Applications of energy storage systems

Main Applications for Energy Storage Systems

Applications of Energy Storage: Behind-the-Meter (BTM)

Where can energy storage systems (ESS) generate value? Applications can range from ancillary services to grid operators to reducing costs "behind-the-meter" to end users. Battery energy storage systems (BESS) have seen the widest variety of uses, while others such as pumped hydropower, flywheels and thermal storage are used in specific applications.

Applications for Grid Operators and Utilities

Energy ArbitrageIn markets where there is a significant difference in locational marginal price (LMP) of electricity at different times, energy arbitrage can be used to offset costs. Wholesale electricity is purchased and stored when the LMP is low to be resold when the LMP is high. Some losses occur due during charging and discharging. Arbitrage on its own is not typically a profitable energy storage application, however can be combined with others by value stacking.

Energy Arbitrage refers to wholesale buying and selling which is done by grid operators -- for end-users using similar tactics see time-of-use management. Load following (ramping up electricity supply as activity increases in the morning and ramping down as activity diminishes towards the evening is considered a subset of energy arbitrage.

Flexible Peaking Resource/Resource AdequacyPeak demand on the grid generally only occurs for a few hours a day. In addition to the power generation that makes up the "base load" of electricity, utilities and grid operators keeping peaking resources on standby, ready to inject a surge of additional power into the grid. Peaker supply resources typically have been served by fossil fuels such as gas peaker plants.Many different types of electricity storage are seeing a surge of popularity as peaker resources due to their extremely fast response times -- in the case of lithium-ion batteries, in the milliseconds. Pumped hydropower storage is extensively used as a peaker resource.

Frequency RegulationThe electrical grid transmits power from generators to end users at a fixed alternating current (AC) frequency -- in general, 60 Hz for North and South American, 50 Hz for Europe and Asia. When power generation is equal to power usage, the frequency is stable. If usage is higher than generation, the frequency drops: brownouts and blackouts. When power generated exceeds the demands of the grid, the frequency rises: this can damage the grid and connected devices.

Frequency regulation involves regulating supply and demand on a second-by-second basis to keep the AC current within the exacting required tolerance bounds. As more and more renewables are connected to the electrical grid, variability in supply and fluctuations in frequency are increasingly frequent and severe.

Typically, generating assets are ramped up or down to provide frequency regulating services. In today"s market, it is the highest value ancillary service to the grid. Energy storage is increasingly being used instead of fossil fuel plants for this application -- their flexibility and up to millisecond fast response times make them well-suited.

Reserve Capacity (Spin/Non-Spin)A crucial requirement for electrical utilities, or groups of electrical utilities, is to keep the power on even if a generator goes offline. The system as a whole must not experience excessive variation in frequency and power flow even if the largest of the system"s generators goes down.

Typically, all generating assets in the system are deliberately run with a small percentage of reserve capacity, which adds inefficiencies, extra costs and waste. Fast-acting energy storage systems such as capacitors, flywheels and batteries can be used instead for this application, allowing generators to be run closer to their rated value. Reserve capacity is further split into spinning reserve (can respond within 10 seconds), Supplemental reserve (can respond within 10 minutes) and backup supply (can respond within one hour).