BTM Solar Modeling Whitepaper

Abstract

In the current Installed Reserve Margin (IRM) study process, the estimated behind-the-meter (BTM) solar energy reduction is embedded in the load shape before being utilized in the study. This current modeling subjects the BTM solar impact to Load Forecast Uncertainty (LFU) multipliers applied to load, while other renewable resources are represented as supply resources with random selection among the most recent 5 years of historical profiles for each of the LFU bins. This difference in modeling may result in less uncertainty from BTM solar being reflected in the simulation as compared to other similar supply resources. In addition, with the expectation of increasing BTM solar penetration over time, monitoring and quantifying the impact of BTM solar resources in the IRM model is of increasing importance. By modeling BTM solar explicitly as a supply resource, the impact of BTM solar is reflected consistently with similar supply resources, and the evolving impact of BTM solar on the New York Control Area (NYCA) system becomes more directly measurable.

Modeling BTM solar explicitly as a supply resource involves both load-side and supply-side modeling adjustments. For this whitepaper, the NYISO's 2024 Load & Capacity Data report (Gold Book) was used to develop the hourly profiles for BTM solar production for each zone. During the research, a limitation with the current IRM load shape adjustment process was identified. While the current load shape adjustment process is not impacted by the recommended changes to the BTM solar modeling, the current process may distort the impact. Therefore, enhancement of the load shape adjustment process is recommended before (or in conjunction with) modeling BTM solar as a supply resource in the IRM base case. Modeling BTM solar as a supply resource and enhancing the load shape adjustment process should be considered as a complete package to be implemented with the explicit modeling of BTM solar as a supply resource.

With future enhancements to the load shape adjustment process, it is recommended that the modeling of BTM solar as a supply resource be effectuated using negative Demand Side Management (DSM) profiles for the load-side modeling in conjunction with 5-year historical BTM solar production profiles. An impact assessment conducted with Tan45 methodology demonstrated a 1.05% increase to the IRM from the approved 2025-2026 IRM Preliminary Base Case (PBC), as well as increases to the Tan45-determined locational capacity requirements (LCRs). In addition, both the Loss of Load Hours (LOLH) and Expected Unserved Energy (EUE) also increased with the recommended BTM solar modeling. The observed increase is due to the probabilistic nature of the recommended BTM solar modeling construct which increases randomness and uncertainty in the model.

1. Background

In the current IRM study, the load modeling is based on the 2013, 2017, and 2018 historical representative load shapes, as recommended in LFU Phase 2 study.[1] During the years of 2013, 2017 and 2018, BTM solar was already present on the system. These historical representative load

[1] Load Forecast Uncertainty (LFU) Phase 2 Study – Updated Load Shape Recommendation: https://www.nyiso.com/documents/20142/29418084/07%20LFU%20Phase%202_Recommendation.pdf/8c95bef1-8091-3a3e-8990-f5534b53024a

shapes have embedded the impact from BTM solar at the penetration levels for the respective years. During annual the IRM study process, the historical load shapes are adjusted to reflect the impact of the increased penetration of BTM solar expected in the study year as compared to respective historical level. In other words, to develop the load shapes for the 2025–2026 Capability Year, the historical load shapes, which would reflect the historical BTM solar penetration level, are adjusted deterministically to reflect the expected installed capacity penetration of BTM solar in year 2025. Therefore, the underlying load shapes used in the IRM study embed the impact from the expected penetration of BTM solar.

Each year, a peak load forecast is developed for the IRM study and the underlying load shapes are adjusted to reflect the forecasted peak load. Similar treatment is applied to the peak load forecast, by reflecting the expected peak demand reductions from the BTM solar penetration. The current load modeling treatments, including the underlying load shape adjustment and the peak load forecast, captures the effect of BTM solar consistently and reflect the impact of BTM solar on the load side. After these treatments, LFU multipliers are applied to the adjusted load shapes, representing uncertainties with the level of forecasted load. Since the BTM solar impact is embedded in the adjusted load shapes, the probabilistic uncertainty of the BTM solar is currently modeled consistent with the uncertainty of load.

In the IRM study, other intermittent resources, such as in-front-of-the-meter (FTM) solar, are modeled with a random selection among 5 years of historical production profiles. With the same resource type (i.e., solar), FTM solar is currently modeled with higher uncertainty than BTM solar in the IRM study. Such inconsistency can lead to distortion of BTM solar impact. In addition, the embedded modeling of BTM solar also makes it challenging to quantify its system reliability impact.

With the expectation of increasing BTM solar penetration in the NYCA system over time, monitoring and quantifying the reliability impacts of BTM solar in the IRM model is of increasing importance. Therefore, this whitepaper explores methodologies of modeling BTM solar explicitly as a supply resource and evaluates the potential impact of such modeling change.

2. IRM Load Shape Adjustment Process and Limitations

The load shape adjustment procedure currently being used in the IRM study[2] includes non-coincident peak, coincident peak, and G-J Locality peak adjustments. 2013, 2017, and 2018 historical load shapes (reflecting the expected load reduction caused by the BTM solar) are adjusted to reflect the forecasted summer peak demand level for the Capability Year covered by each IRM study. Once the NYCA load shapes are adjusted, the external load shapes are adjusted to ensure that the external control areas have the same top three peak load days as the NYCA. The current procedure does not include any annual energy forecast adjustment. However, due to the nature of the non-coincident peak scaling method, the historical load shapes with less prominent peak loads, in particular the 2017 and 2018 shapes, would consequently result in overinflated energy levels. The lack of annual energy representation in the load shape adjustment process is particularly problematic with modeling BTM solar explicitly as a supply resource because the available BTM solar hourly production data is normalized based on the forecasted annual energy level. The current load shape adjustment procedure also lacks the winter demand modeling, which may result in inaccurate

[2] Current IRM Load Shape Adjustment Procedure – 02.27.2024 ICS: https://www.nysrc.org/wp-content/uploads/2024/02/IRM-Load-Shape-Adjustment-Procedure-02272024-ICS28518.pdf

representation of BTM solar impact during the winter periods. This issue exists today but will be exacerbated when accompanied by an explicit modeling of BTM solar as a supply resource.

3. BTM Solar Modeling Methodology

In the IRM study database, modeling BTM solar explicitly as a supply resource would require both load-side and supply-side modeling adjustments. This is because the current load shapes used in the IRM study already capture the expected load reduction caused by BTM solar. The NYISO's 2024 Gold Book Baseline Forecast (Table I-9b) and energy normalized historical representative BTM photovoltaic (PV) hourly values were used to develop the hourly profiles for BTM solar production for each zone. The zonal annual energy reduction values for year 2025 (noted in the figure below) were used for the impact assessment presented herein.

Table I-9b: Solar PV Annual Energy Reductions, Behind-the-Meter

Reflects Total Cumulative Impacts

Reductions in Annual Energy by Zone - GWh

Year	A	B	C	D	E	F	G	H	I	J	K	NYCA
2024	378	616	871	71	652	767	803	116	162	618	1,231	6,285
2025	457	748	1,078	92	795	882	944	133	186	705	1,382	7,402
2026	533	870	1,276	107	933	994	1,077	147	207	790	1,525	8,459
2027	603	987	1,457	123	1,061	1,095	1,202	163	228	870	1,659	9,448
2028	664	1,088	1,620	138	1,174	1,188	1,312	178	245	941	1,781	10,329
2029	720	1,176	1,757	149	1,273	1,267	1,408	190	263	1,001	1,885	11,089
2030	764	1,250	1,875	156	1,357	1,332	1,487	200	280	1,051	1,971	11,723
2031	801	1,310	1,968	165	1,421	1,383	1,556	206	289	1,094	2,045	12,238
2032	827	1,353	2,039	171	1,470	1,430	1,614	212	299	1,130	2,107	12,652
2033	847	1,388	2,092	176	1,508	1,464	1,666	220	308	1,162	2,159	12,990
2034	863	1,414	2,134	181	1,535	1,492	1,706	225	317	1,184	2,201	13,252

Figure 1: The NYISO's 2024 Load & Capacity Data Report (Gold Book) [3] *Table I-9b*

The implementation of the new modeling does not warrant changes to the IRM calculation method because BTM solar is not an Installed Capacity (ICAP) market-participating resource. For the same reason, the derating factor of BTM solar resource should not be utilized in the ICAP zonal derating factors used in the shifting methodology when conducting GE MARS simulations.

3.1. Load-side modeling

The load-side modeling entails adding previously adjusted BTM solar penetration back to the underlying load shapes used in the study, resulting in effectively modeling the expected gross load.

[3] 2024 Load & Capacity Data – NYISO: https://www.nyiso.com/documents/20142/2226333/2024-Gold-Book-Public.pdf/170c7717-1e3e-e2fc-0afb-44b75d337ec6

To avoid the issues related to the existing load shape adjustment method, utilizing the negative DSM shapes is recommended to represent the load-side modeling of BTM solar. 2013, 2017, and 2018 BTM solar zonal hourly load profiles are programmed to be aligned with the underlying load shapes.

	LFU Bins 1 – 2	LFU Bins 3 – 4	LFU Bins 5 – 7
Representative Historical Weather Year	2013	2018	2017

The negative hourly DSM shapes effectively mimic the effect of hourly load shapes independent of the underlying load shape adjustment process. The use of DSM shapes also avoids application of the LFU multipliers to the BTM solar production.

However, capturing annual energy demand and modeling season specific load forecasts remains of interest. Reflecting the annual energy forecast in the load modeling is especially important for accurately measuring the impact of BTM solar because the performance of BTM solar resources is measured in energy reduction. Not modeling the annual energy forecast in the load modeling could potentially produce an inaccurate representation of the impact of the BTM solar resources on the NYCA system. As NYCA winter reliability becomes more important, it is critical that the IRM study captures the winter peak forecasts as well as the summer peak forecasts in the load modeling.

Other modeling options explored:

Prior to the recommended load-side modeling described above, other modeling options were explored:

3.1.1. Modeling Gross Load Shapes with Gross Peak Load Forecast

To model BTM solar resource as a separate supply resource, one option is to model the gross level on the load side (i.e., using the gross load shapes as well as the gross peak load forecasts). This option involves adding the historical BTM solar impact back into the underlying load shapes, and adjusting these underlying load shapes to the peak forecast with the expected BTM solar penetration added (i.e., gross peak load forecast). Modeling the gross load shapes with the gross peak load forecast was determined suboptimal due to the limitations of the current IRM load shape adjustment method. The current load adjustment method does not account for the annual energy forecast. Adopting the gross level representation on the load side could lead to higher-than-expected energy modeled in the system and lead to amplified impact on the IRM and LCRs.[4] A concern was also noted that, under this approach, the gross load (which has BTM solar impact added back) is subject to the underlying LFU multipliers. However, based on prior observation, it is believed that severe summer weather conditions do not necessarily translate to increased solar energy production. As a result, this approach may not accurately represent the estimated production from BTM solar.

[4] BTM Solar Modeling – Separation Load – 01.30.2024 ICS: https://www.nysrc.org/wp-content/uploads/2024/01/BTM-Solar-Methodology-and-Impact-ICS-01302024-Market-Sensitive27148.pdf

3.1.2. Alternative Load Shape Adjustment

Due to the issue of overstating modeled energy with the current load shape adjustment process, an alternative load shape adjustment method[5] was explored. This method aligns with the methodology used in the NYISO's Reliability Needs Assessment (RNA) and captures the annual energy forecast as well as the seasonal peak demand forecasts. The assessment of the alternative load adjustment method confirmed that adjusting the annual energy of the load shapes to match the forecast would yield more intuitive results[6] with respect to modeling BTM solar explicitly as a supply resource. However, load duration curve and Loss of Load Expectation (LOLE) distribution analysis revealed that the alternative load adjustment method would alter the underlying load profiles. Therefore, it was determined that this option may not be appropriate for the purpose of the IRM study and additional evaluation is needed to assess other options to enhance the current load shape adjustment process.

3.2. Supply-side modeling

The supply-side modeling of BTM solar is consistent with current modeling approach for intermittent resources within the IRM study, which involves random selection from 5 years of historical productions profiles.

Due to the nature of BTM solar resources, no historical production data is available. Therefore, the NYISO's estimated BTM solar hourly production data was utilized, specifically the hourly estimated production profiles for 2019–2023 were used in the impact assessment. The modeling for the random selection of these BTM solar profiles is also consistent with other intermittent resources to ensure weather-year consistency during the GE MARS simulation.

4. <u>Results</u>

Using the Tan45 methodology, an impact assessment of the recommended modeling construct to represent BTM solar explicitly as a supply resource was conducted on the 2025–2026 IRM PBC. As indicated in the table below, the impact assessment demonstrated that the recommended BTM solar modeling construct produced a 1.05% increase to the IRM determined for the 2025-2026 PBC, as well as increases to the locational requirements. The Load Zone K LCR demonstrated a greater increase because the quantity of BTM solar in Load Zone K is almost double that of Load Zone J.

[5] Alternative Load Adjustment Method – 06.05.2024 ICS: https://www.nysrc.org/wp-content/uploads/2024/06/Alternative-Load-Adjustment-Method-06052024-ICS33406.pdf
[6] BTM Solar Modeling with the Alternative Load Adjustment Method – 06.26.2024: https://www.nysrc.org/wp-content/uploads/2024/06/BTM-Solar-Modeling-06262024-ICS33553.pdf

Case (Tan45)	IRM	Load Zone J LCR	Load Zone K LCR	G-J Locality
2025 – 2026 IRM PBC	23.60%	75.98%	102.52%	87.54%
+ BTM Solar Modeling	24.65% (*+1.05*)	76.88% (*+0.9*)	104.14% (*+1.62*)	88.2% (*+0.66*)

The increase to the IRM and LCRs observed for the 2025-2026 PBC is due to the probabilistic nature of the recommended BTM solar modeling construct which increases randomness and uncertainty in the model. The observed increase in both LOLH and EUE using the recommended BTM solar modeling construct supports this observation.

Case	LOLE (days/yr.)	LOLH (hrs./yr.)	EUE (MWh/yr.)	Normalized EUE "Simple Method" (ppm)	Normalized EUE "Bin Method" (ppm)
2025 – 2026 IRM PBC	0.100	0.388	234.724	1.554	1.386
+ BTM Solar Modeling	0.100	0.410	260.175	1.723	1.537

5. Recommendation

Based on the research and analysis conducted, an additional impact assessment of the recommended approach for modeling BTM solar explicitly as a supply resource should be conducted using the approved 2025–2026 IRM Final Base Case (FBC) to ensure that the implementation of the recommended BTM solar modeling produces consistent and intuitive results. Additionally, it is recommended that an enhancement to the load shape adjustment methodology, specifically to capture the annual energy requirement and the seasonal peaks, be developed and adopted along with the recommended BTM solar modeling change as a complete package.

References

1. Load Forecast Uncertainty (LFU) Phase 2 Study – Updated Load Shape Recommendation: https://www.nyiso.com/documents/20142/29418084/07%20LFU%20Phase%202_Recommendation.pdf/8c95bef1-8091-3a3e-8990-f5534b53024a

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5. Alternative Load Adjustment Method – 06.05.2024 ICS: https://www.nysrc.org/wp-content/uploads/2024/06/Alternative-Load-Adjustment-Method-06052024-ICS33406.pdf

6. BTM Solar Modeling with the Alternative Load Adjustment Method – 06.26.2024: https://www.nysrc.org/wp-content/uploads/2024/06/BTM-Solar-Modeling-06262024-ICS33553.pdf