential of future ESS provision through inverter-connected equipment. The precision with which batteries follow automatic generator control set points while providing frequency control ancillary services as compared to a traditional thermal generator is striking (see Figure below). The performance of the battery (typically sub-second) has provided an impetus for the consideration of a fast frequency response service, which is critical for maintaining security in the power system as inertia levels continue to decrease.



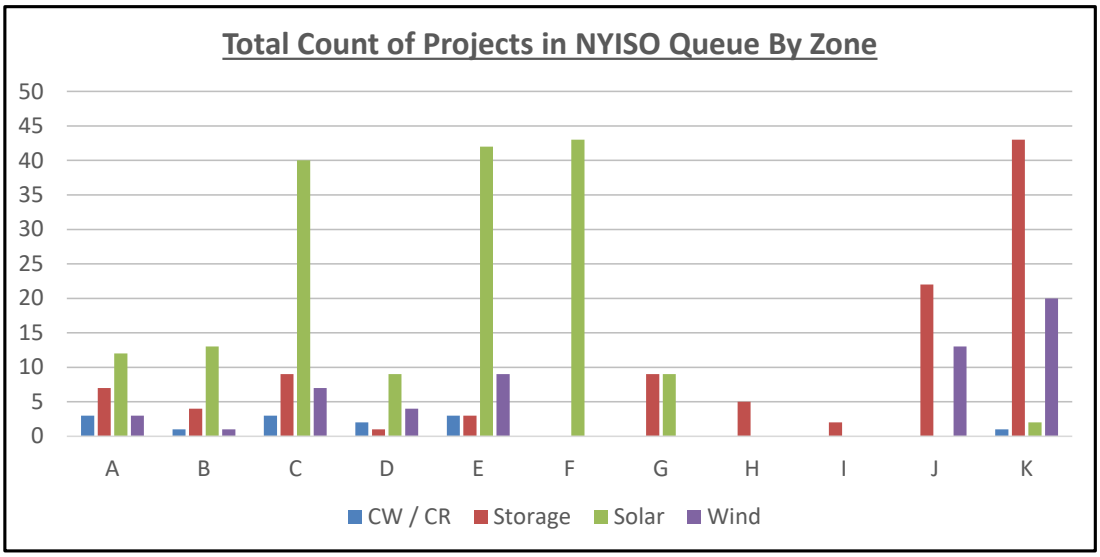
Interconnection Queue: Monthly Snapshot – Storage / Solar / Wind / CSRs (Co-located Storage)

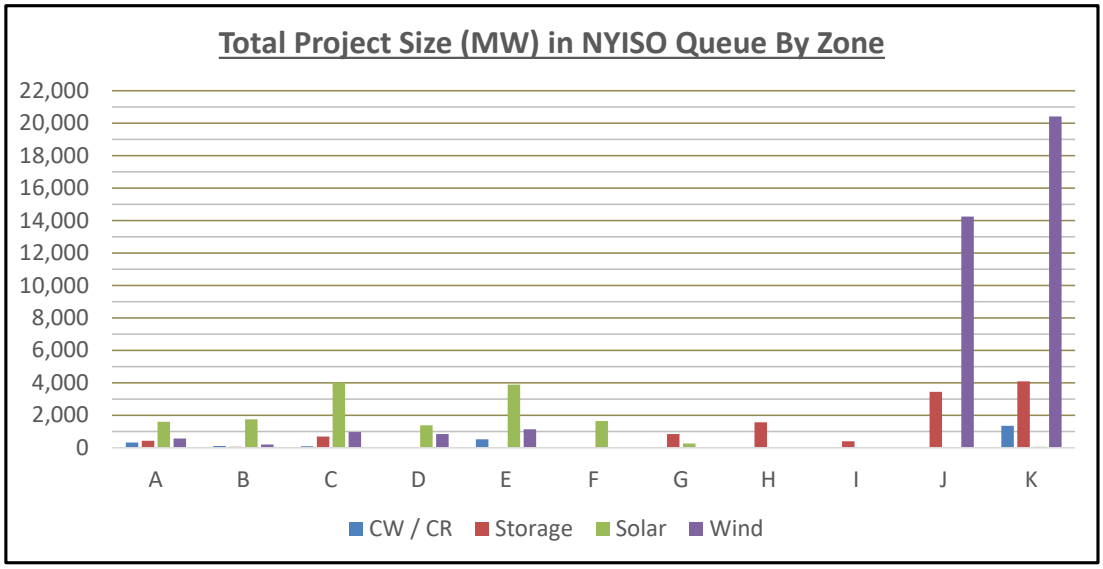
The intent is to track the growth of Energy Storage, Wind, Solar and Co-Located Storage (CW / CR) projects in the NYISO Interconnection Queue, looking to identify trends and patterns by zone and in total for the state. The information was obtained from the NYISO Interconnection Website, based on information published on September 16th, and representing the Queue as of August 31st. Note that 13 projects were added and 13 were withdrawn during the month of August. Results are tabulated below and shown graphically on the next page.

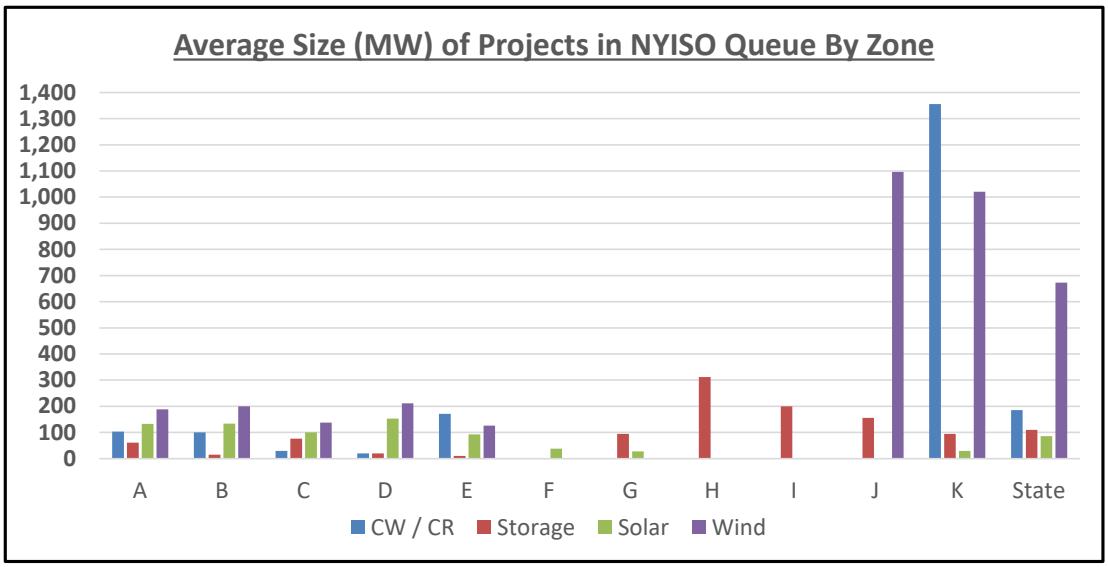
Total Count of Projects in NYISO Queue By Zone				
Zone	CW / CR	Storage	Solar	Wind
A	3	7	12	3
B	1	4	13	1
C	3	9	40	7
D	2	1	9	4
E	3	3	42	9
F	0		43	
G	0	9	9	
H	0	5		
I	0	2		
J	0	22		13
K	1	43	2	20
State	13	105	170	57

Total Project Size (MW) in NYISO Queue By Zone				
Zone	CW / CR	Storage	Solar	Wind
A	310	430	1,590	566
B	100	61	1,745	200
C	90	689	4,017	960
D	40	20	1,377	847
E	513	30	3,895	1,135
F	0		1,645	
G	0	847	250	
H	0	1,560		
I	0	400		
J	0	3,436		14,248
K	1,356	4,086	59	20,418
State	2,408	11,559	14,577	38,374

Average Size (MW) of Projects in NYISO Queue By Zone				
Zone	CW / CR	Storage	Solar	Wind
A	103	61	132	189
B	100	15	134	200
C	30	77	100	137
D	20	20	153	212
E	171	10	93	126
F	0		38	
G	0	94	28	
H	0	312		
I	0	200		
J	0	156		1,096
K	1,356	95	29	1,021
State	185	110	86	673


Total Count of Projects in NYISO Queue By Zone
50
45
40
35
30
25
20
15
10
5
0
A
B
C
D
E
F
G
H
I
J
K
CW / CR
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
CW / CR
Storage
Solar
Wind


Average Size (MW) of Projects in NYISO Queue By Zone
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
CW / CR
Storage
Solar
Wind