

BATTERIES vs FLYWHEELS

A **battery** stores energy by converting electrical energy to chemical energy using electrolytes and electrodes. In a **flywheel**, electricity is stored as mechanical energy by simply spinning a rotor.

HOW FLYWHEELS WORK

A flywheel is a very simple device. It consists of a wheel (rotor) that spins on two bearings. The spin axis is vertical. The wheel is attached to an electric motor which, when connected to power, spins it up to a maximum rated speed. At this speed, the wheel has energy by virtue of its rotation. To minimize air friction, the wheel is enclosed inside a vacuum chamber. When the motor is switched to act as a generator, it slows the wheel as it removes some of the wheel's kinetic energy in the form of electrical energy.

An energy source, such as solar panels, is used to spin the flywheel up during the day when the sun is shining. At night, the solar panels are inactive and the energy stored in the flywheel is discharged to power lighting and other devices. In this way, a periodic energy source (the sun) becomes a steady source to power devices all day and night.

COMPARATIVE MEASURES

	Comparative Measures	BATTERIES	FLYWHEELS	Comments
1.	Method by which energy is stored	Chemical	Mechanical	Batteries are flammable & contain materials that can be toxic to the environment & are difficult to recycle. The Omnes steel flywheels use recycled steel that is recyclable & non-toxic.
2.	Efficiency	85%	85%	
3.	Operating Temperature Range	-20°C to 45°C	-40°C to 70°C	Flywheels are insensitive to temperature while batteries cannot be charged at temperatures approaching -20°C. Also at the high temperature extreme, battery efficiency is very low.
4.	Cycle Life	2000	>50,000	Battery cycle is dependent on how much the battery is discharged in each cycle. Higher life is obtained at the expense of the amount of energy that can be stored in each cycle.
5.	Design Life	3-5 years	25+ years	Utilities require a 15-year minimum equipment life (Source: <i>Electric Power Research Institute</i>)

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6.	Energy Storage Capacity Degradation	?	Zero	Battery systems must be “refreshed” after a few months due to memory effects; otherwise the capacity is reduced significantly.
7.	Control Complexity	Complicated & not well understood	Simple & straight-forward	Controlling a flywheel is much simpler than managing a battery. The reason is that batteries, unlike flywheels, have memory & change their characteristics with time, temperature, number of cycles & past charge/discharge history.
8.	Weight	Light	About 5 times heavier	Unlike batteries, steel flywheels are heavy & are not practical for vehicles.
9.	Volume	Small	Small	Both batteries & flywheels occupy relatively small volume.
10.	Installation	Requires air-conditioned space	Above or below grade with no air-conditioning required	Steel flywheels are much more robust than batteries & can be used in remote locations with rudimentary infrastructure requirements.
11.	Levelized Cost of Storage (LCOS)	11c/kWh	3.8c/kWh	Levelized Cost of Storage (LCOS) for 25-year life microgrid applications @ 1 cycle/day.
12.	Infrastructure	Requires separate building with conditioned space	Standard blockhouse or below grade sewer pipe-lined shaft	