Case No. 15-E-0302
-Via Electronic Filing-
July 2, 2024

Re: Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard – Zero Emissions Target

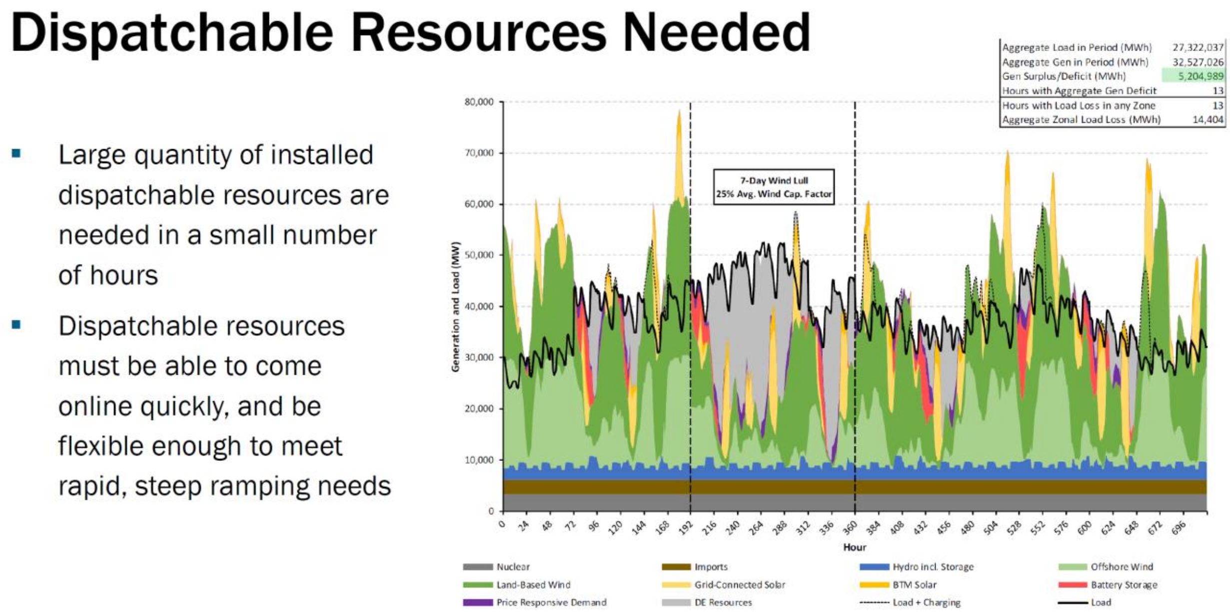
These comments are in response to comments submitted by Sierra Club and Earthjustice dated June 14, 2024. These relate to my previously submitted comments recommending a study that the Commission should undertake with respect to the development and deployment of resources capable of achieving a zero emissions grid and other comments regarding the presentation by Zachary Smith of the New York Independent System Operator (NYISO) that described the attributes of the Dispatchable Emissions-Free Resource (DEFR). I believe that the Sierra Club and Earthjustice fail to appreciate the potential magnitude and duration of the wind and solar resources "gap" in their comments in Section 4: "Significant Modeling Gaps in NYISO's Presentation at the Technical Conference Cast Doubts on the Operator's Conclusion that New York Will Have a DEFR Need of 30 GW+."

I have been following the Climate Leadership & Community Protection Act (Climate Act) since it was first proposed, submitted comments on the Climate Act implementation plan, and have written over 400 articles about New York's net-zero transition. I am a meteorologist with over 40 years' experience in the electric generating sector. I represent the Environmental Energy Alliance of New York on the New York State Reliability Council Extreme Weather Working Group (EWWG). The opinions expressed in this comment do not reflect the position of the Alliance, the Reliability Council, the Extreme Weather Working Group, or any of my previous employers or any other company I have been associated with, these comments are mine alone.

Ultimate Reliability Problem

In my January comments I focused on the second attribute in Smith's presentation about the ten attributes for reliability that must be provided by DEFR. His second attribute explained DEFR must be "non-energy limited and capable of providing energy for multiple hours and days regardless of weather, storage, or fuel constraints". This is a particular concern of mine. Wind and solar resources correlate in time and space as shown by the NYISO analysis referenced in Smith's presentation (Figure 1). The seven-day wind lull example in the dispatchable resources needed figure illustrates the problem. If there are insufficient resources during a wind lull, then load cannot be met. The consequences of that situation would be catastrophic.

Figure 1: Dispatchable Resources Needed from Zero Emissions by 2040 Technical Conference Slide Presentation Dispatchable Emission-Free Resources (DEFRs) by Zachary Smith NYISO



Feasibility Concern

My primary concern is the feasibility for the New York Climate Act implementation plan or more appropriately, the lack of a proper feasibility analysis, that addresses the worst-case wind and solar energy resource drought. All the credible analyses done for future grid reliability point out the same expected worst-case scenario : when New York electrifies heating and transportation the peak load will be in the winter when temperatures are coldest. The Integration Analysis identified a multi-day period winter wind lull. The NYISO has done similar analyses and showed that winter wind lulls that coincide with low solar availability and high loads will be the ultimate problem. This proceeding also addresses the worst-case renewable resource drought. In my opinion, however, no analysis done to date has identified the worst-case scenario because they have all used relatively short periods of historical data.

All renewable resource projection analyses should use historical meteorological data to provide the basis for projections of future load and estimates of electric resource availability based on projected deployment of wind, solar, energy storage, and other technologies needed to supply the expected load. Hourly profiles of weather variables produced using current weather forecast modeling techniques yield hourly demand forecasts and energy output profiles for wind and solar resources for the periods being studied. Credible analyses only differ in their assumptions for the characteristics of the buildouts and the sophistication of potential availability based on climatological and geographical constraints. Such an analysis can be used to estimate low wind and solar resource droughts and identify the worst case.

The NYISO is working with its consultant DNV to assess New York onshore wind, offshore wind, and solar resource availability. Their analysis uses a 23-year historical meteorological database for the New York State renewable resource areas. Similar analyses are underway in other regional transmission operator regions. It has also been recognized that larger areas need to be treated similarly. The Electric Power Research Institute has a Low-Carbon Resources Initiative that has been evaluating the North American continent. Researchers outside of the industry have also done analyses of wind and solar power droughts using the ERA5 reanalysis data from 1950 to the present. The reanalysis data analysis uses current weather forecast models and historical observations to provide hourly meteorological fields for input to the resource availability models. The data can be further refined to finer scales to project refined wind and solar resource availability for New York State.

Gap Resource Availability Results

All of these analyses find there are frequent and extensive periods of low renewable resource availability. For example, the New York State Reliability Council Extreme Weather Working Group (EWWG) analyzed the high resolution NY offshore wind data provided by NYISO and its consultant DNV for offshore wind resources. The summary of the report stated:

> *The magnitude, duration, and widespread geographic impacts identified by this preliminary analysis are quite significant and will be compounded by load growth from electrification. This highlights the importance of reliability considerations associated with offshore wind and wind lulls be accounted for in upcoming reliability assessments, retirement studies, and system adequacy reviews to ensure sufficiency of system design to handle the large offshore wind volume expected to become operational in the next five to ten years.*

That analysis used a 21-year database. In a similar type of analysis, the Independent System Operator of New England (ISO-NE) Operational Impact of Extreme Weather Events, the ERA5 data were used to prepare a database covering 1950 to 2021. The analysis evaluated 1, 5, and 21-day extreme cold and hot events.

One of the important results presented in the ISO-NE analysis is a table of projected system risk for weather events over the 72-year data record. In the analysis, system risk was defined as the aggregated unavailable supply plus the exceptional demand during the 21-day event. Note that the analysis considered sliding windows for the 21-day events by shifting the 21-day window every seven days. The Important point to highlight is that the system risk increases as the lookback period increases. If the resource adequacy planning for New England had only looked at the last ten years, then the system risk would be 8,714 MW, but over the whole period the worst system risk was 9,160 MW and that represents a resource increase requirement of 5.1%.

ISO-NE Operational Impact of Extreme Weather Events with % Differences
Top 10 Unique Events (of 1,470)

Rank	21-Day Event Start Date	Avg. System Risk (MW)	% Difference to Max
1	1961-01-22	9,160	
2	1979-02-02	9,005	1.7%
3	1961-01-15	8,899	2.9%
4	1981-01-01	8,719	5.1%
5	2015-02-14	8,714	5.1%
6	2010-07-05	8,696	5.3%
7	1979-07-13	8,685	5.5%
8	1971-01-15	8,665	5.7%
9	1994-01-11	8,660	5.8%
10	1979-02-09	8,656	5.8%

Source: ISO-NE Operational Impact of Extreme Weather Events, available here

Note that there was an EWWG analysis of Historical Weather and Climate Extremes for New York performed by Judith Curry and myself that identified the January 1961 event as the probable worst-case scenario in New York. We found that there was a 15-day period from January 20 until February 3, 1961 that will likely turn out to be the worst-case cold wave. This was a period when high-pressure systems dominated the weather in the Northeast and those conditions caused light wind speeds.

Concerns Raised By Sierra Club and Earth Justice in Section 4: Significant Modeling Gaps in NYISO's Presentation at the Technical Conference Cast Doubts on the Operator's Conclusion that New York Will Have a DEFR Need of 30 GW+.

My analyses directly contradict the Sierra Club and Earthjustice ("SC&E") concern that "NYISO's presentation at the December technical conference overstates the need for dispatchable, emissions-free resources ("DEFRs") and downplays the value of taking steps in the near term to minimize this gap." SC&E claim that "If the PSC overestimates the size of the gap, the agency is more likely to feel the need to begin imprudently investing state resources in experimental DEFR technologies before these have had a few more years to develop and prove their viability." However, if the PSC underestimates the size of the gap and insufficient resources are available during an extended wind and solar drought during extremely cold weather then people will die.

The SC&E comments characterized Zachary Smith's slideshow at the "Characterizing the potential 'gap'" Panel presentation during the technical conference as "particularly alarming". The comments said that the slideshow suggested that New York will require 30 GW of DEFRs. But said that "the analysis shown in slide 3 of Mr. Smith's presentation has multiple flaws":

The first flaw relates to the "Wind Lull" analysis. The "Wind Lull" analysis only uses three wind profiles (including just two upstate wind profiles) to determine whether a "Wind Lull" occurs. An analysis of "Wind Lulls" limited to two upstate profiles likely misses the diversity of wind in the NYISO footprint which includes wind in Zones B, C, and E in addition to other wind sites in Zones A and D aside from Niagara and Plattsburgh. Further, despite a maximum winter "Wind Lull" of five days in the historical record evaluated, the analysis determined that the winter "Wind Lull" period should be 7 days because "it is possible that there have been more severe wind lulls than in the time span we analyzed, and that there could be more severe wind lulls going forward, particularly if such outcomes are made more likely by climate change." While this may be true, this assumption was not substantiated by any climate models or other analysis and should not be used as the basis for determining the length of winter "Wind Lull" periods to be evaluated. The limited number of wind profiles evaluated and unsubstantiated lengthening of the "Winter" wind lull period arbitrarily increase "wind lull" period lengths leading to a conservative assumption on wind availability and an overestimate of the DEFR gap.

I disagree with most of this. In the first place, there is a very high correlation of wind resources in New York. For example, I used a NYISO resource that provides 2021 wind production and 2021 wind curtailment data that list the hourly total wind production and curtailments for the entire New York Control Area (NYCA) as shown in the following table. All of the wind in the state must be highly correlated if 25% of the time only 7% of the state total wind capacity is available. Only using two upstate wind profiles is not the best practice but neither is it particularly bad for the highly correlated New York data. In addition, this concern is addressed in the more recent work by the NYISO that was not available at the time of the Technical Conference.

NYISO 2021 Hourly Wind Production at the Aggregated NYCA-Wide Level

Statistic	Production (MW)	Curtailments (MW)	Production % of Total	Curtailment % of Total
Maximum	1,889.9	494.8	86%	25%
99%	1,648.8	198.3	78%	10%
95%	1,329.3	57.5	63%	3%
90%	1,089.4	16.9	52%	1%
85%	930.1	5.9	44%	0%
80%	805.5	1.7	38%	0%
75%	695.6	0.2	33%	0%
70%	601.7	0.0	29%	0%
65%	523.5	0.0	25%	0%
60%	460.0	0.0	22%	0%
55%	401.7	0.0	19%	0%
50%	345.4	0.0	16%	0%
45%	299.3	0.0	14%	0%
40%	257.6	0.0	12%	0%
35%	223.3	0.0	11%	0%
30%	185.7	0.0	9%	0%
25%	151.6	0.0	7%	0%
20%	116.3	0.0	5%	0%
15%	83.6	0.0	4%	0%
10%	51.9	0.0	2%	0%
5%	19.2	0.0	1%	0%
Mean	469.2	9.6	22%	0%

As shown in the preceding section, the concern about assuming a 7-day wind lull when the short period analyzed only found a 5-day wind lull is not an issue. As the period of record increases the length of the gap increases and the NE-ISO found that it was appropriate to evaluate 21-day periods. In addition, SC&E comments overlook the need to consider the state of the energy storage resources going into a shorter poor resource availability period. If moderate weather conditions prevented full energy storage capacity, then that will affect the ability of the system to provide sufficient electric energy when it is needed the most.

As a result the SC&E comments underestimate the DEFR requirement in their evaluation. They argue that it is premature to “deploy expensive and untested DEFRs risks committing New York to flawed technologies, as it is unclear at the present time which technologies will emerge as commercially scalable and cost effective”. I agree that we should be cautious but all the analyses I have seen in my own attempts to estimate necessary resources indicate that the SC&E proposal to “focus on accelerating the build out of storage, solar, and wind, along with other existing methods to minimize the DEFR gap” is inadequate. Solar, wind, and storage are insufficient in these gaps as shown in the Climate Act Scoping Plan analysis and work done by the NYISO – DEFR is needed.

SC&E suggest alternatives for DEFR that I also think are flawed. They recommend “improving inter-regional coordination, expanding import capability with inter-regional transmission, and expanding intra-regional transmission” but I believe that all those options will be shown to be inadequate when a continent-wide analysis of wind and solar resource availability is completed. Wind may be blowing somewhere but getting to where it is needed when all other jurisdictions also need energy across huge areas is impractical. The other options for “increasing energy efficiency, mandatory demand response, and incorporating flexibility of large loads if possible” do not provide sufficient reliability safeguards to be including in a robust and resilient reliability plan for the intense worst-case periods.

The SC&E comments go on to tout “new long duration storage to fill any gap may also become a viable avenue for filling whatever gap remains.” They claim that “Between now and 2026, the average battery project is expected to have 89 MW of peak capacity.” The appropriate gap constraint is not the power capacity in MW but the energy requirement in MWh. In Smith’s Figure 1 shown above, eyeballing the 7-day wind lull with a 25% wind capacity factor highlighted in grey I estimate that there are at least 120 hours with generation deficits of at least 15,000 MWh so DEFRs would have to produce 1800 GWh to keep the lights on. That is an enormous challenge.

The SC&E comments argue that “since a sizeable gap may not emerge until the later 2030s, employing the methods listed above can drastically shrink the potential DEFR gap while buying time for viable DEFR technologies to emerge.” To have a reliable electric grid, a commercially viable DEFR must be proven at scale long before it is needed to cover a potential gap caused by the renewables.

The SC&E comments go on to claim that the NYISO Table 1 analysis did not reflect correlated wind, solar, and load data. If true, then I agree. However, subsequent analyses by the NYISO and NE-ISO do use correlated hourly meteorological data, estimate wind and solar resource availability, and project loads based on that data. All those results show that the magnitude of this problem is greater than appreciated in the comments. The SC&E conclusion that “If correlated wind, solar, and load shapes (without arbitrary adjustments) were used, it is likely that the DEFR Capacity need would be significantly reduced” is wrong. Correlated data over the period of record show that the DEFR capacity requirement will be greater than shown in the Smith analysis at the Technical Conference.

There is another instance where the SC&E misunderstanding of the magnitude of the DEFR capacity gap needs to be addressed. In the first section that discussed hydrogen transportation and storage issues, an example of the storage for a DEFR power plant was included:

> *To illustrate this challenge, assume that hydrogen is used for a 60 MW peaking plant with a 9,600 Btu/kWh lower heating value heat rate like the Siemens SGT- 400 gas turbines that recently ran a 100% hydrogen fuel test.*[16] *This facility would have a requirement of 8 hours of fuel storage to ensure that it can operate when needed and mitigate fuel supply risks. The total amount of hydrogen required to run this plant at full output for 8 hours would be 10,100 kg.*

Eight hours of fuel storage is far less than necessary to provide adequate DEFR support. The 7-day wind lull example showed the need for on the order of 120 hours or fifteen times more storage. The SC&E example calculates that "gaseous hydrogen storage tube trailers onsite it would require approximately 14 trailers at 500 bar (731 kg/trailer), if it used liquid hydrogen, it would require 2.4 liquid hydrogen tanks (16,000 gallon tank equivalent to 4,300 kg of liquid hydrogen)." When the 20-hour period is addressed 210 trailers or 36 liquid hydrogen tanks would be required. While I don't think that the SC&E comments appreciate the magnitude of the gap problem, I agree with their concerns about the viability of hydrogen pipeline and storage feasibility.

Discussion

The SC&E comments raise another issue. This Proceeding must address some fundamental planning issues regarding the proposed dependence upon wind and solar resources to provide zero-emissions electricity. Today electric system resource adequacy planners do not have to be concerned that many generating resources may not be available at the same time. All solar goes away at night and wind lulls affect entire regional transmission organization (RTO) areas at the same time. Therefore, when a future electric grid relies on wind and solar those resources will correlate in time and space. This issue is exacerbated by the fact that the wind lull will cover multiple RTO areas at the same time the highest load is expected. This paradigm shift for electric planning must be addressed.

It is an overarching issue. I do not believe we can ever trust a wind, solar, and energy storage grid because if we depend on energy-limited resources that are a function of the weather, then a system designed to meet the worst-case is likely impractical. Consider the ISO-NE events where it was found that the most recent 10-year planning lookback period would plan for a system risk of 8,714 MW. However, if the planning horizon covered the period back to 1961, the worst-case to 1950, an additional 446 MW would be required to meet the system risk. I cannot imagine a business case for the deployment of energy storage or the yet to be identified DEFR that will only be needed once in 63 years. For one thing, the life expectancy of these technologies is much less than 63 years. Even over a shorter horizon such as the last ten years, how will a required facility be able to stay solvent when it runs so rarely without subsidies and very high payments when they do run.

On the other hand, the alternative to ignore the worst case is unacceptable. In the net-zero future that the electric grid is supposed to rely on wind and solar at the same time heating and transportation are electrified, the need for reliable electricity is magnified. If we do not provide resources for the observed worst case, when those conditions inevitably reoccur, there will be a catastrophic blackout. Electricity will not be available when it is needed the most.

Recommendation

I recommend a detailed feasibility analysis that determines the worst-case observed wind and solar resource drought. The meteorological data reanalysis techniques that enable a period of record back to 1950 should be used. It should be a continental-scale analysis with realistic estimates of maximum available buildout of resources. Obviously, this is a major effort but everyone else in the country needs the same information so that we can determine how much energy will be available for import and export. The worst-case resource availability analysis will define the conditions and then resource planners can determine what must be deployed. Using a long period of record will allow planners to analyze return time relative to life expectancy of resources. The Commission should encourage coordination amongst all the RTOs to prepare this analysis.

Given the magnitude of the electric system transition I also recommend proof before proceeding. If it is feasible and economical to have an electrical grid powered predominantly by wind and solar generation, then it should not be difficult to put together a zero-emission demonstration project on a small or intermediate scale to prove how that can be done. Such a project does not exist anywhere in the world, which suggests that this might not be feasible.

My final recommendation is to establish safety valve guard rails for implementation. New York Public Service Law § 66-p (4). "Establishment of a renewable energy program" includes safety valve conditions for affordability and reliability that are directly related to the zero emissions resource. § 66-p (4) states: "The commission may temporarily suspend or modify the obligations under such program provided that the commission, after conducting a hearing as provided in section twenty of this chapter, makes a finding that the program impedes the provision of safe and adequate electric service; the program is likely to impair existing obligations and agreements; and/or that there is a significant increase in arrears or service disconnections that the commission determines is related to the program".

Because of the enormity of the challenge, the lack of a feasibility study, and a successful model operating elsewhere, I believe that the zero emissions resource could be a primary driver of the reliability and affordability provisions of § 66-p (4) so it is incumbent upon the Commission to address these considerations in this Proceeding. The criteria used to define "safe and adequate electric service" and "significant increase in arrears or service disconnections" should be defined. This is necessary so that there is a clearly defined standard for invoking the § 66-p (4) safety valve.

Conclusion

The SC&E comments properly make the point that there is a critical reliability issue that must be addressed. I disagree with their solutions and believe that they underestimate the magnitude of the problem. Moreover, given the complexity of electric system planning I believe it is best to rely on the work of the NYISO on the system analyses and critical needs. They have developed a resource planning process using decades of specialized experience, run the electric system and have no vested interest in any technology, but a clear interest in building a reliable power system.

Nonetheless, I believe the SC&E comments raise valid points. I agree with some of those points. I also have concerns that are based on niche experience. To address their comments and mine the PSC must prepare a feasibility analysis to reconcile the NYISO analyses with the Climate Act Scoping Plan and resolve the issues raised.

The technical feasibility concerns about the Gap resource gap and the business case for developing adequate resources for the rare worst-case observed event must be addressed in the feasibility analysis. From everything that I have seen I believe that even if the technical issues are overcome so that commercial DEFR operations are possible the necessity to build enough capacity for a very rare event will be impractically expensive. As mentioned before, ignoring this issue is unacceptable because of the risk of a catastrophic blackout when energy is needed most.

Ultimately there is a risk management problem that will have to be resolved at the highest levels. The tradeoff between practicality and necessity is not going to be resolved by the resource adequacy planning groups in organizations like NYISO doing the analyses described. I do not think organizations like the New York State Reliability Council or NERC should make the final decision how much risk is acceptable given the stakes. The Commission must start planning how best to resolve this risk management issue.

The Proceeding must also consider the § 66-p (4) "Establishment of a renewable energy program" provisions for affordability and reliability. The Proceeding should define acceptable criteria for both. All zero-emissions resources must meet those criteria to be considered acceptable.

The importance of the resource gap and the DEFR technologies necessary to address it cannot be overstated. Simply put, if no technological and cost-effective DEFR solutions are feasible, then the current strategy to depend on solar and wind generating technologies is impossible. Given the critical nature of this problem it is incumbent on the Commission to increase the urgency and pace of this Proceeding.

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