Passive cooling of battery energy storage systems using SRI's Self-Cooling Paint™

Results of an independent field test

Extreme Heat Effects and Grid Failure Risk in Battery Energy Storage Systems (BESS)

Battery energy storage systems (BESS) are incorporated into electrical grid networks to provide energy demand balancing and resilience to grid failure. In 2024, an energy consultant for a public electricity provider near Las Vegas initiated an independent field test of SRI's Self-Cooling Paint to determine whether this coating could be used to keep battery storage containers cooler.

The interior of these metal storage containers is known to reach temperatures of over 100ºF, because of the dual impacts of the heat generated by the solar heat gain on the exterior container surfaces combined with the heat generated by the batteries themselves during operation. These containers have a thin (~1") layer of thermal insulation on the interior ceiling and walls. Depending on location, season, and weather conditions, the solar heat gain for battery energy storage systems can be significant.

Extreme heat can result in reductions in equipment lifetime and performance, as well as unscheduled system shutdowns negatively impacting customer services. Current approaches to mitigate overheating include planned shutdowns, reductions in service, and the implementation of active cooling systems that increase power usage, require ongoing maintenance, and are also susceptible to failures in high heat conditions.

Passive cooling as a mitigation strategy

SRI's Self-Cooling Paint is a passive solution; it does not consume power or require any electrical maintenance to keep the surface cold.

The objective of this field test was to verify the cooling performance of the Self-Cooling Paint, note any reduction in temperature to the interior of the container, and validate the consequent reduction of power demand during solar peak hours enabled by the reduced cooling load requirements. We noted the client experience of using SRI's Self-Cooling Paint, including mixing, applying to the metallic battery-storage container surface, and observing the cooling effect on the coated surface.

Solution

Self-Cooling Paint can cool down any surface up to 5-8 ºC (8-12ºF) below ambient temperature*, and 10 – 15 ºC (18 – 25 ºF) below the surface temperature of an uncoated metallic surface.** Achieving sub-ambient temperature is significant. It has been accomplished by engineering this coating that combines high solar reflectance with high infrared emittance in the sky transparency window.

** Ambient temperature is measured by placing a temperature sensor outside in air. The sensor used is the same kind as the one used to measure surface temperature.*
*** Internal tests conducted on aluminum substrate, and with a convective shield.*

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APROACH

The effectiveness of the coating was determined by: the ease of application of the paint by the industrial painter, using a conventional paint sprayer; the surface quality of the applied coating (smooth and even texture, without cracking, bubbling, etc.); a comparison of the temperatures of surfaces coated with SRI's Self-Cooling Paint compared to the those coated with a regular white paint; a comparison of the exterior surface temperature vs the internal container temperature to determine interior cooling effect at a commercially deployed site.

APPLICATION

The roof surface of the metal container had a previous coat of old, standard white paint that was mostly smooth except for a few areas of rust and flaking. The surface was cleaned with a wire brush and power washed. Areas to be protected were covered and taped off. The Self-Cooling Paint was mixed in the five-gallon bucket in which it was packaged and was applied using a sprayer. No primer was used.

The Self-Cooling Paint was applied midday, between 10am and 2pm, in mid-November. At the time of paint application, relative humidity levels were <20% during peak solar hours, and <50% during off-solar hours. The sky was reported to be "clear" to "mostly clear" for most of the daytime, and wind speed was reported to be <10mph most of the time, with few exceptions during which it was <20mph during the duration of test results shown here.

Paint went on smoothly, adhered well, and was dry to the touch within a couple of hours. Once applied, the paint coating appeared smooth, neither glossy nor matte, and was aesthetically pleasing - much like regular paint, though very white. Visually, and to the touch, it seemed just like regular paint.

COMPONENTS

- SRI's Self-Cooling Paint and tools (commercial paint sprayer, open drum paint mixer)
- Telemetry equipment – temperature sensors, data acquisition by HOBO loggers, battery management in-built telemetry system.
- An infrared thermal imaging camera

Paint was mixed in a 5-gallon container, without modification, using an overhead, open drum paint mixer.

The paint was sprayed using a commercially available spray gun, without primer.

The painted roof of a 20 foot container was dry to the touch within a few hours.

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RESULTS

The roof, which is sky facing and therefore subject to the greatest solar gain, was coated with Self-Cooling Paint. The walls were coated with regular white paint.

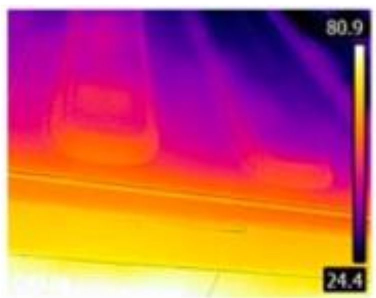
The south facing wall gets direct sunlight and the north facing wall does not.

The following photos, captured through an infrared thermal imager, illustrate the temperature differences between the roof and walls.

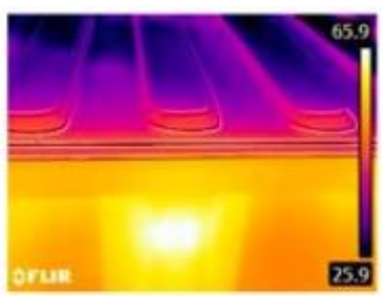
Despite their direct exposure to the sun, the roof surfaces coated with Self-Cooling Paint were significantly colder than the walls coated with regular white paint, showing a measurable reduction in solar heat gain.

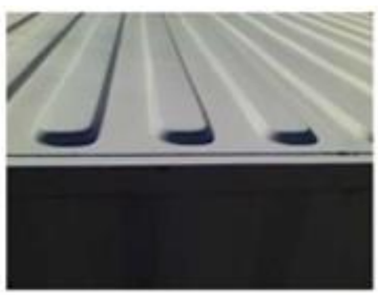
"We are very encouraged by the initial performance of the paint. There is a noticeable temperature difference between treated and untreated surfaces equally exposed to the sun. We see obvious benefits in our initial test object and are excited to proceed with more testing."

-Field Test Customer



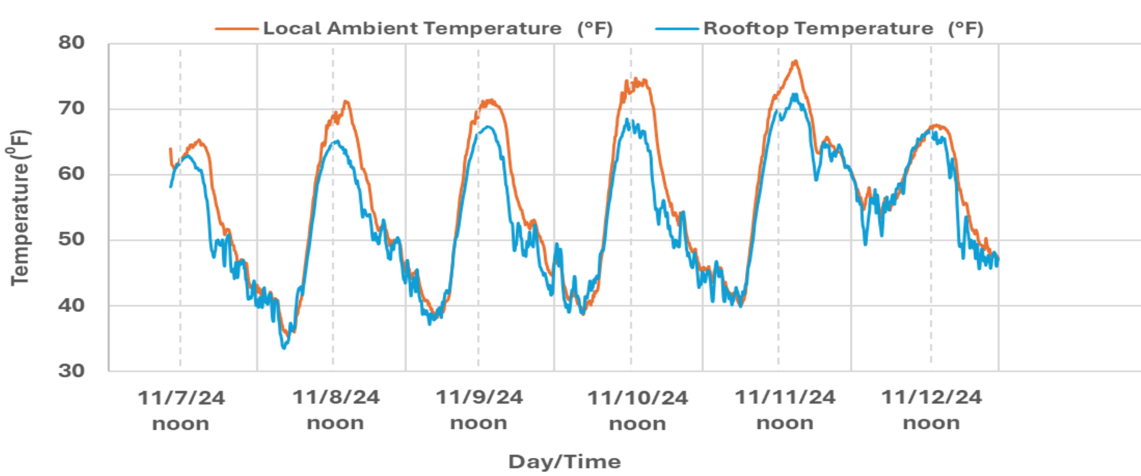
Roof and South Wall Images:
Thermal image (scale in degrees C) shows that the roof is much cooler than the wall. (This wall gets direct sunlight.)





Roof and North Wall Images
Thermal image (scale in degrees C) shows that the roof is much cooler than the wall. (This wall does not get direct sunlight.)

Comparison of external ambient temperature vs. coated rooftop (ceiling) temperature



Roof was consistently cooler than ambient temperature

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CONCLUSION

SRI Self-Cooling Paint performed consistently over the entire duration of the test maintaining a lower rooftop temperature of the battery storage container, especially during the warmest time of the day. The paint coating achieved a maximum surface temperature differential of 4⁰F - 6⁰F colder than the local ambient air temperature, and 25⁰F - 35⁰F surface temperature differential compared to a standard white paint.

Measurements of the temperature differential between the roof temperature of uninsulated containers with a 320 sq. ft. roof and the conditioned temperature maintained inside the containers (68°F) showed a peak temperature differential of 96°F, an average temperature differential of 42.3°F during daylight hours, and 22.4 ⁰F over entire day, when averaged over 40 consecutive days.

Applying the measured peak daytime temperature differentials of a client uninsulated container with a 320 sq. ft. roof and a conditioned temperature inside the container maintained at 68°F, the resulting calculated cooling load reductions comparing the container roof painted with the SRI Self-Cooling Paint versus regular white (ΔT=17.6°F) , cool roof white (ΔT=30°F)and the client brown color (ΔT=96°F) results in cooling load reductions of 0.8 tons (SRI vs cool roof white), 1.3 tons (SRI vs regular white) and 4.2 tons (SRI versus client brown). Using the measured average temperature differential (SRI vs client brown) during daylight hours (ΔTaverage=42.3°F) results in a cooling load reduction of 1.5 tons. Such reductions in temperature by SRI Self-Cooling Paint application could reduce conventional cooling equipment sizing and energy costs needed for maintaining the interior temperature of the container.

Thermal performance and wear was monitored throughout 2025. The condition of the painted container was assessed periodically, and pictures were taken to record anomalies. The condition of the roof remained consistent over time with only a slight indication of dust and dirt settling on the roof.

About SRI

SRI is an independent nonprofit research institute, headquartered in Menlo Park, California., with a rich history of supporting government and industry. We create and deliver world-changing solutions for a safer, healthier, and more sustainable future. For 80 years, we have collaborated across technical and scientific disciplines to discover and develop groundbreaking products and technologies and bring innovations and ideas to the marketplace. Learn more at www.sri.com.

Contact

Contact SRI to inquire about partnership or licensing of the paint.

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