EXECUTIVE SUMMARY

Making the Most of Electric Vehicle Batteries

How Recycling, Innovation, and Efficiency Can Support a Sustainable Transportation Future

HIGHLIGHTS

Transitioning to electric vehicles (EVs) will slash air pollution and heat-trapping emissions and avoid the daily consumption of millions of gallons of gasoline in the United States. The nationwide transition is in its early stages and we have the opportunity to minimize the minerals needed for electrification and create a resilient, just, and sustainable EV supply chain.

UCS research quantifies the potential to minimize mineral demand for passenger cars and trucks in the United States through battery recycling, improved vehicle efficiency, right-sizing vehicle range for different driving needs, technological innovation, and increasing transportation options for people.

Key findings:

- ***With smart policies, investments, and industry leadership, newly mined lithium needs can be reduced by nearly half (48 percent) from 2025 to 2050.***
- ***This reduction amounts to 1.5 million metric tons, equivalent to 180 million of today's typically sized EV batteries.***

Electrifying the US transportation system is essential to rapidly decarbonizing the economy and reducing the public health costs from burning gasoline and diesel fuel in our cars and trucks. Electric vehicles (EVs) powered by lithium-ion batteries have become the preferred alternative to gasoline vehicles, and they vastly reduce heat-trapping emissions and petroleum consumption (Clemmer et al. 2023). EVs promise to eliminate millions of barrels of oil consumed every day in the United States (EIA 2024), but the production of EVs and their batteries will increase the need for minerals, including lithium, cobalt, nickel, and graphite. Estimates show there are enough mineral reserves to meet demand forecasts (Ambrose and Kendall 2020; Shen, Slowik, and Beach 2024); however, implementing strategies to minimize new mineral demand, and responsibly mine where necessary, can ease the transition to electric transportation, reducing pressure on supply chains and lessening the environmental and social harms of increased mining activity.

While the EV market share is ramping up, there is an opportunity to influence how we get to 100 percent electric. Future demand for newly mined EV battery-related minerals depends on many factors, including recycling, vehicle and battery design, and transportation alternatives available to households that can reduce the number of vehicles needed. **This analysis finds that implementing strategies to reduce mineral demand and increase battery recycling could cut in half the amount of newly mined lithium needed to electrify US passenger vehicles and transit buses between now and 2050.** Key strategies examined include the following:

- **Battery recycling:** High recovery rates of minerals from EV batteries recycled at their end of life provide a domestic supply for new battery production.
- **EV efficiency:** Making EVs energy efficient reduces battery size requirements by using less energy per mile.
- **Battery innovation:** Higher energy density and battery chemistry innovations can lead to lower amounts of key minerals used per EV.
- **Charging availability:** Convenient, fast, and reliable public charging access reduces the need for extremely long-range EVs requiring larger batteries.
- **Increased mobility options:** Convenient and affordable transportation alternatives, including public transit, walking, and biking, along with more convenient community planning allows households to rely on fewer personal vehicles.

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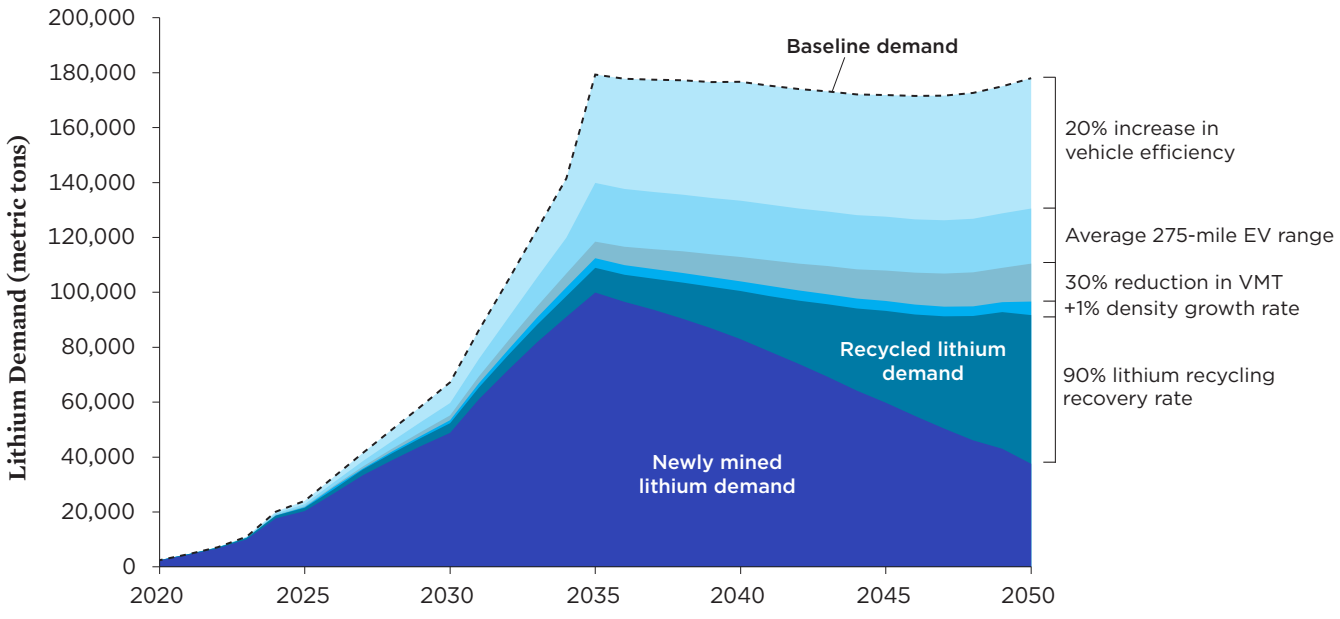
The Analysis

To understand the potential impact on future EV battery-related mineral demand, we examine scenarios that reduce overall mineral demand while rapidly electrifying light-duty vehicle sales and transit buses (so that EVs represent 100 percent of new vehicle sales by 2035) and compare these scenarios to a future in which reducing mineral demand is not prioritized (baseline). Findings demonstrate the following:

1. If reduction strategies are implemented, we can reduce demand for newly mined lithium by nearly half (48 percent) from 2025 to 2050. This amounts to 1.5 million metric tons, equivalent to the lithium requirements for 180 million typically sized EV batteries.
2. Achieving high recovery rates of lithium (90 percent) while implementing the other demand reduction strategies can result in nearly 60 percent of 2050 lithium demand being met with recycled content, effectively displacing newly mined minerals.
3. Ensuring that future EV models are as energy efficient as possible could cut 14 percent of lithium demand by 2035 and 22 percent by 2050.
4. Slightly lowering EV model vehicle range to an average of 275 miles, supported by ubiquitous charging infrastructure, could reduce new lithium demand by 12 percent by 2035 and 20 percent by 2050, compared to increasing average vehicle ranges to 325 miles.
5. Increased transportation options leading to reduced vehicle miles traveled (VMT) and fewer cars per household could cut total demand by 8 percent by 2035 and 15 percent by 2050.
6. Increasing the rate of energy density gains from 4 percent to 5 percent per doubling of sales could reduce total mineral demand by 7 percent in 2035 and 11 percent by 2050.

Taking these mineral conservation measures would result in a lower peak and overall demand for minerals, as demonstrated in Figure ES-1. From 2035 on, recycled materials meet more future mineral demand because of high lithium recovery rates, thereby reducing the demand for newly mined minerals even further.

FIGURE ES-1. Yearly Lithium Demand for EV and Plug-In Hybrid Light-Duty Transportation and Transit with Reduction Strategies Implemented



Implementing strategies that result in better EV efficiency, slightly lower range, and reduced VMT will result in savings of 1.5 million metric tons of newly mined minerals for cars and trucks in the United States from 2025 to 2050. Due to the reduced demand and a higher lithium recovery rate, more mineral demand—nearly 60 percent in 2050—can be met by recycled content.

Recommendations

Transitioning to EVs will slash air pollution and global warming emissions and avoid the daily consumption of millions of gallons of gasoline. It also presents an opportunity for policymakers and EV manufacturers to maximize the transition's benefits by conserving minerals and creating a more sustainable, just, and resilient future. To create this future, we recommend the following:

- **Federal EV battery recycling and mineral recovery requirements:** Minerals recovered from recycling retired EV batteries can be used to manufacture next-generation EVs while also greatly reducing the demand for newly mined minerals in the long term. This can be achieved by requiring vehicle manufacturers to reuse or repurpose batteries when they are retired and to use recycling processes that have high material recovery rates.
- **Improved EV efficiency:** Energy-efficient EVs not only use less electricity, but also require smaller batteries to travel a given distance. EVs on the market today have a wide range of energy efficiencies. Standards incentivizing EV efficiency would ensure consumers benefit from lower charging costs and smaller batteries.
- **Increased deployment of charging infrastructure:** A vehicle's range greatly influences battery size and the resulting amount of minerals needed to produce the battery. Increasing the availability of fast, publicly accessible charging infrastructure through tax credits, incentives, and investments in charging equipment and related grid infrastructure can help reduce the need for longer-range vehicles requiring large batteries.
- **Increased transportation choices:** Ultimately, demand for minerals used in EV batteries depends on the size of the batteries in individual vehicles and the number of vehicles produced. Investments that make it easier for households to meet their travel needs with alternatives to driving, such as public transit, biking, and walking, can give families the flexibility needed to rely on fewer household vehicles.
- **Increased mining standards, mineral tracing, and transparency:** Despite the mineral reduction strategies employed in this research, there will still need to be an increase in mining to meet EV demand. While we know EVs reduce life-cycle global warming emissions compared to their fossil fuel–powered counterparts, resource mining has harmed the health and well-being of communities around the world and disproportionately affected Indigenous Peoples. Therefore, crucial changes are needed to reduce potential harm to mining-affected communities and to ensure Indigenous Peoples' right to self-determination when mining is on their land or affecting their natural resources. Measures include increased environmental regulations throughout mine development and the mining process; requirements for free, prior, and informed consent; and increased mineral tracing and auditing of mines.

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