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Docket Number:	20-EPIC-01
Project Title:	Development of the California Energy Commission Electric Program Investment Charge Investment Plans 2021-2025
TN #:	239110
Document Title:	LICAP Technologies, Inc. Comments - Ultracapacitor System Solution Opportunities - Energy Savings, Reduced Emissions, Improved Reliability
Description:	N/A
Filer:	System
Organization:	LICAP Technologies, Inc.
Submitter Role:	Applicant
Submission Date:	7/30/2021 1:07:25 PM
Docketed Date:	7/30/2021

*Comment Received From: LICAP Technologies, Inc.
Submitted On: 7/30/2021
Docket Number: 20-EPIC-01*

**Ultracapacitor System Solution Opportunities - Energy Savings,
Reduced Emissions, Improved Reliability**

Additional submitted attachment is included below.

Ultracapacitor System Solutions

Energy Savings, Reduced Emissions, Improved Reliability

LICAP Technologies, Inc.

7/30/2021

LICAP Technologies, Inc. develops and manufactures innovative energy storage products called ultracapacitors (UC) and lithium-ion capacitors (LIC). As compared to batteries, UC and LIC products have a very long life, high power capability, wide operating temperature range and an excellent track record of reliability. LICAP's UC and LIC products contain no toxic materials, no acid, and have no chance of fire due to thermal runaway. Our industry leading activated dry electrode material and the LIC products are both manufactured in Sacramento, CA. UC and LIC products have replaced batteries in a variety of applications to improve air quality, increase efficiencies, reduce greenhouse gases and improve reliability of critical systems. There are multiple potential applications we can discuss and explore with the California Energy Commission, here are a few examples:

- 1. Grid Energy Storage to improve grid reliability and increase efficiencies:** Solar and Wind Power generation can create problems for grid operators due to variable generation caused by intermittent cloud cover and occasional low wind conditions. To deal with these situations, the grid operators can bring additional resources on-line to provide the additional power buffer. How much power, for how long? To avoid grid power problems the additional power buffer is sometimes over-sized, brought on-line earlier than required and be kept on for longer than required which is highly inefficient. MW scale ultracapacitor implementations can be used to provide efficient high power buffer when required to reduce or eliminate the need for additional generation sources. Ultracapacitors have a longer life, higher reliability and safer track record than any battery based Grid energy storage solution.
- 2. Electric Rail - Energy Recuperation to save energy and improve grid reliability:** Many countries in Europe and Asia Pacific have already taken advantage of ultracapacitor based energy storage systems with proven performance. As the train approaches a station, the braking energy is recaptured and stored in the ultracapacitors either on board the train, or at the station. The stored energy is then used to accelerate the train which reduces grid energy consumption. The grid energy consumption can be reduced by up to 25% in this application. The second operating mode of these systems is grid stabilization mode. During peak hours the grid voltage can become unstable and drop below a minimum acceptable level, which can cause system failures that are relying on stable power supply. With ultracapacitor energy storage, the grid operator can feed power into the grid as required to maintain the required grid voltage and prevent system failures.
- 3. Port equipment – Reduced emissions and grid stabilization.** Logistics systems at harbor ports often rely on diesel powered equipment to load, unload and move containers around the port. This includes rubber tire gantry cranes, straddle carriers, forklifts and ship-to-shore cranes. During peak load events, such as lifting, the diesel engine must increase RPM which results in heavy emissions from the exhaust and fuel consumption.

A bank of ultracapacitors can be designed-in to handle the peak power events reducing the load on the diesel generator. This results in reduced emissions and reduced fuel consumption. The systems can also be designed to use a diesel engine that is 50% smaller than a standard system without ultracapacitors, which results in further reductions in fuel consumption and emissions. The ultracapacitors can be rapidly recharged by recapturing energy when the loads are being lowered, and also recharged from the diesel engine as needed. Other port facilities that use an electrical grid instead of diesel-powered equipment can also benefit from banks of ultracapacitors. Port operations have many unsynchronized peak power events that can cause the grid power to become unstable, create voltage sags and the potential for system failures. MW scale ultracapacitor banks can be placed on-site to feed power into the grid to stabilize the grid power on demand.

In all of the above examples, an ultracapacitor based energy storage system will outperform a battery-based solution in terms of life, operating temperature range and power performance. The ultracapacitor solution will be safer, non-toxic, lower maintenance, higher reliability and have a predictable end-of-life. The table below summarizes some of the characteristics and performance differences between ultracapacitors and batteries.

Energy Storage Technology Comparison			
Characteristic	Ultracapacitor	Lithium Ion	Lead Acid
Operating Temp Range	-40C to +65C	-20C to +45C	0C to +45C
Efficiency	95%	80% - 90%	75%
Cycle Life	1,000,000	500 - 1000	500
Calendar life	10+ years	4 years	4 years
Environmental/Safety	Hermetic, non-toxic, no lead, no acid	Considered hazardous material, thermal runaway potential	Lead content, corrosive acid, explosion hazard

LICAP Technologies has relationships with system integrators that can provide turn-key solutions as required. Please contact us for additional information and you are welcome to visit our Sacramento factory anytime.

Thank you,

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