Resource Production Correlation White Paper

New York State Reliability Council

Installed Capacity Subcommittee

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Introduction

As the grid evolves, intermittent resources will take up an increasing share of the supply mix required to maintain a reliable and cost effective grid. These resources may include renewable weather-dependent resources such as front-of-the-meter ("FTM") solar photovoltaic ("PV"), onshore wind, and offshore wind, and other intermittent resources such as run-of-river hydro and landfill gas. The New York State Reliability Council ("NYSRC") Executive Committee is committed to understanding the impact of high renewable resources penetration on the reliability of the New York bulk power system. As a part of that commitment, the NYSRC Installed Capacity Subcommittee ("ICS") expressed interest in evaluating the degree to which intermittent, and especially weather-dependent, resource production correlates over a coincident period to determine how these correlations affect New York bulk power system reliability.

This study tests the correlation of onshore wind, FTM solar PV, landfill gas, and run-of-river hydro to determine whether correlation exists and, if so, whether such correlation is important to model in the IRM Study. This comparison focuses on the 2014 – 2018 period based on data availability.

Separately, this study evaluates the correlation of onshore wind production data (*i.e.,* NYISO billing-quality meter data) and offshore wind production, as determined for the High Renewable Whitepaper. This comparison focuses on the 2012 period based on data availability.

Background

To model intermittent resources, the NYISO uses historical and modeled "shapes[1]". Solar PV, onshore wind, run-of-river hydro, and landfill gas production "shapes" draw from historical production data. For each of these resources, there are shapes for each calendar year in the period 2014-2018.

The GE MARS program, for each iteration, will pick a shape year for each resource. In previous IRM studies, the NYISO did not apply coincidence between resources. That means, for example, MARS could have picked the 2014 shape for solar PV, 2018 for onshore wind, and 2016 for run-of-river hydro.

For offshore wind, due to a lack of historical data, the NYISO utilizes modeled data. There is a shape for each calendar year in the period 2007-2012.

[1] A "shape" is a hourly profile of production in MW over the course of a year; 8,760 data point for each hour.

Methodology

The purpose of this study is to:

1) force coincidence between land-based intermittent resources and measure the effect on the New York's bulk power system reliability, and
2) investigate patterns of low production hours between onshore and offshore wind

Solar PV, Onshore Wind, Run-of-river Hydro, and Landfill Gas

The NYISO began the evaluation using the 2020 IRM Technical Study Final Base Case ("FBC"), which satisfies the loss of load expectation ("LOLE") criterion of 0.1 as discussed in the 2020-2021 IRM report[2]. The FBC, in which none of the intermittent resources are correlated, was used as a control. The second case modified the base case such that solar PV and onshore wind were correlated. This means that for each of the years between 2014 and 2018, solar PV and onshore wind shapes were guaranteed to have the same shape year picked for each iteration (*i.e.,* if MARS picked 2016 wind, it would be also pick 2016 solar). The third case modified the second one such that solar PV, onshore wind and run-of-river hydro were correlated. The final case modified the third case such that solar PV, onshore wind, run-of-river hydro, and landfill gas were correlated. The NYISO recorded the New York Balancing Area ("NYBA") LOLE for each of these four cases, as well any changes in capacity requirements from the FBC.

Onshore and Offshore Wind

The offshore wind shapes cover the period 2007-2012, which does not overlap with the period for which there is data for other resources. Therefore, the same analysis could not be performed to determine correlation between onshore and offshore wind. However, the NYISO does have 2012 historical onshore wind data, which enabled two approaches to happen.

The first approach was a comparison of hourly deltas for each of the onshore and offshore 2012 shapes. This allowed the NYISO to observe whether production patterns matched (*i.e.,* if onshore wind decreased over a certain period, was a decrease observed in the offshore wind shape over the same period?).

The second approach was to record both the 50 lowest recorded production hours and the 100 lowest recorded production hours for both 2012 shapes, and see if there was any overlap between those sets of hours.

[2] http://nysrc.org/PDF/Reports/2020%20IRM%20Study%20Body%20Final%2012-9-19.pdf

Results

Solar PV, Onshore Wind, Run-of-river Hydro, and Landfill Gas

Case	NYBA LOLE	IRM	Zone J	Zone K	G-J Locality
FBC, no coincidence	0.100	18.9%	83.4%	101.8%	98.0%
Wind & Solar PV coincidence	0.100	18.9%	83.4%	101.8%	98.0%
Wind, PV& RoR coincidence	0.100	18.9%	83.4%	101.8%	98.0%
Wind, PV, RoR & LFGcoincidence	0.100	18.9%	83.4%	101.8%	98.0%

Each of the three runs in which resources are correlated yielded no significant changes in New York Balancing Area (NYBA) LOLE, and no changes in capacity requirements.

Onshore and Offshore Wind

Of the lowest 50 hours of production for both 2012 onshore and 2012 offshore wind, only one hour coincided for both (August 24, @ HB11). If we expand that criteria to days in which the 50 hours of lowest production occur, then there are three days of coincidence (August 9, August 24, and November 27).

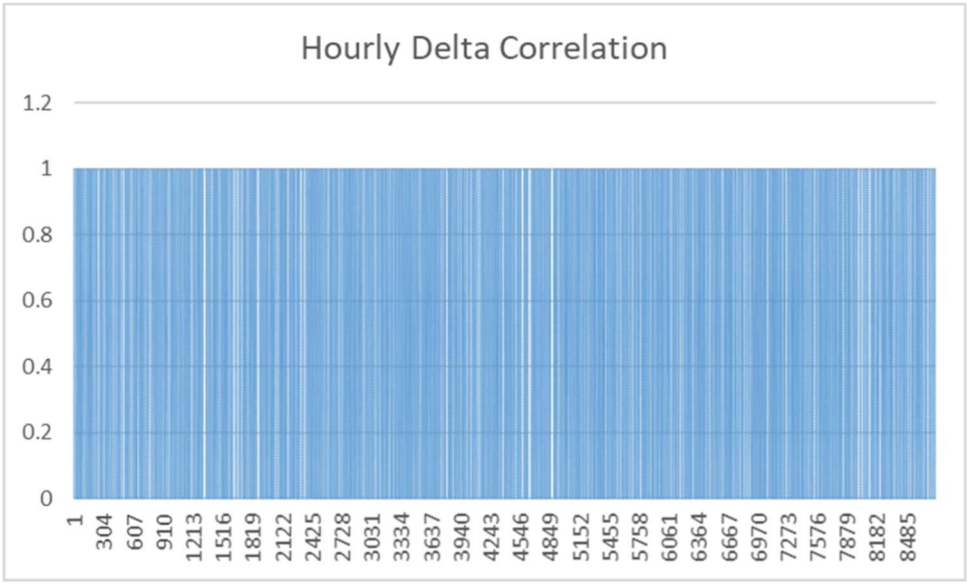
Further, the table below shows average, maximum, and minimum hourly capacity factors during the lowest 100 hours of offshore wind output in 2012. The same metrics are reported for on-shore wind during those same 100 hours (for example, if off-shore output was lowest during the 30th – 130th hours of the year, on-shore wind metrics are calculated for the 30th through 130th hours of the year; the actual lowest offshore wind hours were dispersed throughout the year).

100 Lowest Production Hour Comparison	Average Capacity Factor	Max Capacity Factor	Min Capacity factor
2012 offshore	0%	0%	0%
2012-onshore	17%	88%	0%

The lowest 100 offshore wind hours in 2012 have nearly zero offshore wind generation. On-shore wind output during the same hours at less than 20% of its ICAP value.

With regard to the comparison of hourly deltas, the chart below shows how often the direction of the deltas between both shapes coincided over the 8760 hour period. When the directions of the delta matched (i.e. both onshore and offshore wind increased from hour n to hour n+1 or both onshore and offshore wind decreased from hour n to hour n+1), the chart returns a 1. When the delta directions do not

match (i.e. onshore wind increased while offshore wind decreased from hour n to hour n+1, or onshore wind decreased while offshore wind increased from hour n to hour n+1), the chart returns a 0.



As evidenced in the above chart, onshore and offshore wind shapes spend a fair amount of time both moving in the same direction (51% of the time) and moving in the opposite direction (49% of the time).

Neither comparison between onshore and offshore wind yielded any significant correlation patterns.

Recommendations

Forcing MARS to pick the same years for each of these resources has an insignificant effect on NYBA LOLE and no effect on capacity requirements. To reiterate, this project sought to determine the degree to which these resources are correlated, and how that correlation affects NY bulk power system reliability.

With regard to that scope, both the correlation and its effect on reliability are negligible. However, as New York State law and policy mandates substantial buildouts of both wind and solar resources, it will be important to monitor the effect that the coincidence of those resources has on reliability. Therefore, the NYISO recommends that the 2021 IRM adopt the practice of correlating FTM solar PV and onshore wind data.

In terms of onshore and offshore wind, the NYISO's study suggests that there is limited correlation between the two resources that was not already captured in the High Renewable Whitepaper. . However, as with solar, there will be substantial buildout of these two resource types in the coming future. Accordingly, the NYISO recommends that as more offshore wind data becomes available, the IRM study should adopt methods to examine the correlation of these two resources.