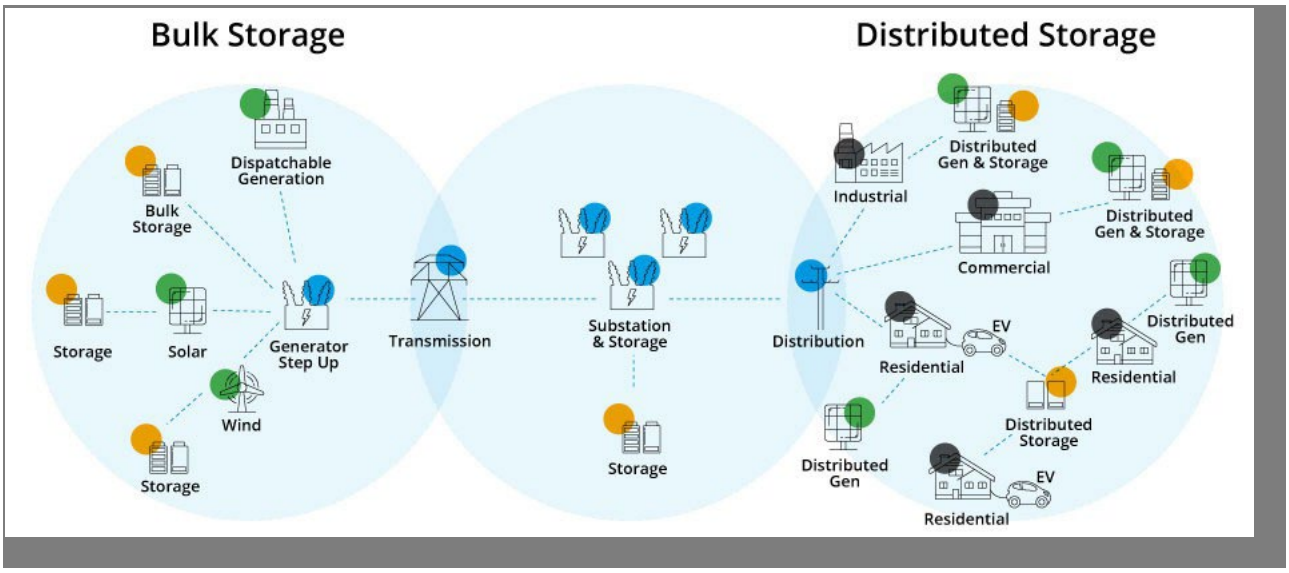
BESS

Battery Energy Storage Systems

Lithium-ion batteries are rechargeable and commonly found in devices like cellphones, laptop computers, power tools, and electric vehicles. They are increasingly popular for larger scale electrical energy storage in homes, businesses, and on the power grid. Today, lithium-ion battery storage is considered the benchmark for “short duration storage” in the electrical power industry. Short duration storage is generally four hours or less in discharge duration at rated power. Battery energy storage systems (BESS) work together with renewable energy, like wind and solar, to store energy by charging the batteries when those resources are abundant. The stored energy is then used during times when wind and solar are not available. Typical energy discharge duration is between 30 minutes and 4 hours. Figure 1 illustrates how lithium-ion batteries are integrated into the electrical infrastructure. Lithium-ion battery storage (orange) can be installed in various locations; where electricity is generated (green), where it is transported (blue) and where it is consumed (grey).

Figure 1
Lithium-Ion Battery Storage Infrastructure



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Characteristics of Lithium-Ion Batteries

- Rechargeable
- Energy dense, modular, scalable, and flexible
- Easily integrated with renewable power generation
- Lithium-ion batteries for grid-scale stationary energy storage is growing and account for more than 80 percent of all new battery storage installations in 2023
- Made from minerals such as lithium, cobalt, nickel, and manganese
- Electrochemical battery performance is highly dependent upon the immediate surrounding ambient temperature of the individual battery cells. Temperature control is accomplished with heating, ventilation, and air conditioning systems that are used to maintain the desired environmental parameters for consistent operation.
- Improvements in engineering design and manufacturing processes are enabling more precise and effective cooling of the battery cells for optimum performance

Advantages of Batteries

- Batteries provide grid stability by complementing renewable energy resources such as wind and solar. The concern of grid instability increases as the amount of renewables generation increase; batteries improve stability by smoothing voltage fluctuations
- Lithium-ion batteries are being used in place of fossil fueled peaking power plants to supply electricity to the grid
- Batteries have low operating and maintenance costs when compared to other forms of electrical power equipment
- The development time for lithium-ion battery energy storage is one of the shortest timelines among all major grid-power system facilities
- The time to construct a battery energy storage system using lithium-ion batteries is relatively short in duration and is generally 18 to 24 months

Performance for Power Applications

- Electrochemical batteries are very efficient energy storage devices
- Lithium-ion batteries have an average round trip (charging and discharging) efficiency of 90 percent the lifetime of the system
- Lithium-ion battery facilities have a design life of 20 years. The life is expected to increase as new or enhanced designs are developed
- Batteries by themselves do not emit any carbon emissions. When charged using renewables, the entire process emits no carbon. However, if the electrical power generation used to charge the batteries use carbon-based fuels, then the charging source does generate carbon emissions

Safety

- Lithium-ion batteries, like all electrical equipment, have caused fires. Improved designs, adoption of early detection and fire suppression systems, education, and awareness are layers of protection to improve the safe operation of lithium-ion battery energy storage systems.

Opportunities, Challenges, and Risks

- The cost of lithium-ion batteries has declined rapidly over the last 10 years. The costs are expected to continue to decline as much as 47 percent by 2030 from improved manufacturing and higher economies of scale.
- Batteries degrade over time and lose some capacity over their expected life. This is typically mitigated by system overbuild or augmentation to maintain expected capacity over the life of the system.
- Recycling of lithium-ion batteries is not yet common, but advancements are being made. Recycling is expected to be commercialized at large scale in the next few years.
- There are some safety challenges that have impacted lithium-ion batteries in the past. These safety challenges have been addressed by the industry through improved designs and education.

Leverage Black & Veatch's experience across renewables, transmission, distribution, and smart grids to **identify, implement, and manage the energy storage solutions of the future.**

For more information please contact:
Parker Lohrenz, Battery Energy Storage Manager
P +1 303-256-4084 | E LohrenzP@bv.com

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bv.com/energystorage