

Lithium-Ion Battery Production Is Surging, but at What Cost?

Gigafactories intended to scale the production of electric-vehicle batteries can exact a human toll.

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Bolivia lithium brine

Photo Credit: Dimitry B./Flickr

In his first Tesla Motors master plan, Elon Musk wrote (<https://www.tesla.com/blog/secret-tesla-motors-master-plan-just-between-you-and-me>), “The overarching purpose of Tesla Motors (and the reason I am funding the company) is to help expedite the move from a mine-and-burn hydrocarbon economy towards a solar electric economy, which I believe to be the primary, but not exclusive, sustainable solution.”

Just over a decade later, it looks like that sustainable solution is within reach -- solar deployments are booming (<https://www.greentechmedia.com/articles/read/global-solar-capacity-set-to-surpass-global-nuclear-capacity>) and Tesla is leading the charge toward the greater proliferation of electric vehicles (<http://www.greentechmedia.com/articles/read/everyone-is-revising-electric-vehicle-forecasts-upward>) that can run on renewably generated electrons.

But as clean energy flourishes, the solutions from electric-vehicle companies and battery-makers have had a lot more to do with mining than Musk's manifesto would suggest. Though an explosion in EVs and energy storage will allow countries to rely on less carbon-intensive energy, the extraction of essential ingredients to make cost-effective lithium-ion batteries generally leaves environmental and human devastation in its wake.

Industry leaders have come closer to solving how to store energy and power cars without fossil fuels on a large scale, but they're just beginning to grapple with the moral implications of a clean energy industry supported by the ugly truths of child labor and pollution.

"It's quite an interesting case, where you have the benefits of moving to green technology being outweighed, in some cases, when you look at the mine production," said Stefan Sabo-Walsh, lead of commodities research at Verisk Analytics.

The lithium triangle

Australia and South America, specifically the "lithium triangle" of Argentina, Chile and Bolivia, currently dominate 80 to 90 percent of lithium production, according to James Whiteside, a managing consultant on Wood Mackenzie's metal and mining consulting team.

South American production relies on brines pulled from deep inside the earth. At brine sites, the salty water is spread out over large surfaces (<https://www.thebalance.com/lithium-production-2340123>) at a level of a few feet deep and left to evaporate for months. Moved from pond to pond, the concentration of lithium slowly increases until it can be separated from the rest of the brine. The raw lithium is then processed into lithium chloride to be used in applications like batteries. In Australia, raw producers concentrate on the more energy-intensive and costlier hard rock mining, where lithium is crushed out of stones.

In 2016, lithium production grew by 16 percent over the previous year. Australia produced most of it, 14,300 metric tons, much of which is shipped to China for processing.

The so-called "white gold rush" has allowed battery producers to scale up production and keep plans for gigafactories in the pipeline (<https://www.greentechmedia.com/articles/read/10-battery-gigafactories-are-now-in-progress-and-musk-may-add-4-more>). But its results haven't been so positive for indigenous people like the Atacama community in South America, prompting protests with handwritten signs that read "We Don't Eat Batteries," as *The Washington Post* reports (<https://www.washingtonpost.com/graphics/business/batteries/tossed-aside-in-the-lithium-rush/>).

Indigenous people in the lithium triangle worry that the high levels of water needed to produce lithium -- as much as half a million gallons per ton -- may cut into the already limited water supply in the arid and drought-ridden areas where brine sites are located. These concerns have triggered protests against the exploitation of the resources by large companies. In 2012, 33 indigenous communities took calls for consultation about lithium development to Argentina's Supreme Court.

"No telling what kind of damage could be done"

Helle Abelvik-Lawson, a doctoral student and researcher at the University of Essex who focuses on the impacts of lithium mining in Bolivia and Argentina, said many -- but not all -- communities are learning to live with the activity and development that mining companies bring, because they're also delivering jobs. "The main thing is that the communities, if they're going to have this massive industry, want to be involved," she said.

But there are also communities, she said, "that are dead against it."

According to Abelvik-Lawson, the current impacts of small-scale lithium mining are relatively minimal. But as demand skyrockets, how companies grow production could change that. "There are concerns," she said. "As soon as anything really scales up, there's no telling what kind of large-scale damage could be done."

Brine sites generally consume little energy because the sun processes lithium from the pools. But Whiteside said the recent uptick in demand has spurred the practice of "direct-shipping ore" from rock mining sites to China in the last three to six months. To speed up the process, more raw material is sent out before it is concentrated.

"That means that your energy consumption for transportation is much higher -- roughly three times higher," said Whiteside. "That's not going to be cost-competitive in the long term, but currently with prices where they are, that sort of production is being incentivized."

Lithium-based batteries also require raw materials like cobalt, nickel and graphite, which further complicate the supply chain (<https://www.greentechmedia.com/articles/read/why-lithium-isnt-the-big-worry-for-li-ion>). Labor injustices in the extraction of cobalt are well documented. Over 20 percent of exports from the Democratic Republic of Congo, the world's top producer, come from unregulated artisanal mines that often employ children. For raw materials like nickel and graphite, producing countries cope with water contamination and deforestation.

Scaling and mass-production of lithium batteries is complex, but the human rights and environmental pitfalls of their production will make it even more so for producers and end users. Raw source material derives from mines around the world, and identifying its origin isn't always easy. For companies peddling ethically branded cleantech products like electric cars and solar-plus-storage, it will be necessary to seek out better choices as battery use continues to explode -- or risk facing blowback.

The battery boom

According to Bloomberg New Energy Finance (<https://www.bloomberg.com/news/articles/2017-05-22/move-over-tesla-europe-s-building-its-own-battery-gigafactories>), global battery-making capacity is set to double by 2021 (<https://www.greentechmedia.com/articles/read/10-battery-gigafactories-are-now-in-progress-and-musk-may-add-4-more>) to more than 278 gigawatt-hours per year. Lithium-ion batteries are also expected to be 43 percent cheaper by that same year.

While makers of alternative batteries have tried to give lithium models (<https://www.greentechmedia.com/articles/read/how-alternative-battery-makers-are-trying-to-compete-with-lithium-ion>) a run for their money in recent years, it's been a losing battle, in part

because of the simplicity and flexibility of the technology. Shockingly low prices for lithium-based batteries will remain the chief factor in driving the technology's dominance into the future -- as long as producers can keep the lithium coming (<https://www.greentechmedia.com/articles/read/is-there-enough-lithium-to-maintain-the-growth-of-the-lithium-ion-battery-m>).

The reserves-to-production ratio for lithium (the remaining amount of a non-renewable resource, expressed in time) is in the [magnitude] of hundreds, where for most mined commodities it's in the tens," said Whitehouse. "There are a lot of resources out there."

"Over the next coming decade, there is definitely enough...lithium," he added. "The question is how long it will take for those sources to come on-line."

The concern doesn't stem from known reserves, of which there are plenty. Whiteside, who is working on a Wood Mackenzie study on the lithium market (<https://www.woodmac.com/reports/metals-energetic-growth-lithiums-role-in-a-decarbonising-world-49909144>), describes lithium's supply-and-demand curve following a traditional path. Though battery prices are reaching new lows, prices are building (currently at around \$12,000 per ton (<https://oilandgas-investments.com/2017/top-stories/lithium-prices-to-stay-high-to-2024-ubs/>)), as is demand. To meet that demand, manufacturers have planned projects around the world. But because extracting lithium is so time-consuming, and many of these projects won't be complete for years, high demand and constrained supply is likely to continue for the time being, according to Whitehouse.

"There will be cycles in the market," he added. "I'm sure that the market will move into oversupply at some point, simply due to the number of projects being developed."

But, for now, battery-makers are hungry for all of the lithium they can get. The search for ethically mined lithium is likely only to increase demand and prices.

Another way forward

There are other ways to expand lithium production without relying on the dubious labor and environmental practices now endemic within the lithium mining process.

Companies including MGX Minerals, based in Canada, are working to find accessible and underutilized lithium stores. Beginning in 2016, MGX has been testing a nano-filtration system that uses a set of highly specialized membranes to passively sift lithium from wastewater. According to CEO Jared Lazerson, the MGX system returns 70 percent of lithium and takes just a day, rather than the traditional months-long time frame.

So far, MGX has partnered with companies like Canadian Natural Resources Limited in Alberta, and it is working on a commercial plant that could process 7,500 barrels of wastewater per day and yield a significant volume of lithium carbonate equivalent.

MGX's process cleans the water left over from traditional oil operations, and it yields a return. An attractive side benefit could be bringing traditional energy majors into the fold.

“The oil companies are very, very traditional in their thinking, but they’re watching what’s going on,” said Lazerson. “It’s making them a little nervous, and it’s making them look at these [projects] very seriously.”

In terms of bringing accountability to traditional mining, that will likely fall to companies and corporate coalitions, said Sabo-Walsh. He said past examples surrounding the conflict minerals of gold, tungsten, tin and tantalum, which are regulated by the Dodd-Frank act, may hold lessons for industry-wide partnerships around sharing information on supplier practices, assessment questionnaires and environmental rankings. Consideration of where lithium goes after it’s used could also make manufacturers more mindful about the production process.

“There needs to be some conversations and planning by automotive companies about what the end of use for lithium-ion batteries will be,” said Whiteside. “It’s something that a lot of automotive companies aren’t even considering.”

Ultimately, as production ramps up, companies will need to make accountability a throughline of a battery’s lifetime. Though the world’s lithium stores will be enough to fuel a large-scale storage revolution, the current costs are anything but negligible.

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