Congo battery recycling

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Electric vehicles are critical to reducing transportation pollution and solving the climate crisis, but manufacturing them at the necessary scale will require significantly increasing production of the batteries that power them. How batteries are made, what they are made of, and whether they are reused or recycled affect the sustainability of this crucial component.

Even though batteries last many years, they eventually reach the end of their useful life for powering electric vehicles. Policies and incentives for recycling and reusing batteries, including strong health and labor standards, will further lessen the impacts of electric vehicles.

Battery electric vehicles (BEVs) are a key strategy for reducing air pollution and global warming emissions. They have zero tailpipe emissions, and even when powered by today"s sources of electricity, their life cycle global warming emissions are significantly lower than those for vehicles fueled with gasoline or diesel (O"Dea 2019; Reichmuth 2020). However, the increased adoption of BEVs raisesimportant questions about the availability, recyclability, and sustainability of battery materials.

Scaling up BEV manufacturing will mean increasing the production and processing of several materials used in today"s lithium-ion batteries. Fortunately, strategies for recycling lithium-ion batteries offer the possibility of a sustainable, long-term supply of such materials, supporting the continued deployment of electric vehicles (EVs). However, implementing those strategies will require addressing a number of technical, economic, logistic, and regulatory barriers.

To facilitate smooth charging and discharging, battery packs consist of multiple cells bundled into modules. Combining several modules with additional packaging and thermal management systems creates the finished battery pack used in EVs.

Of the materials used in lithium-ion battery cells, the US government deems many to be "critical" (Box 1) (DOI 2018). These elements are crucial to battery performance, yet their supply is at risk, whether due to material shortages or because supplies are concentrated or processed in a single country (Bauer et al. 2010).

Different types of lithium-ion batteries are distinguished by the metals that make up the cathode. The choice of materials affects important battery characteristics such as longevity, cost, and energy density (the amount of energy a certain size battery stores). The choice also affects other battery components, such as thermal and power management systems.

The cathode, which accounts for roughly one-quarter of the cost of a battery, combines lithium with nickel, manganese, cobalt, aluminum, or iron. Aluminum is also used as the cathode"s current collector and in packaging for the cell and module. The anode typically consists of graphite and a copper current collector.

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Early lithium-ion battery cathodes relied heavily on cobalt. Today"s batteries use less cobalt per kilowatt-hour (kWh) of energy capacity, although it is still commonly used because it contributes to a battery"s energy density and chemical stability. Both the high price of cobalt and negative impacts of mining it motivate efforts to reduce the amount of cobalt in batteries. In 2018, lithium-ion batteries averaged 28 kilograms of cobalt per 100 kWh across all battery end uses and chemistries. This amount is expected to decrease by 60 percent by 2035 (Figure 1, p. 3).

New and low-cobalt cathode chemistries can offer improved battery performance through higher energy densities. Battery cathodes using less cobalt include nickel-cobalt-aluminum oxide ("NCA") and some nickel-manganese-cobalt oxide ("NMC") compositions. In addition, major manufacturers of light- and heavy-duty BEVs widely use cobalt-free cathodes based on lithium iron phosphate ("LFP").1

In the 10 years since manufacturers deployed the first modern BEVs, the capacity of battery packs in passenger vehicles has increased while costs have decreased. Battery pack capacity in the first Nissan Leaf, released in 2010, was 24 kWh; the 2020 Tesla Model 3 has up to 75 kWh in capacity. With improved chemistries and larger energy capacities, the range of a passenger BEV has reached 400 miles on a single charge (Baldwin 2020). Meanwhile, between 2010 and 2020, the average price of battery packs decreased from $1,200 per kWh to $137 per kWh (Boudway 2020).

For conventional vehicles, their operation represents their largest contribution to global warming emissions. Roughly 90 percent of global warming emissions from combustion vehicles occur at the tailpipe. In contrast, all global warming emissions associated with BEVs occur "upstream." That is, they come from manufacturing vehicles and generating electricity to power them.