

Startups, researchers race in the Wild West of electric vehicle battery recycling

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Electric vehicles are expected to take off dramatically in the coming years. They'll be followed, eventually, by a wave of used batteries that—as it stands now—will be headed mostly for landfills.

A number of companies and energy researchers are doing their best to

change that vision of the future.

Some [battery](#) recycling startups claim they can recover roughly 95% of the lithium, cobalt, nickel and other minerals that go into batteries, dramatically cutting down the need for new mining projects and decreasing U.S. companies' reliance on foreign supply chains. And unlike many other products, those minerals don't degrade as they're recycled, making a relatively closed-loop battery economy possible.

Cracking the code on battery recycling is one of the keys to shoring up the battery supply chain needed to make the United States a major player in the next-gen autos, according to a recent report from the Department of Energy. And in the long term, there's money to be made for early adopters who can pioneer models that are financially viable.

"In the near term, there's just not enough volume of batteries to really be a huge business," said Sam Abuelsamid, principal analyst leading e-mobility research at Guidehouse Insights. "But 10 years from now? Absolutely. There's a lot of potential for them to be a very substantial business."

That's easier said than done. The two leading methods for battery recycling are largely considered inefficient or expensive. Most EV batteries in use today weren't built to be recycled, which makes them hard to break down, and they're expensive to ship long distances because they're considered hazardous material.

The end goal is to develop a battery recycling process that is cheaper than getting new minerals out of the ground—and the race to do so is already underway.

"There simply haven't been enough batteries that have gone through the full life cycle yet. So there's just not enough scale to make it

economically worthwhile," Abuelsamid said. "But there are a bunch of companies that are working on various recycling technologies ... because it is critically important."

Mountains of waste

The Detroit Three plan to invest billions in electrifying their fleets in the coming years, mirroring a global trend of the auto industry pivoting hard to electric vehicles. Around two-thirds of all vehicles sold will be electric by 2040, according to forecasts by Bloomberg.

Most [lithium-ion batteries](#) used in electric vehicles today will last between 11 and 13 years. But eventually they'll be put out to pasture, creating millions of tons of battery waste per year, by some estimates.

Batteries that end up in a landfill "pose a serious threat to ecosystems and human health" due to the heavy metals and chemicals inside, experts say. Trashing them also requires companies to secure new minerals.

Some mining projects raise environmental and human rights issues, such as cobalt, which largely comes from the Democratic Republic of Congo. Many workers there, including children, dig for the material by hand and are exposed to frequent safety hazards.

That's not a good look for automakers now seeking to field more environmentally-conscious brands, said Glenn Stevens, executive director of MICHauto, a Detroit-based economic development organization dedicated to supporting the Michigan auto industry.

"We're very much in this circular economy now, where sustainability is extremely important for a variety of reasons. But so is profitability," Stevens said.

Finding ways to increase battery recycling helps automakers control their supply chain by reducing dependence on new mining projects, he said. That can take years to permit, are largely based in foreign countries and often have their own environmental complications.

Today's electric vehicle batteries aren't built to be broken down and recycled, with automakers to date focusing on extending battery life and capacity and reducing costs. Plus, electric vehicles still make up only around 2% of new vehicle sales, which makes it difficult for companies to make money recycling the few batteries that are currently out there.

"But there's definitely money to be made on battery recycling," said Stevens, and the opportunity to use those recovered materials to build new products. "Which is not easy to do because recycling a lithium-ion battery is very different than recycling a lead acid battery."

The race is on

Right now, there are two main ways to break down a used battery to collect the minerals inside. One, pyrometallurgy, involves heating the battery up to remove excess materials, leaving an alloy containing minerals, such as copper, nickel and cobalt. But most of the lithium and aluminum is lost in the process.

The other, hydrometallurgy, involves shredding the battery and submerging it in acid to remove the unwanted material. Companies are left with a soup containing the needed metals, which is precipitated to leave recycled minerals that can be used again.

"The value is hard to make work in many instances. You have to actually pay to recycle your battery, and that's not good," said Jeffrey Spangenberg, director of the ReCell Center within the Department of Energy's Vehicle Technologies Office, which researches battery

recycling methods.

A number of startup companies are experimenting with ways to change that. Batteries aren't currently built to be recycled, so taking them apart and shipping them to a facility costs money—and a lot of it, because whole lithium-ion batteries are both heavy and considered hazardous, so they are subject to higher shipping fees.

Li-Cycle, a Canadian battery recycling company that partnered with General Motors Co. in May to recycle scrap metal from battery manufacturing, works to mitigate that by shredding batteries at localized "spokes" and sending them to a centralized hub to recycle the batteries using hydrometallurgy.

Li-Cycle can recover up to 95% of the battery's critical minerals through the process, said Chief Commercial Officer Kunal Phalpher. Much of the company's existing recycling comes from the byproduct of building batteries, rather than recycling the used batteries themselves.

So "now is a critical time to start building capacity. A lot has changed in terms of aggressiveness by OEMs in this space in the last 12 months, which has pushed recycling forward," Phalpher said.

Redwood Materials, a Nevada-based recycling company founded by former Tesla Inc. co-founder JB Straubel, uses a proprietary calcination process to break down the batteries and then dissolves the minerals using hydrometallurgy.

The company claims it can recover 95% to 98% of the nickel, copper, cobalt and lithium used in the battery. It has partnered with Panasonic, which supplies batteries to Tesla, and with Envision AESC to recycle the scrap from the battery-making process. Redwood recycles around 20,000 tons of material annually, said Alexis Georgeson, vice president

of communications and government affairs for Redwood.

"We're just focused on building and ramping our process as quickly as possible and continuing to innovate," she said. "We are always going to be exploring the best way to innovate and iterate technology."

Ford Motor Co. plans to research mineral mining and battery recycling through its \$185 million "Ion Park" facility planned in Romulus. And Stellantis NV has said it intends to recycle and reuse batteries for energy storage with a partner it has not yet announced.

Looking ahead

The first generations of [electric vehicles](#) are just beginning to die, said Spangenberg of ReCell, meaning the tsunami of batteries will only get larger from here.

"Once it hits, it's going to hit hard," he said. "There's all these new startups that want to get involved in this. The more people the merrier. The sandbox is big, so we can all play in it. But there's areas for improvements over what's currently here."

ReCell is working on a new method of recycling called "direct cathode" recycling, which would avoid breaking down the cathode—the "main guts" of the battery—into raw minerals and instead refurbish the cathode to be used again whole, saving money on the process to re-form the minerals into a cathode.

The existing recycling options used by companies like Redwood and Li-Cycle are "great," Spangenberg said. "They're better than mining the material from the ground, making batteries and throwing them out. So it's all better environmentally speaking—the big thing is we want people to turn in their batteries for recycling."

The startups and Spangenberg's lab are mulling ways to do that. Spangenberg suggests incentivizing consumers to return their batteries to manufacturers through rebates or cash incentives.

While there will be a need for better battery recycling processes, companies should also look to make it easier to fix problems with batteries instead of scrapping them altogether when something goes wrong, Spangenberg said. "It's important to get the most value—I call it by 'triaging'—the batteries at end of life."

But [recycling](#) can only go so far in solving the U.S.'s battery supply chain problems, he noted. Because the U.S. has almost no processing capacity for raw minerals, most minerals recovered from existing batteries will have to be shipped abroad, further increasing reliance on other countries for a critical economic driver.

For all of the challenges and opportunities facing battery recyclers, ReCell's goal is to develop a system, prove it's viable and convince companies it's worth taking up the method.

"It's still in development mode," he said, "but I think it's getting close."

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