

How True Balancing Maximizes Energy Out of the Battery: Balance During Discharge

Do you want to maximize the driving range of your EV?

Getting as much energy into the battery as possible is only one-half of the equation for maximum driving range. If you can't move all of that energy from the battery to the motor(s), your EV is not getting maximum driving range.

Delivering as much battery energy as possible is essential to maximize EV range.

To maximize the energy that is delivered to the load, the BMS must do two things:

1. Deliver as much energy as possible from each cell in the battery to the load
2. Do not let any cell drop below the low voltage cutoff

This sounds simple and straightforward, but passive balancing systems cannot do this.

True Balancing can.

The following pages illustrate how True Balancing maximizes the amount of energy that the battery can deliver to the load.

A Discharged Battery

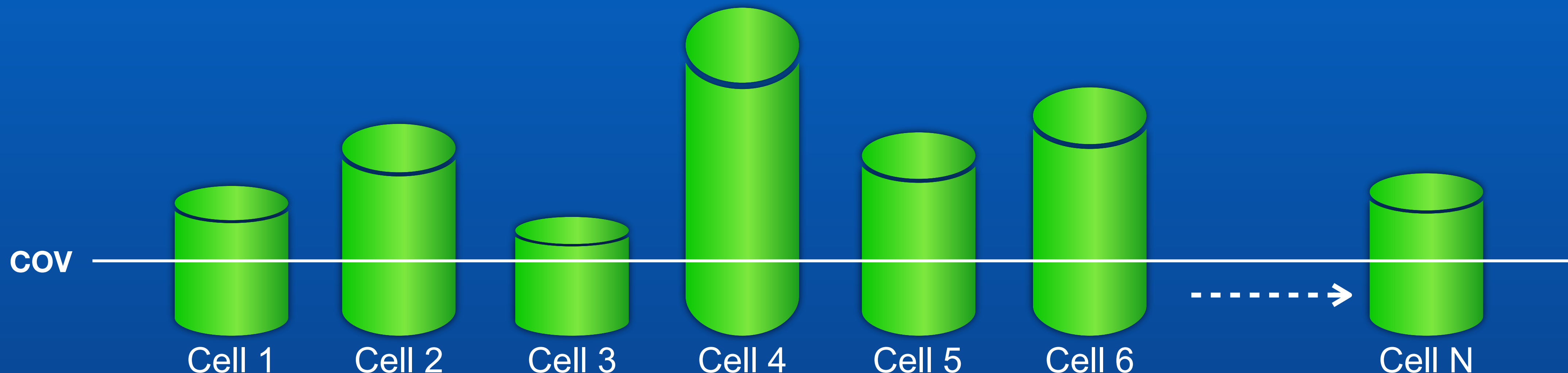
The cells in a battery will look something like this as they near the end of a discharge cycle. All of the cells are pretty deeply discharged, and they are not perfectly balanced.

In this illustration, the height of each bar represents the SOC of the cell. (The bars would go to the top of this page for cells that are at 100% SOC.) In a typical EV, the total number of cells in series (N) is about 100.

The horizontal white line represents the cutoff voltage (COV). No cell can go below this voltage. If any cell reaches COV, the battery must stop discharging and must be recharged before it can continue to operate.

In this example, cell 3 is the first cell to approach COV. If this were in an EV, the driver would have to get to a charging station immediately and recharge the battery before driving any further. There are 99 other cells in the battery that still contain energy that could be used. But the instant one cell reaches COV, all of the energy in all of the other cells becomes unusable. That is wasted energy that could and should be used to drive the vehicle further.

If this vehicle had True Balancing, it would utilize all of this energy. The driver might be able to get home rather than having to stop and recharge.



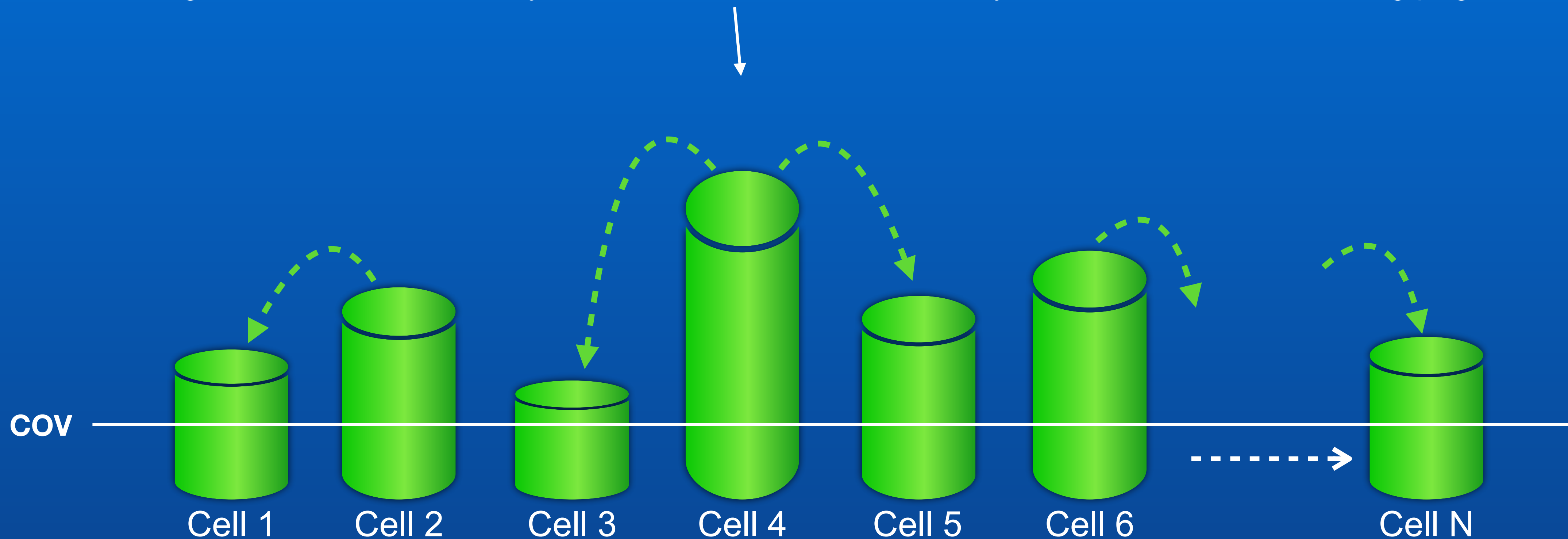
True Balancing Actively Balances During Discharge

True Balancing can move energy from cell-to-cell during discharge, and it can do this very efficiently.

During a discharge cycle (for example, when driving an EV) True Balancing can move energy from high SOC cells to low SOC cells. The ability to balance efficiently during discharge can significantly extend the range of EVs — particularly when cell characteristics have drifted.

The green arrows indicate how True Balancing can move energy from cell to cell.

True Balancing can transform a battery that looks like this into a battery that looks like the following page.



Keep on Driving!

True Balancing has evenly distributed the battery's energy across all of the cells in the pack. This maximizes the amount of energy the battery can deliver to the load. This can be the difference between driving directly home after work vs. having to stop somewhere to charge the battery.

There are some active balancing technologies that can balance during discharge, but they are less efficient, less effective and much more expensive than True Balancing. When these other technologies move energy from cell to cell, a significant portion of the energy is lost as heat, which removes energy from the battery - the opposite of what you are trying to achieve by balancing during discharge. And because these other technologies are less efficient, they must start balancing much earlier in the discharge cycle and must operate much longer. The longer they operate, the more energy they remove from the battery, which means less energy they can deliver to the load.

True Balancing isn't the only technology that can balance during discharge, but it is far and away the most efficient and effective at this task. In the case of EVs, True Balancing provides more extension of vehicle driving range than any other balancing technology that we know of.

True Balancing Maximizes the Driving Range of Any EV

