True Balancing and Solid-State Batteries

Will True Balancing provide benefits to solid-state batteries?

That question has been coming up a lot. Here is a short answer, a medium answer and a long answer.

Short answer: We won't know for sure until we can get our hands on some solid-state batteries, or until there is published data on characteristics of EV-sized solid-state cells in mass-production. (And it will probably be many years before that is available.)

Medium answer: It is highly likely True Balancing will improve the performance of solid-state batteries. When new battery technologies first go into mass-production, the production processes typically have low precision and repeatability, which causes wide variations in cell characteristics. This has been the case with every new battery technology in the past 60 years. And variations in cell characteristics – even minor variations – are the primary cause of batteries getting out of balance.

So when battery manufacturers finally start ramping up mass-production of solid-state cells, they will probably be building very high-density, very expensive batteries that get out of balance very quickly.

That is exactly the situation that True Balancing addresses and solves.   We fully expect that True Balancing will improve the performance of and accelerate the time-to-market for solid-state batteries.

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Warning: *The long answer is four pages long. But if you have an interest in solid-state batteries this is probably worth reading.*

Long answer, part 1: The long path to commercial viability of solid-state batteries

There are companies that have prototypes of solid-state batteries that are big enough to power a cell phone or a laptop computer. That is the first step on the path to commercially viable solid-state batteries for EVs.

Development of solid-state batteries is an enormous technical challenge. Making a small solid-state cell in an engineering lab is hard enough. Making solid-state cells that are big enough to power an EV is an order of magnitude more difficult. Setting up production lines that can make millions of cells is the next task — it's very expensive and technologically risky. Then there will be a long learning curve of refining and iterating and optimizing the manufacturing and QC processes to attain acceptable defect rates and to achieve target levels of precision and repeatability. And finally there will be years of cost reduction engineering to make solid-state cells competitive with liquid-electrolyte lithium-ion batteries.*

** The cost of lithium-ion batteries is dropping steadily. So the performance parity price point that solid-state cells need to reach is steadily getting lower — which means it's continually getting harder to reach.*

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Long answer, part 2: A brief history of liquid-electrolyte lithium-ion batteries

Late 1960s: Stanley Wittingham proposed the concept of lithium batteries.

Early 1970s: The first prototypes of lithium-ion cells started appearing.

1991: After years of intensive R&D, Sony introduced the first commercial lithium-ion battery (LIB).

Around 2011: It took about 20 more years of R&D to develop and manufacture batteries that could be used in EVs. But the cost was still exorbitant, and quality, reliability and safety were below automotive standards.

Today: It is only in the past few years that costs have dropped enough and quality has risen enough to make LIBs viable for EVs - and they are just barely viable. Cost is still high compared to internal combustion engines (ICEs). Energy density is low compared to ICEs. Battery capacity declines steadily. Reports of battery fires surface regularly.

This is 50 years after the first prototypes appeared and 30 years after Sony launched the first commercial lithium-ion battery.

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Long answer, part 3: **How does the history of lithium-ion batteries relate to solid-state batteries?**

The long development path of LIBs was not an anomaly. Every new battery technology has had a long and expensive path to commercial viability.

The trend in battery technology is towards higher energy density and lower impedance. As energy density goes up and impedance goes down, very small variations and imperfections in the cells become exponentially more critical. This means that the path to commercial viability is much harder, takes longer and costs more.

Solid-state batteries may bring the next great leap in battery performance. When they become commercially viable, solid-state batteries could be a great new battery technology. However,…

There is no reason to expect that history will reverse itself and that solid-state batteries will have a fast, easy and cheap path to commercialization. On the contrary, the new production processes required to make solid-state electrolytes and the increased energy density of solid-state cells suggest that the path to commercialization of this technology will be longer and more difficult and more expensive than it was for liquid electrolyte batteries. Remember,…

Commercially viable liquid-electrolyte LIBs were just “one or two years away” for more than 30 years.

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Long answer, final page: The potential of solid-state batteries vs. the reality of True Balancing

Solid-state batteries have the potential to become the next great battery technology. The prototypes that are being demonstrated today look promising. But many years of R&D expenses measured in the billions of dollars lie ahead.

True Balancing offers an interesting contrast to solid-state batteries:

- True Balancing is proven technology that provides immediate improvements in battery performance.
- True Balancing is much lower cost than any other active balancing technology.
- True Balancing outperforms every other balancing technology (active or passive) by wide margins.
- True Balancing is very low risk. No further research is needed. The only work remaining is system integration engineering, which is the low-cost, low-risk phase of product development.
- True Balancing is available now. No need to wait for years (or decades).
- And,… when solid-state battery technology is more mature, True Balancing will almost certainly improve its performance and accelerate its time to commercial viability.