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January 23, 2020

Hon. Kathleen H. Burgess
Secretary to the Commission
New York State Public Service Commission
Three Empire State Plaza
Albany, New York 12223-1350

Re: Reply Comments Case No. 19-E-0530 Via Electronic Filing
Proceeding on Motion of the Commission to Consider Resource Adequacy Matters

Dear Secretary Burgess,

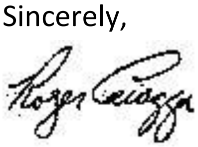
I am writing in response to the invitation to submit reply comments in response to the initial comments filed in the proceeding regarding resource adequacy matters, docket Case 19-E-0530. I am concerned that the Commission's statutory obligations to ensure the provision of safe and adequate service at just and reasonable rates is not being addressed with respect to the Climate Leadership and Community Protection Act (CLCPA). While costs to consumers are a primary and ultimate consideration, current New York State policy also must be evaluated with regards to feasibility and cumulative environmental impacts in order to determine whether safe and adequate service is possible.

I am submitting these comments as a citizen scientist. Before I retired, I worked in the electric generating sector but the opinions expressed in these comments do not reflect the position of any of my previous employers or any other company I have been associated with, these comments are mine alone.

I believe a quote attributed to Robert Louis Stevenson, "Sooner or later everyone sits down to a banquet of consequences", is apropos to this proceeding. It would be far better to determine the consequences of the CLCPA now than to try to muddle through trying to implement something that will have far worse consequences to the citizens of New York than the purported problem.

Thank you for the opportunity to provide comments on this proceeding.

Sincerely,



Roger Caiazza Reply Comments on Resource Adequacy

1.0 Summary

At this time the Commission's statutory obligations to ensure the provision of safe and adequate service at just and reasonable rates is not being addressed with respect to the Climate Leadership and Community Protection Act (CLCPA). The fact of the matter is that absent a comprehensive evaluation that assesses historical renewable energy resource availability coupled with historical and projected load, no one knows if a 100% fossil-free electric sector is possible in New York. The legislation that mandated that target naively assumed it was feasible and affordable but those assumptions may violate the laws of physics. I think that the electric energy sector experts that are party to this proceeding have an obligation to the citizens and businesses of New York to insist on an analysis to determine feasibility and costs. It would be far better to determine the consequences of the CLCPA now than to try to muddle through trying to implement something that would have far worse consequences to the citizens of New York than the purported problem.

My reply comments cover several aspects of the comments submitted and information that has become available since the initial comment period ended. I address the lack of representation for the residential consumer in the parties commenting on the proceeding. My reply comments do not address specifics of any of the initial comments but I do offer cautionary observations on the comments describing the purported success of the de-regulated market and support for the NYISO carbon pricing initiative.

Since the time the initial comments were submitted other feasibility issues came up. The NYISO had the Analysis Group evaluate winter peak resources for the short-term. In response to a NYISO press release on a record for wind generation I took another look at the historical wind data. The Citizen's Budget Commission did an analysis of the CLCPA that included an estimate of the future load. I show that all these studies are relevant and underscore the need for the feasibility study.

Finally, I made some recommendations. I re-iterated my plea for a comprehensive feasibility study and cumulative environmental impact study. I suggest that the State provide solar energy facility applicants with a site-specific design year database based on the feasibility study meteorological data to improve their applications. I recommend full payment for renewable resources only if they are dispatchable, i.e., they include energy storage. I also have a suggestion for the future stakeholder process and recommend that this proceeding endorse energy storage R&D.

2.0 Commenters

I submitted comments to represent consumers who value safe and adequate service at just and reasonable rates for customers over a virtue-signaling climate gesture[1]. I want to make the point that those interests were under-represented in the 51 comments submitted. The Joint Utilities of NY, NY Association of Public Power, and New York Municipal Power Agency have a stake in representing their customer's interests. Consumer Power Advocates, Multiple Intervenors, and the New York Energy Consumers Council directly represent the concerns of commercial and industrial consumers whereas the City of New York and Dutchess County are more concerned with residential consumers. Two State Senators and one Assemblyman submitted comments stressed the need for affordable and reliable electricity. I was the only individual representing residential consumer interests. The energy providers have to work in the New York regulatory climate where criticism of any Governor policy is grounds for retribution from the Administration so they cannot represent consumer interests strongly. Among those that represent consumer interests, the City of New York fully supports the need for climate action and it is not clear how much their comments weigh that concern more than consumer interests. On the other hand, comments from Dutchess County clearly put consumer interests first. Finally, although the Utility Intervention Unit, Division of Consumer Protection, Department of State technically should represent consumer interests they are an agency under the thumb of the Administration and certainly cannot stray too far from the party line.

Only four other commenters directly addressed the disconnect between the mandated goals of CLCPA and electric system reality. Senator Funke, Senator Ortt, Assemblyman Palmesano, and Allan Page of A. Page & Associates LLC. Allan Page commenting on behalf of Dutchess County New York notes that "It is essential that customer well-being take precedence over State electric policy." I endorse those comments and reiterate my position that as well-intended as the CLCPA electric system targets may have been, without a feasibility study, consumers in the State have no assurance that the current reliability levels will be maintained. Only when the feasibility study determines the infrastructure necessary to meet the goals can we estimate costs.

3.0 General Observations on the Comments Submitted

I am not submitting these reply comments to address any of the particular comments submitted. However, I do want to address two aspects of comments made by many: the success of the de-regulated market and the NYISO carbon pricing proposal. In both cases my observations are simply meant to caution the DPS.

[1] The ultimate impact of a 100% reduction of New York's 1990 218.1 million metric ton of emissions on projected global temperature rise would be a reduction, or a "savings," of approximately 0.0032°C by the year 2050 and 0.0067°C by the year 2100. This small a temperature difference cannot be measured.

3.1 Success of the de-regulated market

A common theme in many of the comments was that the existing de-regulated market system has been an unqualified success. I want to make cautionary comments in this regard.

I concur with the following in the comments by Allan Page on behalf of Dutchess County:

> "Based upon a well designed and engineered electric system, historically built with quality materials, the existing New York State electric transmission and distribution systems have been able to accommodate many recent intermittent policy imperatives while maintaining a very high level of reliability."

The electric system described in his comments was the product of the now disparaged regulated and integrated utility system. The generating component of that system was similarly well designed and engineered and has been a key reason that New York reliability has remained so high. For all the supposed accomplishments of the de-regulated electric system, the fact is that those accomplishments have generally relied on the performance of generating and transmission assets built before de-regulation. It is important to note that New York legislation encouraged development of a significant number of co-generation facilities in the 1990's but that many of those facilities are no longer operational. While the majority of retired facilities stopped operating because of hosting issues, it is dis-quieting that some facilities[2] had operational problems that forced shutdowns well before their expected retirement dates.

Much has been made of emission decreases and cost stability since de-regulation with the implicit if not overt claim that were it not for de-regulation those improvements would not have happened. However, both emission reductions and steady prices are directly related to the natural gas revolution. The dramatic decrease in natural gas prices because of a technology that New York State has banned stimulated the use of more natural gas and less coal and residual oil. As a result emissions went down and costs were reduced. I don't think you can say that the regulated utilities (at least eventually) would not have made similar investments in natural gas generation. It is not appropriate to claim all the benefits of natural gas emission decreases and lower costs were the exclusive result of de-regulation.

My caution is that past performance is not a guarantee of future success.

3.2 Carbon Pricing

Multiple commenters expressed support for the New York Independent System Operator (NYISO) Carbon Pricing Initiative**.** Carbon pricing theory says that when the price of energy is raised by adding a cost for carbon, the increased costs at the higher CO2 emitting sources of energy will

[2] For example, the Ilion Energy Center was a co-generation facility at Remington Arms that came on line in 1993. It closed in 2006 after only 13 years partly due to problems with the generating system.

provide incentives to transition to lower or zero CO_2 energy sources. This is supposed to lead to the most cost-effective reductions. I think that there are a number of practical reasons that carbon pricing will not work as theorized in general: leakage, revenues over time, theory vs. reality, market signal inefficiency, and implementation logistics. My concerns are exacerbated in the NYISO carbon pricing initiative

3.2.1 Leakage

Leakage refers to the situation when a pollution reduction policy simply moves the pollution around rather than actually reducing it. Ideally you want the carbon price to apply to all sectors across the globe so that cannot happen. I don't think a global carbon pricing scheme is ever going to happen because of the tradeoff between the benefits which are all long term versus the costs which are mostly short term. I don't see how anyone could ever come up with a pricing scheme that equitably addresses the gulf between the energy abundant "haves" and those who don't have access to reliable energy such that "have nots" will be willing just to pay more to catch up with those who have abundant energy.

For any carbon pricing scheme in a limited area I think that leakage will be an insurmountable problem. Trying to force fit this global theory into just the New York electricity market is an even more difficult problem. As proposed, it will likely result in locational leakage where energy and emissions are not reduced but simply shift emission location out of the state within the inter-connected electric grid. Additionally, note that a carbon price on just the electric sector may even result in leakage if more consumers generate their own power using unpriced fossil fuel.

3.2.2 Revenues Over Time

A fundamental problem with all carbon pricing schemes is that funds decrease over time as carbon emissions decrease unless the carbon price is adjusted significantly upwards over time. This problem is exacerbated because over time reducing CO_2 emissions becomes more difficult. It has been observed that roughly 80% of the effects come from 20% of the causes and everyone knows the implications of the low hanging fruit analogy. This phenomenon has been observed with regard to New York's observed CO_2 emission reductions to date. Supporters of the Regional Greenhouse Gas Initiative (RGGI) point out that since its inception that New York electric sector emissions have dropped over 40% between 2006 and 2018. However, I have shown that those reductions were primarily because of retirements and fuel switching to lower emitting fuels. It can be argued that those reductions would have happened anyway because retirements and fuel switching were lower cost options without even considering CO_2 emissions. Importantly, in the future reductions will primarily occur due to RGGI investments. Unfortunately, RGGI investments to date are only directly responsible for less than 5% of the total observed reductions. Furthermore, from the start of the program in 2009 through 2017, RGGI has invested $2,527,635,414 and reduced annual CO_2 emissions 2,818,775 tons. The resulting cost efficiency,

$897 per ton reduced, is disturbingly high. Coupled with my belief that air pollution control costs increase exponentially as efficiency increases, it is clear that the need for stable revenues over time is acute.

This difficulty should be even more of a concern with CO2 emission reductions because at some point replacing existing fossil-fired generation not only has to consider the direct power output conversion costs but must also address dispatchability and grid support costs. When those costs are included there will be a sharp increase in total costs per CO2 reduced. Like many others, the NYISO Carbon Pricing Initiative proposes to use the social cost of carbon (SCC) as the carbon price. The SCC cost increases over time but the costs over time do not increase enough in my opinion to keep pace with the necessarily more expensive total costs to maintain reliable electricity to consumers.

3.2.3 Theory vs. Reality

Another problem with carbon pricing theory is that in practice affected sources may not act rationally or as theory expects. The Regional Greenhouse Gas Initiative (RGGI) is a market-based carbon pricing program and I have written extensively on it. The academic theory for RGGI market behavior is that affected sources will treat allowances as a storable commodity and act in their own best interest on that basis. If that were true affected sources would be purchasing allowances for long-term needs and "playing" the market to maximize earnings. In practice RGGI affected sources plan and operate on much shorter time frames and have shown no signs of making allowance compliance obligations a profit center.

Carbon pricing theory claims that when the cost of using higher emitting energy increases that will provide incentives to develop alternatives and discourage continued use of existing resources. However, these incentives are indirect and again assume rational behavior in the market. While theory says that a company that currently operates a fossil-fired plant will change its business plan and develop a renewable energy facility to stay in business, there are a whole host of reasons why the company may not go that route and instead treat the carbon price as a tax, continue to operate with that constraint, and give up on fossil-fired plant as a long term asset. In my opinion RGGI did not induce any NYS companies to change their business plans.

3.2.4 Market Signal Inefficiency

I am also concerned because the carbon price signal is an indirect inducement for emission reductions. CO2 emission reduction efficiency is an issue based on New York's experience in RGGI. The New York State Energy Research and Development Authority (NYSERDA) report New York's RGGI-Funded Programs Status Report - Semiannual Report through December 31, 2018 ("Status Report") describes how New York invested the proceeds from the RGGI auctions. That report lists the many programs that are funded using RGGI proceeds. I have included Table 2 Summary of

Expected Cumulative Annualized Program Benefits through December 31, 2018 from that report as an attachment to my comments because it costs and savings for programs in six program categories: Green Jobs – Green New York, Energy Efficiency, Renewable Energy, Community Clean Energy, Innovative GHG Abatement Strategies, and Clean Energy Fund.

I combined the data for the six program categories in Table 1, Consolidated Summary of Expected Cumulative Annualized Program Benefits through 31 December 2018. It summarizes the emission reduction benefits and costs for those categories. The cost per ton reduced ratio ranges from $167 to $3,437. At the high end the GHG Abatement Strategies category emphasizes long-term research and development. Because this research could lead to a cost breakthrough this funding ineffective can be justified. Looking at the other categories it appears that the more investments are focused on direct reductions rather than indirect investments the better the cost benefit ratio. For example, the best ratio ($167 per ton removed) is in Community Clean Energy and that category includes direct support for renewable energy projects. The Energy Efficiency category is an example of indirect support because investments in this category do not directly reduce emissions. Instead the investments reduce energy use which reduces the need for energy production and indirectly reduces emissions. However, the cost per ton removed, $425, is markedly higher than the best category.

Table 1: Consolidated Summary of Expected Cumulative Annualized Program Benefits through 31 December 2018

Programs	Total Costs ($millions)	Net Energy Savings (Annualized mmBtu)	Renewable Generation or Electricity Savings (Annualized MWh)	Net GHG Savings (tons CO2e)	Cost Benefit Ratio ($/ton CO2e)
Green Jobs - Green New York	$172.50	2,479,924	157,579	264,048	$653.29
Energy Efficiency	$260.20	1,055,649	842,566	611,898	$425.23
Renewable Energy	$79.90	4,157	245,864	144,408	$553.29
Community Clean Energy	$21.80	375,729	131,680	130,662	$166.84
Innovative GHG Abatement Strategies	$6.20	100,246	4,820	1,804	$3,436.81
Clean Energy Fund	$17.40	281,836	38,923	50,961	$341.44
Total	$558.00	4,297,541	1,421,432	1,203,781	$463.54

Theory says that the carbon price alone can incentivize lower emitting energy production and that the market choices will be more efficient than government mandated choices. However, as a result of these observations, I do not think that carbon pricing schemes, like the NYISO initiative, that raise the cost of energy and do not include specific funding aspects will work as efficiently in the short term and in limited markets like New York as theory suggests. There are risks involved so who is going to make the investments and even if they do will they make investments in the time frames necessary to meet New York's ambitious goals? The Social Cost of Carbon (SCC) is supposed to represent the future price impact to society of a ton of CO2 emitted today. Because these cost per ton of CO2 reduced results are far greater than the SCC, these are not cost-effective programs.

3.2.5 Implementation Logistics

I also believe that there are significant logistical issues associated with carbon pricing that the NYISO process has simply ignored. In order to set a carbon price, you have to know what the carbon emissions are for every source providing energy to the market. For a global all-sector pricing scheme, you could set the price as the fuel is produced so that everyone pays the cost all the way through its end use. On the other hand, the NYISO has to set the carbon price as electric energy is sold on a real-time basis. Tracking emissions on that basis is a non-trivial problem. In New York, NYISO knows which generators are running and has a pretty good idea of their emission rates. However, the final emission numbers are not available real-time because the emission values reported to prove compliance are not finalized until quality assurance post processing is complete and that can be months after the fact. The more significant problem is that NYISO has no way to calculate imported electricity carbon emissions on a real-time basis so cannot assign a carbon price value that accurately reflects how imported electricity is being generated. These issues have been glossed over to date.

3.2.6 Vermont Regulatory Analysis Project Carbon Management Study

The Regulatory Analysis Project (RAP) recently completed a relevant study: Economic Benefits and Energy Savings through Low-Cost Carbon Management for Vermont that raises relevant concerns. The introduction describes the genesis of the analysis:

> In the 2018 legislative session, the Vermont Legislature called for a study to examine the possible methods, costs, and benefits of using carbon pricing to address the problem of carbon pollution in the state. Resources for the Future (RFF) was commissioned by the legislature's Joint Fiscal Office to conduct that study, using the economic models and approaches available to RFF.
>
> The Regulatory Assistance Project (RAP) has been asked to assess the RFF study and its conclusions, and to offer suggestions for action based on its results and our expertise in energy and climate policy. RAP has, over the past 25 years, examined these issues not only in Vermont but across the globe. Our observations and recommendations are based on that broad base of experience.
>
> For the purposes of this report, in the short time available, we commissioned two expert studies. The first, on low-carbon transportation, was completed by M.J. Bradley & Associates (MJBA), which has conducted several studies on this topic across our region and

> beyond. The second, on opportunities for energy savings in housing and public buildings, was completed by the Energy Futures Group (EFG), an expert consulting firm based in Hinesburg, Vermont. We are grateful to these two firms for lending their expertise to Vermont and offering leading insights to this review.
>
> What have we found? Based on the plain facts of Vermont's physical and economic conditions, we conclude that an attempt to reduce Vermont's carbon emissions based on carbon pricing alone will cost more, and deliver less, than a program of carbon reductions that is based on practical public policies—policies that attack the main sources of carbon pollution through tailored, cost-effective programs geared to Vermont's families, businesses, and physical conditions.

Although the focus of the RAP study was on transportation and energy efficiency the over-arching conclusions are also applicable to New York and the NYISO Initiative. The report raises the important question policy question: What does a climate policy cost consumers per ton of carbon avoided? Their answer is relevant:

> Many advocates of carbon pricing begin with the proposition that the main point is to charge for carbon emissions "appropriately" and that carbon reductions will surely follow in the most efficient manner. While carbon pricing is a useful tool in the fight against climate change, there is now substantial experience to suggest that wise use of the resulting carbon revenues is equally important, or even more important, if the goal is to actually reduce emissions at the lowest reasonable cost. One of the principal conclusions of the RFF study is that, even if carbon charges were set as high as $100/ton, the reduction in carbon emissions achieved statewide would be only about 10 percent below the expected business-as-usual case.
>
> This seems to present us with an insoluble problem. On the one hand carbon pricing is said by many to be the "best" and "most efficient" way to drive down emissions in line with global targets and Vermont's statutory goals. But on the other hand, as common sense and studies—including even RFF's analysis—conclude, carbon pricing alone will be a weak tool to deal with the realities of consumer behavior, our historic buildings infrastructure, rural settlement patterns, and the many barriers that working families and businesses face in choosing to invest in energy efficiency or other low-carbon options.
>
> But this challenge is not as intractable as it may seem. Fortunately, Vermont decision-makers now have easy access to at least three demonstrations of the ways that energy pricing can be married to public policies to drive energy savings, carbon reductions, and bill reductions—all at the same time. We touch on three important examples here, although many more could be given.

I believe that the RAP analysis supports my concern about carbon market pricing signal investment efficiency. Even though they still claim that "energy pricing can be married to public policies", the high hurdles of leakage, reduced revenues over time and the disconnect between the theory and reality are unaddressed and still remain.

3.2.7 Paul Homewood on Carbon Pricing

Paul Homewood at the Not a Lot of People Know That blog described the flaws of an article supporting a carbon tax plan that are also relevant to this discussion. Although he described seven flaws in the plan, I will focus only on one of his comments. He said that "The only logical reason for a carbon tax is to reduce emissions. Such a tax might help to reduce energy consumption, but only at punitive levels, because energy demand is so inelastic. Therefore, the real intention is to make fossil fuels so expensive that renewables can eventually become competitive, along with CCS, hydrogen heating etc." I agree with his contention here and that makes the case for a New York only, electric sector only carbon pricing plan even less viable. I believe that the primary rationale for the NYISO carbon pricing initiative is to make the renewable subsidy accounting easier for some participants. I don't believe that is in the best interests of everyone else in New York.

3.2.8 Carbon Pricing Cautionary Summary

The NYISO claims that "An increasing number of organizations recognize this unique, market-based solution as a viable, scalable option for helping to reduce carbon emissions market-based solution". I frankly don't think those organizations have had actual experience with a carbon pricing initiative logistics and have not evaluated whether the carbon prices proposed will provide the market signals necessary to spur the necessary renewable development needed to meet any CO_2 emission reduction goals as a viable, scalable option for helping to reduce carbon emissions for the CLCPA.

The success of any carbon pricing scheme boils down to the question whether the carbon price set will provide enough of an incentive for projects that produce emission reductions that displace today's generators and eventually covers the costs to provide the dispatchability and grid support functions provided by today's generation mix. There are no estimates that this will be the case for the NYISO initiative.

In my opinion, NYISO carbon price initiative support is based on parochial interests. In the case of NYISO they appear to believe it will simplify the cost accounting for New York's renewable implementation efforts. I think they have under-estimated the difficulty implementing the infrastructure necessary to accurately track the price of carbon and have ignored the potential that the complex scheme needed to reduce leakage will lead to unintended consequences. Other support appears to be based on the potential to make money and it is not clear that is in the best interest of the State's desire to reduce CO_2 emissions as cost-effectively as possible.

The more I study the practical implementation of carbon pricing schemes the more skeptical I become. I think that there are a number of practical reasons that carbon pricing will not work as theorized. Because a global program is impractical, leakage is always going to be a problem. The carbon price has to be set such that revenues over time increase significantly because the revenues go down as carbon emissions are going down but the difficulty of making further reductions gets more expensive. The economists who support this theory seem to be blissfully unaware of the realities of the energy market that are at odds to their theories. Based on observed results I think that indirect market signals are going to lead to less cost-effective reductions in the time frame necessary for the aggressive reduction rules. Finally, no supporters seem to understand the very real problems of implementation logistics. The fact that the RAP study raises similar issues to those described here means that my comments should be considered and not disregarded or ignored.

4.0 Feasibility Concerns

I am just a retiree with time on his hands. I have little experience in the protocol for a DPS proceeding in general and no experience in the reply comment protocol in particular. As a result, I don't know if it is appropriate to expand on my previous comments but additional information since my original comments needs to be shared in this proceeding.

Ultimately the feasibility problem boils down to the fact that the existing electric system that includes fossil fuels as an integral component is a known quantity. The system has worked well for decades providing cheap and abundant energy reliably to New York State. What we know about modern renewables, on the other hand, is, to say the least, much less certain. The burden of proof, then, must be on those who believe that wind and solar are now competitive and can replace conventional sources of energy in the legislated time frame.

4.1 Winter peak renewable resources

In my original comments I stated that I thought the winter peak was going to be an issue going forward. NYISO had the Analysis Group do a forward-looking assessment of the fuel and energy security of the New York electric grid during winter operations that supports my concern. This section describes that report and its implications to the Proceeding.

The November 2019 final report was titled: Fuel and Energy Security In New York State: An Assessment of Winter Operational Risks for a Power System in Transition. The objective was to assess winter fuel and energy security risks and identify key factors that would affect risks. Specifically, the study targeted potential reliability risks and impacts under *severe* winter conditions and adverse circumstances regarding system resources, physical disruptions, and fuel availability. Importantly it is a snapshot of the winter of 2023-2024 before the CLCPA renewable energy and electrification of other sectors implementation really kicks in.

In my original comments and elsewhere I have analyzed the effect of winter peaks and used a period, 12/29/17 to 1/12/2018, chosen based on a cursory check of extreme conditions. The Analysis Group did an analysis over the last 25 years and this period was called out. They defined extreme weather events including the largest increase above average daily load over a long period as 14 days from 12/25/2017 to 1/8/2018 and more extreme shorter periods where they found in the last 25 years the fourth lowest 3-day cold snap was 1/4/2018 to 1/7/2018. In their analysis they evaluated different scenarios that included different combinations of "(a) timeframe for the development of new renewable resources; (b) capacity imports from neighboring regions; (c) potential retirement of units affected by the peaker rule; and (d) availability of natural gas for power generation". The evaluation determined where extreme winter weather might cause problems.

The analysis included the following relevant conclusions (two key points underlined by my emphasis):

- "With the continued operation and availability of most of the assets currently expected to be in place in the winter of 2023/2024, the NY grid contains sufficient diversity and depth of fuel supply to support reliable winter operations. This result is consistent with the historical operating experience in recent past winters, including during severe weather conditions."
- "Meeting the state's renewable and clean energy goals can provide valuable reliability support, and may be particularly true with respect to offshore wind. Delayed realization of renewable resource additions (as compared to the 2017 CARIS Phase 1, System Resource Shift case levels that are assumed under initial conditions) can lead to potential LOL events that would not otherwise occur when combined with other adverse system conditions. The potential magnitude and pace of change to the resource fleet stemming from requirements under the CLCPA may be of far greater importance for evaluation than the considerations, scenarios and physical disruptions evaluated in this fuel and energy security study with respect to winter operational risks. "
- "The availability and contributions of adequate levels of natural gas-fired and oil-fired (or dual fuel) generating resources is necessary to maintain power system reliability in cold winter conditions in the near-term. This is particularly true for Long Island and New York City. Simply put, avoidance of potential loss of load events in these load centers, under plausible adverse winter conditions, requires operation of natural gas and oil-fired units. Reduction in the generation available

from such resources - whether through capacity retirements, low initial oil inventories, reduction in natural gas availability for power generation, or interruptions in the ability to refuel oil tanks throughout the winter represents the most challenging circumstances for reliable winter system operations in New York over the coming years."

4.1.1 Implications for this Proceeding

The analysis notes that the "potential magnitude and pace of change to the resource fleet stemming from requirements under the CLCPA may be of far greater importance for evaluation than the considerations, scenarios and physical disruptions evaluated in this fuel and energy security study with respect to winter operational risks". I agree because I believe that it is absolutely necessary for the State to prove that when the energy load increases when other sectors are electrified that fuel and energy security can be maintained without using fossil fuels. The analysis also states that "Simply put, avoidance of potential loss of load events in these load centers, under plausible adverse winter conditions, requires operation of natural gas and oil-fired units". The CLCPA requirement that all electric energy must come from non-fossil fired sources in 2040 is an extraordinarily difficult goal to meet. The political calculus to include this in legislation was not backed up by any analysis. The state has to show how this can be done as soon as possible lest New York resources be squandered on an impossible quest. As I show below, the actual renewable resource may not support this target because of logistical issues and even if it does, there may be immense costs.

4.1.2 Need for Renewable Energy Resource Analysis

In my previous analyses of the summer peak energy storage requirements I used actual wind speed data to estimate the New York off-shore wind resource. In this analysis I will do the same for a winter peak period.

New York State awarded the first two contracts for off-shore wind projects in July 2019. The Equinor 816 MW winning project press release said "The project is expected to be developed with 60-80 wind turbines, with an installed capacity of more than 10 MW each". Among the many details redacted in the public version of their proposal was specific information on the proposed wind turbines. The public version included a diagram of the proposed wind turbine size as compared to the Chrysler building and showed that top tip of the blade at 250 m. I estimated the hub height to be 173 m by scaling the drawing. In this analysis I characterized wind energy output as a function of observed wind as follows. I used a wind turbine power output variation curve that had a cut-in speed of 3.5 m/s and a cut-out wind speed of 25 m/s. Using that wind variation curve, I estimated that the straight-line output of each 10.2 MW wind turbine will equal 0.971 times the wind speed minus 3.4.

For the input meteorological data, I used a National Oceanic and Atmospheric Administration buoy located 30 nautical miles south of Islip, NY (40°15'3" N 73°9'52" W) that I used to represent NY offshore wind resource availability. The observed wind speed at the hub height is proportional to the logarithm of the height above ground. For that calculation I assumed a hub height of 173 m and a surface roughness of 0.0003 using the buoy anemometer height of 4.9 m. I downloaded hourly NDBC data for 2018 and 2017 and calculated the wind energy output for every hour in the period 12/25/2017 to 1/8/2018 using that relationship and the wind turbine output variation equation I derived.

The key finding is that there were two no-wind energy output periods on 3-4 January 2018 during an intense cold snap when electric load is high as shown in the Table 2, New York Off-Shore Wind Generation Estimate for 9000 MW CLCPA Off-Shore Target. I was surprised to see that the wind resource went to zero during a high load period not only when the winds were light on January 3 but also when a deep low pressure developed and the wind speeds exceeded 25 m/s on the very next day. The wind generation estimate table lists the output from a single 10.2 MW wind turbine, 80 turbines in the Equinor proposed wind facility and for all 9,000 MW of Cuomo's CLCPA target of 9,000 MW of off-shore wind. It is important to note that adding even more wind turbines still does not preclude the need for substantial energy storage. While all the New York off-shore wind resource may not go to zero simultaneously that resource is going to be highly correlated across the available area so they all will track closely. Clearly the wind resource is going to go very low across New York State frequently.

4.1.3 Winter Peak Conclusion

Every time I look at the meteorological data relative to the winter peak, I get a surprise. I expected that the winter observed peak load would occur during very cold weather associated with a slowly moving high pressure system that originated in the cold northern plains large enough to cover the entire northeastern US. The resulting multi-day period of clear skies, light winds, and inherently cold temperatures would result in very high energy demand for heating. The early January 2018 high load period was very different. Weather maps for this period (Attachment 1: January 2018 Weather Maps) show a relatively small high pressure system in the central US on January 2 that moved east ahead of a storm system on January 3. The high pressure was strong enough over the New York offshore wind region that winds were less than 3.5 m/s for five hours on January 3. However, the storm system moved eastward and re-developed into a strong storm just off the coast on January 4 with an eleven-hour period of greater than 25 m/s wind speed 13 hours after the light wind period ended. By January 5 the storm had raced northeast to the Canadian

Table 2 New York Off-Shore Wind Generation Output (MW) Estimates for one 10.2 MW turbine, Equinor Proposed Facility, and 9000 MW CLCPA Off-Shore Target

Assumed cut-in wind speed 3.5 m/s and cut-out wind speed 25 m/s

Date/time EST	Temperature deg C	Wind Speed m/s	Hub Height Wind Speed m/s	10.2 MW Turbine MW	Equinor Facility MW	CLCPA Target MW
1/3/2018 0:00	-5.3	11.5	15.7	10.2	816	9,000
1/3/2018 1:00	-5.1	10.6	14.5	10.2	816	9,000
1/3/2018 2:00	-5.2	10.9	14.9	10.2	816	9,000
1/3/2018 3:00	-5.3	10.7	14.6	10.2	816	9,000
1/3/2018 4:00	-5.2	10.7	14.6	10.2	816	9,000
1/3/2018 5:00	-5.4	10.5	14.4	10.2	816	9,000
1/3/2018 6:00	-5.6	10.6	14.5	10.2	816	9,000
1/3/2018 7:00	-5.7	9.8	13.4	9.6	769	8,484
1/3/2018 8:00	-6	9.4	12.9	9.1	727	8,015
1/3/2018 9:00	-5.8	8.6	11.8	8.0	642	7,077
1/3/2018 10:00	-6	7.8	10.7	7.0	557	6,140
1/3/2018 11:00	-5.9	6.7	9.2	5.5	440	4,851
1/3/2018 12:00	-5.7	7.1	9.7	6.0	482	5,320
1/3/2018 13:00	-5.9	6	8.2	4.6	365	4,031
1/3/2018 14:00	-6.3	4.7	6.4	2.8	227	2,507
1/3/2018 15:00	-5.6	4.2	5.7	2.2	174	1,922
1/3/2018 16:00	-5.2	3.6	4.9	1.4	110	1,218
1/3/2018 17:00	-4.6	3.3	4.5	1.0	79	867
1/3/2018 18:00	-4	2.5	3.4	0.0	0	0
1/3/2018 19:00	-3	1.6	2.2	0.0	0	0
1/3/2018 20:00	-2.8	1.6	2.2	0.0	0	0
1/3/2018 21:00	-2.1	1.7	2.3	0.0	0	0
1/3/2018 22:00	-2	2	2.7	0.0	0	0
1/3/2018 23:00	-2.4	3.2	4.4	0.8	68	750
1/4/2018 0:00	-2.8	4.2	5.7	2.2	174	1,922
1/4/2018 1:00	-2.7	4.8	6.6	3.0	238	2,625
1/4/2018 2:00	-3.1	6	8.2	4.6	365	4,031
1/4/2018 3:00	-2.8	7.8	10.7	7.0	557	6,140
1/4/2018 4:00	-2.7	8.7	11.9	8.2	652	7,195
1/4/2018 5:00	-2.9	11.5	15.7	10.2	816	9,000
1/4/2018 6:00	-3.2	14	19.1	10.2	816	9,000
1/4/2018 7:00	-3.4	14.5	19.8	10.2	816	9,000
1/4/2018 8:00	-3.6	15.6	21.3	10.2	816	9,000
1/4/2018 9:00	-3.8	16	21.9	10.2	816	9,000
1/4/2018 10:00	-3.8	15.9	21.7	10.2	816	9,000
1/4/2018 11:00	-3.6	17.5	23.9	10.2	816	9,000
1/4/2018 12:00	-3.6	18.4	25.2	0.0	0	0
1/4/2018 13:00	-3.5	20.1	27.5	0.0	0	0
1/4/2018 14:00	-3.2	20.1	27.5	0.0	0	0
1/4/2018 15:00	-2.8	21.8	29.8	0.0	0	0
1/4/2018 16:00	-2.1	22.1	30.2	0.0	0	0
1/4/2018 17:00	-1.7	21.1	28.8	0.0	0	0
1/4/2018 18:00	-1.2	19.7	26.9	0.0	0	0
1/4/2018 19:00	-0.6	21.9	29.9	0.0	0	0
1/4/2018 20:00	-0.2	21	28.7	0.0	0	0
1/4/2018 21:00	0.2	19.3	26.4	0.0	0	0
1/4/2018 22:00	0.6	18.4	25.2	0.0	0	0
1/4/2018 23:00	1.3	17.8	24.3	10.2	816	9,000

Maritimes but was pumping cold air back across New York State. These conditions caused the fourth lowest 3-day cold snap observed in the last 25 years.

The Resource Adequacy Proceeding must ensure that this period is analyzed in more detail by New York State to determine whether the CLCPA requirements endanger fuel and energy security. If the assumptions I used for no wind power due to light winds and strong winds are correct then there will be 16 hours of no wind power in a 29-hour period during the coldest extended duration cold weather event that the Analysis Group identified after analyzing 25 years of data. The State needs to estimate what the future load will be when the home heating and transportation sectors are electrified to meet the CLCPA emission reduction goal and then assess whether renewable resources will be adequate during the entire extended duration period using the proprietary energy output information in the renewable energy proposals submitted to the State not only in the NYSERDA off-shore wind program but also the Article Ten applications. This analysis has to be done for the entire state and obviously will lead to an estimate of the amount of energy storage necessary in 2040 when electric energy from fossil-fired facilities is outlawed by the CLCPA. It is not clear to me if there is enough space available where it is needed to site all the renewable and energy storage necessary. Even if there is enough space, this analysis will provide the information needed to estimate how much all this will cost.

4.2 New York Wind Energy Resources

The New York Independent System Operator (NYISO) issued a press release on December 17, 2019 announcing a new wind generation record for the state: "The new record output of 1,675 megawatts (MW) was set during the 11:00 p.m. hour on Saturday, December 14". The NYISO press release noted that the "record output represents 84% of the 1,985 MW of installed wind capacity in New York State. That got me thinking. The State has already invested in wind energy and plans to do much more but the best they have done is 84% of the total installed. That spurred the following analysis of the overall wind energy resource in New York.

4.2.1 Approach

I used two sources of data from NYISO to evaluate the existing New York wind energy resource. For an overview I used the annual report that presents load and capacity data including historical and forecast seasonal peak demand, energy usage, and existing and proposed generation and transmission facilities. The Load and Capacity Date Report or Gold Book is a featured report in the NYISO document library. I used data in Table III-2 Existing Generating Facilities from those reports to describe the annual wind energy resources available. Keep in mind that in 2018 all wind energy came from on-shore facilities.

The NYISO Real-Time Dashboard includes a window for the real-time fuel mix that includes the amount of wind generation being generated in the state. The window also includes a link to historical data. I downloaded data for all of 2018, sorted out the wind production numbers, and then calculated hourly averages to compare with the annual numbers from the Gold Book. I use Statgraphics Centurion software from StatPoint Technologies, Inc. to do my statistical analyses and in this case I loaded the hourly data and calculated frequency distribution statistics for presentation here.

4.2.3 Results

Table 3: NY 2018 Wind Facilities in the NYISO 2019 Gold Book, lists data from all the New York wind energy facilities. The NYISO table provides the name plate ratings and 2018 net energy produced. I used that information to calculate the annual capacity factor for each facility. Note that there is a wide variation of capacity factors, that the highest is only 35.7%, and the state-wide capacify factor is only 24.5%. In other words, New York wind facilities only provide a quarter of their name plate capacity. The best hour wind energy has reached 84% of the nameplate capacity and over the year wind energy only produces only 24.5% of the possible power that could be produced. That is bad enough but there is more.

Another wind-resource issue is the distribution of the hourly output. Figure 1: 2018 Hourly Wind Generation (MW) Frequency Distribution has four parts that describe frequency distribution data for all hours in 2018. The histogram of wind output categories shows a skewed distribution such that low output is more frequent than high output. The frequency tabulation for wind table shows that there were 10 hours when none of the 24 wind facilities in the state produced any power and that 32% of the time less than 200 MW per hour was produced. The percentiles indicate that half the time hourly wind output is less than 346 MW and that for 876 hours (the tenth percentile) wind energy provides less than 49 MW of energy. The normal probability plot is used to determine if the observed data are normally distributed. For these data that is not the case.

If New York has to rely on renewable energy in the future it is important to know the frequency distribution of wind at night when solar output is unavailable. I used the New York City sunrise and sunset times and calculated when it was dark for every day in the year. Figure 2, 2018 Hourly Wind Generation (MW) Frequency Distribution at Night, lists the same statistics as before but only includes night time hours. While there was only one hour with no wind output and the frequency of hours with output less than 200 MW was down to 28% there still is a significant number of hours when there is no appreciable renewable energy being generated. The percentiles indicate that half the time at night hourly wind output is less than 367 MW and that for 876 hours (the tenth percentile) wind energy provides less than 65 MW of energy.

Table 3: NY 2018 Wind Facilities in the NYISO 2019 Gold Book

Station	Zone	Town	In-Service Date	Name Plate Rating (MW)	2018 Net Energy (GWh)	Capacity Factor
Altona_Wind_Power	D	Altona	9/23/2008	97.5	168.6	19.7%
Arkwright_Summit_Wind_Farm	A	Arkwright	9/1/2018	78.4	82	35.7%
Bliss_Wind_Power	A	Bliss	3/20/2008	100.5	192.8	21.9%
Canandaigua_Wind_Power	C	Avoca	12/5/2008	125	245.5	22.4%
Chateaugay_Wind_Power	D	Chateaugay	10/7/2008	106.5	190.9	20.5%
Clinton_Wind_Power	D	Clinton	4/9/2008	100.5	146.9	16.7%
Copenhagen_Wind_Farm	E	Copenhagen	12/1/2018	79.9	8.2	13.8%
Ellenburg_Wind_Power	D	Ellenburg	3/31/2008	81	144	20.3%
Erie_Wind	A	Lackawanna	2/1/2012	15	26.2	19.9%
Fenner_Wind_Power	C	Fenner	12/1/2001	30	54.5	20.7%
Hardscrabble_Wind	E	Fairfield	2/1/2011	74	176.8	27.3%
High Sheldon Wind Farm	C	Sheldon	2/1/2009	112.5	247.7	25.1%
Howard_Wind	C	Howard	12/1/2011	57.4	125.1	24.9%
Jericho_Rise_Wind	D	Chateaugay	12/1/2016	77.7	226.1	33.2%
Madison_Wind_Power	E	Madison	9/1/2000	11.6	18.7	18.4%
Maple_Ridge_Wind_1	E	Lowville	1/1/2006	231	536	26.5%
Maple_Ridge_Wind_2	E	Lowville	12/1/2007	90.7	203.2	25.6%
Marble_River_Wind	D	Ellenburg	7/1/2012	215.5	488.9	25.9%
Marsh Hill Wind Farm	C	Jasper	12/1/2014	16.2	46.4	32.7%
Munnsville_Wind_Power	E	Bouckville	8/20/2007	34.5	58.2	19.3%
Orangeville_Wind_Farm	C	Orangeville	12/1/2013	93.9	289.6	35.2%
Steel_Wind	A	Lackawanna	1/23/2007	20	46.9	26.8%
Western_NY_Wind_Power	B	Wethersfield	10/1/2000	6.6	4.6	8.0%
Wethersfield_Wind_Power	C	Wethersfield	12/11/2008	126	257.3	23.3%
State Wide Totals				1981.9	3985.1	24.5%

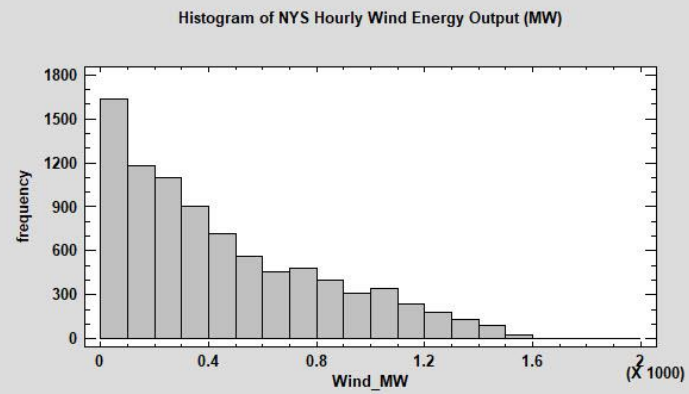
.

Figure 1: Frequency Distribution Tables and Graphs for Hourly New York State Wind Energy Production (MW) in 2018

Frequency Tabulation for Wind_MW

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
	at or below	0		10	0.0011	10	0.0011
1	0	100.	50.0	1632	0.1863	1642	0.1874
2	100	200.	150.	1178	0.1345	2820	0.3219
3	200	300.	250.	1099	0.1255	3919	0.4474
4	300	400.	350.	902	0.1030	4821	0.5503
5	400	500.	450.	721	0.0823	5542	0.6326
6	500	600.	550.	561	0.0640	6103	0.6967
7	600	700.	650.	457	0.0522	6560	0.7489
8	700	800.	750.	480	0.0548	7040	0.8037
9	800	900.	850.	397	0.0453	7437	0.8490
10	900	1.E3	950.	311	0.0355	7748	0.8845
11	1000	1.1E3	1.05E3	347	0.0396	8095	0.9241
12	1100	1.2E3	1.15E3	235	0.0268	8330	0.9509
13	1200	1.3E3	1.25E3	178	0.0203	8508	0.9712
14	1300	1.4E3	1.35E3	135	0.0154	8643	0.9866
15	1400	1.5E3	1.45E3	92	0.0105	8735	0.9971
16	1500	1.6E3	1.55E3	25	0.0029	8760	1.0000
17	1600	1.7E3	1.65E3	0	0.0000	8760	1.0000
18	1700	1.8E3	1.75E3	0	0.0000	8760	1.0000
19	1800	1.9E3	1.85E3	0	0.0000	8760	1.0000
20	1900	2.E3	1.95E3	0	0.0000	8760	1.0000
	above	2000		0	0.0000	8760	1.0000

Mean = 453. Standard deviation = 374.



Percentiles for Wind_MW

	Percentiles
1.0%	3.83333
5.0%	24.0833
10.0%	49.4583
25.0%	142.708
50.0%	346.721
75.0%	701.458
90.0%	1039.42
95.0%	1195.54
99.0%	1434.25

The StatAdvisor
This pane shows sample percentiles for Wind_MW. The percentiles are values below which specific percentages of the data are found
selecting Quantile Plot from the list of Graphical Options.

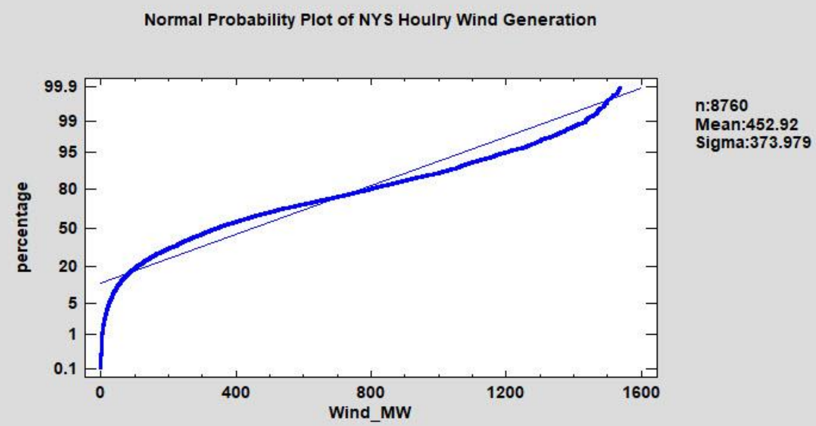
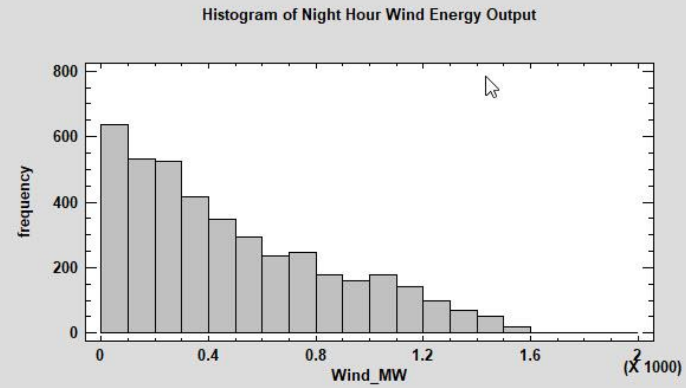


Figure 2: Frequency Distribution Tables and Graphs for Hourly New York State Wind Energy Production (MW) in 2018 – Night Time Hours

Frequency Tabulation for Wind_MW

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
	at or below	0		1	0.0002	1	0.0002
1	0	100.	50.0	635	0.1539	636	0.1541
2	100	200.	150.	531	0.1287	1167	0.2828
3	200	300.	250.	524	0.1270	1691	0.4097
4	300	400.	350.	417	0.1010	2108	0.5108
5	400	500.	450.	349	0.0846	2457	0.5953
6	500	600.	550.	295	0.0715	2752	0.6668
7	600	700.	650.	236	0.0572	2988	0.7240
8	700	800.	750.	245	0.0594	3233	0.7834
9	800	900.	850.	179	0.0434	3412	0.8268
10	900	1.E3	950.	161	0.0390	3573	0.8658
11	1000	1.1E3	1.05E3	178	0.0431	3751	0.9089
12	1100	1.2E3	1.15E3	141	0.0342	3892	0.9431
13	1200	1.3E3	1.25E3	98	0.0237	3990	0.9668
14	1300	1.4E3	1.35E3	68	0.0165	4058	0.9833
15	1400	1.5E3	1.45E3	51	0.0124	4109	0.9956
16	1500	1.6E3	1.55E3	18	0.0044	4127	1.0000
17	1600	1.7E3	1.65E3	0	0.0000	4127	1.0000
18	1700	1.8E3	1.75E3	0	0.0000	4127	1.0000
19	1800	1.9E3	1.85E3	0	0.0000	4127	1.0000
20	1900	2.E3	1.95E3	0	0.0000	4127	1.0000
	above	2000		0	0.0000	4127	1.0000

Mean = 487. Standard deviation = 381.

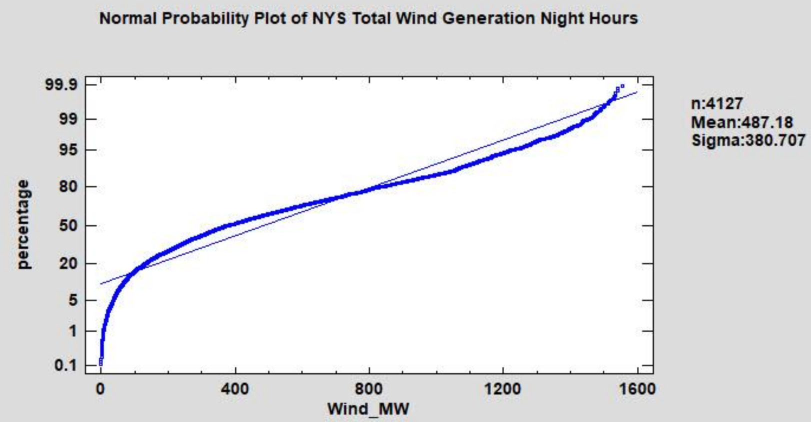


Percentiles for Wind_MW

	Percentiles
1.0%	6.66667
5.0%	37.25
10.0%	66.3333
25.0%	169.833
50.0%	382.083
75.0%	740.083
90.0%	1078.67
95.0%	1222.5
99.0%	1449.75

The StatAdvisor

This pane shows sample percentiles for Wind_MW. The percentiles are values below which specific percentages of the data are found
selecting Quantile Plot from the list of Graphical Options.



4.2.4 Conclusions

In my original comments I included a white paper that evaluated a summer peak period and showed that adding solar and wind capacity increases overall production and production peaks but does not increase output nearly as much during production valleys. This analysis provides additional support to the intuitive result that no amount of additional solar and wind capacity will help during a light wind night. These graphics illustrate just how big a problem this is.

4.3 Citizens Budget Commission "Getting Greener" Report

After I had completed my draft of these reply comments a relevant report from the Citizens Budget Commission (CBC) was released entitled Getting Greener: Cost-Effective Options for Achieving New York's Greenhouse Gas Goals. The report raises resource adequacy and implementation issues associated with the CLCPA. In addition, the report includes an estimate of the renewable energy resources necessary to meet the 2040 "eliminate fossil fuels from the electric sector" goal. I converted their energy estimate to power so I could make a projection of number of renewable facilities required. Once I had that estimate, I looked at the winter peak period evaluated in these comments to determine how much energy storage would be required using the methodology from my white paper in my original comments.

4.3.1 Annotated Findings

In this section I present selected findings and recommendations with my italicized comments.

1. "Immense scaling up of renewable generation capacity is necessary and is likely infeasible by 2030. Much of New York's GHG strategy rests upon continued reductions in the electric sector; specifically, state plans are to more than double renewable generation capacity, mostly from offshore wind turbines. However, it will be challenging to install the required resources by 2030: too few projects are underway and project timelines are lengthy and are likely to be delayed by extensive permitting procedures and often community opposition. New York is poised to direct the expenditure of billions of dollars and still fall short of the stated goals."
    - *I agree with these concerns. From the standpoint of resource adequacy, the concern has to be the total system. It is not just the renewable resources themselves but also the transmission and energy storage needed to ensure power is available when it is needed and where. This underscores the need for a comprehensive plan.*
2. "The focus on building renewable resources, particularly offshore wind, and entering into long-term power contracts limits flexibility and diminishes consideration of other cost-effective approaches. Efforts to scale up renewables are necessary, but projects planned require the State to offer supplemental payments to make them work. Furthermore, the massive infrastructure investment required to procure offshore wind capacity will require long-term contracts that will lock in increased costs for electric customers for years to come. Based on analysis of a recent offshore wind project contract, meeting the renewable

target entirely with offshore wind will increase electricity costs by $2.3 billion annually, an increase of between 8 and 12 percent to New Yorkers' electric bills, which could be a significant increase in monthly living expenses for some low-income and working class New Yorkers. Other options may be more cost-effective, particularly as technology evolves in the long term."

- *The importance of concern about locking in long-term contracts cannot be over-estimated. If the State does this wrong then we will be locked into significant cost increases for a long time. Moreover, I think that their cost estimates are low because they only consider the cost of the turbines themselves and do not include the extra costs necessary to make off-shore wind power dispatchable.*

3. "State policies on nuclear, natural gas, and hydropower are counterproductive. First, the state's six nuclear power plants are scheduled to shut down between 2020 and 2046. Elimination of the nuclear fleet will erase nearly all previous emissions gains as that power supply by necessity will likely be replaced in the near-term by natural gas, which produces greater emissions than nuclear power. Second, attempts to expand natural gas pipelines have been blocked, which resulted in moratoria on new gas installations downstate. Natural gas provides an economical alternative to dirtier fossil fuels and is a dependable source when renewable sources like solar and wind are not available. Third, while hydro is a key renewable resource, state policies have not supported use of hydro when construction of a new dam is involved, limiting the ability to access additional affordable and clean power from Canada."
    - *New York's electric system has been reliable because of its diversity of fuel sources. The CLCPA requirements threaten that capability. For example, eliminating coal, which was one source of generation that could store fuel on-site, forces reliance on other resources. In that light I admire the restraint of this section. Calling the nuclear, natural gas and hydro policies counterproductive is kind. The massive hypocrisy of on one hand calling for a response to an existential threat while at the same time shutting down operating nuclear plants begs out to be called stupid at least. Energy facts undermine the current administration's irrational war on fracked natural gas and directly threatens reliability. Throw in the lack of support for hydro and the diversity of New York's electric system is endangered.*
4. "The focus on other sectors—particularly transportation—is insufficient. The State's strategy to tackle growing transportation emissions is focused on facilitating expanded use of electric vehicles, which is expensive and challenging for some parts of the state. Furthermore, achieving the long-term goals to cut GHGs by 85 percent will require electrifying almost all heating and transportation, affecting every home and business and nearly every vehicle in the state. This conversion from direct fossil fuel consumption to electric power will necessitate a dramatic further increase in renewable energy supply and energy efficiency: New York State will need to add an additional 94,000 Gigawatt hours of

renewables, more than double existing renewable resources. It will also require an expansion of the state's transmission capacity, which is already constrained from upstate to the downstate area, where most energy is used. The construction of offshore wind facilities will bring more renewable energy directly to the downstate market, but a larger mix of resources, some operating intermittently, will require an expanded transmission grid to deliver power throughout the state."

- *This paragraph summarizes a fundamental issue with the CLCPA very well. On one hand the State proposes to completely re-make the energy production system while simultaneously increasing our dependency upon reliable power. The resource adequacy issue raised here is resiliency. What happens when everyone depends on electric heat and an ice storm takes out the power lines?*

The report offers the following six recommendations:

1. Establish an economy-wide carbon pricing system to deliver effective price signals to energy consumers. Two options for such a system are: (1) a carbon fee and (2) a cap-and-trade system. To be most effective, these policies should be implemented on at least a regional, if not national, scale, so that dollars are directed most effectively toward the dirtiest energy sources and states. CLCPA tasks the New York State Department of Environmental Conservation with estimating a "social cost of carbon," that is, a monetary figure capturing the costs of an incremental increase in carbon emissions, an important step for implementing a pricing scheme. New York is already a member of the Regional Greenhouse Gas Initiative (RGGI), an effective 9-state cap-and-trade system covering the electrical generation power sector. To be most effective RGGI should be expanded to other sectors of the economy, including transportation.
    - *As noted previously in these reply comments I do believe carbon pricing has theoretical appeal but in practice I am very pessimistic that the results will work out as planned based on the results of the Regional Greenhouse Gas Initiative. CBC correctly recognizes that carbon pricing should be economy-wide and regional, if not national. Because the NYISO carbon pricing initiative is one state and one sector, I believe that CBC does not endorse its implementation.*
2. Look beyond New York's borders for low-cost, low-emission energy supplies and to cut GHG emissions. New York should explore the possibility of a multi-state buyers' consortium to purchase large-scale low- and zero-GHG energy resources. New York, New Jersey, Connecticut, Rhode Island, and Massachusetts are all in the process of developing offshore wind energy projects. The states are seeking low-cost electricity, but also vying for jobs from the burgeoning offshore wind industry. Rather than compete, these states should work together to bring the most cost-effective resources to the market. Another opportunity is to import Canadian hydropower, which is competitively priced and clean.
    - *No comment - this seems reasonable.*

3. Retain nuclear energy to retain the benefits of carbon avoidance. The state's nuclear facilities operate with the help of subsidies, known as Zero Emissions Credits, that expire in 2029. If these subsidies are not extended, the nuclear plants may shut down while still holding valid operating licenses. The state should explore further extensions of these operating licenses with the U.S. Nuclear Regulatory Commission. The implementation of a properly priced carbon fee would be a benefit to the nuclear plants, which generate no greenhouse gases.
   - *CBC recognizes that if there is a climate emergency then reducing power from the largest source of carbon free electric generation in the state is counter-productive.*
4. Avoid self-imposed constraints such as limiting gas pipeline capacity. A strong preference for renewable energy has resulted in constraints on expansion of natural gas. Denying permits to several natural gas pipelines is constraining energy markets to the point that New York will not be able to reap the GHG reduction benefits of converting home heating from oil to natural gas. Likewise, a lack of stable natural gas supply for new businesses may harm the state's economic competitiveness. Regulatory and legal actions should not hamper use of resources that can continue to reduce GHG emission and provide reliable energy solutions. New York should create a competitive market of options to reduce greenhouse gases.
   - *CBC recognizes that renewable energy implementation for the entire energy sector is a long-term process and that natural gas should be an interim part of the transition or a rational energy plan when the State realizes it cannot afford the CLCPA extreme target boondoggle.*
5. Promote broad transportation solutions that build on existing infrastructure. New York has made a large commitment to electric vehicles that will subsidize both car buyers and the construction of charging stations. This is an expensive GHG emissions reduction strategy. Greater emphasis should be placed on one of the areas that has made New York a low GHG-emitting state: energy-efficient public transportation. While a hybrid or electric vehicle produces fewer GHGs than a gasoline powered vehicle, public transportation produces even less per passenger mile traveled.
   - *CBC recognizes that the commitment to electric vehicles is expensive and suggest greater emphasis on energy-efficient public transportation. I agree with the sentiment but the problem is what do you do in rural and suburban areas where cost-effective public transportation is out of the question. From the standpoint of this proceeding we can only estimate future load requirements when transportation policies are proposed.*
6. Establish a prioritization system to pursue renewables that provide the greatest GHG reductions at lowest cost. Renewables are and must be an increasing part of the state's energy portfolio; however, policymakers should allow price signals to determine how much wind capacity, distributed solar, utility-scale solar, and hydropower is built rather than

mandating specific technologies. All these projects should be put on a common basis of cost to consumer for tons of GHG avoided and those with the lowest net cost should be prioritized for development and contracts. A balanced portfolio of resources and contract term lengths will provide New York with the greatest security and stability to reach its long-term GHG reductions goals. This also will allow for competition from new resources so that if newer projects can be completed at lower cost, New York will reap the benefit. It also allows for the possibility that leaps in technology will be able to fill the mix rather than being locked into old technology for 20 years. New York is now leading the way on greenhouse gas reductions, but it should also lead the way in using competition to provide the greatest emissions reductions at the lowest cost.

- *I agree that spending priorities should be established based on emission reduction cost effectiveness but I think if CBC spent some time looking at the numbers, they would be surprised how expensive these technologies are. I fully support their suggestions to minimize future financial exposure and think that the resource adequacy proceeding should adopt a similar recommendation.*

4.3.2 Renewable Resources Projection

The CBC report is useful because it provides an estimate of the renewable resources required to meet the CLCPA 2040 fossil-free electric sector target. The State has not admitted that 2040 load is going to be substantially higher than the current levels but this report makes a compelling case for a significant increase in annual load. Their results indicate that "as New York moves to a path of decarbonizing heating and transportation in New York, the total electric demand will rise to 211,100 Gwh by 2040. To serve that demand with 100 percent non-emitting resources, nearly 94,000 Gwh of additional renewables will need to be added, a total that is roughly double the amount to be added from offshore wind (37,800 Gwh) and distributed solar (8,400 Gwh) now set by the CLCPA."

I used their projections of the resources needed to meet the energy requirements (GWh) to estimate the power capacity (MW) needed. As shown in Table 4: CBC Forecast of 2040 Capacity (MW) Resources to Meet CLCPA Goals, I calculated that New York would have to build 11,395 MW of residential solar, 16,117 MW of utility-scale solar, 18,457 MW of on-shore wind and 16,363 MW of off-shore wind to meet the increased load estimated by CBC. The total capacity including the other sources is estimated to be 70,470 MW.

To put those numbers in perspective, consider the number and space requirements. For residential solar I used the rule of thumb that you need 66 square feet to generate 1kW of solar energy and that would require 36 solar panels. That means that nearly 27 square miles of residential roofs would have to be covered by over 364.6 million solar panels to meet the 11,395 MW estimate. For utility-scale solar I found a recent application that showed that each MW of utility scale solar will cover 7 acres so 112,816 acres or 176 square miles will be needed to meet the 16,117 MW of utility scale solar output estimate. Assuming a 4.8 MW on-shore wind turbine would mean that over 3,845 on-shore wind turbines would be needed to meet the 18,457 MW output estimate. One of the recently awarded off-shore wind project proposes to use 10.2 MW turbines and that means that 1,604 wind turbines would be needed to meet the 16,363 MW output estimate.

The number and areal extent of these resources underscores the importance of a cumulative environmental impact analysis. While a solar facility or two may not have significant impacts 176 square miles of fenced in solar panels certainly could. The same could be said for 3,845 on-shore wind turbines and 1,604 off-shore wind turbines.

I do have one concern about the CBC forecast of resources to meet CLCPA goals. In order to make a better estimate of the resources it is necessary to look at peak periods rather than just annual loads. It is inappropriate to assume that a “smart” grid and more energy efficiency is going to eliminate electric load peaks so that they do not have to be considered. Residential heating and transportation electrification will impact the winter peak very likely shifting the annual peak to winter simply because you cannot shift heating when it is very cold. However, it is unfair to ask the CBC to address the winter peak expected load because it is a very complicated problem and would take a lot more effort.

I took a look at a winter peak period renewable resources derived from the CBC forecast. I made a first cut attempt to estimate the capacity necessary to meet future energy load but I made a crude assumption that the peak load could be met with the resources needed to meet the annual energy estimate. The results shown in Table 5: January 3-4 2018 Winter Peak with CBC Forecasted 2040 Capacity Resources to Meet CLCPA Goals are influenced by the cut-on and cut-off generation output assumptions I made for off-shore wind turbine output because there were two no-wind energy output periods during the two-day winter peak period I analyzed. I was surprised to see that the wind resource went to zero not only when the winds were light on January 3 but also when a deep low pressure developed and the wind speeds exceeded the upper wind speed cut-off I used on the very next day. As a result of these conditions, there were twenty hours out of 48 hours that the output from all the resources available to New York in the CBC scenario for 2040 were negative and would require energy storage to keep the lights on, homes heated and vehicles charged.

Table 4: CBC Forecast of 2040 Capacity (MW) Resources to Meet CLCPA Goals

	2017 GWh	2025 GWh	2030 GWh	2035 GWh	2040 GWh	C.F. %	2040 MW
Existing Hydro	37,913	37,913	37,913	37,913	37,913		4,253
Existing Wind	5,170	5,170	5,170	5,170	5,170		1,739
Existing large-scale solar							32
Existing other renewable							327
NYSERDA Renewable Pipeline Wind		10,884	10,884	10,884	7,075	26%	3,106
NYSERDA Renewable Pipeline Solar					3,809	20%	2,174
Existing Nuclear	49,062	33,687	16,987	16,987	16,987		
Natural Gas	52,728	57,388	44,413	22,206			
CLCPA Solar		8,400	8,400	8,400	8,400	20%	4,795
CLCPA Wind		6,300	22,050	37,800	37,800	48%	8,990
Coal, Oil & Solid Waste	8,289						
Additional Residential Solar					15,971	16%	11,395
Additional Utility-Scale Solar			35,283	56,740	15,971	20%	9,116
Additional On-Shore Wind					31,002	26%	13,612
Additional Off-Shore Wind					31,002	48%	7,373
TOTAL GENERATION	153,163	159,742	181,100	196,100	211,100		

Total Residential Solar	11,395
Total Utility-Scale Solar	16,117
Total On-Shore Wind	18,457
Total Off-Shore Wind	16,363

Table 5: CBC Forecasted 2040 Capacity Resources to Meet CLCPA Goals During January 3-4 2018 Winter Peak

Date/time	NYS Generation 211,100 GWh	Offshore Wind 16,363 MW	Onshore Wind 18,457 MW	Utility Solar 16,117 MW	Other Renewable 409 MW	Residential Solar 11,395 MW	Nuclear 3,477 MW	Hydro 4,253 MW	70,470 Margin
1/3/18 0	23,103	16,363	10,476	0	299	0	3,247	1,610	8,891
1/3/18 1	22,636	16,363	9,204	0	301	0	3,247	1,639	8,118
1/3/18 2	22,048	16,363	9,120	0	299	0	3,247	1,590	8,571
1/3/18 3	22,310	16,363	8,130	0	299	0	3,247	1,592	7,321
1/3/18 4	22,348	16,363	8,331	0	299	0	3,247	1,596	7,487
1/3/18 5	22,755	16,363	8,413	0	297	0	3,247	1,599	7,164
1/3/18 6	25,113	16,363	8,631	0	297	0	3,247	2,083	5,507
1/3/18 7	26,360	15,424	8,676	4,029	303	2,849	3,247	2,689	10,856
1/3/18 8	27,115	14,572	9,666	8,058	308	5,697	3,247	3,069	17,501
1/3/18 9	26,970	12,867	8,299	12,087	323	8,546	3,246	3,155	21,554
1/3/18 10	26,337	11,163	7,744	16,117	330	11,395	3,246	3,033	26,691
1/3/18 11	25,810	8,820	6,710	16,117	333	11,395	3,244	2,673	23,481
1/3/18 12	25,162	9,672	5,155	16,117	333	11,395	3,245	2,525	23,280
1/3/18 13	25,063	7,328	4,470	16,117	326	11,395	3,245	2,504	20,321
1/3/18 14	24,633	4,559	3,870	16,117	322	11,395	3,245	2,460	17,334
1/3/18 15	25,306	3,494	3,508	12,087	309	8,546	3,246	2,554	8,438
1/3/18 16	26,575	2,215	3,245	8,058	301	5,697	3,246	2,652	-1,160
1/3/18 17	28,247	1,576	4,291	4,029	318	2,849	3,246	3,150	-8,788
1/3/18 18	28,537	0	5,513	0	318	0	3,245	3,010	-16,452
1/3/18 19	28,421	0	5,830	0	323	0	3,245	2,936	-16,086
1/3/18 20	27,918	0	4,364	0	322	0	3,244	2,953	-17,035
1/3/18 21	26,541	0	3,785	0	324	0	3,245	2,581	-16,607
1/3/18 22	24,489	0	3,259	0	323	0	3,245	2,308	-15,354
1/3/18 23	22,367	1,363	2,833	0	323	0	3,246	1,860	-12,742
1/4/18 0	21,808	3,494	2,425	0	326	0	3,245	1,509	-10,809
1/4/18 1	21,665	4,772	2,162	0	323	0	3,245	1,451	-9,713
1/4/18 2	21,071	7,328	1,691	0	322	0	3,246	1,394	-7,090
1/4/18 3	20,182	11,163	1,806	0	329	0	3,246	1,297	-2,342
1/4/18 4	20,366	13,080	1,311	0	324	0	3,245	1,378	-1,028
1/4/18 5	21,293	16,363	790	0	326	0	3,245	1,555	986
1/4/18 6	23,453	16,363	1,033	0	324	0	3,245	2,162	-326
1/4/18 7	25,012	16,363	1,988	4,029	330	2,849	3,245	2,853	6,645
1/4/18 8	25,172	16,363	2,660	8,058	330	5,697	3,245	3,036	14,216
1/4/18 9	26,184	16,363	2,176	12,087	329	8,546	3,245	3,214	19,775
1/4/18 10	26,900	16,363	2,126	16,117	332	11,395	3,245	3,363	26,041
1/4/18 11	27,496	16,363	2,752	16,117	331	11,395	3,245	3,366	26,071
1/4/18 12	27,602	0	3,915	16,117	328	11,395	3,245	2,929	10,325
1/4/18 13	27,874	0	5,908	16,117	334	11,395	3,245	2,752	11,876
1/4/18 14	27,832	0	7,716	16,117	330	11,395	3,245	2,794	13,765
1/4/18 15	27,686	0	8,353	12,087	330	8,546	3,245	2,713	7,588
1/4/18 16	27,877	0	9,220	8,058	330	5,697	3,245	2,814	1,488
1/4/18 17	29,271	0	10,817	4,029	328	2,849	3,246	3,304	-4,699
1/4/18 18	30,062	0	12,737	0	325	0	3,246	3,456	-10,298
1/4/18 19	29,931	0	12,921	0	328	0	3,246	3,365	-10,071
1/4/18 20	28,599	0	12,703	0	327	0	3,247	2,911	-9,411
1/4/18 21	26,852	0	13,166	0	327	0	3,247	2,630	-7,482
1/4/18 22	26,005	0	13,168	0	328	0	3,247	2,383	-6,880
1/4/18 23	24,824	16,363	13,404	0	328	0	3,247	1,844	10,361

4.3.3 Energy Storage Requirement

If the state goes ahead to build the amount of renewable energy that the CBC estimated would be necessary to meet the 2040 goal, it still does not preclude the need for energy storage. Table 5 shows that there was a fifteen-hour period from January 3, 2018 at 1600 until January 4, 2018 at 0600 with hourly storage deficits totaling 134,545 MWh. I used that period to calculate the amount of storage needed using the same methodology as the Initial Estimate of Energy Storage Required White Paper included in my original comments.

Briefly, I assumed that the least cost energy storage approach would maximize energy storage duration based on lower costs per MWh in a recently released report from the National Renewable Energy Lab (NREL): "2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Cost Benchmark". I arbitrarily chose different duration and capacity systems so that the battery systems covered the negative load to generation hours. Table 6: Estimated Energy Storage Required and Potential Price Necessary to Prevent Deficit on January 3-4 2018 summarizes the energy storage needs and my projection for the amount of different duration energy storage systems needed. Finally, I adapted the results from the NREL study to estimate the cost of this amount of storage. Table 6 also lists the estimated cost for the energy storage necessary to meet this winter peak period at a staggering $47 billion.

But that's not all. NREL reported on an analysis of the life expectancy of lithium-ion energy storage systems in 2017 in Life Prediction Model for Grid-Connected Li-ion Battery Energy Storage System. The study tested batteries to simulate how long they would last in real-world conditions by reaching a certain depth of discharge rates and testing battery degradation over time. Under NREL's scenarios, an energy storage system is expected to last between seven and 10 years. The report states: *"Without active thermal management, 7 years lifetime is possible provided the battery is cycled within a restricted 47% DOD operating range. With active thermal management, 10 years lifetime is possible provided the battery is cycled within a restricted 54% operating range."* Therefore, the reality with these batteries is that over the expected lifetime of the solar and wind facilities we have to expect to replace the batteries at least once and would need many more batteries to cover the expected increased load due to increased electrification. Clearly the resource adequacy proceeding requirement to address affordability has to consider this issue.

Table 6: Estimated Energy Storage Required and Potential Price Necessary to Prevent Deficit on January 3-4 2018

			Energy Storage Systems								
		Total (MWhr)	9,600	60,800	61,600	1,200	2,100	800	300	**Total**	**Storage**
	Deficit	**Capacity (MW)**	1,200	7,600	7,700	600	2,100	800	300	**Storage**	**Margin**
Date Time	**MWhr**	**Duration (Hr)**	8	8	8	2	1	1	1	**Used**	**(MW)**
1/3/2018 16:00	-1,160		1,200							1,200	40
1/3/2018 17:00	-8,788		1,200	7,600						8,800	12
1/3/2018 18:00	-16,452		1,200	7,600	7,700					16,500	48
1/3/2018 19:00	-16,086		1,200	7,600	7,300					16,100	14
1/3/2018 20:00	-17,035		1,200	7,600	7,700	600				17,100	65
1/3/2018 21:00	-16,607		1,200	7,600	7,700	200				16,700	93
1/3/2018 22:00	-15,354		1,200	7,600	6,700					15,500	146
1/3/2018 23:00	-12,742		1,200	7,600	4,000					12,800	58
1/4/2018 0:00	-10,809			7,600	3,300					10,900	91
1/4/2018 1:00	-9,713				7,700		2,100			9,800	87
1/4/2018 2:00	-7,090				7,100					7,100	10
1/4/2018 3:00	-2,342				1,600			800		2,400	58
1/4/2018 4:00	-1,028				800				300	1,100	72
1/4/2018 5:00	986									0	986
1/4/2018 6:00	-326					400				400	74
Total	-134,545										

NREL Energy Storage Benchmark Prices ($millions)

$/KWhr	$ 339	$ 339	$ 339	$ 436	$ 563	$ 565	$ 570
Battery Total	$ 3,253	$ 20,587	$ 20,858	$ 523	$1,182	$ 452	$ 171
Grand total	**$ 47,026**						

4.4 NYISO Climate Change on Resilience Study

On December 17, 2019, the New York Independent System Operator (NYISO) Installed Capacity Working Group meeting included a presentation on the NYISO Climate Change on Resilience Study – Phase 1 by Eric Fox from Itron. The study included estimates of future load expected as a result of the CLCPA so I have added this section to further expand on my primary feasibility concern.

The purpose of the Itron analysis was to develop long-term energy, peak, and 8,760 hourly load forecasts that reflect the potential impact of climate change. Itron evaluated temperature trends using state climate impact studies and developed scenarios that reflect state policy goals with climate change impacts. I am not a big fan of studies that try to estimate the impact of climate change on future operations simply because weather variability is larger than climate variability. I believe trying to tease out a small climate effect is mostly bogus. The report does note that "state policy to address greenhouse gas emissions will have more impact on loads than the impact due to temperature trends". They also come to the same conclusion that I have that the winter peak will be more important than the summer peak in the future.

In addition to the climate change impacts the report included an analysis that included a scenario addressing CLCPA impacts on load in the residential sector. They estimated the reduction in residential emissions needed to meet the CLCPA targets. Then they calculated the cumulative increase in electricity needed overall and on the average per residence. They found that in their policy case with accelerated energy efficiency gains and behind-the-meter PV adoption that the savings outweigh gains from electric vehicles and electrification. However, the CLCPA scenario has much higher electrification targets and state-wide annual energy use goes up about 50%. They predict that the summer peak will increase from 43,317 MW in their reference case to 57,109 MW in the CLCPA scenario. Importantly they expect that the electric load peak will shift from summer to winter. They predict that the winter peak will increase from 31,131 MW in their reference case to 71,859 MW in the CLCPA scenario. This compares to the 70,470 MW that I calculated based on the CBC study.

Using the same methodology and date period, I calculated the energy storage for both capacity scenarios. Table 7 lists the results for the two projections. For the 2040 capacity projection of 56,071 MW $52.5 billion would be needed for the Li Ion storage batteries necessary to provide electricity during the renewable deficit periods. The increased capacity projected for 2050, 71,859 MW, reduces the battery storage cost to $43.1 billion. This certainly reinforces my concern about energy storage costs.

The analysis underscores the importance of a comprehensive study of renewable resource availability relative to expected load when the CLCPA electrification requirements kick in because the peak energy storage requirement may not necessarily occur during the peak load period.

Table 7: Energy Storage Estimate Based on NYISO Climate Change on Resilience Study 2040 56,071 MW Capacity

		Energy Storage Systems								
		Total (MWhr)	58,400	40,000	34,600	1,500	2,700	12,800	**Total**	**Storage**
	Deficit	**Capacity (MW)**	7,300	5,000	5,000	500	2,700	1,600	**Storage**	**Margin**
Date Time (EDT)	**MWhr**	**Duration (Hr)**	8	8	7	3	1	8	**Used**	**(MW)**
1/3/2018 15:00	-344		400						400	56
1/3/2018 16:00	-7,245		7,300						7,300	55
1/3/2018 17:00	-12,425		7,300	5,000				200	12,500	75
1/3/2018 18:00	-17,785		7,300	5,000	5,000	500			17,800	15
1/3/2018 19:00	-17,496		7,300	5,000	5,000	200			17,500	4
1/3/2018 20:00	-18,090		7,300	5,000	4,200			1,600	18,100	10
1/3/2018 21:00	-17,522		7,300	5,000	3,700			1,600	17,600	78
1/3/2018 22:00	-16,141		7,300	5,000	2,200	100		1,600	16,200	59
1/3/2018 23:00	-13,279		6,900	4,800				1,600	13,300	21
1/4/2018 0:00	-11,016			5,000	4,500			1,600	11,100	84
1/4/2018 1:00	-9,718			200	5,000	500	2,700	1,400	9,800	82
1/4/2018 2:00	-6,703				5,000	200		1,600	6,800	97
1/4/2018 3:00	-1,566							1,600	1,600	34
Total	-149,329									

NREL Energy Storage Benchmark Prices ($millions)

$/KWhr	$ 339	$ 340	$ 345	$ 396	$ 567	$ 396
Battery Total	$ 19,775	$ 13,585	$ 11,944	$ 594	$ 1,530	$ 5,072
Grand total	**$ 52,500**					

Table 7, continued: Energy Storage Estimate Based on NYISO Climate Change on Resilience Study 2050 71,859 MW Capacity

		Energy Storage Systems						
		Total (MWhr)	9,600	60,800	55,500	1,100	**Total**	**Storage**
	Deficit	**Capacity (MW)**	1,200	7,600	7,000	700	**Storage**	**Margin**
Date Time (EDT)	**MWhr**	**Duration (Hr)**	8	8	8	2	**Used**	**(MW)**
1/3/2018 16:00	-3,112		1,200		2,000		3,200	88
1/3/2018 17:00	-9,492		1,200	7,600	700		9,500	8
1/3/2018 18:00	-16,290		1,200	7,600	7,500		16,300	10
1/3/2018 19:00	-15,916		1,200	7,600	7,200		16,000	84
1/3/2018 20:00	-16,907		1,200	7,600	7,500	700	17,000	93
1/3/2018 21:00	-16,496		1,200	7,600	7,500	200	16,500	4
1/3/2018 22:00	-15,258		1,200	7,600	6,500		15,300	42
1/3/2018 23:00	-12,094		1,200	7,600	3,300		12,100	6
1/4/2018 0:00	-9,291			7,600	1,700		9,300	9
1/4/2018 1:00	-7,673				7,500	200	7,700	27
1/4/2018 2:00	-4,004				4,100		4,100	96
Total	-105,498							

NREL Energy Storage Benchmark Prices ($millions)

$/KWhr	$ 339	$ 339	$ 339	$ 436
Battery Total	$ 3,253	$ 20,587	$ 18,793	$ 479
Grand total	**$ 43,112**			

4.5 Other Feasibility Concerns

There are other issues that a feasibility study must address that are potential deal-breakers for the CLCPA goals. Gail Tverberg has described issues with the Green New Deal targets and some of her concerns are relevant to CLCPA implementation:

- Battery backup for renewables is very expensive. Because of their high cost, batteries tend to be used only for very short time periods. At a 3-day storage level, batteries do nothing to smooth out season-to-season and year-to-year variation.
- Even in sunny, warm California, it appears that substantial excess capacity needs to be added to avoid the problem of inadequate generation during the winter months, if the electrical system used is based on wind, hydroelectric, solar, and a 3-day backup battery.
- None of the researchers studying the usefulness of wind and solar have understood the need for overbuilding, or alternatively, paying backup electricity providers adequately for their services. Instead, they have assumed that the only costs involved relate to the devices themselves, plus the inverters. This approach makes wind and intermittent solar appear far more helpful than they really are.

These additional concerns underscore the importance of a detailed feasibility study. The analysis of the solar, on-shore and off-shore wind resources using historical data from the NYS Mesonet recommended in my initial comments could be used to estimate the amount of short-term energy storage needed. I had not considered the need for annual and seasonal resource availability but believe that should also be included in the NY feasibility study. Excess capacity is the theoretical solution to the cost of batteries issue but again we can only estimate how much renewable capacity is needed if we know how much renewable resources are available. It is inevitable that the full costs of providing renewable power that can be dispatched will need to be calculated to get a true estimate of meeting the CLCPA goals.

5.0 Recommendations

5.1 Feasibility Study Proposal

In my original comments I showed examples of renewable potential resource estimates based on real world data and then recommended an extensive detailed feasibility study to determine the state's renewable potential availability. I suggested that actual meteorological data be used to determine if there will be adequate resources. Additional examples in these comments underscore the importance of the feasibility analysis.

Researchers at the University at Albany Weather & Climate Enterprise recently released an assessment on what it will take for New York to reach the renewable energy goals in the Climate Leadership and Community Protection Act in a white paper entitled Toward 100 Percent Renewable Energy in New York. The white paper provides more extensive documentation on the NYS Mesonet that I recommended as the primary source of real world data. It notes that "The siting and operation of renewable energy facilities depends on accurate, representative measurements and power-production forecasts that are used to predict short-term output (minutes to days) as well as cumulative future power generation over the next 20-25 years." They note that the Atmospheric Sciences Research Center at the University of Albany faculty have been and continue to be actively involved in foundational research essential to the development of New York's renewable energy portfolio. Finally. they state: "The siting and operation of renewable energy facilities depends on accurate, representative measurements and power-production forecasts that are used to predict short-term output (minutes to days) as well as cumulative future power generation over the next 20-25 years."

I recommend that NYSERDA and NYISO work with this organization to evaluate data since the inception of the NYS Mesonet to predict how much renewable energy is available on a long-term and short-term basis. The emphasis has to be not only on the winter peak load needed when heating is electrified for the CLCPA but also periods when renewable energy resources are low. It is important that the University at Albany Weather & Climate Enterprise staff work with New York's experts on our energy system. I am not comfortable that their staff understand the unique constraints of the New York electric system to work independently.

5.2 Actual Design Year Database

Article 10 permit applications for siting new electric generating facilities greater than 25MW are required to do electric system production modeling. The production cost modeling for those analyses uses a design year approach. In order to accurately represent winter conditions, I believe it is more appropriate to develop a more representative design year for the solar energy projects. Given the level of effort necessary to prepare that information and the State's goals for renewable development I recommend that this resource adequacy proceeding recommend the development of more state-wide representative design input for use by Article Ten applicants. It is simply not fair to expect each applicant to develop the background information to do this necessary analysis.

In order to try to determine how renewable energy resources will affect the electric sector once CLCPA is implemented projected output information is necessary. I have submitted public comments on many solar energy project applications requesting that the electric system production modeling information provided in the application not be redacted, that an analysis specifically addressing the winter peak be included, and that the applicant use local meteorological data rather than a design year approach for the production modeling. The meteorological analysis needed to do the recommended feasibility study can serve as input for county-specific design year input.

I believe this is a particularly important requirement for Upstate New York in general and any areas downwind of the Great Lakes in particular. This is because the lakes create meso-scale features, most notably lake-effect snow, that can affect cloudiness many miles from the lake shore. No design year that relies on general location and estimates of average cloud cover can adequately represent what actually happens in these areas. This is needed to determine how much energy proposed facilities can provide to the system when there are high energy demands in the winter and, ultimately, how much energy storage will be needed on the system.

5.3 Cumulative Environmental Impact Study

As noted in my initial comments I think that the State Administrative Procedure Act (SAPA) and the State Environmental Quality Review Act (SEQRA) requirements for environmental reviews do not apply to the Climate Leadership and Community Protection Act. The problem is that while an individual industrial wind facility or solar facility may not have a significant environmental impact the cumulative impact of 176 square miles of utility-scale solar panels, 3,845 on-shore wind turbines, and 1,604 off-shore wind turbines certainly could have negative environmental impacts. Therefore, I recommend that the resource adequacy feasibility study include a cumulative environmental impact statement.

5.4 Dispatchability Requirement

I do not have much experience with the NYISO economic process. However, it occurs to me that something has to be done to insure reliability from intermittent wind and solar resources. I recommend that in order for a resource to get full payment of the market price that the source be dispatchable. That would mean that wind and solar facilities would have to include energy storage capability but clearly that is the equitable approach because someone, somewhere has to cover their intermittency. The simplest and most direct solution would be to require them to provide that necessary service to get full market price.

5.5 Future Stakeholder Process

Several commenters suggested that significant aspects of this proceeding should be incorporated into the NYISO process. I am opposed to that idea because the NYISO stakeholder process is not receptive to non-member participation. It was my experience that the comments I submitted on their carbon pricing initiative were never acknowledged, much less addressed in the rationale. In some instances, particularly in regards to emission reporting linkage to the Initiative's reporting recommendations, I am a subject matter expert more qualified than anyone at the NYISO. With regards to the emissions reporting my comments were well aligned with the Environmental Energy Alliance of New York. Both sets of comments were not addressed when the proposed reporting scheme was announced. While I recognize the enormity of the job, I think that all comments should be formally addressed in a summary of comments document. I cannot support the NYISO stakeholder process as a viable exclusive approach for anything in the resource adequacy proceeding.

5.6 Advocate Innovative Energy Storage Research

California has similar greenhouse gas reduction targets and has recognized that existing energy storage systems are inadequate. Given the enormous costs suggested in my analysis of energy storage I believe that, absent battery improvements, those costs may make CLCPA implementation impossible. The Proceeding should advocate for research to provide alternative energy storage systems.

In December 2019 the California Energy Commission released a solicitation (GFO-19-305) to fund innovative, non-LI-ion energy storage research projects, including green electrolytic hydrogen systems. The purpose of the solicitation is to fund innovative energy storage research projects.

The solicitation manual states:

> SB-350 (de León, Chapter 547, Statutes of 2015) and SB-100 (de León, Chapter 312, Statutes of 2018) cannot be met with currently fielded technologies alone, because they do not have the energy density, daily cycle capability, longevity, safety, and price to be viable for the diverse set of applications that will be needed in the State. SB-1369 (Skinner, Chapter 567, Statutes of 2018) identifies the need for the Energy Commission to "consider green electrolytic hydrogen an eligible form of energy storage, and shall consider other potential uses of green electrolytic hydrogen."
>
> The timing is right for supporting emerging technologies that can out-perform existing energy storage technologies because a substantial amount of the energy storage in California was installed in the last few years and will need to be upgraded or replaced in the next 7-15 years. Additionally, as the State makes changes to the electric grid to accommodate higher levels of renewables and a carbon free future by 2045, the need for cost effective and high performing energy storage solutions are expected to increase and be diversified. This means that developing new and emerging technologies now will enable them to be positioned for substantial upcoming market opportunities.
>
> This solicitation aims to fund the development and field testing of emerging energy storage technologies for the purpose of raising the Technology Readiness Level (TRL) and accelerating market penetration.
>
> - **Group 1:** Develop and validate new and emerging non-Lithium ion energy storage technologies that focus on customer side of the meter applications.
>
>   This group will focus on supporting energy storage technologies that are in the early stages of development. Group 1 will support the development and field testing of emerging and prototype energy storage systems.
> - **Group 2**: Develop and validate green electrolytic hydrogen storage systems in customer side of the meter applications with an electricity-in and electricity-out capability.

This group will focus specifically on green electrolytic hydrogen systems. Group 2 will be open to Applied Research applications of green electrolytic hydrogen as a stationary energy storage system that is comparable in performance to other stationary energy storage systems (like advanced batteries, flywheels, thermal storage, and compressed air systems). The hydrogen systems must demonstrate an electricity-in and electricity-out solution in customer side of the meter applications (not just generate electrolytic hydrogen). Additional services (such as heat, oxygen, compressed air or other non-electricity products) can be proposed as long as they have value to the customer and the primary input and output is electricity and the overall system is projected to be cost effective when it reaches the scale necessary for future commercialization.

California has similar legislation to the CLCPA. Senate Bill 350, The Clean Energy and Pollution Reduction Act, established clean energy, clean air, and greenhouse gas (GHG) reduction goals, including reducing GHG to 40 percent below 1990 levels by 2030 and to 80 percent below 1990 levels by 2050. Senate Bill 100, the 100 Percent Clean Energy Act of 2017, increases the Renewables Portfolio Standard (RPS) requirement from 50 percent by 2030 to 60 percent, and creates the policy of planning to meet all of the state's retail electricity supply with a mix of RPS-eligible and zero-carbon resources by December 31, 2045, for a total of 100 percent clean energy. Their solicitation is based on their realization that these requirements cannot be met with currently available energy storage technologies alone, because “they do not have the energy density, daily cycle capability, longevity, safety, and price to be viable for the diverse set of applications that will be needed” in California. The same problem exists in New York so this Proceeding should advocate for similar research to provide alternative energy storage systems.