High Intermittent Renewable Resource Analysis – White Paper -- Phase 3

Scope and Problem Statement

The NYSRC Executive Committee ("EC") is committed to understanding the impacts on electric system reliability of the addition of high levels of renewable resources to the New York grid. As such, the EC has requested that the Installed Capacity Subcommittee ("ICS"), with the support of the New York Independent System Operator ("NYISO"), prepare a Phase 3 High Intermittent Renewable Resource analysis based on Climate Leadership and Community Protection Act ("CLCPA") 2030 requirements to evaluate impacts on the IRM of a future New York Control Area ("NYCA") system. The electricity-sector related 2030 requirements of the CLCPA[1] include:

- 70% Renewable Energy by 2030
- 6 GW of Energy Storage Resources[2]
- Approaching 9 GW of offshore wind (2035 target)
- 10 GW of photovoltaic solar ("PV")[3]

The Phase 1[4] and Phase 2[5] studies also recommended that the NYSRC conduct periodic studies to consider future developments regarding intermittent resources. Additionally, future studies were recommended to evaluate substantial Energy Storage Resources ("ESR") that were not evaluated previously. Accordingly, this analysis is intended to provide understanding of these potential impacts on the Installed Capacity Requirement Margin ("IRM") and Minimum Locational Installed Capacity Requirements ("LCRs").[6] This memo aims to outline assumptions that can be utilized for such a further study.

The EC is also interested in understanding the impacts of the New York State Department of Environmental Conservation's regulation to limit nitrogen oxides emissions, also known as the "Peaker Rule.[7]" This regulation will affect the availability of generation capability in the lower Hudson Valley, New York City, and Long Island. As such, the EC directed ICS to include an evaluation of the impacts that the unavailability of the units subject to this rule will have on the IRM and LCRs for the Zones G-J, Zone J and Zone K.

[1] https://climate.ny.gov/

[2] https://www.governor.ny.gov/sites/default/files/2022-01/2022StateoftheStateBook.pdf

[3] https://www.governor.ny.gov/news/governor-hochul-announces-expanded-ny-sun-program-achieve-least-10gigawatts-solar-energy-2030

[4] https://www.nysrc.org/PDF/Reports/HR%20White%20Paper%20-%20Final%204-9-20.pdf

[5] https://www.nysrc.org/PDF/Reports/IRM%20White%20Papers/High%20Renewable%20Phase%202%20Summary%20FINAL_5_21.pdf

[6] The term 'locational capacity factors' used here is identified in the IRM Study Report as the 'preliminary LCRs' and is based on the Tan45 methodology. The NYISO establishes final LCRs using other methods.

[7] https://www.dec.ny.gov/regulations/116131.html

Study Overview

The NYISO conducted the Phase 3 study in three parts.

Part 1 takes the New York electric system as assumed in the NYSRC 2022 IRM Study Final Base Case ("FBC") and increases renewable capacity by a hypothetical 27,000 MW (9,000 each of front-of-meter (FTM, or utility scale solar PV), onshore wind, and offshore wind). This set of assumptions meets the 2030 ESR requirements, the 2035 offshore wind requirements, and approaches the 2030 PV solar goal.

Part 2 takes the case from Part 1 described above (the 2022 FBC + 27,000 MW renewable capacity) and increase energy storage resources ("ESR") by a hypothetical 6,000 MW.

Part 3 is developed based on Part 2 and adds deactivation of the generation units that will be unavailable starting in the summers of 2023 and 2025 due to the Peaker Rule (approximately 1,600 MW ICAP).

Methodology

The NYISO uses the 2022 IRM Study Final Base Case assumptions, which satisfy the LOLE criterion that the probability of an unplanned disconnection of firm load due to resource deficiencies is, on average, no more than 0.1 days per year. The analysis assumes 9,000 MW each of onshore wind, offshore wind and FTM PV resources, for a total of 27,000 MW, and 6,000 MW of ESR. A total of 1,609.8 MW of thermal generation affected by the DEC Peaker Rule will be subtracted from this case. The hypothetical renewable resources will be added in a manner consistent with the previous high renewable studies. The ESR capacity is modeled with a 4-hour duration, from HB16 through HB19, consistent with the ICS' "Energy Storage Resource Modeling Whitepaper." [8]

The three parts of the Phase 3 study were developed without capturing the impacts of transmission constraints. It is important to note that, by removing transmission constraints on the system, there are no longer trade-offs between Zone J/K and the rest of the system. Therefore, all the results in Phase 3 study are based on parametric comparisons.

Location

The locations of Installed Capacity ("ICAP") placement for both FTM PV and onshore wind units are based on the projections of wind and solar installation represented in the 70x30 renewable mix assumptions for the NYISO 2021-2030 Comprehensive Reliability Plan

[8] https://www.nysrc.org/PDF/Reports/IRM%20White%20Papers/Energy%20Storage%20Whitepaper.pdf

Appendices.[9] These projections are scaled on a zonal basis to the requisite 9,000 MW for each resource type. The placements of offshore wind capacity are split between Zones J and K, with two-thirds of capacity in Zone J and one-third in Zone K. ESR Capacity is distributed proportionally with respect to renewable ICAP by zone. The Zonal ICAP values by resources represented in this sensitivity analysis are provided in Table 1.

Table 1–ICAP added to FBC Assumptions by Resource Type (MW)

Zone	Solar PV	On-Shore	Off-Shore	Renewable Total	ESR	Total Additions
A	2632.9	2345.1		*4978.0*	1106.2	6084.222
B	300.0	322.1		*622.1*	138.2	760.3444
C	1642.6	2473.4		*4116.0*	914.7	5030.667
D		1807.6		*1807.6*	401.7	2209.289
E	1037.8	2051.8		*3089.6*	686.6	3776.178
F	2133.9			*2133.9*	474.2	2608.1
G	1207.1			*1207.1*	268.2	1475.344
H				*0.0*		
I				*0.0*		
J			6000.0	*6000.0*	1333.3	7333.333
K	45.7		3000.0	*3045.7*	676.8	3722.522
Total	**9000.0**	**9000.0**	**9000.0**	***27000.0***	**6000.0**	**33000.0**

These additions are modeled as renewable resources and ESR ICAP resources incremental to those represented in the FBC, provided in Table 2. The current system contains 214 MW of utility scale solar PV resources and no offshore wind resources.

[9] https://www.nyiso.com/documents/20142/26735166/2021-2030-Comprehensive-Reliability-Plan-Appendices.pdf/3cac252d-7eee-87e7-441c-f039c7730fcf

Table 2 – Existing Renewable ICAP in FBC by Resource Type (MW)

Zone	Solar PV	On-Shore	Off-Shore	Renewable Total	ESR	Total ICAP
A		304.9		*304.9*		304.9
B		0.0		*0.0*		0.0
C		512.8		*512.8*		512.8
D		678.4		*678.4*		678.4
E		521.4		*521.4*		521.4
F	160.0			*160.0*		160.0
G				*0.0*		0.0
H				*0.0*		0.0
I				*0.0*		0.0
J				*0.0*		0.0
K	54.4			*54.4*		54.4
Total	**214.4**	**2017.5**	**0.0**	*2231.9*	**0.0**	**2231.9**

The retirement of the peaker units is based on the DEC Peaker Rules assumptions as represented in the NYISO 2021 Q4 Short-Term Assessment of Reliability[10]. Table 3 represents the ICAP retired on a zonal basis.

Table 3 – Peaker Rule Retirement Capacity by Zone (MW)

Zone	Total[11] ICAP
G	37.7
J	1,412.5
K	116.6
Total	**1,566.8**

[10]https://www.nyiso.com/documents/20142/25620932/03%202021%20Q4%20STAR%20Key%20Study%20Assumptions.pdf

[11] The total ICAP in Table 3 is not identical to that in the Q4 STAR assumptions because two of the units in those assumptions were already excluded from the 2020 FBC.

Figures 1 and 2 provides a comparison of the installed capacity mixes by fuel type for both the 2022 IRM study FBC and high renewable resources scenarios.

Figure 1: High Renewable Study ICAP Mix Comparison by Fuel

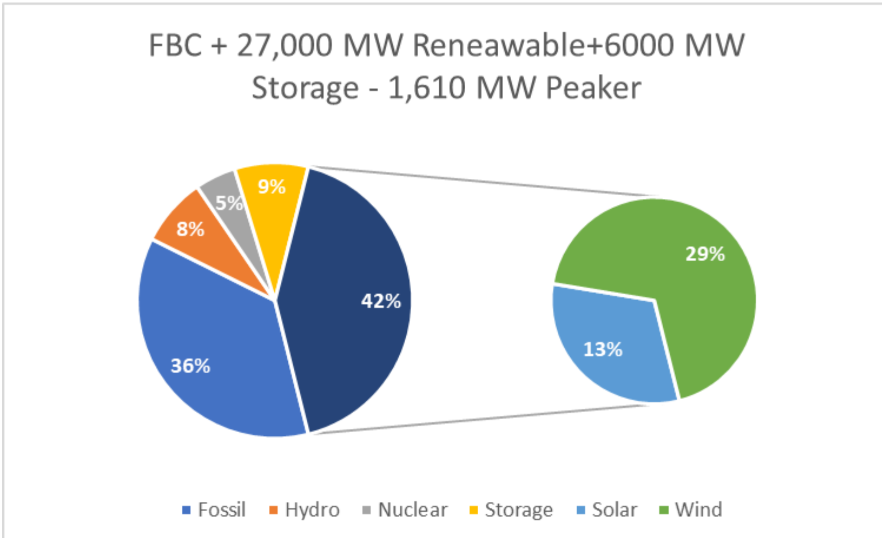
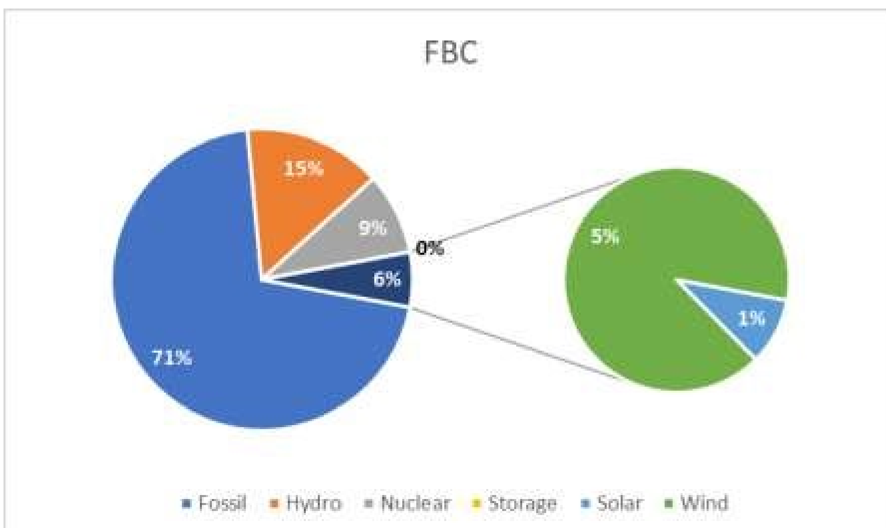


Figure 2: FBC ICAP Mix Comparison by Fuel



Study Results

Parts 1, 2, and 3 of this Phase 3 high renewables case yielded Installed Reserve Margins (IRM) of 80.2%, 98.5%, and 98.8%, respectively.

Included in this analysis is a metric called the Unforced Capacity Reserve Margin, or URM. This value is the IRM translated to an UCAP basis considering the NYCA-wide forced outage ratings, based on the average of all capacity suppliers' forced outage ratings. For example, the forced outage rate is based on five-year performance data. The URM is defined as such:

$$URM = \frac{UCAP_{@0.1\ LOLE}}{Peak\ Load}$$

In comparison to the results of the FBC*[12], Part 1 of the High Renewable Phase 3 study yields a significantly higher IRM, and a sizably higher URM.

Table 4 – Results Comparison

Case and Scenarios	**2022 FBC**	**2022 FBC***	**Phase 3 Part 1**	**Phase 3 Part 2**	**Phase 3 Part 3**
Resource Changes	N/A	N/A	FBC* + 27,000 MW Renewables	Part 1 + 6,000 MW ESR	Part 2 - 1,567 MW Peakers
Transmission Constraints	Included	Removed	Removed	Removed	Removed
Installed Capacity Reserve Margin Comparison					
NYCA	119.7%	117.0%	180.2%	198.5%	198.8%
Unforced Capacity Reserve Margin (URM) Comparison					
NYCA	105.0%	102.7%	112.3%	125.3%	125.0%

Table 5 shows five related ICAP and UCAP metrics for NYCA, while Table 6 shows the deltas for those metrics.

[12] FBC* is the 2022 FBC without transmission constrains

Table 5 – ICAP and UCAP Changes Comparison

NYCA	FBC	FBC*	Part 1	Part 2	Part 3
NYCA Peak Load	32,139	32,139	32,139	32,139	32,139
ICAP Changes					
As Found ICAP (MW)[13]	41,037	41,037	68,037	74,037	72,470
ICAP @ LOLE = 0.1 (MW)	38,470	37,614	57,903	63,781	63,906
ICAP Removed (MW)	2,567	3,423	10,135	10,256	8,564
ICAP Reserve Margin	119.7%	117.0%	180.2%	198.5%	198.8%
UCAP Changes					
As Found UCAP (MW)	36,084	36,084	42,938	47,256	46,035
UCAP @ LOLE = 0.1 (MW)	33,746	33,017	36,081	40,255	40,188
UCAP Removed (MW)	2,338	3,067	6,857	7,001	5,847
UCAP Reserve Margin	105.0%	102.7%	112.3%	125.3%	125.0%

Table 6 – ICAP and UCAP Changes Delta Comparison

DELTAS	FBC* - FBC	Part 1 - FBC *	Part 2 - Part 1	Part 3 - Part 2
ICAP Changes				
As Found UCAP (MW)	0	27,000	6,000	-1,567
ICAP @ LOLE = 0.1 (MW)	-856	20,289	5,878	125
ICAP Removed (MW)	856	6,712	122	-1,692
ICAP Reserve Margin	-2.7%	63.1%	18.3%	0.4%
UCAP Changes				
As Found UCAP (MW)	0	6,854	4,318	
UCAP @ LOLE = 0.1 (MW)	-729	3,065	4,174	-67
UCAP Removed (MW)	729	3,789	144	-1,154
UCAP Reserve Margin	-2.3%	9.5%	13.0%	-0.2%

Conclusions

The NYSRC Executive Committee requested that the ICS, with the support of the NYISO, perform an analysis of the potential impact on the IRM from a hypothetical case in which the NYCA has a high immediate penetration of intermittent renewable resources, a high immediate penetration of ESRs, and immediate deactivations during the period May 2022 through April 2023 (2022 Capability Year). The results must be interpreted in qualitative terms because,

[13] "As found" here refers to the sum of subtotal capacity of all internal NYCA generating units, contracts and net capacity imports with external control areas, and capacity associated with special care resources

among other reasons, the conditions at the time 27,000 MW of renewable resources, 6,000 MW ESR, and approximately 1,600 MW lesser fossil units have been included to the system will not be the same as the current system, the distribution of such resources will be different and the impact of additional retirements of existing resources were not considered. With this caveat, the analysis concluded:

For Part 1:

- When increasing the penetration of renewable resources, the ICAP required to maintain the system LOLE at the 0.1 criterion increases. This result is largely driven by lower availability of intermittent resources compared to the average resources on the system.
- Similarly, the required UCAP for the NYCA also increases with higher penetration of renewable resources, albeit at a significantly lesser slope than that of the IRM.

For Part 2[14]:

- When adding significant amount of ESRs to the system, the ICAP and UCAP required to maintain the system LOLE at the 0.1 criterion increases.
- The sizeable increases in the IRM and URM suggest that a portion of the added ESRs is still needed for system at criterion, indicating that the modeled ESRs have lower-than-expected effectiveness in addressing system LOLE.
- The inclusion of a significant amount of ESRs on a system model that is still comprised with a majority of traditional, high availability, dispatchable resources may have a different impact than when modeled on a system that is more heavily intermittent
- Predetermined output profiles do not have capabilities to model significant amount of ESRs. Output profiles with coincident output and charging periods across all ESR units are not appropriate. Developing multiple output profiles with different output and charging periods would require arbitrary assumptions on the differences in the ESRs operating behavior.
- While there is no immediate need for the IRM to model significant amount of ESRs, penetration of ESRs is expected to increase gradually. In the near term, the ELR functionality in MARS developed by GE has the capability to model a moderate amount of ESRs. The functionality was tested in NYSRC's the Energy Limited Resources whitepaper and had demonstrated that with a small storage unit (Test Unit A), the ELR functionality with an output window limitation showed better performance compared to predetermined output profiles (test cases TC-1c and TC-1d) [15]. This functionality will require model enhancement with higher penetration of ELR resources, which is also noted in the whitepaper.

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[14] Part 2 Results were discussed in detail at the June 1, 2022 Installed Capacity Subcommittee meeting. *See,* ICS 6/1 Meeting Presentation: https://www.nysrc.org/PDF/MeetingMaterial/ICSMeetingMaterial/ICS%20Agenda%20261/A.I.%207.0%20-%20High%20Renewable%20Phase%203%20Part%202%20Results[4947].pdf

[15] NYSRC White Paper on Energy Limited Resources Modeling: https://nysrc.org/PDF/Reports/IRM%20White%20Papers/ELR%20Modeling%20White%20Paper%20May%202021%20FINAL.pdf.

For Part 3:

- Results of Part 3 should be considered with caution as the modeling issues of ESRs in Part 2 continues to impact results in Part 3.
- When including the deactivation of the generation units that will be unavailable starting in the summers of 2023 and 2025 due to the Peaker Rule, the ICAP required to maintain the system LOLE at the 0.1 criterion increases slightly. This result differs from the previous 2 parts because for this case, the as-found ICAP decreases while the ICAP required to maintain the LOLE criterion increases. The trend of this result is expected as the deactivations increase the NYCA average unavailability.
- Similarly, the required UCAP for the NYCA also slightly increases with the deactivations.

Recommendations

1. Future studies are recommended to develop an enhanced ESR modeling approach using the MARS functionality. It is also recommended that the ongoing work to further enhance the GE MARS ELR functionality continue recognizing the need to develop a modeling approach and tools for high penetration of ESRs, considering both the flexibility of output necessary to meet demand and the charging requirements of these resources
2. It is recommended that in future studies, any fossil fuel retirements occur before the inclusion of ESRs

It is recommended that the impact of additional renewable and intermittent resources on external areas LOLE's be investigatedAppendix – Additional Items for Futher Considerations

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Given the uncertainty with the future system and policy directions, the system evolution may impact the assumptions used in the analysis, such as:

- Updated load shapes reflecting different load patterns
- Generation assumptions reflecting constraints and unavailability during winter season
- Increasing generation fleet changes due to State policy on fossil fuel retirement
- Correlated unavailability of weather-dependent resources and extreme weather scenarios