WILL AI HELP US BUILD BETTER BATTERIES?

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We have written a series of blog articles about different things artificial intelligence (AI) is being used for to help advance other megatrends:

- *AI Continues to Build the Foundation for a Remarkable Future in Biology*
- *Can AI Replace People? The Truck-Driving Case Study*
- *The World Needs More Metals—Maybe AI Can Find Them*

We believe in continuing to not only talk about AI but also find ways to connect it back to how it is catalyzing advances in other megatrends. This way, it can be viewed less as a black box of algorithmic complexity and more as something that is focused on helping solve concrete problems in the world.

A Brief Primer on Electrochemical Batteries[1]

What we know today as "lithium-ion" batteries fall into the class of "electrochemical batteries." For the battery to generate power, the chemical process has to generate electrons, and for the battery to be "recharged," it has to store electrons.

The structure of the battery involves the anode (negative side), electrolyte and cathode (positive side). The current that the battery can generate relates to the number of electrons flowing across from negative to positive, and the voltage relates to the force with which the electrons are traveling.

Using the battery—i.e., using your smartphone or driving your electric car—means that the electrons are flowing from the anode through the electrolyte to the cathode. Charging your devices means that you are forcing the process to occur in reverse, where the electrons are leaving the cathode, going back across the electrolyte and ending up in the anode.

Why Do We Have to Know All of That?

Some of you might be like me and think, "my last chemistry class was more than 20 years ago." The reason we set that foundation, however, is that it now allows us to think in terms of the following:

- The different parts of the battery can be fashioned out of different elements.
- Changing the mix of metals in the cathode, for example, may impact the energy density, speed of charging, heat dispersion or other battery characteristics.
- Researchers can experiment with all sorts of different anodes, cathodes and electrolytes as they seek to optimize the characteristics of a given battery to its use case.

Now, we can better understand the ways in which an artificial intelligence process can be utilized to seek to improve the different characteristics of the batteries that we use.

Who Wants Electric Vehicles to Charge Faster?

One of the many obstacles to the wider usage of electric vehicles is how people compare the time it takes to fill a tank with gasoline or diesel to the time it takes to charge a battery to the appropriate level. Since filling the tank is much faster, they opt for the vehicle with the internal combustion engine over the vehicle with the electric battery.

There is huge marketability for automobile manufacturers and battery-makers for every unit of time they can shave off charging times.

Researchers at Carnegie Mellon used a robotic system to run dozens of experiments designed to generate different electrolytes that could enable lithium-ion batteries to charge faster. The system is known as Clio, and it was able to mix different solutions together as well as measure performance against critical battery benchmarks. These results were then fed into a machine-learning system known as Dragonfly.[2]

Dragonfly is where the process starts to get exciting—the system is designed to propose possible combinations of chemicals to be used in the electrolytes that could possibly work even better. Using this process during this particular period led to six different electrolyte solutions that outperformed a standard one when they were placed into standard battery test cells. The best option showed a 13% improvement relative to the top-performing battery baseline.[3]

In reality, electrolyte ingredients can be mixed and matched in billions of different ways, but the benefit of using the system of Clio and Dragonfly working together is that it can get through a wider array of possibilities faster than humans alone. Dragonfly also isn’t equipped with information about chemistry or batteries, so it doesn’t bring the “bias of previous knowledge or experience” to the process.

Using AI to Help the Progress of Solid-State Batteries

While the aforementioned path involves improving liquid electrolytes, it is not the only critical area of battery research today.

If the flammable liquid electrolyte is replaced by a stable solid, it’s possible that there would be improvements in battery safety, lifetime and energy density. However, finding the appropriate materials to facilitate building solid-state batteries that fit all specifications and can be produced at scale is not a simple matter.

Researchers at Stanford have noted a particular process where they compile data on 40 materials with both good and bad measured room temperature lithium conductivity values. This particular characteristic is thought to be the most restrictive of all the different constraints on candidate materials. The 40 examples are “shown” to a logistic regression classifier, which can “learn” to predict whether the material performed well or not based on the atomistic structure. After the training phase, the model can then evaluate more than 12,000 lithium-containing solids and find around 1,000 of them that have a better than 50% chance of exhibiting fast lithium conduction.[4]

Progressing solid-state batteries along the development path is, therefore, another clear use case for artificial intelligence.

Conclusion: Energy Storage Is One of the Most Important Considerations for the Coming Decades

Having better energy storage solutions will help global society in myriad different ways. The classic case: there are intermittent power generation sources like solar and wind that can use batteries to equilibrate the flows of energy across time. However, I think we’d all love smartphones that don’t need a charge for a week or two or electric vehicle batteries with a long range that can charge in similar times to what it previously took to fill up at a gas station. Those interested in energy storage solutions and possible investments would do well to look more deeply at the WisdomTree Battery Value Chain and Innovation Fund (WBAT). On the other hand, those interested in how artificial intelligence can supercharge many different megatrends may want to look more closely at the WisdomTree Artificial Intelligence and Innovation Fund (WTAI).

[1] Source: https://www.volts.wtf/p/a-primer-on-lithium-ion-batteries#details.
[2] Source: James Temple, "How robots and AI are helping develop better batteries," MIT Technology Review, 9/27/22.
3 Source: Temple, 9/27/22.
4 Source: https://reedgroup.stanford.edu/research/eletrolyte.html.

Christopher Gannatti is an employee of WisdomTree UK Limited, a European subsidiary of WisdomTree Asset Management Inc.'s parent company, WisdomTree Investments, Inc.

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DEFINITIONS

Artificial intelligence : machine analysis and decision-making.

Megatrends : A major movement, pattern or trend emerging in the macroenvironment; an emerging force likely to have a significant impact on the kinds of products consumers will wish to buy in the foreseeable future.

Electrochemical : An electrochemical process or reaction is one in which electricity is produced by a chemical reaction.