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The Three Revenue Streams of Storage

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Data Sources Used in This Publication
CAISO
EIA

To discover more about the data sources used, click here.

No Steady State in Battery Storage Picture

Additions to renewable power generation will continue to increase this year, next year, and over the next decade. In the circumstances, the potential of cheaper utility-scale storage is a big factor removing lingering intermittency fears that spawn arguments to consider and enforce reliability mandates where renewables threaten intermittent service. In the past, power markets overlooked storage because of an inability to overcome capital costs and a diminishing return on additional marginal storage units that would collapse the daily arbitrage. With the Federal Energy Regulatory Commission order 841 requiring additional integration rules for storage and further battery cost drop-offs, we expect more storage being added than ever before, especially with renewable pairing projects. Cost has been a driving factor, but so has potential revenue. This note will look at three available market revenue streams for storage and its future potential.

The Three Time Steps

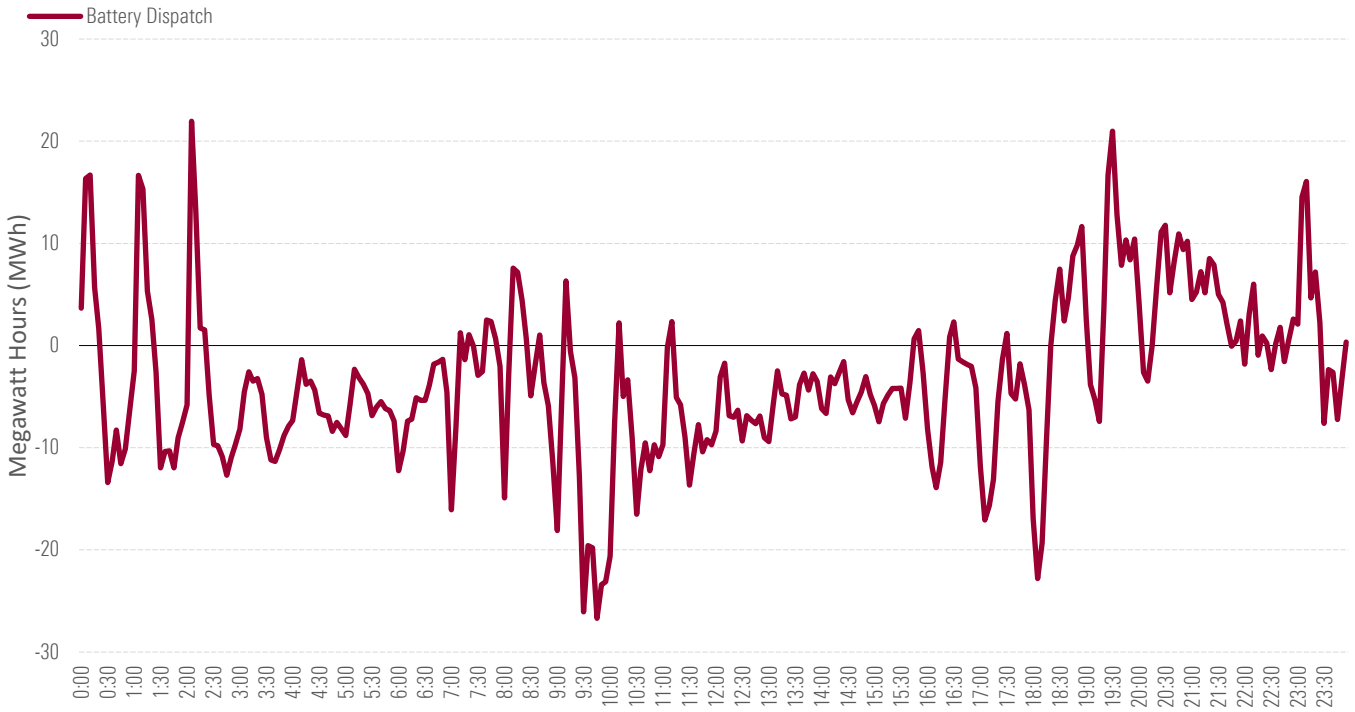
Power markets in the United States are set up in a dual-market design with day-ahead and real-time elements, but there are really three time-step categories. The first is real time, or short term, at an hourly to subhourly frequency. Ancillary products work mostly in this realm with voltage support or frequency regulation, spinning reserves, nonspinning reserves, and black start all ramped up in a few minutes or within an hour or so. Second is the daily level for both real time and day ahead that captures day-ahead versus real time or on-peak versus off-peak spreads to optimize and load follow throughout the day to capture hourly and daily arb values. The third time step is the forward dimension, including balance-of-week, next week, next month, and so on in energy and next-day capacity markets.

Short-Term Ancillary

Batteries are now affecting the short-term subhourly market with an ability to immediately dispatch. Manufacturing costs are dropping, and with subsidies or renewable project pairing, they are starting to attain viable energy market levels. In the longer term, the technology is still only operating in a range between four and eight hours, making it harder to manage load over longer-term horizons. However, the presence of electricity storage can help smooth out intermittent renewable profiles.

Short-term frequency response, regulation up and down, and spinning reserve ancillary products all occupy a market space where batteries are advantageous. Services can use the speed of battery dispatch to manage mismatched dispatch issues on the grid. This is the quickest and easiest deployment. Even in small quantities, batteries can result in improved response and lower system costs. Exhibit 1 shows average battery dispatch on the California independent system operator, or CAISO, grid has an erratic pattern throughout the day as spikes occur that batteries respond to. This subhourly dispatch pattern shows the short-term battery turnaround, which helps even out subhourly dispatch deviations.

Exhibit 1 Average 2019 Battery Dispatch per 5-Minute Interval



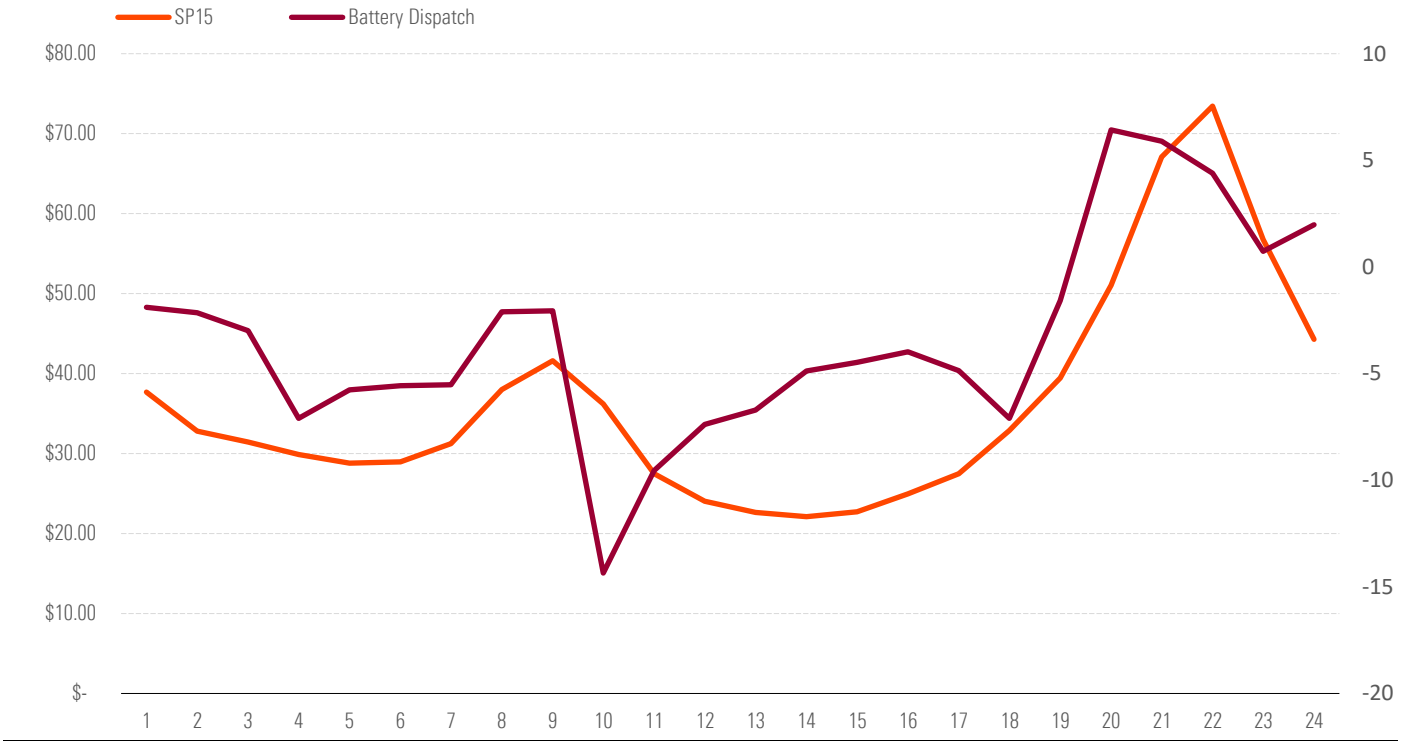
Source: CAISO, Morningstar

Daily Arbitrage

Taking advantage of the daily arbitrage between peak and lower net demand periods to buy low and sell high is the most discussed use case for storage. For example, SP-15 prices in CAISO may reach a maximum $73.44 per megawatt-hour and a minimum of $22.12/Mwh, leading to a $51.33 differential. However round-trip efficiency is not 100%, so you need to take losses into account as well as the market challenge to always charge on the cheapest hours of the day and dispatch at the most expensive. Exhibit 2 shows battery storage in CAISO does a pretty good job of price following, but it's not perfect. While the average may be over $50/MWh, the ability to always garner that is not guaranteed. In addition, while marginal cost projections do see cost dropping to under $70 per MWh, current storage costs are over $80/MWh. That means a $51 arbitrage opportunity is still not in the money without subsidization.

This year has seen a sizable increase in announced solar plus storage projects. Oversupply leading to midday curtailments is a win-win scenario when coupled with storage, supplementing arbitrage opportunities. Instead of seeing negative prices midday due to oversupply the excess generation can be stored in batteries and released later in the day, allowing producers to mitigate the impact of negative pricing. This allows a solar power producer to capture the maximum peak price net its own supply instead of bearing negative pricing or curtailment.

Exhibit 2 Average FMM SP-15 Price vs Hourly Average Battery Dispatch



Source: CAISO, Morningstar

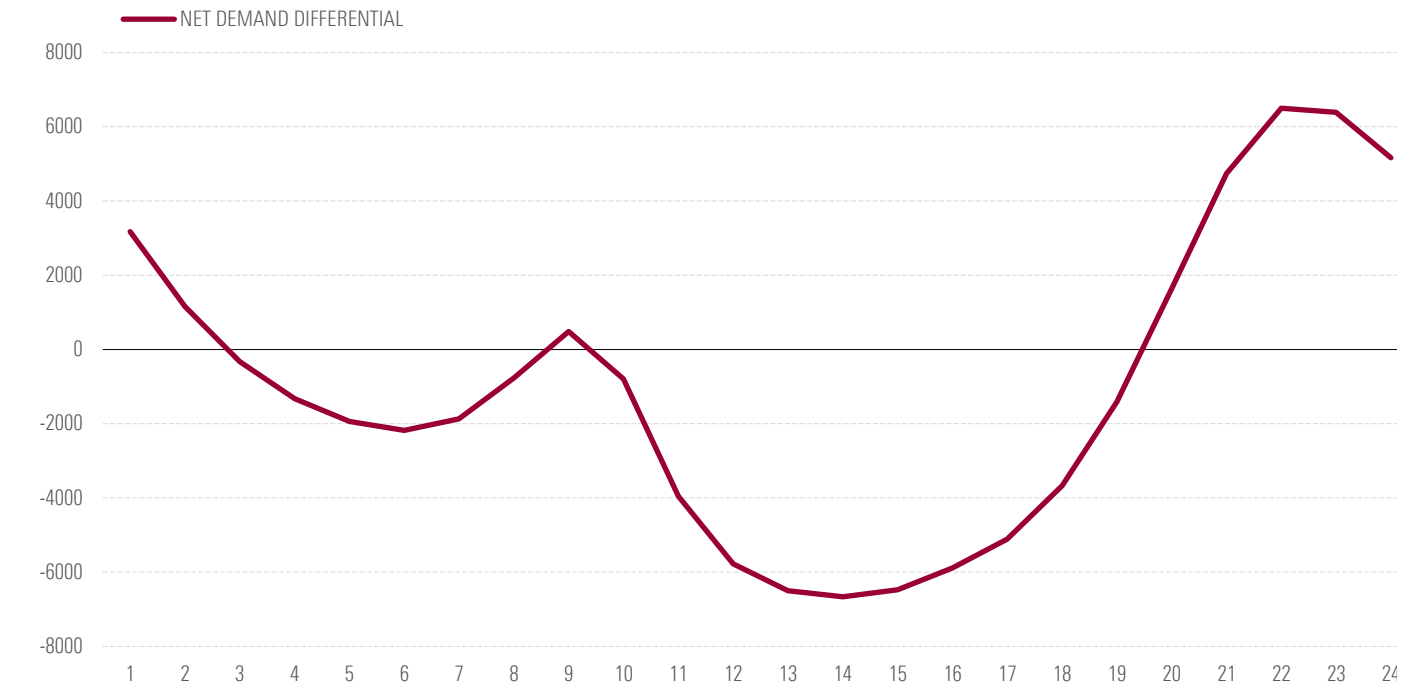
Capacity Extension

One additional storage revenue stream comes from capacity. With FERC Order 841, independent system operators are building out formal pricing and tariff revisions to integrate storage into their supply mix. If batteries can meet capacity requirements in markets like PJM or ISO-NE, they can procure capacity payments. In addition to capacity payments, solar plus storage projects can achieve higher capacity factors when participating in capacity auctions.

In a more classic capacity sense, the ability to have MWh supply during peak hours gives solar producers the capacity to capture evening super peak energy pricing. Exhibit 3 shows the net demand differential for baseload units. Negative price trading opportunities provide advantages for producers that invest in storage assets as peaking hours flatten and reduce the need for reserves.

However, even though capacity extension can add daily smoothing, the longer-term ability to store energy over multiple days is still limited at current costs. While all power generation has a use case for electrical storage, the ability to deal with cloudy weather for solar power, no wind for wind power, pipe freezes for natural gas, wet coal or mechanical failure at a coal plant all would need to look elsewhere in such extreme weather events.

Exhibit 3 Net Demand Differential from Baseload Constant

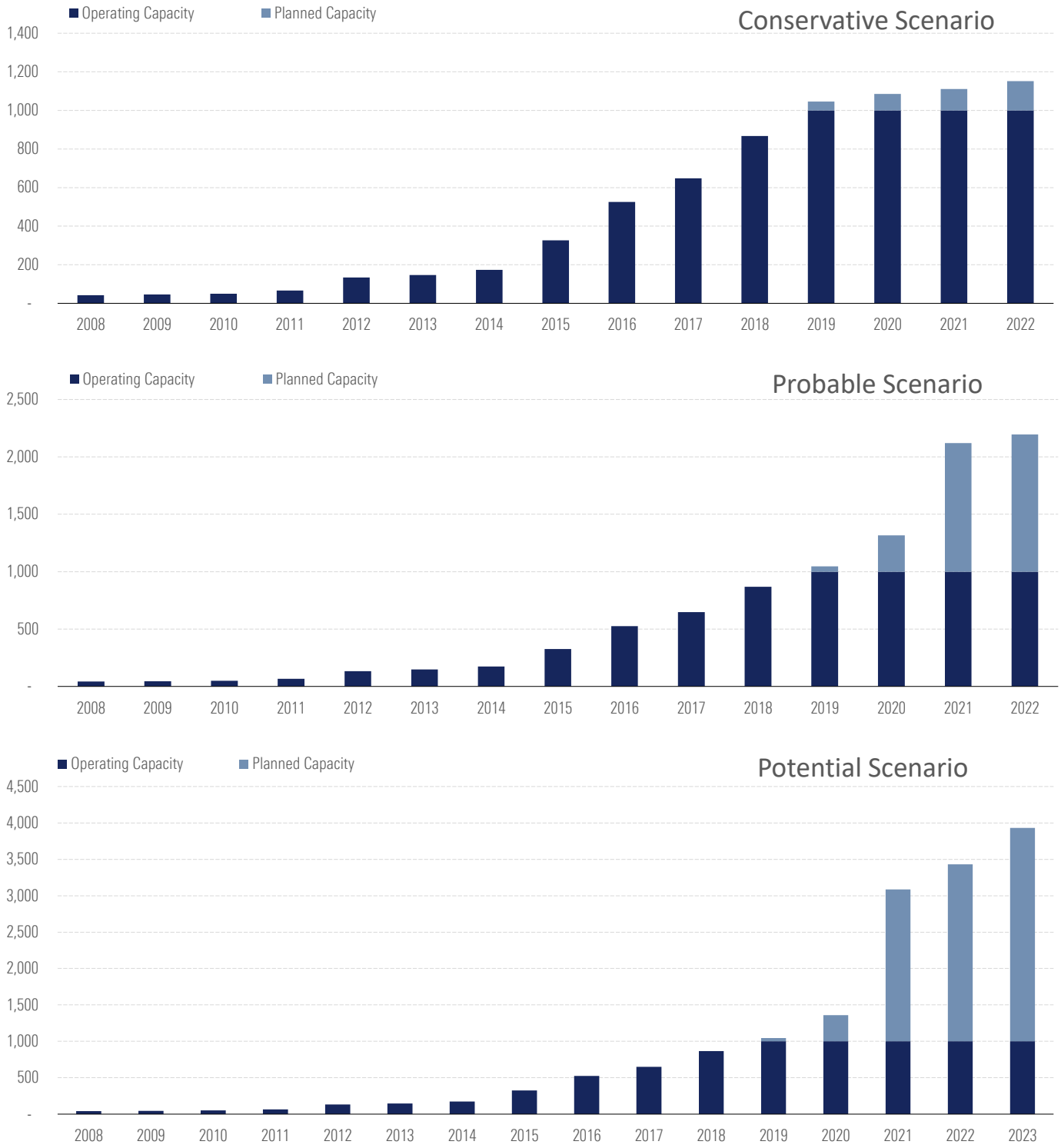


Source: CAISO, Morningstar

Capacity Outlook

The absence of storage options has been a hallmark of power markets. The result is the most volatile commodity pricing market, with ranges that can dip into negative territory and jump to quadruple-digit pricing for an hour even within the same day. But in the last five years, the market has started a transformation to add a few hundred megawatts of battery storage onto the U.S. grid and the expansion in front of the meter batteries have reached 1 gigawatt. Much like the advent of wind and distributed solar generation in the 2000s, the impact of storage is still negligible but should at a minimum continue to see a couple hundred megawatts, as seen in Exhibit 4, with a very conservative view of additions. Longer-term project proposals could double or even quadruple storage capacity in the next five years, though, looking at Exhibit 4 with likely projects and all potential projects according to the U.S. Energy Information Administration.

Exhibit 4 Storage Capacity Scenarios (Conservative, Probable, Potential, Scenarios)



Source: EIA, Morningstar

Storage Additions

Battery storage is poised to break out to some degree over the next decade. Expansion coming online in the next decade will start building flexibility that has not existed in the market before. As storage builds, the ability to generate revenue will likely evolve. In the meantime, battery technology still needs to realize greater efficiencies to push costs down without the need for subsidies, which may not be too far away. If a breakthrough results in a significant cost drop-off, the market could see an even greater build-out than the potential scenario. The key to understanding the impact of battery storage will be a net demand curve that not only takes into account solar and wind but also factors in storage to understand and resolve underlying elements of the demand and supply curve.

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