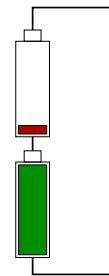




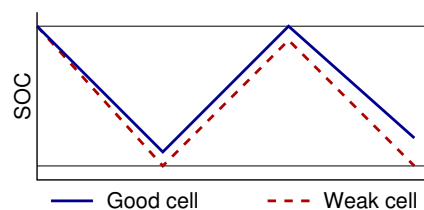
## Importance of balancing

- We've now explored a BMS's basic *estimation* tasks
- We now turn to the *control* tasks required by a BMS
- The first two weeks of this course focus on *balancing* or *equalizing* a battery pack
- Balancing or equalizing is the process of modifying the level of charge in cells on a cell-by-cell basis
- We will look at some balancing circuits later, but first we consider why balancing is important
- Consider again the trivial battery pack to the right
  - Because the cells are out of balance, this pack can neither deliver nor accept energy/power



## Evolution of imbalance

- A cell that is “weak” in some sense will limit pack’s performance, will ultimately render pack useless unless cells are “balanced”
- There is no mechanism for series-connected battery packs to balance automatically
- Instead, even if the pack begins life perfectly balanced, the natural tendency is for the cells gradually to become less and less balanced
- Balancing circuitry and balancing algorithms are needed to keep pack properly balanced
- We will study both in this course



## Balancing methods and strategies

- Balancing circuits must somehow equalize charge levels
- There are two basic approaches to balancing:
  - Passive balancing drains charge from cells having more charge than others and dissipates drained energy as heat
  - Active balancing moves charge from “high cells” to “low cells,” attempting to conserve energy in the battery pack
- Nearly all balancing concepts require BMS control of balancing activity
  - Balancing setpoint, scheduling, rates all under BMS authority
- You will study different circuitry and strategies in this course



## Summary

- Battery packs naturally evolve toward imbalance
- Unless this imbalance is corrected, pack utility is degraded even though all cells are still perfectly healthy
- Balancing changes the amount of charge in one or more cells to make charge distribution more uniform among cells
- BMS may use either passive or active balancing circuitry
- BMS may choose balancing setpoint, scheduling, rates and so forth
- Next, we examine causes (and not causes) of imbalance