



THE LEADING MANUFACTURER OF ULTRACAPACITORS AND LITHIUM-ION CAPACITORS

LICAP Technologies Application Note

An Ultracapacitor Energy Storage System For Grid Balancing

Grid imbalance between generation and load is monitored and balanced by tracking changes in AC line frequency, commonly referred to as 'frequency response'. The rotating mass of generators (spinning wire coil within a magnetic field) provide a flywheel inertia buffer to sudden changes in load demand. As load demand suddenly increases beyond this buffer capacity and the flywheel starts to slow, line frequency decreases. If load demand suddenly decreases, frequency will increase but is typically dealt with by reducing generator output. Rapid response to a decreasing frequency event is critical in preventing a cascading loss of service.

Dedicated peaker generators and renewable generation resources such as wind, wave, and solar are not dependable sources to mitigate sudden peak load demand. Peakers take time to come online and renewables can exacerbate the overload condition by going off-line at an inopportune point in time.

LICAP ultracapacitor systems provide additional inertia buffering against sudden load changes within milliseconds. This fast response stabilizes the deviant change in frequency and bridges the time gap in bringing additional generator capacity on-line.

Advantage LICAP

- High power density in a space 3 to 5 times smaller than a battery solution
- Low maintenance compared to a lead acid battery system
- Up to 1 million cycles and calendar life of 15 years
- Scalable to allow for over 100MW

- Extends battery life in hybrid systems by buffering high rates of discharge

Grid Balancing Application Considerations

Energy storage efficiency, or ‘round trip efficiency’ is the ratio of energy input to energy retrieved. Low efficiency requires topping off the energy storage system with real-time purchase of energy which is best avoided.

Lifetime of ultracapacitor energy storage systems is measured in cycles, or calendar life. Cycle life is the number of full charge/discharge cycles, while calendar life (typically associated with UPS systems with infrequent charge/discharge cycles) is primarily a function of voltage and temperature.

Ultracapacitors have superior life (cycle and calendar) as compared to batteries, as well as greater efficiency. Ultracapacitors are also safer and maintenance free:

Energy Storage Technology Comparison

Characteristic	Ultracapacitor	Lithium Ion	Lead Acid
Efficiency	95%	80% - 90%	75%
Cycle Life	1,000,000	500 - 1000	500
Calendar life	10+ years	5 years	4 years
Environmental/Safety	Hermetic, non-toxic, no lead, no acid	Considered hazardous material, thermal runaway potential	Lead content, corrosive acid, explosion hazard

For grid balancing applications, the following points should be considered when determining ultracapacitor sizing to meet peak load requirements:

- Maintain frequency deviation within grid operator established tolerances and time limits
- Ultracapacitor energy storage capacity is based on 80% of initial capacity at end of life and should be compensated for as such
- Usable energy storage of ultracapacitors is always calculated with lower voltage cut off at 50% of maximum voltage per cell
- Power loss due to efficiency levels of bidirectional DC to DC conversion/DC to AC inverter between the ultracapacitors and grid

- Proper cell de-rating and system cooling considerations at higher temperatures to ensure expected ultracapacitor life span

Recommended LICAP Module



SM0125-064ATH Specifications

Rated capacitance	125F
Rated voltage	64V DC
ESR (DC) – typical	8 mΩ
Max leakage current	6 mA
Max continuous current	140 A
Max peak current	1900 A
Stored energy	71 Wh
Power density	4000 W/kg
Operating temp range	-40°C to +65°C
Scalable, rack mounted, zero maintenance	

Our Story

LICAP Technologies, established in 2016, is a manufacturer of innovative ultracapacitor electrode material, high quality ultracapacitor cells and ultracapacitor modules. Our patented LICAP Activated Dry Electrode manufacturing process was developed in our California R&D laboratories. Dr. Linda Zhong, the leader in modern ultracapacitor electrode design with over forty patents in the US and abroad, is our company President. LICAP Technologies leads the way in ultracapacitor performance.