Will Your Electric Car Save the World or Wreck It?

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The manufacturing of batteries, such as in those in electric vehicles, may have a greater environmental impact than you thought. (Image courtesy of Tesla.)

Patting yourself on the back for buying a Prius? It might surprise you to find that electric vehicles, dependent on batteries, may have significant negative environmental impact. You may have cut back on greenhouse gas emissions at the pump only to step into other environmental pitfalls.

Here’s something that electric car companies do not want you to know: the materials that make up your car battery are born deep in mines, may be extracted by child labor and in some of the most polluting ways possible.

Even if the mining industry were ecologically sustainable, lithium-ion (Li-ion) batteries have been known to explode and/or catch fire. Avoiding such incidents, the batteries are extremely difficult to recycle, often resulting in the disposal of a spent, but still toxic and flammable battery in your local landfill.

The Lithium Battery

Why use lithium to power cars? Casting aside environmental considerations for a moment and looking at the basics of battery power versus fossil fuel, you'll note one big advantage to battery-powered electric vehicles (BEVs) when it comes to energy efficiency. Where energy efficiency for internal combustion engines is between 20 and 60 percent, an electric motor can be 60-80 percent efficient. The drawback, on the other hand, lies in energy density. The energy by mass of gasoline is 2 orders of magnitude greater, 2,000Wh/kg, compared to a modern Li-ion battery with only 200Wh/kg.

Keeping that in mind, the challenges behind building the battery in a BEV cannot be understated. Getting a ton of metal, plastic and rubber to move for any significant amount between refuels or recharges requires exceptionally high energy-density. In all of engineering, there has only ever been one battery material that can cut it: Li-ion. Known for its singularly high-power output per kg compared to other electric batteries, Li-ion batteries keep our smartphones and laptops powered long enough to serve their purposes as portable devices.

Though the magic Li-ion powers both the iPhone and the Tesla, it is like comparing a matchstick to a bonfire. The iPhone 6 weighs in at six ounces whereas a Tesla Model S contains a whopping 12 kg of pure lithium alone. In

Li-ion batteries, it's the lithium ions that move from anode to cathode to release energy from the battery–and back again during the recharging period. This constant discharge/charge cycle process slowly chips away at the capacity of the battery over time. And where a smartphone may have a three-year battery life with 500 charge/discharge cycles, this kind of lifespan is not acceptable for a $75,000 vehicle. To make the battery last as long as possible, you need the three best ingredients for your cathodes and anodes: cobalt, nickel and graphite.

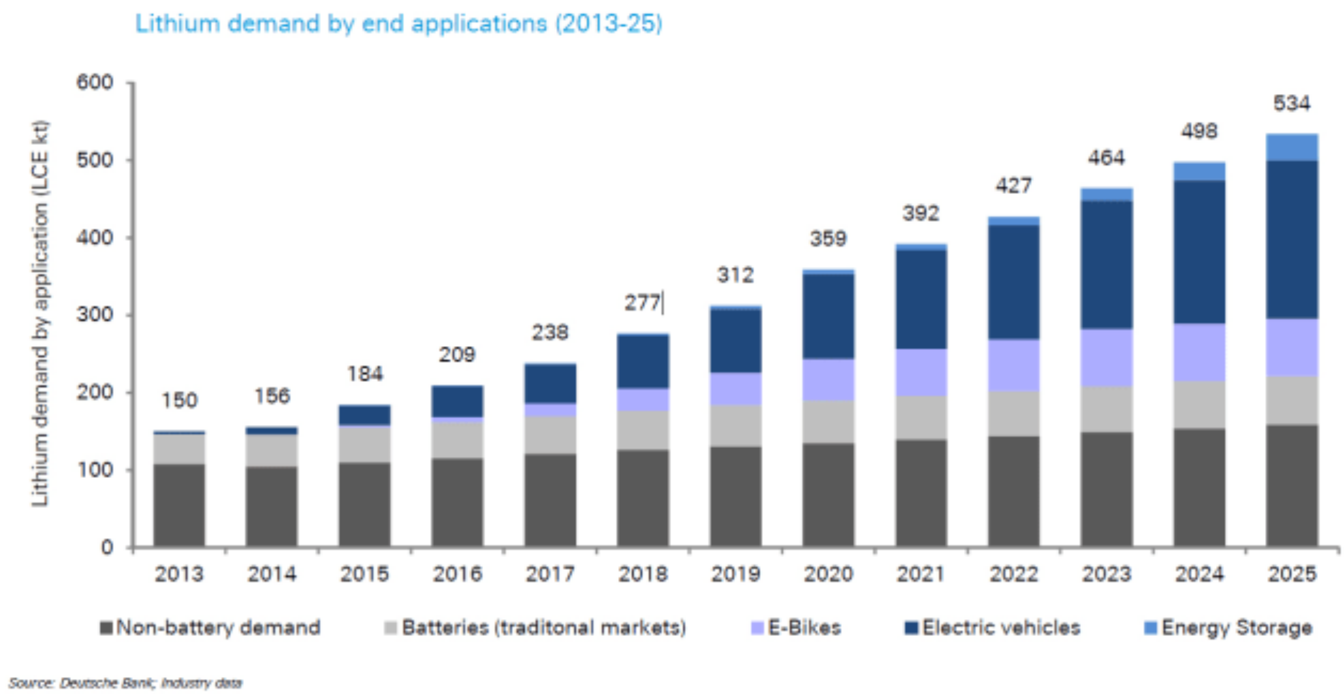
And therein lies the problem. Getting any of these materials out of the ground is neither friendly to the environment nor the miners. EVs and their appetites for batteries are on the verge of causing major upheaval in the world's metal markets. 10 years after the first Tesla, many of us are only just beginning to assess the impact.

Meeting Demand

Lithium consumption has been growing exponentially since the early 2000s and is, according to some sources, expected to quadruple again by 2025. In 2016, Tesla CEO Elon Musk tried to quiet concerns about the lithium shortage by likening lithium to the "salt on the salad" of the Li-ion battery. "Our cells should be called nickel-graphite, because primarily the cathode is nickel and the anode side is graphite with silicon oxide," he explained.

Musks' words don't tell the whole story. Lithium is sold not as a pure element but as lithium carbonate. A 70kWh Tesla engine uses 63kg of lithium carbonate, the price of which doubled in 2017, compared to the year before to $13.90 per kg. The rather heavily-salted BEVs of the 21st century are shaping up to be a global driving force of lithium demand by exponential proportion. According to industry data from Deutsche Bank, BEVs have caused an estimated 150 percent increase in lithium consumption since

2013. Meanwhile, traditional battery and non-battery demands hold steady.



Measured and projected data on lithium demand. (Image courtesy of Deutsche Bank.)

Meeting the oncoming demand will not be easy. Currently, our main source of the stuff lies in the "lithium triangle" in the Andes mountains, between Argentina, Chile and Bolivia. China and Australia hold key reserves as well. But with China pushing for its own fleet of BEVs (in 2016, 30 percent of the world's Li-ion batteries were used in Chinese electric buses alone), and Australia looking into supplementing its grid with megabatteries, it's not likely that we'll be seeing much of these reserves make it to US production lines. Instead, it's far more likely that we're looking at South America becoming the Middle East of the BEV era.

Chile, which accounts for a full third of the world's lithium reserves, has already been called by some the "Saudi Arabia of lithium." Bolivia, Chile's impoverished neighbor, holds even more. Looking at projected demand, its likely that we will be heading smack into a political, territorial rearrangement of power not seen since OPEC (Organization of the Petroleum Exporting Countries) got together, with small countries becoming powerful, and using their resources for leverage over larger countries. With the widespread adoption of electric cars, such relationships could easily be established with battery materials, as occurred with oil before.

Impact of Extraction

Lithium production in South America doesn’t have so much to do with the element’s availability in the soil, but with water. The Andes mountains are very dry, but the lithium extraction process requires water in no small amount to bring the element up to the surface in a salty brine—500,000 gallons of water per ton of lithium, according to *Wired*. In some regions in Chile, 65 percent of water is used up in lithium production, diverting it from local food production. The brine then requires 12 to 18 months to evaporate. Any water returned to the farmers could be tainted with chemicals.

Rich brine pools containing lithium and other minerals evaporate in the Atacama desert in Chile. (Image courtesy of SQM.)

Another core concern lies in the vast wealth that lithium will represent for these smaller, poorer countries when demand starts to escalate. The lengthy evaporation period for the lithium brine can be sped up by heating the water, a process achieved by burning fossil fuels -- defeating the entire purpose of reducing greenhouse emissions in the first place. But when the price is up and the bottleneck forms, the desire for faster, cheaper production may outweigh our ability to maintain environmental standards.

Cobalt miners in the Republic of Congo often work in unsafe conditions, without proper equipment. (Image courtesy of Scholastic.)

Then there's cobalt. In addition to the environmental concerns related to lithium production, cobalt mining is unequivocally destructive on multiple levels. Currently, half of the world's cobalt is produced in the Republic of Congo. Concerning cobalt mining in the Congo region, journalists have revealed human and environmental abuses ranging from child and slave labor, to toxic waste leakage and radioactivity in cobalt mines. "In 2014, according to UNICEF, about 40,000 children were working in mines across southern DRC, many of them extracting cobalt," *The Guardian* reported.

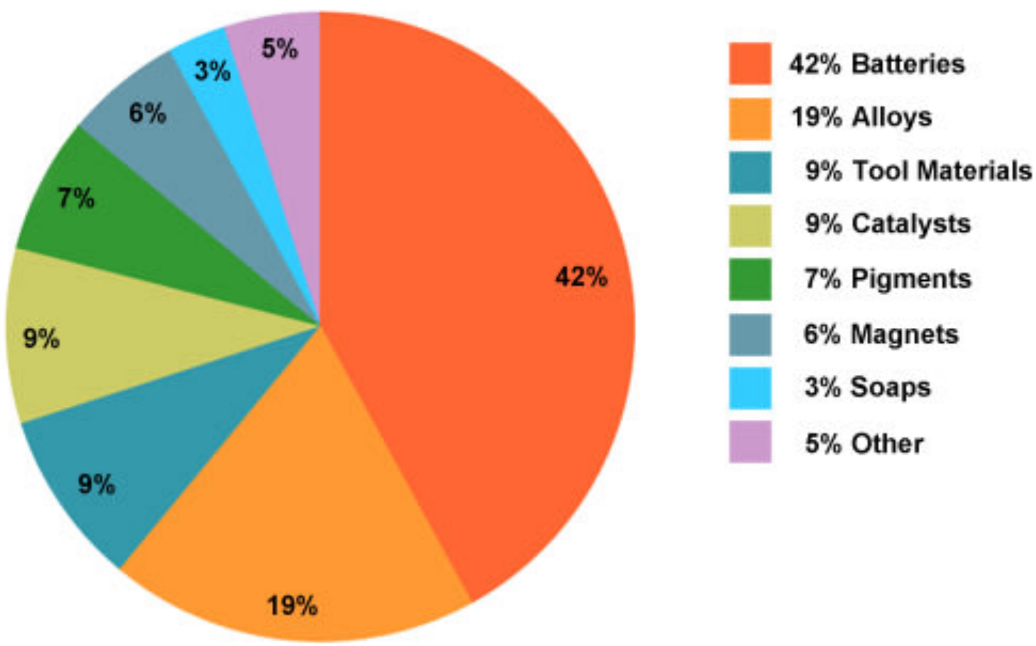
Although Tesla is doing everything in its power to lessen the amount of cobalt used in its batteries; reducing cobalt in the cathode directly corresponds to reducing the safety and lifecycle of the battery. Experts say that the lower limit on cobalt has pretty much already been achieved, and to go further would compromise the safety of the car.

Like the mining industry as a whole, graphite and nickel mining is associated with human rights abuses and can lead to pollution in the air and water.

Residents near Chinese graphite mines have remarked on the sparkly nature of air particles, with the dust ultimately contaminating food and water supplies. In areas surrounding nickel mines, there have been increased rates of deformities and respiratory problems linked to pollution from nickel mining and smelting.

In previous interviews addressing materials supply, Tesla has stated that "[suppliers are] three or four layers removed from Tesla. It is obviously quite difficult to have perfect knowledge about everything that happens this far down in the supply chain, but we've worked extremely hard to gather as much information as possible and to ensure that our standards are being met."

But if a major company can't be relied upon to ethically source its batteries, who can?



The majority of the world's cobalt currently goes into batteries. (Image courtesy of batteryuniversity.com.)

Recycling

An immediate concern for some manufacturers may be supply chain bottlenecks, it is worth taking a glimpse at the far future. In truth, no one really knows if there is enough lithium for humanity's projected needs or where lithium can come from. This is an ironic twist for those who thought that the electric car was the solution to our non-renewable fuel crisis, instead of another sustainability trap.

Whereas lithium batteries are said to be 95 per cent recyclable, the practice of recycling them is more easily said than done. Throughout their lifespan, lithium batteries undergo irreversible damage, meaning that they can't simply be repurposed. Instead, they need to be entirely taken apart, the lithium extracted, and then re-manufactured. But even this is an oversimplification.

Battery manufacturers incorporate several additives into the electrolyte liquid in the Li-ion battery. The purpose of these additives is to improve the battery in many ways, such as by speeding up the manufacturing process, or making the battery more durable in hot and cold weather. But when manufacturers keep the battery cocktail a secret, repurposing the precious minerals contained within becomes difficult and, therefore, expensive.

Moreover, the electrolyte mixture is the component of the battery that has been known to explode when handled incorrectly, for instance, if it is subjected to high temperatures. This means that any attempt at creating a recycling process will need to find a way to ensure that the batteries are dismantled in a safe manner.

With these difficulties in mind, it's not surprising that recycling rates for lithium battery is really low; only 2 per cent of lithium batteries in Australia are recycled, with the rest left to rot in landfills. But the problem does not necessarily come from members of the public carelessly tossing their cracked iPhones into the trash.

It might be argued that sustainable recycling infrastructure should come from the car companies—a process that is still not cost effective compared to market lithium costs, and therefore provides little incentive. "Recycled lithium is as much as five times the cost of lithium produced from the least costly brine based process," Waste-Management-World stated. Even with our best efforts, recycled lithium is not pure enough to produce batteries, and the material ends up being used for non-battery purposes.

Adding up the Cost

"Under the average U.S. electricity grid mix, we found that producing a midsize, midrange (84 miles per charge) BEV typically adds a little over one ton of emissions to the total manufacturing emissions, resulting in 15 percent greater emissions than in manufacturing a similar gasoline vehicle. However, replacing gasoline use with electricity reduces overall emissions by 51 percent over the life of the car."

That's from a 2015 report from the U.S.-based Union of Concerned Scientists on battery-powered electric vehicles. The result is stunning: manufacturing a BEV adds an entire ton of greenhouse gases to the atmosphere more than a gasoline vehicle. But perhaps more shocking is that the total carbon footprint of a BEV is not zero, it's half of what it is for the total lifespan of a gasoline vehicle.

Now, consider the cost of water loss to South American farmers, child labor in the Congo, impending geopolitical tensions, lack of recycling, and our current inability to expand the lifespan of a BEV past 10 years. Factor in also the infrastructure changes that it will require to install charging stations to every gas station in America.

That isn't to say that the benefits of BEVs don't outweigh the emissions and international conflict related to vehicles powered by fossil fuels, but it should inspire reflection into our global supply chain and technological developments. It's clear that Li-ion batteries are not a panacea to the world's energy problems in the midst of climate catastrophe. The problems raised by Li-ion battery production might spur new technologies that resolve these issues. Or the solution to these issues may not be technological at all.