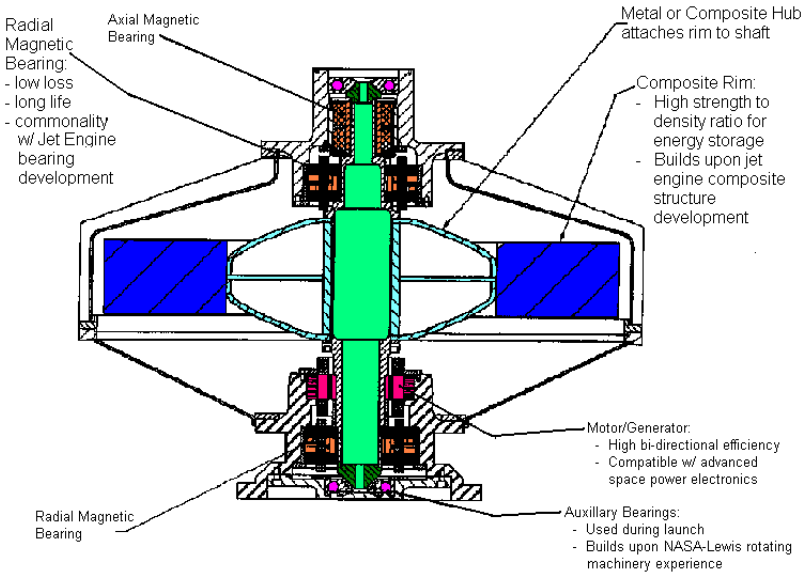
Flywheels

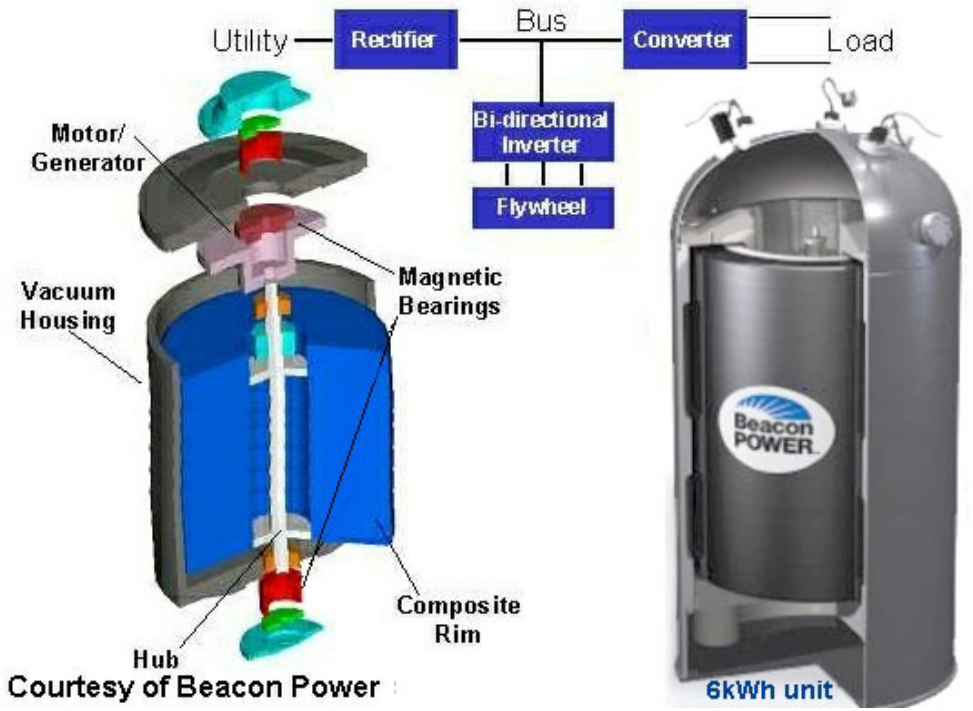
Principle of operation

Kinetic energy of a rotating solid with a moment of inertia I is expressed as : $E_c = \frac{1}{2} I\omega^2$.



Usually, it is coupled with a generator and an engine for energy extraction/injection out of/into the flywheel.

Example



Technical data

Temperature of operation	Energy	Rotation speed	Number of deep cycles	Power at steady state/ 30s	Charge/discharge efficiency	Self discharge
–20 to +50 °C	30-100 Wh/kg 60-120 Wh/dm^3	4000 to 200000 rev/min	>10000 (20 years)	400 - 1600 W/kg	90%	0.1 % /hour !

Maintenance	Environmental impact	Safety
Periphery system Bearings control : every 30 months	No particular risk for environment Metal and material Recycling	Rotor speed must be controlled for the system to work properly and securely

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Applications

Application	Type	Power	Capacity	Development status
UPS	Low speed	40 kW	0.67 kWh (60s)	market
UPS	Low speed	480kW	1.67 kWh (12.5s)	market
UPS	36000 rev/min	100kW	0.8 kWh (30s)	market
UPS	40800 rev/min	300kW	0.25 kWh (3s)	market
Power Quality	17500 - 35000 rev/min	50 kW	1.3 kWh	

R&D Perspectives

- Rotor materials (tensile strength, stability) and manufacturing technology
- Magnetic and mechanical bearings (fail-safe, reduction of standing losses)
- Safety and Certification
- Power electronics interface & control (losses, pulsed power techniques, storage modules, response time)
- Hybrid storage topologies (e.g. with battery)
- Control strategies (application-specific)
- Instrumentation, condition monitoring, life prediction

Economic data

Current costs :

1000 - 5000 €/kWh
3000 - 10 000 €/kW

Manufacturers:
Piller
Active Power
Urenco Power Technologies
Beacon Power (SatCon)
Acumentrics Corporation
AFS Trinity Power Corporation
Trinity model M3A
Flywheel Energy Systems
US Flywheel
Pentadyne
Boeing
Argonne National Laboratory
Lawrence Livermore National Laboratory (LLNL)

Research Institutes:

NASA, DOE, Rutherford Appleton Laboratory,
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