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Utility Scale Energy Storage [1]

Deck:
Underutilized and Overlooked

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As large data center loads increasingly connect to the grid and the electric power sector struggles to build enough resources fast enough to power these enormous loads, existing battery energy storage is an underutilized resource with greater potential to meet these challenges. The available capacity of a battery Energy Storage Resource (ESR) fluctuates as the ESR operates, charging and discharging.

How much remaining stored energy is available at any moment — known as State of Charge (SoC) — is not transparent to grid operators and planners. Achieving greater visibility into SoC is an overlooked means to unlock greater capacity and reliability for the grid at lower cost.

The amount of ESR, primarily electrochemical-based battery technology to store electricity, is projected to be 65 GW of installed nameplate capacity on the North American grid by 2026. ESR is able to be installed quickly and modularly to increase grid capacity, enable time-shifting of low-cost renewable energy from hours of excess supply to hours of shortfall, and is increasingly the preferred resource for Ancillary Services to support grid reliability due to ESR's quick response and low opportunity cost.

But full utilization of ESR is inhibited by the grid's current operational practices, market rules, and planning conventions. The primary reason for such practices, rules, and conventions is lack of visibility into SoC by grid operators and planners as well as ESR operators themselves.

The inefficiencies from this state of affairs — that is, the difference between an ESR's true SoC and the amount of capacity the grid actually obtains from the ESR at any moment — may be as much as 20%. Even if the inefficiency were only one percent, as much as 650 MW of capacity would be underutilized — the rough equivalent of one large gas turbine generator being offline!

Finding a way to fully utilize ESR's available capacity will help meet data center load growth while requiring little additional investment. If grid operators had greater visibility into SoC and were able to

accurately estimate and predict an ESR's SoC, the underutilized capability of ESRs might be unlocked via a bulletin board, similarly to how underutilized lodging is exchanged on Airbnb.

State of Charge Uncertainty Leads to Undercounted Capacity

Uncertainty in SoC is inherent in battery technology. SoC is an ESR's fuel gauge: zero when empty and 100% when full, reflecting the percentage of available energy in a battery compared to the energy available when the battery is fully charged. But unlike measuring how much liquid is in a tank or reservoir, one cannot directly measure how much electricity is stored inside a battery.

Electrical energy is measured when it is flowing, that is, when the ESR is charging or discharging. Simple accounting for how much energy flowed in and out is not perfectly accurate due to errors from physical losses and chemical properties affecting the ability of the battery to store the energy.

Being uncertain about SoC, grid operators and planners respond by propagating operational practices, market rules, and planning conventions. Such constraints include minimum and maximum energy limits, constraints on SoC, beginning-of-day SoC values, SoC rules tied to awards for ancillary services, and resource adequacy rules for minimum number of hours of capacity.

ESRs also self-report their SoC levels and are penalized for any shortfalls in their delivered energy. Since ESR operators want to limit their exposure to energy shortfall penalties and overscheduling of ESR leads to reliability problems, in most markets today there is effectively a belts and suspenders approach to managing SoC uncertainty.

These practices, rules, and conventions adversely impact reliability, the efficiency of market outcomes, and overall affordability. Further, there are no standards today on how ESR data are reported, resulting in variations in the meaning of SoC from region to region.

To determine what SoC truly is requires analysis of empirical performance data. Standardizing the reporting of ESR data is urgently needed to enable grid-wide analysis of ESRs. Standard ESR data will provide a path to determine accurate SoC values, which can be shared on a platform for exchanging ESR capacity.

One Stone — Two Birds

The North American Electric Reliability Corporation's (NERC) 2026 Long Term Reliability Assessment confirms that electricity demand driven by economic growth will far outpace the ability for industry to site and build enough new generators in time. Optimization of ESRs should not be overlooked in this race between capacity and demand.

Recently, much attention has focused on how to quickly approve and build generators to meet the coming wave of large data centers. But immediate attention is also needed to reform rules and requirements on ESR, unlocking existing ESR capacity to maintain reliability and affordability.

Over the years, ESR energy has evolved from a backup energy source to a reliable and cheap source of ancillary services needed by grid operators to operate the grid reliably. ESRs have evolved to be a price leader for these services. As industry continues to find viable low-cost solutions to meet load growth, ESRs will play a greater role as the capacity of these new resources can be dedicated to serving load and lesser for Ancillary Services if the ESR capacity can be extended. This has a dual benefit, more capacity from generators, and more capacity from ESR.

Risks of Ignoring the Issue

What may be a small or inconsequential effect of untapped ESR megawatts today will become greater if SoC uncertainty is not addressed. For the grid operator, access to any and all possible amounts of energy is needed when resources are tight. Energy Emergency Alerts are issued when system conditions approach the limits of energy reserves.

Eliminating SoC uncertainty allows operators to better plan and have more time to call up longer lead time resources to avoid Energy Emergency Alerts and to prevent forced outages. For the ESR owner/operator, being able to schedule more stored energy means more revenue. Both will benefit if participation rules shift from a reported SoC requirement to one which is scientific based with greater certainty. This is a win-win.

Making a Small Investment for More Capacity

Urgent action is needed to reduce or eliminate uncertainty in SoC to increase the inherent benefits of ESR — from those already connected and those which are planned to be. System planners need realistic ESR capacity ratings in order to accurately plan for future resource requirements.

Since battery SoC varies with charging and discharging cycles, this data must be tracked and analyzed so operators have visibility into available stored energy at any given time to optimize economic dispatch and minimize reliability risk. The accounting-based approaches to estimate SoC are not enough.

Data requirements for these resources are not standardized and currently differ between utility agreements, making aggregate studies on a grid scale challenging. Standardized data sets for ESR facilities would allow for common understanding and practices to track and study charging and discharging capabilities. That will enable grid-wide analysis of ESR performance and result in accurate and timely SoC values.

Sharing this SoC with real-time and predictive data on a sharing platform will shift the market away from overconservative SoC estimates. To leave a significant amount of ESR energy untapped in the reservoir of capacity because of uncertainty would simply be doing less than what the industry is capable of.

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