Storage in Practice: Insights from NYSERDA's Energy Storage Programs

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ABSTRACT

New York State has established ambitious energy storage deployment targets, aiming to deploy 6 GW of energy storage capacity by 2030. To achieve these goals, it is critical for program administrators (PAs) and stakeholders to understand the real-world performance of existing Energy Storage Systems (ESS). This paper presents findings from an independent impact evaluation DNV conducted on behalf of the New York State Energy Research & Development Authority (NYSERDA). By integrating market and qualitative research with quantitative analysis, the evaluation team identified how storage systems are currently contributing to the New York grid and provided program recommendations. Fundamentally, it seeks to understand how PAs can design their initiatives to ensure optimal performance from the energy storage systems.

In this study, the evaluation team set out to do the following: (1) understand how energy storage systems (ESS) are performing in real-world conditions, and (2) identify the main drivers (and obstacles) to market adoption of these systems. The evaluation covered 40 sites in NYSERDA's Bulk and Retail Storage programs and the Emerging Technologies and Accelerated Commercialization for the Commercial/Industrial Sector (ETAC-CI) program. Using the programs' 2020-2022 Advanced Metering Infrastructure (AMI) interval data, utility rates, program tracking data, and qualitative insights, the evaluation characterized energy storage system ESS performance across revenue streams and operational strategies. Results show that site operators aim to minimize battery cycling to reduce degradation and extend the battery's lifecycle. They dispatch the batteries only when there is a significant incentive, mainly during the summer for Value of Distributed Energy Resource (VDER) sites. The study also found that, with improved market signals, many sites could increase the frequency and rate of battery discharge, further supporting the role of batteries as a flexible source of energy in the grid.

This study provides key insights into how existing storage contributes to grid reliability and New York's emissions reduction goals, while highlighting gaps that can inform program design. For PAs, these findings suggest that incentive structures and market designs will be critical to maximizing the benefits of ESS as New York pursues its energy storage deployment targets.

[1] The views expressed in this paper are those of the authors and do not necessarily reflect the views of the New York State Energy Research and Development Authority.

Energy Storage in New York: Ambitious Deployment Goals

Energy storage has become a cornerstone of today's electric grid. The New York State Public Service Commission (PSC) and NYSERDA have established a target of 6 GW of energy storage deployment by 2030 (NYSERDA 2025) and have launched a range of incentive programs, such as NYSERDA's Bulk and Retail Storage programs and the Emerging Technologies and Accelerated Commercialization for the Commercial/Industrial Sector (ETAC-CI) program. These initiatives accelerate the deployment and integration of storage into grid and customer operations (NYSERDA 2025). This paper evaluates over 40 sites that have been funded through these programs.

Most of these systems participate in a value-based compensation program that rewards distributed energy for its contribution to the grid. However, the analysis reveals that technical and economic performance vary widely across sites. Site operators are using their systems conservatively to minimize degradation and prolong battery life. The evaluation team found that VDER revenues dominate the financial value proposition for most of the sites. Through quantitative analysis of the energy systems and qualitative analysis of stakeholders (program staff and BESS installers), the study generated actionable insights on technology, economics, and program design for energy storage systems. The team has also outlined detailed takeaways and recommendations to guide PAs, utilities, and regulators.

Exploring the Storage Landscape: Objectives & Methods

In this study, the evaluation team set out to do the following: (1) understand how energy storage systems (ESS) are performing in real-world conditions, and (2) identify the main drivers (and obstacles) to market adoption of these systems. The evaluation team conducted a mixed-method evaluation of 42 projects supported by NYSERDA programs between 2020 and 2022. These projects included bulk and commercial/industrial battery energy storage systems (BESS) and photovoltaic (PV) generation systems. The team assessed technical performance, grid participation patterns, and economic benefits, drawing from a combination of high-resolution interval data, program tracking documentation, utility tariffs, and market research.

Data Sources and Site Selection

The study centered on 42 sites funded by NYSERDA's Bulk and Retail Storage programs and the ETAC-CI program. These sites represented a total of 128 MW and 322 MWh of installed battery capacity. The evaluation team selected these projects because they encompass a range of use cases, system configurations, and participation in the Value of Distributed Energy Resources (VDER) compensation system. This value-based system rewards individuals or businesses for generating electricity and returning it to the grid.

The team collected 15-minute interval data from each site, through the program's data aggregator. The interval data included interval readings for gross battery charging, battery discharging, solar generation, and net facility load. A fraction of sites' data included interval readings for state of charge percentages. Other sources included utility rate tariffs, program tracking records, and qualitative responses gathered through market research and web surveys.

Evaluation Approach

The evaluation team employed a combination of methods to assess the effectiveness of each site's energy storage system. The team examined how the systems performed technically, their participation in programs that support the electric grid, and the amount of money they saved or earned under current market conditions. This involved analyzing detailed energy data and financial models, as well as conducting interviews and observations to understand how the systems operate and how they respond to market trends.

Performance Insights & Program Recommendations

Findings are organized thematically, with each section presenting relevant trends, detailed methodologies, and actionable recommendations or takeaways the evaluation team detailed for PAs, vendors, and regulators during the evaluation period.

Data Quality and Cleaning

Overview

Before analyzing battery performance, the team assessed the quality of the interval data streams, leading to rigorous reprocessing. Battery performance subject matter experts reviewed each data stream to identify and flag outliers, inconsistencies, and anomalies.

The team created a list of outlier detection and removal rules based on these expectations and then conducted a close visual inspection of the interval data using plots. Reviewing the interval data site by site, the team was able to identify site-specific anomalies, which were then incorporated into its data cleaning procedure.

Common Issues Identified

One of the frequently occurring data issues is illustrated below. The plot shows a solar generation data stream from a site that experienced anomalous solar generation between June 14 and July 7, 2022, with high solar output maintained throughout the night.

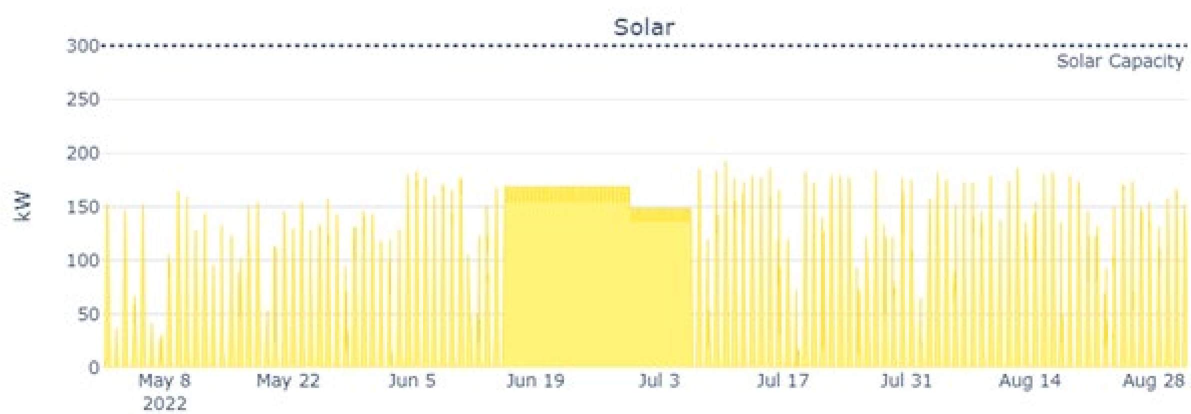

Figure 1. Anomalous solar generation readings registered at a site

Another recurring issue involved discrepancies between the net facility load field and the battery charge and discharge, as well as solar generation and data streams. This sometimes revealed “phantom generation” or anomalous phenomena appearing in the interval data at multiple sites. For example, the team observed a pattern where the net facility load reflected site generation (through solar plus battery discharge minus charge) was greater than that observed via those data streams (i.e., “phantom” generation). This occurred for one of two reasons: There was a lag between data streams due to the different metering technologies used for the net facility load versus generation assets, or there was an interruption in one of the generation data feeds. In these cases, the net facility load continues to show a net export level indicative that the power from that source continued to flow. In the case of the former, there should be no issue when the data is aggregated; in the case of the latter, the phantom generation will persist even after the data is aggregated.

Additionally, the team observed an anomalous pattern at a few sites, where cumulative discharge over the timeseries was significantly higher than cumulative charge. Cumulative discharge can't exceed cumulative charge; cumulative discharge is expected to be lower than cumulative charge by approximately the round-trip efficiency of the battery.

Approach

The team worked closely with the data aggregator to ground-truth the data streams against revenue-grade data streams and built data cleaning rules to incorporate this validation, applying them across all sites.

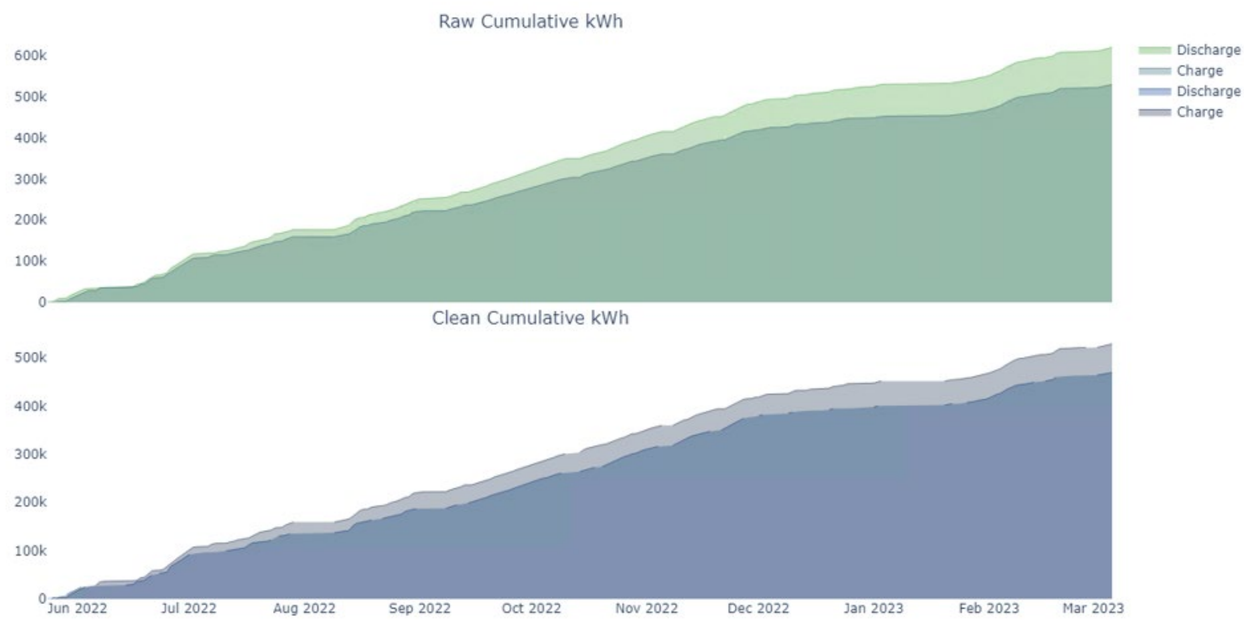

Figure 2. Cumulative charge/discharge at a site before and after data cleaning rules applied

While removing outliers helps, data loss can obscure patterns and impact the accuracy of the analysis. Ultimately, it was not in the scope of this analysis to investigate where the outliers come from and whether they are "real," but rather to arrive at a dataset clean enough to lend itself to meaningful visualization, which would be used to identify trends in battery performance.

Given the high volume of missing data, the team retained most records with null values to preserve the integrity of long-term trend analysis. Otherwise, there would be insufficient data left for subsequent analysis. However, keeping these records could have resulted in an anomalous record that evaded the outlier detection rules. For example, consider a case where the solar generation field is null, the net charge is high, and the net facility load is near zero. This is an anomalous record, but the flag will not be "tripped" because the calculation behind it is not possible without all data streams present. It's unclear how often this occurs, but it illustrates another case where data quality could have compromised this analysis.

Takeaway/Recommendation #1: Ensure consistence in interval data

Electric inputs and outputs from the battery, solar system, and grid must each be captured separately and at high rigor to enable analysis and modeling of hybrid DERs. Varying levels of data feed consistency from metering and control systems introduces uncertainty into the results that the program should address moving forward. Currently, it is difficult to parse what is real activity and what is an issue with the data feed, which complicates the effort to understand how these sites are operating and how they respond to the market incentives. Program requirements already include installation of a revenue grade meter to directly record the net energy charged and discharged from the energy storage system. The team recommended that the program build on this by implementing regular validation of control system data streams against on-site revenue-grade metering. Further, the team recommended that the program consider make addressing data collection issues a requirement for continued participation in the program.

VDER Mechanism Insights

Overview

The Value of Distributed Energy Resources (VDER) is a compensation mechanism available for Distributed Energy Resources (DERs), such as solar and storage, in New York. The VDER mechanism aims to accurately compensate DER owners for the value they provide to the grid (NYSERDA 2025). The hourly unit prices reflect multi-stream, location-specific benefits to the grid. For both solar and storage exports (i.e., electricity injected into the grid), the VDER compensation is based on six different unit prices: Energy Value, Capacity Value, Environmental Value, Demand Reduction Value (DRV), Locational System Relief Value (LSRV), and Community Credit. The six contributing components to the VDER rate's 'Value Stack' are briefly summarized in the table below.

Table 1. Summary of VDER value stack

Value Type	Description
Energy Value	Determined by New York Independent System Operator's (NYISO) location-based marginal price of energy, which updates each hour based on the supply and demand of energy on the grid
Capacity Value	Based on the value the asset provides in helping mitigate strain and meet demand for energy during peak time periods (e.g., hot summer afternoons)
Environmental Value	Reflects the value of load shifting when power is generated via a carbon-free source instead of fossil fuels. Determined by the social cost of carbon calculated by the New York Department of Public Service
Demand Reduction Value	Represents the value of the avoided cost of utility grid upgrades that would have been necessary in the absence of the resource
Locational System Relief Value	Value stream for systems located in utility-designated areas where demand reduction and capacity provided by distributed generation and energy storage are particularly valuable
Community Credit	Additional credit available to Community Distributed Generation sites

Approach

To estimate VDER-related compensation, The evaluation team used NYSERDA's Value Stack Calculator, applying it to each site using available interval data. The VDER calculator has over 50 individual inputs that inform the compensation mechanism. Additionally, the program's data collection did not track all necessary inputs with the required specificity. Furthermore, the team encountered unknown system utility configurations (e.g., Electric Utility, Substation, NYISO zones), unknown system configurations and physical parameters (e.g., VDER configuration, system round-trip efficiency), and missing data and data quality impacts (e.g., Phantom generation). Because the available program data did not include all the inputs required by the VDER calculator, the team proceeded using reasonable best-guess assumptions. While this approach introduced some uncertainty, it allowed for a practical and consistent estimate of site-level compensation across the portfolio.[2]

Takeaway/Recommendation #2: VDER revenue is driving the market currently

Estimated VDER revenues are meaningfully – exceeding an order of magnitude – greater than those from other revenue streams, with an average of $345k per VDER-participating site in 2022. They also represent the revenue stream that most systems are targeting. Survey responses recognized that all six components of the VDER Value Stack provide value to projects: energy value (LBMP), capacity value (ICAP, Option 1, 2, or 3), environmental value (E) – only storage with solar, demand reduction value, locational system relief value, and community credit. To support continued adoption, the team recommended NYSERDA explore alternative stakeholder engagement methods, such as targeted workshops or focus groups. Additionally, refining the VDER modeling tool to let vendors compare projected and actual earnings could enhance confidence and improve performance calibration.

Takeaway/Recommendation #3: Program Information

All contextual information about the site aids in understanding system performance. The accurate calculation of system benefits depends on the availability of comprehensive site information, including utility rates, system specifications, and other operational details. Contextual information collected as part of the program—specifically in utility rate classes and VDER configurations applicable for each site—is key to accurately calculating site benefits (both VDER and otherwise). When this data is unavailable, assumptions must be made that can lead to inaccurate estimates of site benefits. Therefore, to improve data quality and consistency, the team recommended that comprehensive site data collection should be a standard requirement for participation.

Operational Trends from Performance Data

<u>Overview</u>

The evaluation team analyzed site-level performance metrics, including round-trip efficiency, discharge patterns, and seasonal variations. These metrics, when combined with site-level characteristics such as the reported primary use of the BESS and facility category, provide insights into how BESS operators are utilizing their systems.

<u>Approach</u>

Aggregating the 15-minute interval data for each site, the team calculated key indicators of battery performance, including the number of cycles per year, the share of active discharge days, the share of high-performance intervals, round-trip efficiency, maximum discharge, and the frequency of low battery events. The team also plotted seasonal and diurnal battery performance patterns at select sites (as depicted in Figures 3 and 4). In the chart, the green areas represent periods when the battery is discharging, and the blue areas represent periods when the battery is charging. Darker colors represent when the battery is discharging or charging close to its max capacity.

[2] **Site Benefits Assessment:** The team evaluated site-specific financial outcomes for other revenue streams, including energy savings and demand charge reductions from time-of-use (TOU) tariffs. More information on those can be found in the complete report.

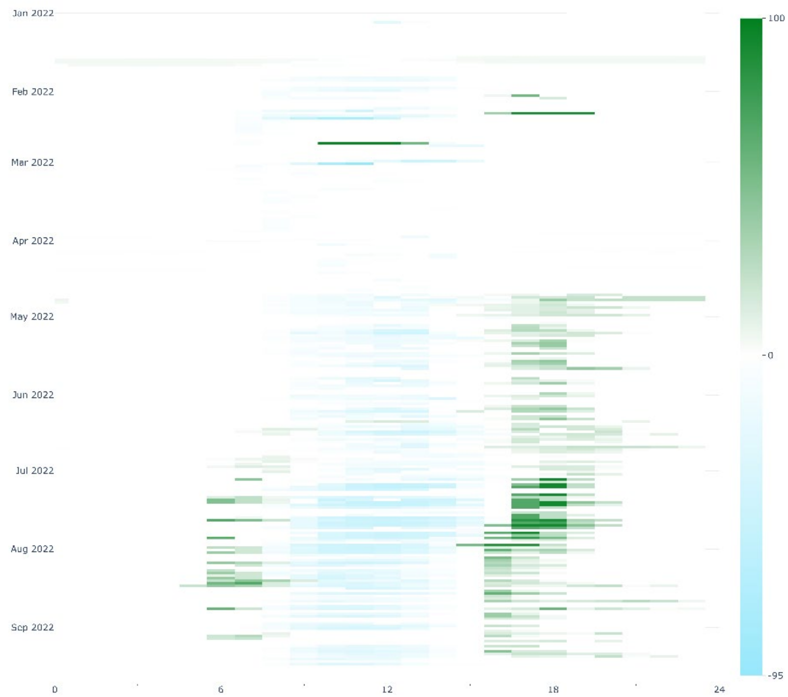

Figure 3. An example of summer season increases in discharge (Hourly discharge as % of capacity)

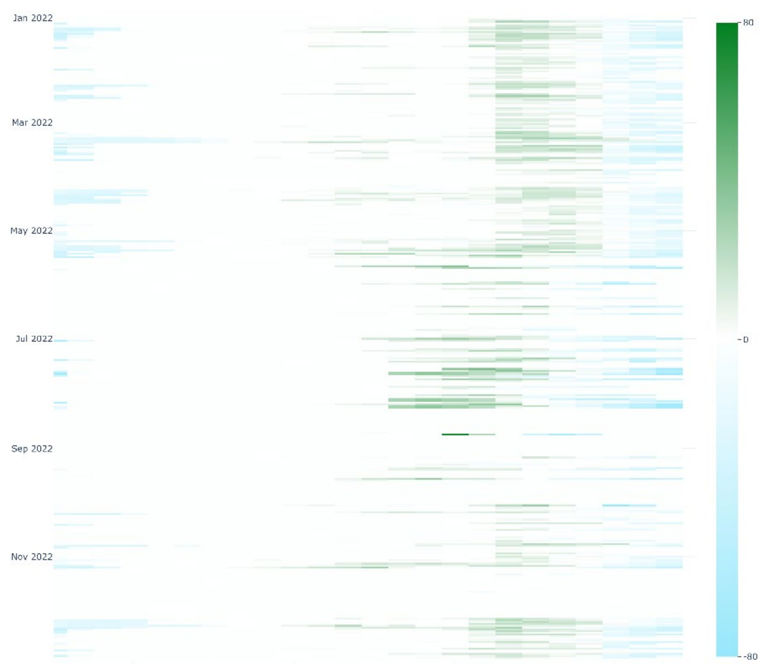

Figure 4. An example of overnight charging (Hourly discharge as % of capacity)

In general, the visualizations depict the diverse ways energy storage is used depending on the nature of the site and the motivations of the operators. Specifically, the team noted that discharge activity was highest during peak demand periods, with commercial and bulk systems more likely to participate in grid services and demand response. Seasonal variations were observed, with increased discharge during summer months.

For the majority of systems in this study, market opportunities and their economic incentives drive operational strategy. As a case in point, see the battery system charging and discharging pattern for two days in August 2022, for the four example sites, shown below.

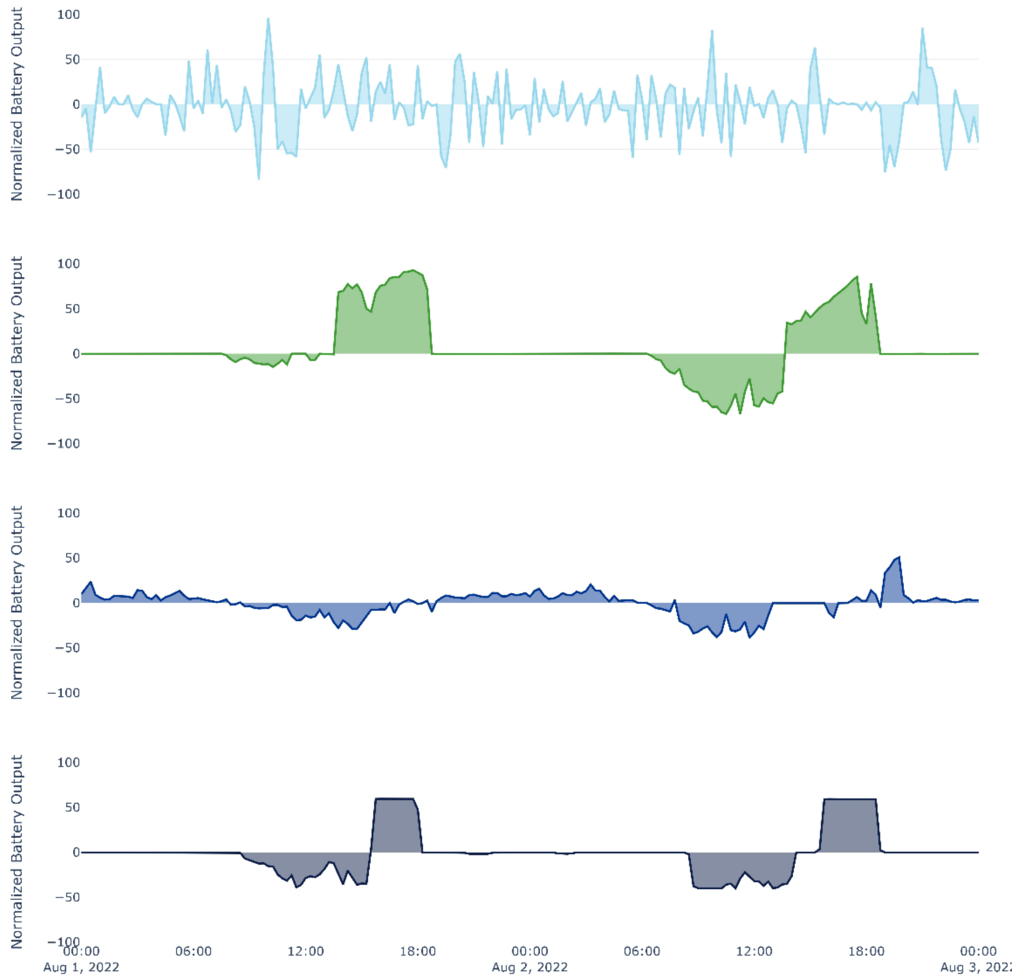

Figure 4. Concurrent Intra-day charging and discharging patterns at select sites

The bottom site (in grey) has a consistent strategy—it charges from mid-morning until afternoon, then discharges in the early evening, which aligns with typical peak hours. The second site (from the top; in green) had a similar strategy. The third site (from the top; in blue) charges and discharges at a lower rate over a longer duration, with discharging occurring from late at night to early morning. The upper-most site (in light blue) is an ancillary services site that provides and absorbs power from the grid to balance the load, as evident in this figure, where it charges and discharges back and forth rapidly.

The team used a metric called "number of cycles" – the total kWh charged divided by the rated battery size – and then annualized that value against the number of intervals for that site to measure the volumetric usage of the battery. This metric approximates the frequency of battery system cycling each year, which correlates with battery degradation.

A) Many sites could be cycling their batteries more often and at a higher rate of discharge. This may be because site operators are using their systems conservatively to prolong the battery's life.
B) Most sites operated within their rated capacity, although a minority experienced frequent high-discharge events, which potentially impacted their long-term health. The systems typically have additional capacity that can be dispatched.
C) Many batteries at these sites remain idle for long periods. For example, 7 of 42 sites cycled fewer than 20 times per year. This may indicate actual inactivity, that is, batteries aren't being dispatched, or it may be due to a metering gap, where usage data is inaccurate, incomplete, or not visible to the program.

Takeaway/Recommendation #5: Market Signals

The review of the system performance data suggested two general trends:

1. Site operators attempt to minimize the battery's cycling to prevent degradation and extend its lifecycle.
2. Site operators dispatch only when there is a significant incentive to do so, which appears to be mostly in summer, particularly for VDER sites.

Given sufficient market signals, many sites could cycle their batteries more frequently and at a higher rate of discharge, further bolstering the case for batteries as a flexible grid resource. For example, VDER sites, which make up 29 of the 42 sites, cycled only 50 times per year on average. Given that most of the battery usage is focused on the summer months, there is an opportunity for winter-targeting programs that have defined hours of need (e.g., winter DR programs), to which the batteries can contribute.

Takeaway/Recommendation #6: System Utilization

The analysis team finds that it is common for sites to have extended periods of no discharge activity. In some cases, this may be a metering issue, but to the extent it reflects real idle time, it signals that these grid assets are sometimes underutilized.

However, low observed activity does not necessarily indicate poor performance; operators may have already optimized battery usage to achieve the best economic outcome. While a case can be made for administrators to engage with operators of sites with low activity to help determine the true cause of underutilization, the underutilization could be based on individual site economic tolerances and the site's desire to optimize VDER incentives.

Conclusion

With 200 storage projects currently in the NYISO interconnection queue—and growing policy momentum to accelerate their development—it is critical that all stakeholders understand how operational storage systems are contributing to the energy transition. This insight is crucial for informing procurement, contracting, and construction decisions, as well as ensuring that future deployments are both strategic and impactful.

By helping characterize the system and site benefits provided by BESS and co-located solar PV + BESS systems – to both system owners and the grid – across different revenue streams, this analysis (and therefore, the paper) provides that insight and documents the challenges faced in doing so.

The evaluation and performance data review conducted to date indicates a clear insight: market opportunities and economic incentives primarily drive the operational strategies of most systems in this study. Consequently, this manifests into two main trends:

•Site operators aim to minimize battery cycling to reduce degradation and extend the battery's lifecycle, and they dispatch the batteries only when there is a significant incentive, mainly during the summer, especially for VDER sites.

•With adequate market signals, many sites could increase the frequency and rate of battery discharge, further supporting the role of batteries as a flexible grid resource.

For PAs, incentive structures and market signals must be aligned with desired grid outcomes. By designing programs that reward not only installation but also performance and responsiveness, utilities and PAs can witness the full potential of distributed storage to deliver both economic and system-wide benefits.

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