Off Shore Wind Data Review NYSRC Preliminary Findings

Final Draft 6/20/2023

1.0 INTRODUCTION

This paper presents preliminary analyses performed by the NYSRC Extreme Weather Working Group on high resolution data characterizing Off Shore Wind (OSW) performance recently provided by NYISO and its weather service provider DNV. This is of particular importance given rapid transformation of the NY power system to decarbonized intermittent renewable resources including large scale off shore wind resources.

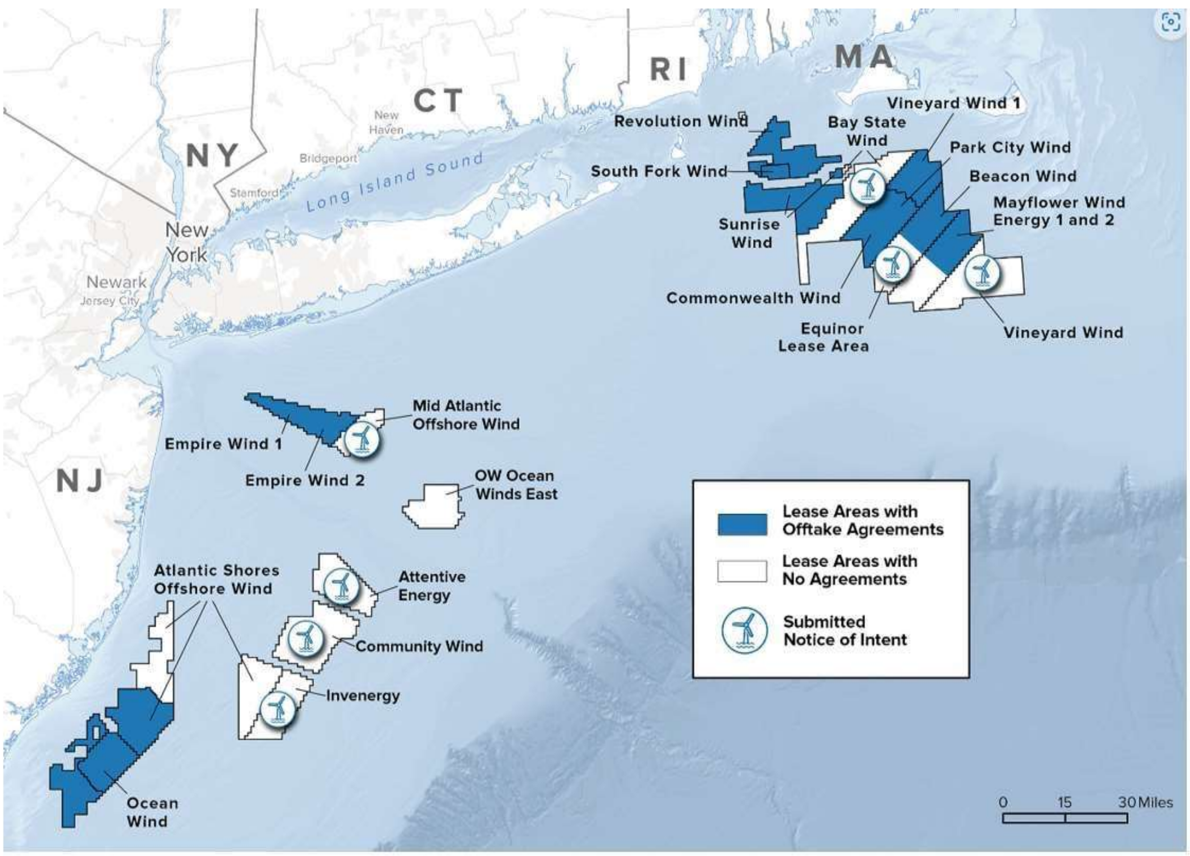
The NY Climate Leadership and Community Partnership Act (CLCPA) calls for the installation of 9,000 MW of OSW by 2035, while the CLCPA scoping plan calls for up to 18,000 MW by 2050. NYSERDA and LIPA have already contracted approximately 4,500 MW, which are under development with near term in-service dates[1]. Further NYSERDA expects to award the winner of its July 27, 2022 solicitation for at least an additional 2000 MW of OSW in spring 2023.[2]

The intent of this paper is to address OSW related aspects of NYSRC goals set forth in the Executive Committee-approved Extreme Conditions White Paper dated 7/8/22. The goal is to "identify actions to preserve NYCA reliability for extreme weather events and other extreme system conditions" and create a corresponding action plan to "evaluate the potential need for new resource adequacy and transmission planning design rules for planning the system to meet extreme weather and other extreme conditions." This paper includes recommendations designed to maintain reliable performance of the NYS electric system in the face of a changing climate. The focus of this paper is wind intermittency and the availability of OSW resources. It is envisioned additional study phases will be undertaken as further data becomes available.

[1] New York's Offshore Wind Projects - NYSERDA
[2] 2022 Solicitation - NYSERDA

2.0 <u>OFF SHORE WIND DEVELOPMENT</u>

The following figure shows areas of contracted wind resources under active development. OSW under development off the coast of downstate NY is expected to exceed 4,500 MW nameplate by the mid to late-2020s.   Further NYSERDA expects to award the winner of its July 27, 2022 solicitation for at least an additional 2000 MW of OSW in spring 2023. Ultimately the NY CLCPA calls for the installation of 9,000 MW of OSW by 2035, with the CLPCPA scoping plan envisioning up to 18,000 MW by 2050. It is noted large-scale OSW development is concentrated in the downstate NY region, which has limited transmission flexibility to withstand large output swings associated with intermittency of wind resources.[3]



3 Transmission expansion projects proposed for this region are not anticipated to be in-service prior to the 2030’s timeframe (e.g. LI PPTN).

In addition, other regions including PJM and ISONE are also contracting similarly large amounts of OSW off the coast of NJ (7.5 GW by 2035 increasing to 11.0 GW by 2040) and Rhode Island/ Massachusetts (8.0 GW by 2035), respectively. In total PJM member States have announced OSW targets totaling 24 GW by 2035, and 32.7 GW by 2040 as summarized below[4]:

		GW	GW
PJM	**State Goals**	**by 2035**	**by 2040**
NJ	7.5 GW by 2035; 11 GW by 2040	7.5	11
MD	1.568 GW by 2030; 8.5 GW by 2035	8.5	8.5
VA	5.2 GW by 2034	5.2	5.2
NC (state goal -- not all in PJM)	2.8 GW by 2030; 8 GW by 2040	2.8	8
Total announced targets for PJM member states		**24**	**32.7**
		GW	**GW**
ISO-NE	**State Goals**	**by 2035**	**by 2040**
CT	2 GW by 2030	2	2
MA	5.6 GW by 2035	5.6	5.6
RI	430 MW	0.4	0.4
Total announced targets for ISO-NE Member States		**8**	**8**

4 NREL Offshore Wind Market Report, 2022 Edition, https://www.energy.gov/sites/default/files/2022-09/offshore-wind-market-report-2022-v2.pdf; New Jersey Department of Environmental Protection, https://dep.nj.gov/offshorewind/; Maryland POWER Act, https://mgaleg.maryland.gov/2023RS/fnotes/bil_0001/sb0781.pdf

2.1 OFF SHORE WIND DATA

At the February 7, 2023 NYISO ICAP WG meeting, NYISO made available 21 years of hourly wind data at seven wind development sites, extending from New Jersey to Rhode Island, prepared by its weather service provider DNV. DNV performed analysis of wind data translating meteorological data into detailed power profiles for each site including loss considerations. DNV assumed a generic 15 MW offshore turbine design consisting of 236 m rotor diameter and 150 m hub height with turbine layout of 1 nautical-mile spacing. This is representative of the type of turbines proposed for installation in the next three to five years. DNV also performed extensive benchmarking and validation of its modeling against other data profiles to verify the veracity of the data set. In total the data provided in this file represented over one million modeled wind power observations which was made available to the NYSRC and other stakeholders in the form of a spreadsheet file. [5] NYISO is also working on an additional effort to obtain a similar data sets for terrestrial wind & solar data, etc. NYISO is targeting summer 2023 timeframe for this to be available.

[5] Installed Capacity (ICAP) Working Group - NYISO

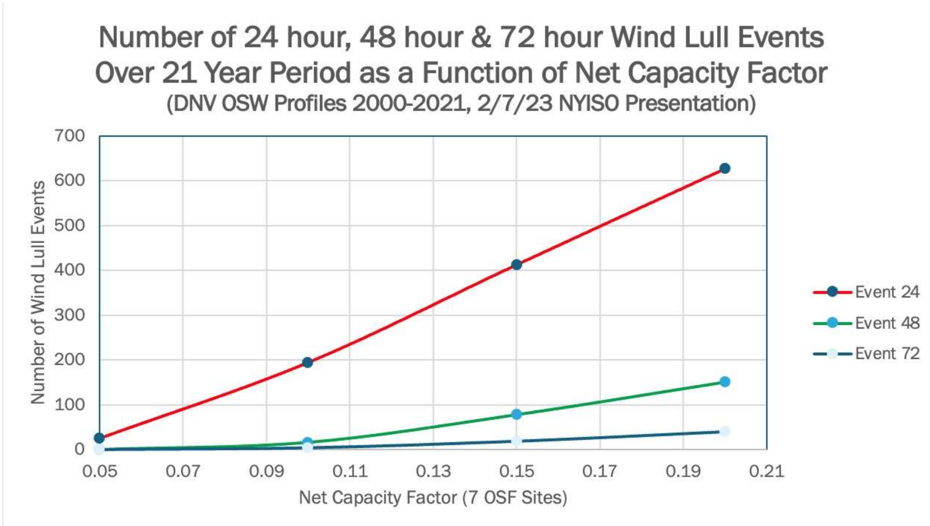
3.0 SUMMARY OF ANALYSIS AND PRELIMINARY FINDINGS

Members of the NYSRC Extreme Weather WG performed preliminary analysis of Off Shore Wind (OSW), highlighting various results which could have a significant impact on the design, operation and reliability of the NYS power system. This included frequency analysis, interregional impacts, and cursory analysis of combined wind/solar events. Analysis of this data by NYSRC Extreme Weather Working Group yielded the following significant findings.

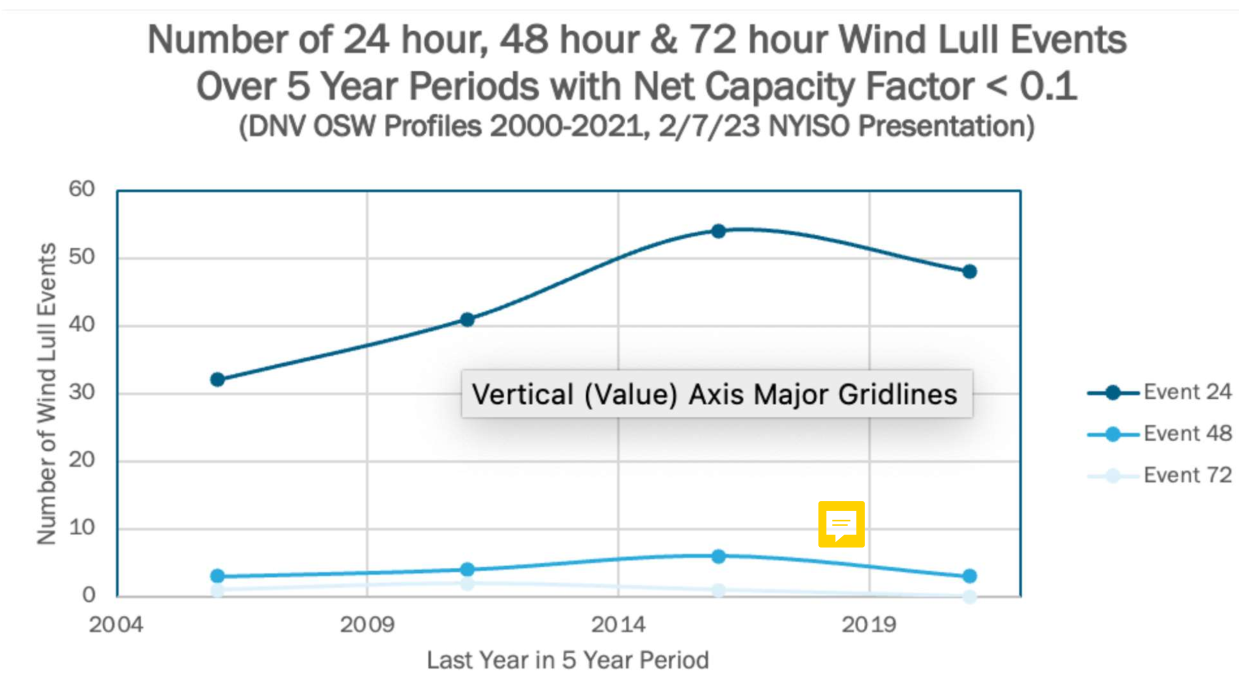
3.1 WIND LULL FREQUENCY ANALYSIS

Analysis was performed on OSW data to determine exposure to periods of reduced power output associated with wind intermittency which could impact NYCA operation and design, i.e. "wind lulls". The table below summarize the results of this analysis. As shown wind lulls, defined for the purposes of this analysis as periods of each hour of wind output of less than 5%-20% for extended periods of 24 hours or longer, occur about 30 times per year on average. Wind lulls of 48 hours or longer occur on average about seven times per year, and wind lulls of 72 hours or longer occur on average two times per year.

It is noted events which occur on average 30 times per year represent highly likely occurrences inconsistent with extreme weather characterization and which warrant normal design consideration.



The number of wind lulls varies significantly over the 21 year data studied. Dividing the DNV data into five-year tranches results in the number of 24 hour wind lull events with net capacity factor less than 10% varying from a low of about 30 to a high of 55 events. Individual annual events indicate even high volatility.[6]



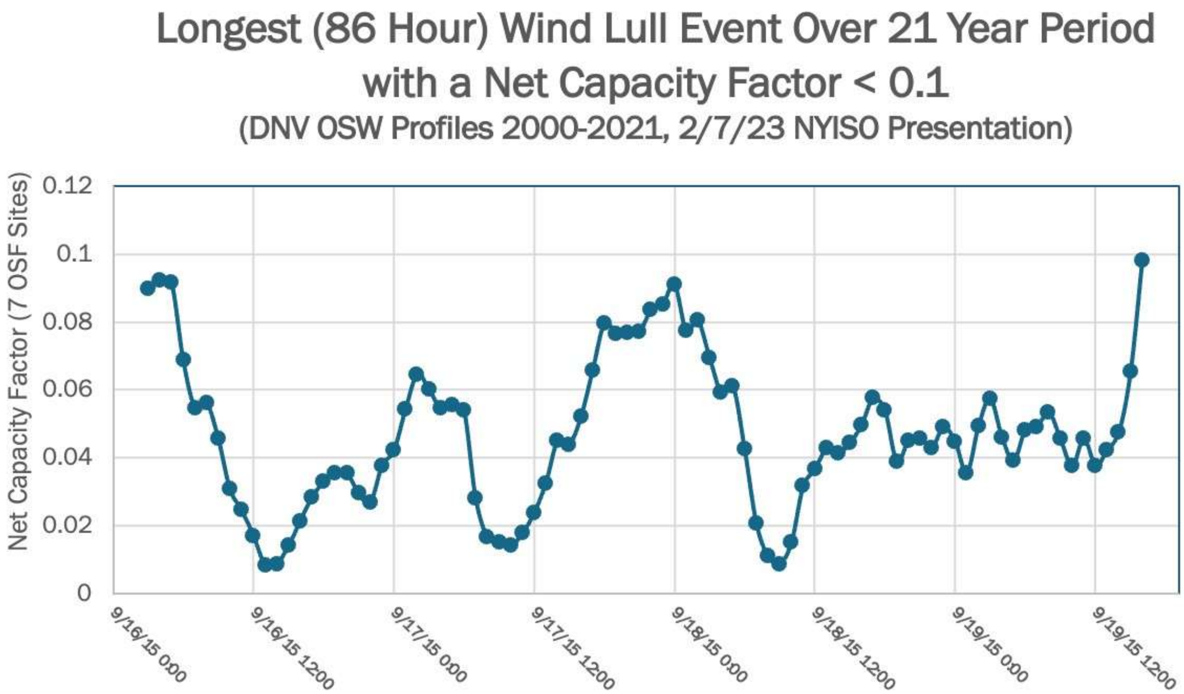
[6] NYSRC Resource Adequacy studies uses a 5 years hourly MW data for front of meter wind, solar, run of river hydro, and 5 years data for other models pertinent to LOLE calculations including thermal forced outage rates.

An analysis was also performed to determine coincident wind lulls with summer peak load periods which are particularly important relative to reliability. About 70% of these wind lulls over the 21-year period occurred during the peak four-month summer period from June to September.

Row Labels	Continuous Lull Starts
Jan	6
Feb	3
Mar	1
Apr	4
May	5
Jun	9
Jul	36
Aug	51
Sep	35
Oct	22
Nov	14
Dec	8
Grand Total	194

Lastly an analysis was performed to identify the most persistent wind lull experienced in the 20-year wind data with net capacity factor less than 10% for the entire period ***across all seven wind sites***. Analysis indicates wind lulls of up to 86 hours with an average energy output of approximately 5% net capacity factor occurring across all seven sites were observed in the DNV dataset (this compares to an average annual net capacity factor of approximately 45%). While data associated with longer periods than 21 years were not readily available it may be appropriate to characterize this as a 1/20 year extreme weather event.[7]

[7] Metrological experts on the Extreme Weather Working Group have suggested a 70 year analysis should be performed to obtain a fuller understanding of range and return period of events.



It is noted OSW under development off the coast of downstate NY is projected to exceed 4,500 MW nameplate by the mid to late-2020s. The magnitude of wind lulls observed may reduce this output by up to approximately 4,500 MW for the duration of the wind lull event. By 2035, NY plans to install 9,000 MW of OSW, which will further increase the impact of wind resources curtailed during wind lull events. This will be compounded by International Impacts discussed in Section 3.2 of this paper. It is worth noting the largest contingency currently considered by NYISO today for 10-minute operating reserves is loss of 1,310 MW.

3.2 INTERREGIONAL IMPACTS

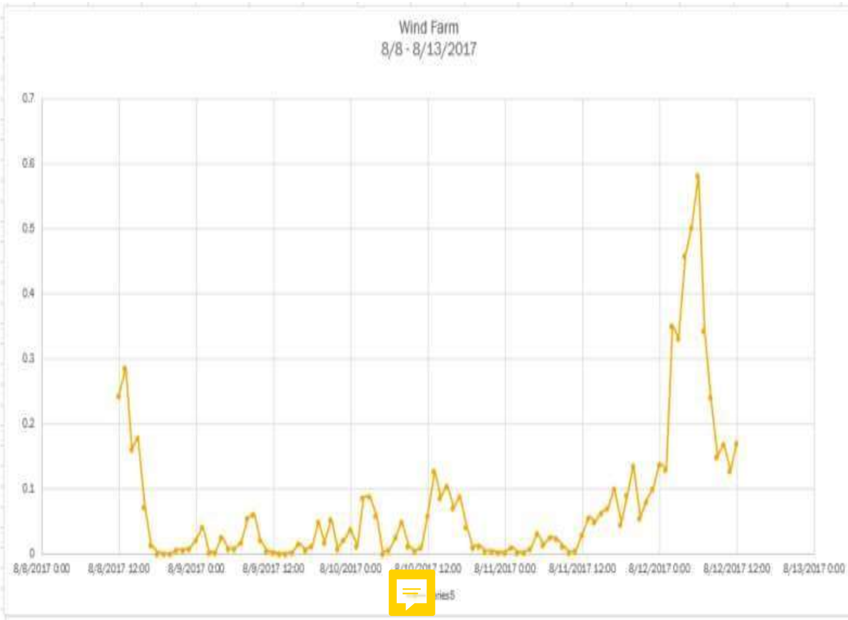
NY relies on emergency assistance from neighboring regions to achieve reliable system design, thus continued availability of surplus power from these areas is an important consideration. [8] Similar to NY, policy makers from PJM and New England are also moving forward with policies to install large scale wind power to address decarbonization and planned shutdown of thermal units, with proposals in each region also totaling tens of thousands of MW. As noted in Section 3.0, OSW off the coast of the state of New Jersey is targeted at 7.5 GW by 2035 increasing to 11.0 GW by 2040, and similarly OSW off the coast of Rhode Island/ Massachusetts is targeted at 8.0 GW by 2035. In total PJM member States have announced off shore wind targets totaling 24 GW by 2035, and 32.7 GW by 2040.

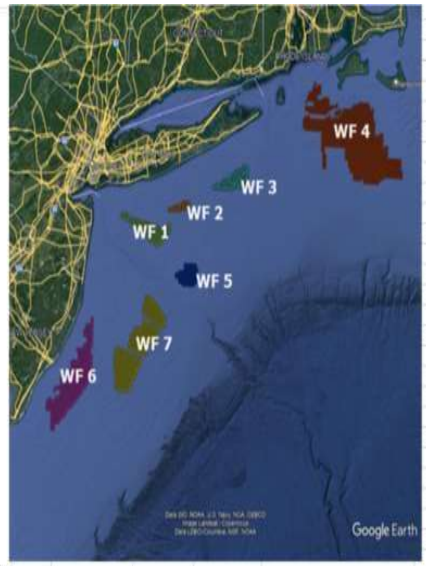
The analysis below finds wind lull events to be highly correlated interregional events extending from NJ to Rhode Island. As shown the impact of wind lulls does not respect control area boundaries and affects OSW located in PJM extending past and NY into NE simultaneous reducing OSW output for the duration of the wind lull events.

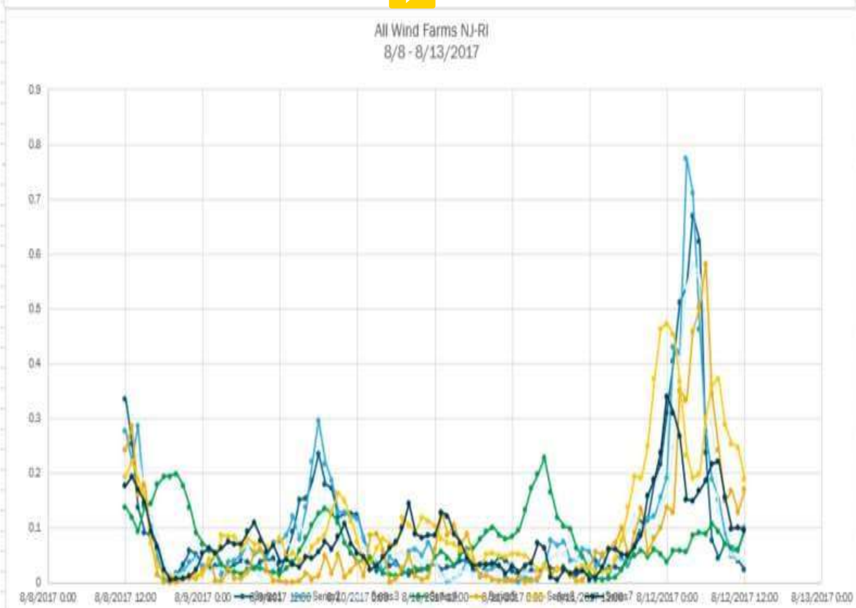
It is noted reliability of the traditional interconnected power system design relies on diversity of forced outage rates and independence of outage events. Correlation of interregional wind lulls eliminates diversity of loss of power output events associated with OSW and alters this aspect of system design.

Interregional wind lulls simultaneously impacting tens of thousands of MWs of interregional OSW located in PJM, NY and NE could reduce reserve sharing and emergency assistance available for support from neighboring control areas significantly impacting operational reliability and resource adequacy.

[8] IRM sensitivity studies show impact of isolated NYCA. Typically this adds about 8% increase in additional margin requirements.







Wind Plant Nar	Capacity (M	Turbine Cou	Sub Area
Wind Farm 1	2,100	140	New York Harbor
Wind Farm 2	390	26	Long Island Shore
Wind Farm 3	1,530	102	Long Island Shore
Wind Farm 4	16,095	1,073	Long Island East End
Wind Farm 5	1,260	84	Long Island Shore
Wind Farm 6	6,075	405	New York Harbor
Wind Farm 7	6,615	441	New York Harbor
	34,065		

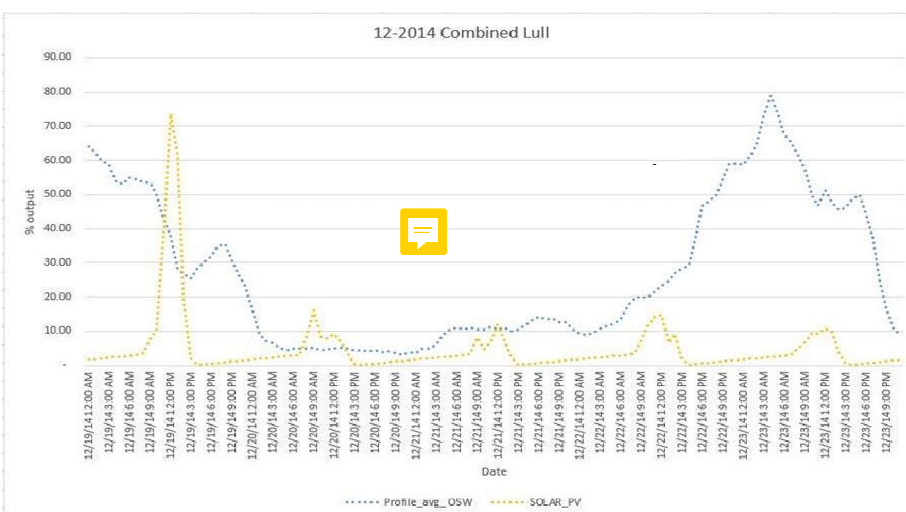
The NYISO notes that the current modeling practice for both the IRM and the reliability planning MARS models is that the wind and solar shapes are removed from the neighboring systems. Additionally, other steps are taken with the goal to limit reliance on external areas, such as: neighboring areas are set to be at a high LOLE between a 0.1 - 0.15 event-days/year range, the top three summer peak load days of the external areas are modeled as coincident with the NYCA top three peak load days; the emergency operating procedures (EOP) steps from external areas are removed; the load forecast uncertainty (LFU) is applied to neighboring systems; the same historical load years are used for external areas and NY (if there is coincidence in shapes, we capture it); implemented a statewide emergency assistance from the neighboring systems limit of 3,500 MW additional to the tie limits.

3.3 COMBINED WIND/SOLAR CORRELATED EVENTS

Another area of concern of the Extreme Weather WG is coincidence of wind lulls with other extreme weather phenomena. Previous analysis performed by the Installed Capacity Subcommittee (ICS) assessed the reliability impact of correlated land-based wind (LBW) and solar resource performance and did not identify an impact, but recommended further examination of OSW.[9] Very Preliminary findings have identified periods of simultaneous OSW wind lulls coincident with solar lulls in downstate region.

While only cursory analysis was performed into this consideration due to limited data availability the analysis below highlights one illustrative event that occurred 12/19/14 – 12/22/14. The point of this analysis is to demonstrate the possibility of combined wind and solar lull events does exist and to highlight this as an area requiring future investigation.

It is noted the CLCPA calls for the installation of 10,000 MW of solar by 2030.

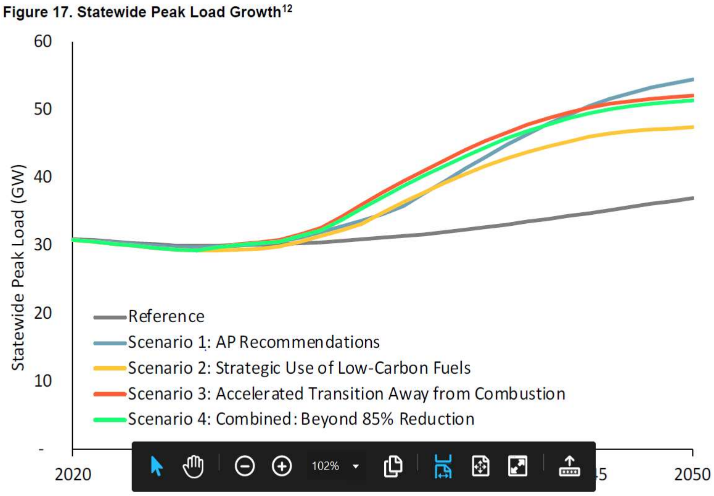


9 AI 5.2 - Intermittent Resource Correlation (1) (nysrc.org)

3.4 OTHER CONSIDERATIONS - ELECTRIFICATION

Decarbonization aspects of CLCPA reduces diversification of alternate energy sources presently in the electric sector including natural gas and petroleum and will reduce energy diversification available to society as a whole as more end uses rely upon electricity. Electrification of the NY economy is also projected to significantly increase electric load. Under CLCPA, electric load is projected to nearly double in the next 20 years, which will substantially increase societal reliance on electricity as a reliable energy source when alternate sources of energy are reduced or eliminated. [10] The 2023 NYISO Gold Book baseline load forecast similarly shows winter peak doubling by 2050 with projected winter peak load exceeding summer forecast by over 30%. Moreover the NYISO Gold book also shows under a "high demand policy scenario" projected winter peak load could triple by 2050 (approximately 25 GW to 75 GW). It is noted this represents more than twice the current NYCA peak summer load level (approximately 32 GW compared to 75 GW)[11] [12]. Mandatory time of use rates shifting load have been enacted by some utilities, notably LIPA, starting in 2024, with the intent of altering daily load cycle shapes to extend usage to traditionally non-peak hours which may reduce the impacts of electrification[13].

Figure 17. Statewide Peak Load Growth[12]



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[10] Draft Scoping Plan - New York's Climate Leadership & Community Protection Act (ny.gov)
[11] https://www.nyiso.com/documents/20142/2226333/2023-Gold-Book-Public.pdf

[12] Winter loads will become increasingly weather-dependent as the penetration of electric heat pumps expands. The NYISO is exploring how best to capture this phenomenon through the use of non-static load forecast uncertainty models in MARS.
[13] Time of Use Rate Plans (TOU) - PSEG Long Island (psegliny.com)

3.5 RESILENCY /RESOURCE ADEQUACY IMPACTS

The preliminary findings discussed in this white paper have obvious implications to the near-term reliability and resiliency of the NY power system. The current reliability procedures were developed for dispatchable generation with well understood forced outage rates with the presumption that outages are independent of each other. Increasing levels of wind and solar correlated generation are changing the paradigm. To mitigate these impacts the NYSRC has started to consider changes to maintain continued reliable operation of the NY power system. These include potential new Reliability Rules for addressing wind lulls in system design and requirements for new data reporting associated with proliferation of new intermittent renewable generation technology. Similarly discussions for considering these findings in NYSRC resource adequacy studies (i.e. NYSRC Policy 5.0) have been initiated with more to follow. There also is a longer-term resiliency concern. In addition to the primary concern regarding the correlation between high loads and low renewable resource availability, the resiliency of electric system resources is a concern particularly if there are trends towards more extreme weather events. These concerns will also be considered by the Extreme Weather WG.

The NYISO noted[14] that the current reliability planning MARS **offshore** wind models already account for a certain level of wind lull by the fact that the model reflects five years of artificial hourly MW data (*e.g.,* DNVGL, NREL-GE, etc.) until real production hourly data becomes available. Additionally, both the IRM and the reliability planning MARS models already reflect rolling five years of production hourly MW data for each **existing front-of-meter land-based wind** and **solar plant in NY**. The planning MARS models also use five years of hourly MW data to discretely model behind-the-meter solar, as forecasted in the NYISO's each Gold Book for each study year. For proposed land-based and solar plants, the nameplate normalized average of units in the same load zone is scaled by the unit's nameplate rating. During the simulations, one shape per replication is randomly selected (equal probability assigned for each of the five shapes) in the Monte Carlo process for each replication and study year; approximately 2000 replications

[14] February 2023 EWWG NYISO's presentation of the reliability planning models assumptions: https://www.nysrc.org/PDF/MeetingMaterial/EWWG%20Meeting%20Material/EWWG%20Agenda%203/ResourcePlanning-MARS-ModelsOverview-Feb27EWWG-v3.pdf

are simulated for each study year in order to determine the NYCA LOLE (event-days/year), which is compared with the NYSRC and NPCC criterion of 0.1 event-days/year to determine whether there are actionable Reliability Needs. These models were and continue to be used for the 2022 Reliability Needs Assessment - 2022 RNA[15] - and Short Term Assessment of Reliability - STAR[16]. Between the bi-annual RNA and the quarterly STARs, the NYISO reliability planning team evaluates 10 future study years. These models also inform other planning, markets and operations processes at the NYISO and externally.

[15] 2022 RNA Report: https://www.nyiso.com/documents/20142/2248793/2022-RNA-Report.pdf
2022 RNA Appendices: https://www.nyiso.com/documents/20142/34651464/2022-RNA-Appendices.pdf

[16] 2023 Q1 STAR: https://www.nyiso.com/documents/20142/16004172/2023-Q1-STAR-Report-Final.pdf

4.0 NEXT STEPS

The results of this analysis suggest it is important to continue to conduct additional studies to identify correlations among decarbonized sources such as OSW, terrestrial wind, solar, and electric demand. This is important to ensure sufficient backup to address wind lulls and other correlated loss of supply events as the renewable energy rapidly increases as a portion of the overall energy mix. More detailed analysis is required to understand what other features of a renewable-dominated electrical grid will need to be present to guarantee sufficiency to meet expected demand at all times.

At the April 28, 2023 Extreme Weather meeting the NYISO indicated it is working with its weather service provider DNV to provide data sets describing hourly input terrestrial wind, solar, and electric demand to perform additional analysis. This data is projected to become available during the summer 2023 period.

5.0 SUMMARY

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

The NYSRC will support NYISO and NYS in conducting these near-term investigations and in taking associated actions to maintain the reliability of the NY power system.