# Mechanical storage

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Mechanical energy storage can be added to many types of systems that use heat, water or air with compressors, turbines, and other machinery, providing an alternative to battery storage, and enabling clean power to be stored for days.

While the physics of mechanical systems are often quite simple (e.g. spin a flywheel or lift weights up a hill), the technologies that enable the efficient and effective use of these forces are particularly advanced. High-tech materials, cutting-edge computer control systems, and innovative design makes these systems feasible in real-world applications.

A flywheel is a rotating mechanical device that is used to store rotational energy that can be called up instantaneously. At the most basic level, a flywheel contains a spinning mass in its center that is driven by a motor - and when energy is needed, the spinning force drives a device similar to a turbine to produce electricity, slowing the rate of rotation. A flywheel is recharged by using the motor to increase its rotational speed once again.

Flywheel technology has many beneficial properties that enable us to improve our current electric grid. A flywheel is able to capture energy from intermittent energy sources over time, and deliver a continuous supply of uninterrupted power to the grid. Flywheels also are able to respond to grid signals instantly, delivering frequency regulation and electricity quality improvements.

Flywheels are traditionally made of steel and rotate on conventional bearings; these are generally limited to a revolution rate of a few thousand RPM. More advanced flywheel designs are made of carbon fiber materials, stored in vacuums to reduce drag, and employ magnetic levitation instead of conventional bearings, enabling them to revolve at speeds up to 60,000 RPM.

Flywheel energy storage systems (FESS) use electric energy input which is stored in the form of kinetic energy. Kinetic energy can be described as "energy of motion," in this case the motion of a spinning mass, called a rotor.

Some of the key advantages of flywheel energy storage are low maintenance, long life (some flywheels are capable of well over 100,000 full depth of discharge cycles and the newest configurations are capable of even more than that, greater than 175,000 full depth of discharge cycles), and negligible environmental impact. Flywheels can bridge the gap between short-term ride-through power and long-term energy storage with excellent cyclic and load following characteristics.

FESS are especially well-suited to several applications including electric service power quality and reliability, ride-through while gen-sets start-up for longer term backup, area regulation, fast area regulation and frequency response. FESS may also be valuable as a subsystem in hybrid vehicles that stop and start frequently as a component of track-side or on-board regenerative braking systems

Compressed air energy storage (CAES) is a way to store energy generated at one time for use at another time. At utility scale, energy generated during periods of low energy demand (off-peak) can be released to meet higher demand (peak load) periods.

Since the 1870"s, CAES systems have been deployed to provide effective, on-demand energy for cities and industries. While many smaller applications exist, the first utility-scale CAES system was put in place in the 1970"s with over 290 MW nameplate capacity. CAES offers the potential for small-scale, on-site energy storage solutions as well as larger installations that can provide immense energy reserves for the grid.

Compressed air energy storage (CAES) plants are largely equivalent to pumped-hydro power plants in terms of their applications. But, instead of pumping water from a lower to an upper pond during periods of excess power, in a CAES plant, ambient air or another gas is compressed and stored under pressure in an underground cavern or container. When electricity is required, the pressurized air is heated and expanded in an expansion turbine driving a generator for power production.

Two existing commercial scale CAES plants in Huntorf, Germany, and in McIntosh, Alabama, USA, as well as all the proposed designs foreseeable future are based on the diabatic method. In principle, these plants are essentially just conventional gas turbines, but where the compression of the combustion air is separated from and independent to the actual gas turbine process. This gives rise to the two main benefits of this method.