

## How An Ultra Capacitor Works

Ultra capacitors & Super Capacitors store electricity by physically separating positive and negative charges—different from batteries which do so chemically. The charge they hold is like the static electricity that can build up on a balloon, but is much greater thanks to the extremely high surface area of their interior materials.

An advantage of the ultracapacitor is their super fast rate of charge and discharge... which is determined solely by their physical properties. A battery relies on a slower chemical reaction for energy. A disadvantage of an ultracapacitor is that currently they store a smaller amount of energy than a battery does. Ultracapacitors are very good at efficiently capturing electricity from regenerative braking, and can deliver power for acceleration just as quickly. With no moving parts, they also have a very long lifespan - 500,000 plus charge/recharge cycles. Ultracapacitors are currently used for wind energy, solar energy, and hydro energy storage. An ultra capacitor, also known as a double-layer capacitor, polarizes an electrolytic solution to store energy electrostatically. Though it is an electrochemical device, no chemical reactions are involved in its energy storage mechanism. This mechanism is highly reversible, and allows the ultra capacitor to be charged and discharged hundreds of thousands of times.

Once the ultra capacitor is charged and energy stored, a load (the electric vehicle's motor) can use this energy. The amount of energy stored is very large compared to a standard capacitor because of the enormous surface area created by the porous carbon electrodes and the small charge separation created by the dielectric separator. Here is a very basic example of how an ultracapacitor works by using a circuit that uses a dc motor.

**TECHNICAL DESCRIPTION:** An ultracapacitor can be viewed as two non reactive porous plates, or collectors, suspended within an electrolyte, with a voltage potential applied across the collectors. In an individual ultra-capacitor cell, the applied potential on the positive electrode attracts the negative ions in the electrolyte, while the potential on the negative electrode attracts the positive ions. A dielectric separator between the two electrodes prevents the charge from moving between the two electrodes. Electrical energy storage devices, such as capacitors, store electrical charge on an electrode. Other devices, such as electrochemical cells or batteries, utilize the electrode to create, by chemical reaction, an electrical charge at the electrodes. In both of these, the ability to store or create electrical charge is a function of the surface area of the electrode. For example, in capacitors, greater electrode surface area increases the capacitance or energy storage capability of the device. As a storage device, the ultracapacitor, relies on the microscopic charge separation at an electrochemical interface to store energy. Since the capacitance of these devices is proportional to the active electrode area, increasing the electrode surface area will increase the capacitance, hence increasing the amount of energy that can be stored. This achievement of high surface area utilizes materials such as activated carbon or sintered metal powders. However, in both situations, there is an intrinsic limit to the porosity of these materials, that is, there is an upper limit to the amount of surface area that can be attained simply by making smaller and smaller particles. An alternative method must be developed to increase the active electrode surface area without increasing the size of the device. A much more highly efficient electrode for electrical energy storage devices could be realized if the surface area could be significantly increased.