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As the global shift towards clean energy continues, energy storage systems are critical in transforming how we generate, store, and consume electricity. The energy storage market nearly tripled in 2023, the most significant year-on-year gain on record. The growth is driven by government mandates and targeted subsidies, as well as the need to balance renewable energy sources, improve grid reliability, and enable consumers to manage energy more effectively.

Understanding the different energy storage applications is essential to grasp the full potential of energy storage. Energy storage applications can be broadly classified into front-of-the-meter and behind-the-meter applications. Front-of-the-meter applications serve utilities and grid operators by enhancing grid stability. In contrast, behind-the-meter applications empower consumers to optimize energy usage, reduce costs, and improve energy resilience. This article will explore the applications of energy storage systems in detail to understand how energy storage is utilized.

Front-of-the-meter (FTM) refers to energy storage systems connected to the grid at the utility level before electricity reaches the end-users. These systems help stabilize the grid, manage large-scale energy demands, and support renewable energy integration.

Energy arbitrage involves grid operators buying wholesale electricity when prices are low, storing it in a battery energy storage system, and reselling it when prices are high. This application allows operators to capitalize on price fluctuations in the market, helping offset energy costs.

Load following is often considered a subset of energy arbitrage. It involves adjusting the electricity output of energy storage systems to match real-time fluctuations in demand. As demand rises, stored energy is output, and as demand decreases, storage systems input or absorb excess generation. For instance, a battery energy storage system would discharge when demand increases and charge when demand decreases. This application helps maintain grid stability by ramping up or down the electricity supply based on consumption data.

Voltage regulation or voltage support utilizes energy storage systems to maintain stable voltage levels on the grid. These systems inject or absorb reactive power to maintain consistent voltage and prevent fluctuations. The injection of reactive power is crucial to compensate for losses along transmission and distribution lines. Energy storage, particularly battery energy storage, is increasingly being used for this application due to its fast response times and ability to be located close to end users.

As electricity demand grows, energy storage systems can defer or reduce the need for costly transmission and distribution infrastructure upgrades. This storage application offers cost savings by avoiding buying new equipment. It also allows the same energy storage system to be used for other applications. This dual purpose maximizes the financial and operational return on investment for energy storage.

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Congestion occurs when the demand on a transmission line exceeds its capacity. Grid operators charge utilities higher prices to use these transmission lines at peak times. By deploying energy storage systems downstream of areas of congested transmission, electricity can be stored during peak congestion times and dispatched when the congestion level eases. This application helps reduce transmission bottlenecks and lowers associated costs.

Behind-the-meter (BTM) refers to energy storage systems installed on the consumer side of the electricity meter. These systems are used primarily by commercial and industrial (C& I) and residential customers in applications to optimize energy usage, reduce costs, and increase reliability.

When combined with solar panels, energy storage enables consumers to store excess solar energy generated during the day for use during the evening or on cloudy days. This application maximizes self-consumption and reduces reliance on the grid, leading to lower electricity bills. This energy storage application is valuable in locations where utilities offer little financial incentive to feed excess solar energy back to the electric grid. Solar Plus storage is ideal for both residential and commercial battery storage.

In areas with time-of-use (TOU) pricing, energy costs vary depending on the time of day. Energy storage allows consumers to take electricity from the grid during off-peak hours when prices are lower, store it, and then use it during peak hours when prices would typically be higher to reduce energy costs. These cost savings are achieved primarily through a strategy known as load shifting.

Many commercial and industrial customers globally face electricity bills based on not just their energy consumption but also their highest peak power draw. This fee for the highest peak power draw used over the billing period is a demand charge. It can make up 30% – 70% of the electricity bill. Energy storage helps to reduce demand charges by discharging stored energy during periods of peak power draw, known as peak shaving, effectively reducing the customer’s peak demand.

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