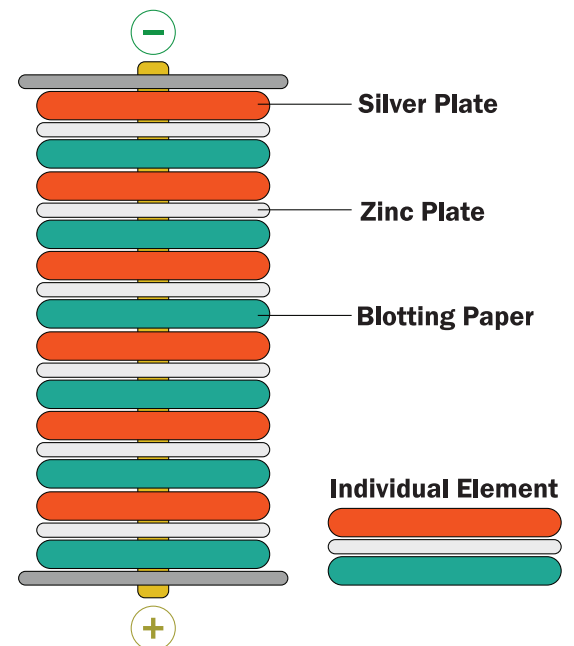


**CONCEPT** In a battery, electric charge is stored in the form of chemical energy, which can be converted into electrical energy when the battery is used. The amount of charge stored in a battery is related to its capacity, which is measured in ampere-hours (Ah).

The capacity of a battery is related to the amount of charge stored in the electrodes, which in turn relates to the number of charged particles present in the battery. Coulomb's law can help explain why batteries with larger capacities can store more charge and deliver more energy than batteries with smaller capacities. By understanding the principles of Coulomb's law, students can gain a deeper appreciation for how batteries work and how they can be used to store and deliver electrical energy.

## BACKGROUND

The history of battery storage dates back to the early 19th century when Italian physicist Alessandro Volta invented the first true battery, the "Voltaic Pile." Over the next century, technological advances led to the development of various types of batteries, including lead-acid batteries, which were widely used in the automotive industry. In the mid-20th century, new technologies such as nickel-cadmium and lithium-ion batteries were introduced, greatly improving battery storage capacity and efficiency. With the rise of renewable energy sources in the 21st century, battery storage has become increasingly important for storing excess energy generated from solar and wind power. Today, battery storage is a rapidly evolving industry, with continued technological advances driving down costs and improving performance, making it an increasingly viable alternative to traditional fossil fuel power generation.



**Voltaic Pile**

## EXAMPLES

**BATTERY CELLS:** The basic unit of a battery that stores electrical energy. These cells are typically made up of a positive electrode, a negative electrode and an electrolyte.

**BATTERY MANAGEMENT SYSTEM (BMS):** A system that monitors and controls the battery's charging and discharging process, ensuring its safe and efficient operation.

**INVERTER:** A device that converts direct current (DC) from the battery to alternating current (AC) that can be used to power electrical devices.

**ENCLOSURE:** A protective casing that houses the battery cells and other components of the battery storage system.

**THERMAL MANAGEMENT SYSTEM:** A system that manages the temperature of the battery cells to ensure optimal performance and prevent damage from overheating.

**ENERGY MANAGEMENT SYSTEM (EMS):** A system that optimizes battery storage by managing when and how energy is stored and discharged.

*Make sure it measures up*



**CABLES AND CONNECTIONS:** The wiring and connectors that transfer electricity between the battery storage system and electrical devices.

**MONITORING AND CONTROL SOFTWARE:** Software that provides real-time monitoring and control of the battery storage system, including performance data, charging/discharging rates and other key metrics.

**ENERGY STORAGE MEDIUM:** The material or substance used to store energy in the battery, such as lithium-ion, lead-acid or flow batteries.

**SAFETY FEATURES:** Various safety features such as circuit breakers, fuses and fire suppression systems that protect the battery storage system from overcharging, over-discharging and other potentially dangerous situations.

## REAL WORLD CONNECTIONS

California's Moss Landing Energy Storage Facility is an example of a utility-scale battery storage system. The facility uses many lithium-ion batteries to store excess energy generated by solar and wind farms during times of low demand. The stored energy can be released back into the grid during high demand periods, reducing the need for fossil fuel-fired power plants to ramp up production. The Moss Landing Energy Storage Facility has a capacity of 750 megawatts (MW) and can provide up to 3,000 megawatt-hours (MWh) of electricity, making it one of the largest battery storage systems in the world. The facility is designed to help California meet its ambitious renewable energy goals by storing excess renewable energy and releasing it into the grid when needed, reducing the state's reliance on fossil fuels and helping to stabilize the grid.



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