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It takes around 138 lbs (63 kg) of 99.5% pure lithium to make a 70 kWh Tesla Model S battery pack. In 2016, OICA estimated that the world had 1.3 billion cars in use. If we replace every car with an electric version, we would need 179 billion pounds or 89.5 million tons (81 million tonnes) of lithium. That’s just the cars. That doesn’t include smartphones, laptops, home power systems, massive grid storage projects, and thousands of other products that use lithium batteries.

Lithium is geologically rare because it is unstable atomically due to it having the lowest binding energies per nucleon than any other stable nuclide. This is good for nuclear reactions (lithium was used as fuel in the first early nuclear reactions in 1932) but bad for finding it in nature. Further compounding its volatility, lithium is an alkali and will combust if allowed to come in contact with elements it reacts with, such as those found in the air. Pure lithium needs to be stored in oil to be transported safely.

Given that it’s rare and reactive, the process of extraction differs from other metals. Currently, there are two ways that lithium can be extracted. The first way is from ionic compounds, such as pegmatitic minerals (made of quartz, feldspar, mica, and other crystals). For a long time, this was the world’s primary source of lithium. Much of Australia’s lithium production as of 2020 comes from spodumene, a pyroxene mineral that occurs in pegmatites and aplites.

In addition to being in minerals, lithium can be found in brines and ocean water because of its solubility as an ion. This means lithium saturated brines found in South America and Nevada can be dried using a solar evaporator, then once a good concentration is reached, the lithium carbonate and lithium hydroxide are precipitated by adding sodium carbonate (washing soda or soda ash) and calcium hydroxide (slaked lime or caustic lime). The brine extraction process usually takes 18 to 24 months.

For example, most of the world’s lithium brines are concentrated in a region known as “The Lithium Triangle”, an intersection of Chile, Bolivia, and Argentina. This triangle is believed to contain over 75% of the existing known lithium. One such source of brine is the Salar de Uyuni salt flats in southwest Bolivia near the top of the Andes (almost 12000 ft or 3700 meters above sea level).

There’s a layer of salt on top that ranges from a few centimeters to several meters thick. Underneath the hard crust is a liquid brine with a relatively high concentration of lithium (0.3%). A hole drilled into the crust allows the brine to be pumped out and processed. As you can imagine, the high altitude complicates extraction and makes it more complex to transport the extracted lithium.

Why does lithium work so well as a battery? The myriad number of battery varieties using lithium seem endless. There is Li-MnO2, the most common consumer-grade battery chemistry, Li-FePO4, Li-CSVO, Li-CFx, Li-CuFeS, and Li-FeS2 are just some of the variants that are in common use today. Lewin Day wrote a beginner’s guide to lithium batteries that can help sort them out.

This reaction does have its limits. Overvolting a battery (5.2 volts) leads to the synthesis of cobalt oxide, which causes damage to the electrodes. Letting the voltage potential drop too low results in the production of lithium oxide, which damages the battery irreversibly by reacting to the battery itself. You can learn a bit more about battery chemistry in this wonderful Bob Baddeley wrote last year.

The short answer is probably. Dozens of different Universities and National Labs have come out with studies predicting one way or another. Lawrence Berkeley National Lab said in a 2011 study that we could build a billion 40 kWh lithium batteries with our existing reserves, however, they assumed only 10kg of lithium per battery (1/6th of a Tesla Model S). Even if we have enough raw materials, the process of converting it into a usable form needs to be considered.