How to bake a battery - a recipe for failure.

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Users have known for decades that heat is the enemy when it comes to battery service life. Unfortunately, even at modern, professionally designed off-grid and battery backup sites there are troubling signs this hard won knowledge has been forgotten or ignored.

At a recent site visit in Texas, I noted a large number of batteries stacked like cordwood against a facility wall. I asked if the company was doing a large battery technology change out and was shocked at the reply, “No, that’s just the batteries that have died in the last few months.”

Multiply this by hundreds of sites, and the annual financial toll to the company due to premature battery failure was near $100,000. I was also told nothing could be done about it, as the battery manufacturer had looked into the situation and all the charge parameters were correct.

“Texas is just hot and kills batteries” the manager said with a shrug.

While it’s true that many regions in the world (the Australian outback, Middle-east and parts of the USA southeast and southwest) experience brutal heat during the summer, steps can be taken to maximize a battery bank’s life and reduce the cost and waste of premature battery replacement.

A quick tour of just three nearby sites in Texas (two shaky grid battery backup banks of batteries and one true off-grid site bank) and I had all the evidence needed to confirm batteries were being cheated out of a longer life by off-grid fashion trends and the Six Sigma dream of the discounted single source purchase order.

Here is a simple list that might surprise the off-grid professional:

1. Many purchasing managers do not understand how component and specification shortcuts can cost a company far more money than the initial savings. At the first site I found a communications storage cabinet that was very pretty to look at, but was missing a crucial component – vents. Batteries under charge convert one form of chemistry to another state in order to store some of that energy for later use. A byproduct of this electrochemical conversion is heat. If the heat has nowhere to go – the battery is less efficient in the electrochemical conversion and wastes charging resources. It also shortens its own life by trying to accept a charge in less than ideal conditions.

2. Ironically the lack of ventilation was noticed by one of the young installers, who asked why the new cabinets were “different” than the others. The Sales Rep explained the batteries the company had switched to were sealed Gel Batteries and some sealed AGMs – so cabinet vents used in the old flooded lead acid battery days were not as important. Nothing could be further from the truth.

All batteries have the potential to off-gas, especially under stress [such as charging in hot conditions] but more importantly heat affects healthy charging. By having no vents in this cabinet, they were cooking their batteries. A call to the sales rep from the field yielded another battery killing scenario – generic, non-technical "Big Box" store training of sales reps, who were told what to say without the technical expertise of knowing why.

3. The Amazon effect has many purchasing managers striving for that ideal supplier who has it all – and can provide the best discounts. In the past few decades, battery and cabinet manufacturers have allowed wholesale distributors to become the front line of the salesforce, yet the technical support burden did not shift with sales.

To accommodate less profit coming in from each sale, technical support is kept to a minimum (if available at all). The knowledgeable integration sales engineer has been replaced by a rep with several hundred products on a line card. Specs become less effective when no one knows why they are there in the first place – and when the question is asked "why are we paying for this" and none of the sales team knows the answer – the spec falls away with the next discounted sale.

In this case, the rep commented "You are paying more for sealed batteries, so you probably don't need to pay an extra $55 for the cabinet vents." The end result of this "logic" was killing batteries off before their time, while costing the company thousands of dollars needlessly.

4. The next stop at site #2 was equally informative. It featured an older cabinet – with vents! The company's first attempt at saving money, the cabinet vents were spec'd in, however no one told the Chinese manufacturer were to put them. As such, the two vents were located at the bottom sides of the cabinet, to the left and right.

Adequate airflow is crucial to a properly ventilated cabinet, which should ideally have several vents located at the bottom, as well as the top. If only two are to be provided, they should be strategically placed (i.e. one at bottom left and the other at top right) to promote air flow through the entire cabinet. Heat rises, but hot air is also very inefficient in moving itself. Cool air can "push" hot air out, but only if a pathway is designed for such a purpose and is unobstructed.

Many off-grid veterans know you can "prime the pump" of air cooling a cabinet by keeping the hottest components near the top of the cabinet and the batteries at the bottom. Equipment such as radios and especially grid powered battery chargers create quite a bit of heat. As such, they should always be located above the battery bank, not near or worse yet below the batteries, where hot air would have to flow over the batteries while being vented from the cabinet.

5. The visit to site #3 was the most informative. Every component – battery cabinet, batteries, charger and even the solar panels had stickers indicating that each was sold by the same supplier. One could say there was a conflict of interest going on. As a result of this one-stop shopping convenience, when the company purchasing all of these batteries asked the seller why they were failing prematurely, the seller simply blamed the region's heat rather than adequately looking

into and address the issue. If they had, the correct answer would have been to revert to properly vented cabinets with small cooling fans – the ones that had once worked so well before all the knowledgeable old timers had retired and the new cabinets were installed.

Once I had the chance to educate the purchasing manager (a professional who was serious about trying to save the company money) the company eliminated the conflict of interest by purchasing batteries from a third party.

The sites referenced above provided good evidence to support the importance of venting, but additional, correlating issues were found not only at each of the three locations, but scores of similar sites nearby.

The battery banks at all these sites had 12 batteries each – four in a row, on each of three shelves (one atop the other) with battery shelf 1 being the top shelf and battery shelf 3 being the bottom nearest the ground. At every site, the four batteries on the top would fail first – often two months before the others. The batteries on shelf two would die next, while the batteries on shelf three always lived the longest. This was because heat rises and accumulates. The cabinets were ovens and the batteries on the top experienced the worst conditions.

Empirical evidence was also found that if a Grid-Tied battery Charger was used at the site (as well as solar) the battery banks were replaced more often. The reason for this was the heat being generated during the conversion from AC to DC within the battery compartment.

With the use of FlexSCADA to power and monitor data, four temperature sensors; one outside the cabinet to get an approximate ambient read, plus one on each battery shelf allowed everyone to see the stacked layers of heat that was affecting the batteries.

The FlexSCADA monitoring and SCADA was also put to work during the redesign of the communications skids - both off-grid and on. The Flex Q5 boards not only monitored temperature data, but were also used to turn cooling fans on and off, based on battery state of charge as well as ambient and in cabinet temperatures.

Turning on the fans during the night (when solar energy charging is not available) might sound like an unacceptable use of power, but if the Battery SOC is part of the equation, cooling the batteries off at night allows them to take a deeper and more efficient charge the next day when the sun comes up, allowing for a full charge opportunity, proper cycling and longer life. Since the FlexSCADA unit uses so little electricity itself, this product along with a small energy efficient DC powered fan can help save thousands of dollars in batteries a year, even in the hottest locations.

The data produced from using a FlexSCADA at a site in hot temperature areas can also help support battery warranties, as battery manufacturers publish battery life expectancy tables based

on temperature. This means if a battery fails after a month or so, the owner has additional information to support a warranty claim – but they have to have the data to make that claim.