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ENERGY PRODUCTS AND TECHNOLOGY

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About Supercapacitor Energy, LLC

Supercapacitor Energy, LLC (SCE) is the premier US Distributor of hybrid supercapacitor-based energy storage solutions.

Our team of industry and technology experts with over 200 years combined experience apply our knowledge to helping customers make informed decisions when it comes to meeting their energy storage needs. We provide economic and technical analysis to tailor every solution to the requirements of our customers and present a variety of alternatives to ensure they achieve the most value from choosing supercapacitor energy storage for its intended use.

The fundamental physics of capacitors is not new. Capacitors have been in use for over 100 years, but our solutions represent a significant and fundamental shift in how they are applied for stationary energy storage needs.

SCE promotes a fundamental shift in thinking and a real solution to advance the usability of renewable energy. What we provide addresses the weaknesses inherent in pure chemical battery storage solutions, specifically, safety, longevity and limited cycling capabilities. The products we represent are capable of daily charge/discharge cycles of 100% for more than 50 years under favorable ambient temperature conditions.

Our solutions will provide many years of reliable service with no maintenance required. Attempting to meet this requirement, using Lithium-Ion batteries or any other chemical energy storage is impractical and exceeds the capabilities of battery-based energy storage. Fundamentally, chemical-based energy storage is not practical, sustainable, or cost effective for a daily use, long-term solution. SCE is

changing the way individuals, industry and utilities think about energy storage and the optimization of renewable energy resources.

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Supercapacitor Energy LLC promotes a fundamental shift in thinking and a real solution to advance the usability of renewable energy.

HYBRID SUPERCAPACITOR ENERGY STORAGE

Hybrid Supercapacitor energy storage is evolving to become an energy dense alternative to Lithium-Ion batteries for stationary energy storage needs. Hybrid Supercapacitor storage modules are long lasting, recyclable and environmentally sound. Hybrid Supercapacitors can be installed as a direct replacement for chemical batteries. The manufacturing, transportation and use of Hybrid Supercapacitors is safe for people and the environment.

Hybrid Supercapacitor's environmental advantages are found across the entire value chain from reduced mining, the materials used in manufacturing, and the reduction of greenhouse gases that their use enables. In addition to Hybrid Supercapacitor's environmental advantages, they offer significant financial, operational and life cycle advantages over chemical (Lithium-Ion and Lead Acid) batteries, making Hybrid Supercapacitors the most durable, efficient and cost-effective energy storage solution in the world.

Supercapacitor Energy is changing the way individuals, industry and utilities think about energy storage and the optimization of renewable energy resources.

Hybrid Supercapacitor Energy Storage advantages include:

➢ Thousands more cycles and therefore, significantly longer life; 10 x Lithium, 50 x Lead Acid.

➢ Minimal capacity decay from repeated cycling; Lithium-Ion capacity is below 70% in 2,000 cycles.

➢ Wider operating temperature range; -40°C to +60°C.

➢ Wider state of charge range; 0% to 100%.

➢ Mitigated thermal runaway risk.

➢ Anode design using Lithium doped Graphene provides high energy density; 120-150 Wh/Kg.

➢ Substantially higher and safer charge/discharge rates than Li Ion batteries; Up to 5C vs. 0.5C.

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➢ Can be fully charged and discharged without damage or loss of capacity retention ability.

➢ They are safe. Chemical redox reaction is limited to Anode and minimized with capacitance Increase.

How Hybrid Supercapacitors address issues created by Distributed Energy Resources on the distribution grid:

1) High daytime voltages on the distribution system as the solar reaches peak production

a. Energy storage during solar hours and release during peak demand hours

2) Reverse power flow, protection coordination issues, and substation strain, particularly on tap changers

a. Distributed energy storage near the DER source

3) Frequency distortion due to rapid fluctuation of solar output

a. Rapid response charge/discharge of supercapacitors @ 3x or more than the rate of chemical batteries

4) Mismatch of energy production with load requirements

a. Distributed and Circuit-level energy storage with twice daily cycling capabilities

5) Potential costly network reconductoring and other mitigation projects

a. Store energy near the loads and dispatch when needed most

How Hybrid Supercapacitors address issues inherent in backup energy and daily cycling applications

In enclosures, Hybrid Supercapacitors require minimal HVAC or integral liquid cooling due to a very wide operating temperature range. (-40C to +70C). Because of Hybrid Supercapacitor's high DC to DC round trip efficiency (98%), supercapacitors do not contribute heat to an energy storage enclosure, further reducing the cooling requirements of power conversion equipment. Supercapacitor's charge rate is 15 times faster than lead acid batteries, allowing them to reduce generator runtime by as much as 75% in off grid scenarios, creating substantial savings in generator fuel and maintenance costs.

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In daily cycling applications such as Time of Use and Peak Shaving, Hybrid Supercapacitor superior cycle life provides years of reliable service. Supercapacitors do not require maintenance, reducing the operating costs of maintaining a communication network.

The following table compares various performance factors of Supercapacitors with chemical batteries.

Supercapacitor / Chemical Battery Comparison

CHARACTERISTIC	HYBRID SUPERCAPACITORS	CHEMICAL BATTERIES
Cycle Life @ 25°C & 95% DoD	**20,000 +**	< 4,000
200 times more cycle life than chemical batteries equals substantially reduced capital costs to replace worn out battery infrastructure.		
DC to DC efficiency (@25°C)	**98% (Minor degradation)**	70% to 95% (degrades over life)
Efficiency between charge and discharge means more electricity is captured and used		
Useable Capacity (% of rated capacity) & degradation over time	**100% (constant over life)**	50% to 80% (degrades over life)
All chemical batteries degrade over time from the first cycle and throughout their usable life. Supercapacitors remain constant over their usable life with little to no performance degradation. Chemical batteries are limited to a depth of discharge some as low as 50% and some as high as 70% but Supercapacitors can be discharged 100% without any damage allowing for greater use of their power as compared to chemical batteries.		
Temperature Range1	**-40°C to 60°C**	0°C to 55°C
Operation outside Temperature Range	**Yes**	No
Greater operating temperature ranges means that there is reduced costs and risks to batteries exposed to temperature extremes that cause damage. Chemical batteries suffer damage and irreparable harm when operated outside their usable temperature range. Supercapacitors do not suffer damage or reduced performance and reduce reliance on HVAC operating support.		

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Max. Rate of Charge	**Up to 5C**	0.1C to 0.5C
Faster rate of charge equates to reduced generator run-time, (off-grid - less fuel costs, less generator maintenance costs) for battery charging. Faster rate of charge additionally increases the usable energy from solar and wind sources by capturing more energy as it is generated. Supercapacitors can also be used for energy arbitrage by rapidly charging them during times of day when grid power is cheaper and using the stored power when rates increase.		
Max. Rate of Discharge	**Up to 5C**	0.1C to 0.5C
High rate of discharge allows Supercapacitors to take on much greater torque loads for starting motors and heavy lifting. They are the optimal solution for peak-shaving at a utility-scale implementation.		
Toxicity	**Non-Toxic / Recyclable**	Toxic
Chemical batteries are made from highly toxic materials such as lead, and sulphuric acid, known to cause harm to humans and the environment. Every year millions of tons of lead and other toxic chemicals make their way to landfills and water sources as a result of chemical batteries. Supercapacitors are made from compostable materials such as paper and graphene and have minimal environmental impact.		
Volatility	**Non-Volatile**	Highly Volatile
Chemical batteries such as Lithium-Ion are known for their volatility. Thermal run-away, which has caused explosions and fires, is an ongoing concern and must be addressed with additional expensive cooling systems or outright restrictions on battery performance. Supercapacitors are safer and require no special systems to manage gases or temperature.		
Form Factor	**Flexible**	Limited
Highly flexible form factor enables supercapacitors to be developed in a variety of dimensions that fit specific needs making for greater flexibility of use and adaptability.		
Discharge Rate in Storage	**<2% / Month**	5% / Month
Lowest overall static discharge rate of any battery allows power to be stored more efficiently over longer periods of time. Furthermore, supercapacitors can be stored for 10 years without a charge.		

“The creation of hybrid supercapacitor-based energy storage module is the most important technical

advancement of mankind since the invention of the microchip.”

Marty Snyder, CEO - CICUSA

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HYBRID SUPERCAPACITORS IN USE TODAY

Tordrillo Mountain Lodge, Alaska

AT&T Cell Site, Alamo, NV

NutraPak Facility, Grand Rapids MI

T-Mobile Site

Tampa Electric Site

https://rfusion.co.uk/hybrid-supercapacitors