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THOUGHT LEADERSHIP

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Making Renewable Energy Usable Energy

Optimizing Utility-Scale Energy Storage Systems for Reliability and Safety

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As of February 2020, the U.S. had over 238,818 GW[1] of utility-scale capacity from renewable energy sources and a rated storage capacity of 23.942 GW. In just one year, the total amount of renewable power generated in the U.S. excluding hydroelectric grew over 24%[2]. This rapid growth in renewable power has driven demand for electrical energy storage systems (ESS), but use of these technologies on the scale necessary for utilities is still a relatively new concept. As a result, we have seen a series of safety-related incidents in Asia[3] following the rush to purchase and implement ESS equipment. In using ESS to harness the full potential of renewables, utilities, regulators, and investors in energy storage must understand the performance and safety requirements, potential risks, and risk mitigation strategies associated with these high-energy systems.

Multiple energy storage technologies are currently available (see Figure 1). Because each energy storage technology has its own implementation requirements, the process of selecting an ESS requires a multi-level understanding of the components involved. We recommend that owners/operators of an ESS perform design and hazard analyses at both the component level, taking care to fill in the gaps between suppliers of different components, and the system level. We believe this holistic view of ESS performance will become increasingly important as the quantity of and price pressure among component suppliers continues to grow.

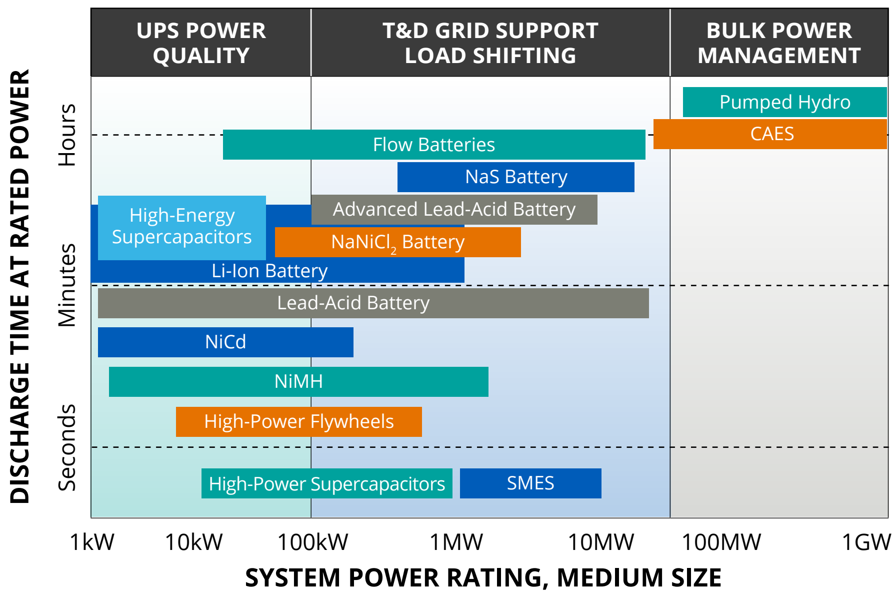

Figure 1. Available Technologies for Energy Storage. Adapted from Center for Sustainable Systems, University of Michigan. 2019. "U.S. Grid Energy Storage Factsheet." Pub. No. CSS15-17[4].

[1] https://www.eia.gov/electricity/monthly/update/archive/april2020/
[2] http://css.umich.edu/factsheets/us-grid-energy-storage-factsheet
[3] http://www.koreaherald.com/view.php?ud=20200206000768
[4] http://css.umich.edu/factsheets/us-grid-energy-storage-factsheet

The U.S. currently has several operational battery-related energy storage projects based on lead-acid, lithium-ion, nickel-based, sodium-based, and flow batteries. Assuming currently planned additions are completed, and no current operating capacity is retired, utility-scale battery storage capacity in the U.S. could exceed 2,500 MW by 2023[5]. Many large utilities and battery suppliers are also investing heavily in Asia to boost regional grid stability. Though the demand for these systems has slightly decreased since the first wave of smart grid construction in the last few years, and the supply chain has recently been impacted by COVID-19, we still expect that emerging markets in the U.S. and Asia—such as China, India, and countries in the Association of Southeast Asian Nations (ASEAN)—will undergo greater growth than North American and European markets[6] in the future.

Comprehensive design and proactive hazard analyses can help optimize the lifetime of these investments and guard against the property damage or loss of life that could occur in the event of a failure. These analyses should include a cell-level evaluation of electrochemical batteries, battery pack thermal and electrical characterization, and a review of battery life expectancy and degradation. Battery facilities should also develop plans for risk mitigation within the facility itself, as well as plans to address environmental and public health concerns related to technology implementation.

How Exponent Can Help

Exponent's multi-disciplinary team of electrical engineers, mechanical engineers, materials scientists, and battery chemists has experience in all aspects of energy storage and renewable energy, including battery sizing, battery management systems, product safety evaluation, risk mitigation, and evaluation of environmental and public health concerns[7]. We can help utilities and other investors in ESS perform component supplier audits, design reviews, failure analyses, abuse testing, risk assessments, risk mitigation planning, and optimization of operating conditions (temperature, cycle profile, etc.) to maximize the lifetime of the ESS battery, thereby reducing the overall cost of the system.

[5] https://www.eia.gov/todayinenergy/detail.php?id=40072
[6] https://www.iea.org/topics/covid-19
[7] https://www.exponent.com/knowledge/publications/mitigating-the-hazards-of-battery-systems/?pageSize=NaN&pageNum=0&loadAllByPageSize=true

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