Plug In America

POWERING THE FUTURE OF TRANSPORTATION

CREATING AN ETHICAL, SUSTAINABLE BATTERY SUPPLY CHAIN

AUGUST 2023

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INTRODUCTION

The global transition to electric, battery-powered transportation is underway. Electric vehicle (EV) sales are growing exponentially; in 2022, over 10 million EVs were sold and sales are projected to surge to yet another record in 2023.[1] No longer is the internal combustion engine the only form of technology on the road. The EV share of the car market has skyrocketed from 4% in 2020 and is predicted to reach 18% in 2023,[2] with the largest markets existing in China, Europe, and the United States. The explosive growth in electrified transportation will forever change the status quo for the car manufacturing industry and for the global energy economy.

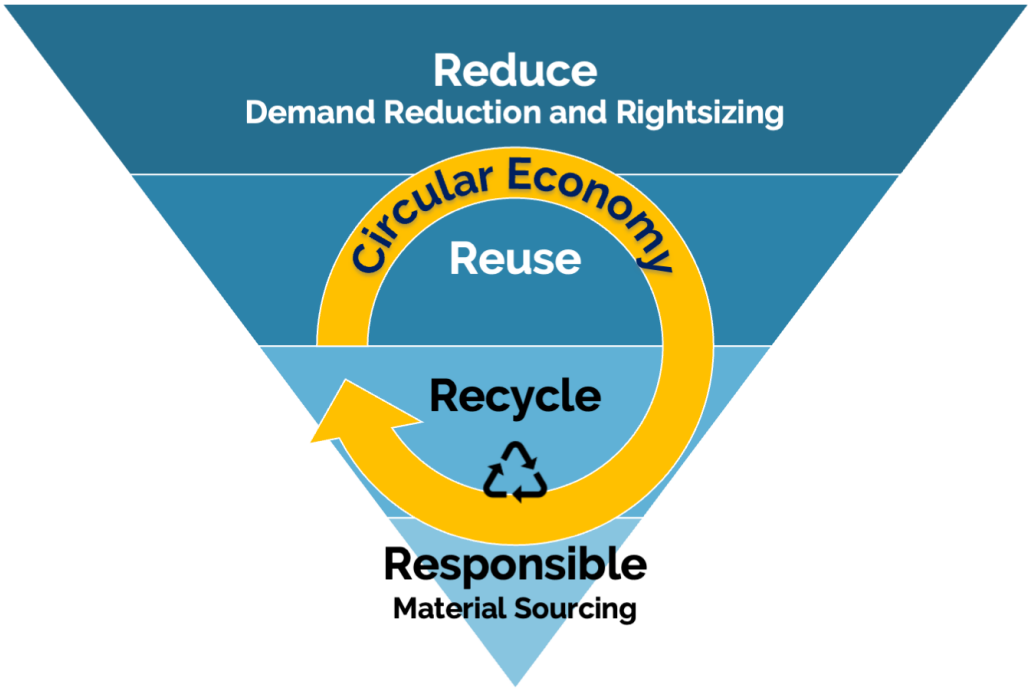
This historic transition has the potential to dramatically reduce climate emissions and create a cleaner, healthier, and more equitable transportation system. According to the International Energy Agency, by 2030, EVs will avoid the need for at least 5 million barrels of oil a day.[3] However, current technologies to produce EV batteries require significant amounts of materials found mainly in environmentally sensitive and historically marginalized and disinvested communities .[4] Without an intentional, ethical approach to battery material sourcing, impacts on these regions and communities will intensify as demand increases.

Like any transition that has brought significant change, there's a risk of repeating past mistakes. For over a hundred years, automobile travel has required continuous oil exploration, drilling, extraction, refining, and burning at the expense of communities, public health, and the environment. In 2022, about 134.55 billion gallons of gasoline were burned to power vehicles in the U.S.[5] Moving towards a circular, renewable energy economy will decrease our reliance on foreign energy sources and improve national energy security through the use of domestically-generated, clean power. As we transition to electric transportation, we can learn from the harm caused by our reliance on fossil fuels and set a more just and innovative course for the clean transportation future. Not only can we reduce emissions and feed our transportation needs for generations to come, but we can do it in a way that lifts our communities, protects those most impacted by the extractive economy, and mitigates further harm to the planet.

For 15 years, Plug In America has represented EV drivers across the U.S. In a 2023 survey of over 4,000 current and prospective EV drivers, the single most important motivating factor for

[1] https://www.iea.org/reports/global-ev-outlook-2023
[2] https://www.iea.org/reports/global-ev-outlook-2023
[3] https://www.iea.org/news/demand-for-electric-cars-is-booming-with-sales-expected-to-leap-35-this-year-after-a-record-breaking-2022
[4] https://earthworks.org/releases/report-recycling-electric-vehicle-battery-minerals-can-significantly-reduce-need-for-new-mining/
[5] https://www.eia.gov/tools/faqs/faq.php?id=23&t=10#:~:text=In%202022%2C%20about%20134.55%20billion,8.78%20million%20barrels%20per%20day)

purchasing an EV was clean air and environmental protection.[6] As an EV advocacy organization, our work includes advocating for a pathway to clean transportation through four primary principles: **demand reduction, battery reuse, battery recycling,** and **responsible material sourcing.** This paper focuses on strategies, policies, and programs that industry and government can develop to ensure that supply chains for EVs and their batteries are secure, circular, and reduce the need for mining virgin minerals, thus reducing adverse impacts on the planet and its people.



OVERVIEW

By prioritizing demand reduction, a circular economy, and responsible, ethical materials sourcing, we can decrease the need for new mining, cut localized vehicle pollution, advance transportation equity, and accelerate the decarbonization of the transportation sector.

The first part of our recommended solution set focuses on reducing our overall need for transition materials using demand-reduction strategies. The volume of extraction for newly mined materials to support the transition to EVs is not fixed.[7] By focusing on multi-modal transportation, we can improve public and active transit and reduce our dependence on single-passenger vehicles and transition materials. This approach to improve multi-modal options is the first step in creating a safer, more connected, equitable, and sustainable transportation system. Simultaneously, decreasing the size of EV batteries through

[6] https://pluginamerica.org/survey/
[7] https://www.climateandcommunity.org/_files/ugd/d6378b_b03de6e6b0e14eb0a2f6b608abe9f93d.pdf

technological innovation, such as increased EV efficiency and improving the energy density of batteries, while shifting to smaller vehicles will reduce the volume of minerals necessary to support the EV transition.[8]

The circular economy elements of our solution set prioritize keeping batteries in use and out of landfills through battery labeling, implementing a global battery passport, battery repurposing, and reuse. When batteries cannot be repurposed or reused, we recommend battery recycling. Plug In America proposes setting overall and material-specific recovery rate targets and recycled content standards to mandate materials recovery through recycling and recirculation of recycled materials into new batteries. Additionally, we propose implementing extended producer responsibility. This shifts the burden for end-of-life product management from consumers to producers and helps ensure that end-of-life considerations are included in the design process. End-of-life batteries are those that have reached the end of their usefulness and/or lifespan within an EV.

Plug In America acknowledges that electrifying our transportation sector will require some amount of material extraction. We advocate for mandatory requirements and administrative and legal reform governing mining to minimize the impacts of extraction on the environment and to protect our communities. We also stress the importance of Free, Prior, and Informed consent (FPIC) as critical to guaranteeing that impacted communities and Indigenous People are central to the decision-making process. Until stringent regulations around mining are codified, Plug In America recommends using The Initiative for Responsible Mining Assurance's (IRMA) standards as a transparency tool to hold mining companies accountable for the human rights, environmental, and labor conditions at mine sites.

REDUCE

Looking at the entire EV lifecycle

EVs produce significantly less cradle-to-grave life-cycle greenhouse gas emissions (GHGs) than internal combustion engine vehicles.[9] In fact, researchers from Ford and the University of Michigan found that, on average, across the U.S., light-duty EVs have approximately 64 percent lower cradle-to-grave life-cycle greenhouse gas emissions than their fossil-fueled counterparts.[10] All manufactured products, including our clothes, appliances, and small electronics, contribute to environmental, public health, and social damage. Battery manufacturing is no different. Potential resource extraction risks include human rights

[8] https://www.climateandcommunity.org/more-mobility-less-mining

[9] https://www.sciencedirect.com/science/article/pii/S1364032122000867#:~:text=Highlights&text=Quantification%20of%20the%20CO2,different%20commercially%20available%20vehicle%20variants.&text=The%20total%20life%2Dcycle%20emissions,to%20internal%20combustion%20engine%20vehicles

[10] https://electrek.co/2022/03/04/light-duty-evs-have-64-lower-life-cycle-emissions-than-ice-vehicles-ford-study/

violations such as Indigenous rights violations, poor working conditions, child labor, and environmental risks involved with production processes like carbon emissions, water contamination, biodiversity loss, and pollution. By reducing demand for mineral extraction through an increase in multi-modal transportation and smaller, more efficient batteries, we can mitigate the potential for these risks.

Demand reduction strategies

Two primary approaches for reducing transportation emissions are (1) replacing gas-powered vehicles with EVs or (2) reducing the number of vehicles on the road. Simply electrifying the current vehicle fleet will not be enough to keepglobal warming below 1.5° Celsius.[11] Additionally, just electrifying the current fleet (without increasing multi-modal options) significantly increases our reliance on newly mined materials. A recent Climate and Community Project report found that if we extrapolate today's demand for EVs to 2050, the U.S. EV market alone will need more than three times the amount of lithium that is currently produced for the whole global market. [12] To meet our climate goals and truly improve quality of life across communities, a multi-faceted approach is required.

Develop a more holistic transportation system

To combat the climate crisis and optimize the efficiency of the minerals we extract, we must electrify vehicles *while* developing a just and accessible transportation system where more people can meet their everyday needs *without* a car. For every one dollar spent on public transit, four dollars go to fund highway infrastructure.[13] Shifting public investments and policies to increase and incentivize active and mass transit improves quality of life, public health, equity, and sustainability while reducing the need for minerals to power single-passenger vehicles.

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Decrease and/or limit battery size

The environmental impact of an EV is not limited to its time driving on the road. We must also consider the embodied emissions of the vehicle, which are the greenhouse gases created at several stages of the vehicle manufacturing process. In pursuit of larger vehicles with longer

[11] https://www.nature.com/articles/s41558-020-00921-7
[12] https://www.climateandcommunity.org/_files/ugd/d6378b_b03de6e6b0e14eb0a2f6b608abe9f93d.pdf
[13] https://www.washingtonpost.com/transportation/2021/07/23/transit-highways-infrastructure-deal/

ranges, we are creating oversized vehicles that far exceed daily driving requirements. Larger, heavier vehicles rely on larger, more powerful batteries, which increase embodied emissions and require more minerals. This isn't an easy problem to solve. Manufacturers make large vehicles like Sport Utility Vehicles (SUVs) and trucks because they sell well and have higher profit margins. Limiting the size of EV batteries can significantly reduce our need for battery materials. In the case of lithium, we can cut demand by as much as 42 percent.[14] As we transition to EVs and consumers become more confident in EV technology, we hope to see auto manufacturers offer smaller, more affordable vehicles.

Make EV efficiency a top priority for auto manufacturers and policymakers

As EV sales continue to increase, EV efficiency should be a top priority for auto manufacturers and policymakers. Similar to the efficiency of vehicles powered by gas, greater EV efficiency offers several environmental and consumer benefits. Greater efficiency means less energy is needed to power the vehicle, resulting in fewer upstream emissions from electricity generation and greater consumer savings. Smaller, more efficient vehicles will decrease the battery size necessary for travel, decreasing the need for mineral extraction and the production of embodied emissions, as well as offering a cheaper vehicle option for consumers.

While EVs are more efficient than their fossil-fuel counterparts, EVs are not created equal in their efficiency or environmental impact. Currently, regulators count all-electric vehicles as having zero emissions regardless of their size or efficiency. A large, rugged SUV with a 212 kWh battery and a small hatchback with a 65 kWh battery are considered equal for emissions regulation purposes. However, the large SUV requires far more minerals than the smaller hatchback. As the EV market matures and we transition to more EVs, a natural policy progression would involve a pivot to account for the upstream emissions of fossil-fuel vehicles and EVs.[15] This shift could reduce both tailpipe emissions and embodied emissions. Accounting for upstream emissions in our regulations would incentivize automakers to create and sell more efficient EVs to meet their regulatory requirements.

Encourage rightsized transportation

In the absence of regulations that foster efficient material use, incentives can reinforce transportation decisions that are good for consumers, their wallets, and the planet. Since most people drive less than 40 miles a day, having a 400-mile range isn't necessary for the vast majority of drivers. As the EV charging network

> **The more we can shape a decarbonized transportation future around right-sized transportation, the more accessible, efficient, and effective the system will be.**

[14] https://www.climateandcommunity.org/_files/ugd/d6378b_b03de6e6b0e14eb0a2f6b608abe9f93d.pdf
[15] https://climate.law.columbia.edu/sites/default/files/content/docs/comments%20and%20legal%20briefs/Burger-Wentz-2017-05-Downstream-and-Upstream-Emissions.pdf

continues to be expanded, drivers become familiar with EV technology, and range confidence improves, we hope to see manufacturers produce smaller, lower-range EVs to provide more options for consumers. Additionally, car-sharing, public transportation, and micro-mobility work well for many lifestyles while being more affordable, convenient, and less resource-intensive. The more we can shape a decarbonized transportation future around right-sized transportation, the more accessible, efficient, and effective the system will be.

Battery technology innovation

The amount of minerals necessary for a clean transportation future is not fixed. Energy density improvements in batteries through technological innovation can reduce current demand projections. As battery energy density improves, the amount of energy a battery can store using the same amount of minerals will increase. Innovation will reduce overall mineral demand while increasing vehicle range without requiring larger, heavier battery packs.[16]

Support improvements in battery energy density

Battery energy density can be increased by creating new battery chemistries and improving current lithium-ion chemistries. Supporting ongoing research and development of new battery chemistries is essential to reach higher energy densities and to find novel materials that reduce our reliance on the current, predominant group of minerals. Current lithium-ion chemistries can be improved by increasing the efficiency of the materials already in use or by switching out existing materials for different ones.[17] Since 2010, the energy storage per kilogram of lithium-ion battery cells has almost tripled, contributing to a 89 percent price drop over the same decade.[18] There are many successful material substitutions in lithium-ion batteries; for example, replacing the graphite anodes with silicon is said to raise the battery energy density by 20 percent.[19] Additionally, manufacturers can alter the chemical makeup of lithium-ion batteries to shift away from minerals linked to human rights concerns. Tesla recently transitioned to lithium-iron-phosphate (LFP) batteries which don't use nickel or cobalt in half of the new cars it produces.[20]

REUSE

The second and third components of Plug In America's recommended framework on battery material sourcing focus on a circular economy. Unlike gasoline vehicles which rely on the

[16] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/mineral-requirements-for-clean-energy-transitions

[17] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/mineral-requirements-for-clean-energy-transitions

[18] https://cleantechnica.com/2020/02/19/bloombergnef-lithium-ion-battery-cell-densities-have-almost-tripled-since-2010/

[19] https://rmi.org/insight/six-solutions-to-battery-mineral-challenges/

[20] https://electrek.co/2022/04/22/tesla-using-cobalt-free-lfp-batteries-in-half-new-cars-produced/

continuous extraction and burning of fossil fuels, many of the resources used to manufacture and power an EV can be reused and recycled. The best source of all battery materials is that which is already "in cycle." In-cycle materials have already been extracted, reused, or recycled. Plug In America is concerned about both electrifying our transportation system and *how* we get there. We aim to achieve our electrification goals in a way that sources responsibly and reduces the environmental, social, and health impacts of transportation electrification.

Keep batteries in cycle and out of landfills

Create battery labeling regulations

Improperly discarding batteries into landfills puts human and environmental health at risk through the leaching of toxic, corrosive chemicals into the soil and water table.[21] These chemicals are extremely difficult and expensive to clean up. Battery labeling is key to prevent improper disposal, as proposed in the European Union's (EU) comprehensive Sustainable Batteries Law.[22] The battery labeling regulation is different from a battery passport. It requires producers to label batteries with a separate collection symbol, an icon of a crossed-out trash bin, to guide users on proper disposal. Additionally, producers must provide information to end users and distributors on the appropriate management of waste batteries, such as the separate collection and available reuse/recycling systems, lifetime and safety risks associated with material makeup, and the meaning of labels and symbols on the battery.[23]

Implement a 'Global Battery Passport'

To develop a sustainable battery value chain, we must first understand where all the materials in a battery cell come from. A battery cell is comprised of a few main parts, including an anode, cathode, electrolyte, and separator, each featuring different materials.[24] From mining to processing to assembly, it can be hard to determine the origin of the materials in each battery part. An additional requirement of the EU Sustainable Batteries Law is that batteries must feature a QR code that provides access to all labeling information, information about the carbon impact and recycled content of the battery, and a label that indicates the fulfillment of safety and sustainability requirements.

This QR code could also serve as the unique identifier for each battery's Global Battery Passport.[25] The Battery Passport is a digital representation of each battery that presents all environmental-social-governance (ESG) and lifecycle information, including manufacturing

[21] https://calmatters.org/environment/2022/04/states-goal-to-keep-batteries-out-of-landfills-needs-a-recharge/
[22] https://www.europarl.europa.eu/RegData/docs_autres_institutions/commission_europeenne/com/2020/0798/COM_COM(2020)0798_EN.pdf
[23] https://www.europarl.europa.eu/RegData/docs_autres_institutions/commission_europeenne/com/2020/0798/COM_COM(2020)0798_EN.pdf
[24] https://www.energy.gov/energysaver/articles/how-lithium-ion-batteries-work
[25] https://www.globalbattery.org/battery-passport/

history, provenance, materials used, place on the battery value chain, and more.[26] The transition to a circular battery value chain requires that stakeholders have access to high-quality data to provide transparency at all stages of the battery value chain, inform decision-making and better policy (i.e., the creation and tracking of material recycling targets), develop performance goals, and keep the battery materials that have already been extracted, in cycle. The ultimate goal of a battery passport is to provide end-users with a record of a battery's sustainability performance, according to reporting standards created by stakeholders from industry, NGOs, academia, and government.[27] The EU Sustainable Battery law requires a passport for every EV battery placed on the market after February 2027.[28] In summary, a battery passport enables progress tracking of the entire industry while helping to set new standards.

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Battery second-life applications

EV batteries are not standardized and vary immensely in shape, chemistry, and design, which makes the extraction, separation, and recycling of each battery's materials possible but not easy. *A preliminary step to take **before** recycling is to reuse or repurpose the battery.* EV batteries typically retain almost 80 percent of their original capacity upon retirement from powering a vehicle for 8-12 years,[29] making them an excellent fit for second-life applications.

Extend the life of EV batteries through reuse and repurposing

There are two main types of second-life applications. The first, battery reuse, is when an EV battery's second life is used for another EV application, such as in a vehicle requiring shorter travel distances. The second application is battery repurposing. These still-useful batteries maintain significant value and eventually even help decrease the cost of storage to enable further integration of solar and wind power into our grids. Battery storage for residential settings, electric vehicle charging stations, and street lighting are typical examples of small-scale applications of second-life batteries.[30] Volkswagen plans to utilize end-of-life EV batteries for energy storage at Electrify America charging stations.[31] Medium-scale applications generally involve energy supply storage for industrial sites or power traction batteries designed for maritime use cases. Carwatt partnered with Renault in 2014 to use second-life EV batteries

[26] https://www.eba250.com/about-eba250/value-chain/
[27] https://www.globalbattery.org/battery-passport/
[28]https://www.energy-storage.news/european-unions-mandatory-battery-passport-sustainability-effort-starts-to-take-shape/
[29] https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8718282
[30] https://theicct.org/wp-content/uploads/2023/02/recycling-electric-vehicle-batteries-feb-23.pdf
[31] https://www.motortrend.com/news/volkswagen-ev-battery-production-recycling-electrify-america/

to power ground-support equipment vehicles.[32] Finally, large-scale applications typically involve the electricity grid, where end-of-life batteries provide backup power for renewable energy and improve grid resiliency. Energy storage is vital for our transition to clean energy and transportation. Audi and the energy company RWE introduced an energy storage solution comprising 60 second-life Audi e-tron batteries. This system can supply approximately 4.5 MWh of stored electricity, effectively supporting the operations of the industrial site.[33]

There are several benefits to extending the life of batteries through reuse and repurposing. First, employing second-life batteries can be more cost-effective than buying a new battery. For storage applications, it is estimated that there is a 30-70 percent cost advantage for second-life batteries over new ones.[34] From a sustainability perspective, the most compelling reason for keeping a battery in operation is the relatively low emissions from battery use versus manufacturing. According to the International Council on Clean Transportation, widespread use of stationary storage applications can increase a battery's lifetime use by 72 percent, in turn reducing the greenhouse gas emissions from the vehicle by 42 percent on a per kilometer basis.[35] The longer we can extend a battery's life, the more we can distribute the initial battery production footprint across more use. As the EV market share continues to grow, a cheap and plentiful supply of retired EV batteries will be available to serve as energy storage to support the electric grid, homes, and businesses.

RECYCLE

The minerals in an EV battery can be recycled almost infinitely. **Research shows that while mining alone could meet the coming demand for EV battery minerals, recycling can support a significant portion of the minerals necessary for the growing EV market.**[36] According to Redwood CEO J.B. Straubel, the metals in batteries don't change or degrade, so the materials from old batteries can be made into new batteries without any tradeoffs in performance or battery life.[37] Building out domestic recycling can also mitigate supply and price volatility across global markets.

While used EV batteries currently have more value as a whole (compared to the value of their separated materials), recycling is essential to reducing demand for newly mined minerals.[38] As we develop a more robust market for recycled battery materials and battery recycling technology evolves, we expect the recycling costs to fall**.** Recognizing the importance of battery

[32] https://www.renaultgroup.com/en/news-on-air/news/carwatt-and-renault-the-future-of-retrofitting/
[33] https://www.rwe.com/en/press/rwe-generation/2021-12-28-second-life-for-ev-batteries/
[34] https://earthworks.org/wp-content/uploads/2021/09/UTS-EV-battery-metals-sourcing-20210419-FINAL.pdf
[35] https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_09022018_vF.pdf
[36] https://blog.ucsusa.org/jessica-dunn/are-there-enough-materials-to-manufacture-all-the-electric-vehicles-needed/#:~:text=The%20short%20answer%20is%20yes,lithium%2C%20cobalt%2C%20and%20nickel
[37] https://www.axios.com/2022/11/10/audi-redwood-ev-battery-recycling
[38] https://blog.ucsusa.org/jessica-dunn/why-do-we-need-ev-battery-recycling-policy/

recycling in the clean energy transition, the Biden Administration recently committed $192 million in grants to advance battery recycling technology in addition to the supportive funding available through the Inflation Reduction Act (IRA)[39]

Battery recycling provides multiple benefits. Recycling helps to alleviate the public health and environmental concerns that can result from improper disposal, but recycling EV batteries is not just about keeping them out of landfills. The ability to extract and reuse these materials will eventually reduce costs and lower our need for new minerals. Additionally, using recycled materials in new batteries can avoid expending energy on obtaining and processing new minerals, thus reducing the lifecycle emissions associated with battery production by 7–17 percent.[40] A study by the American Chemical Society shares, "Under idealized conditions, retired batteries could supply 60% of cobalt, 53% of lithium, 57% of manganese, and 53% of nickel globally in 2040."[41]

Policy pathways to ensure battery recycling

Set recovery rates targets

Plug In America recommends adopting policies that incentivize and mandate the recovery and recirculation of recycled materials into new batteries to promote a circular supply chain. Setting recovery rate targets will be crucial for maximizing material recovery. Two metrics need to be considered when developing these targets: recycling efficiency rate and material recovery rate. The recycling efficiency rate is the percent of the entire battery recovered through recycling. Material recovery rates are the percentage of each recovered material in the recycling process. At the federal level, we encourage the EPA to set recovery rates that ramp up over time, like the EU Sustainable Batteries Law. For lithium-ion EV batteries in 2025, this law sets an overall recycling efficiency target of 65 percent; this target will increase to 70 percent in 2030. Recovery targets for lithium increase from 50 to 80 percent from 2027 to 2031 and from 90 to 95 percent for cobalt, nickel, and copper.[42]

Similar recovery targets in the U.S. would secure a domestic supply chain of battery materials, decrease battery costs, and facilitate regional policy harmonization. Analysis by Transport & Environment shows that higher lithium recovery targets, like those in the EU Battery Law, can reduce the quantity of lithium 'lost" in an end-of-life lithium-ion battery by two-thirds. Higher lithium recovery targets can also cut the amount of newly-mined lithium required to make new batteries by a factor of three compared to the lower targets initially proposed in the EU Battery

[39]https://www.energy.gov/articles/biden-harris-administration-announces-192-million-advance-battery-recycling-technology
[40] https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_09022018_vF.pdf
[41] https://pubs.acs.org/doi/abs/10.1021/acs.est.0c07030
[42]https://www.transportenvironment.org/wp-content/uploads/2022/10/2022_10_Lithium_recycling_factsheet.pdf

Law.[43] Policy alignment between the EU and the U.S. would decrease regulatory uncertainty for battery and material suppliers while improving supply chain and manufacturing standards.[44]

Set recycled content standards

Another tactic to ensure that recycled materials are reused in new batteries is setting recycled content standards. Recycled content standards (RCS) can create a market for reclaimed materials and increase recycling rates by mandating that recovered materials make up a certain percent of constituent material in a product.[45] RCSs already exist for plastic, glass, and newsprint in the U.S.[46] and are employed in the EU as part of the Sustainable Battery Law. The implementation of RCSs could also prevent downcycling. Downcycling may use the same processes as recycling. However, the material recovered is not at a quality suitable for new batteries.[47] This recovered material may be used in other sectors lacking stringent recycling requirements and, consequently, end up in a landfill.

Mandate extended producer responsibility

To ensure higher recycling rates, Plug In America advocates for extended producer responsibility, where producers of EV batteries are responsible for complete waste management of batteries.[48] Placing responsibility for end-of-life product management on producers instead of the general consumer can catalyze safer, more efficient, and sustainable product design. A group of experts and stakeholders convened by the state of California (California's Lithium-ion Car Battery Recycling Advisory Group) published a report on policy recommendations to increase EV battery recycling.[49] The report outlines policies that could become the first lithium-ion U.S. battery recycling regulation – including extended producer responsibility for battery recycling. Extended producer responsibility is a primary regulation featured in the EU Sustainable Battery Law. Implementing extended producer responsibility can create a setting for emerging markets that reflects the true environmental impacts of a product.

The economic viability of battery recycling

The recycling of EV materials holds great economic promise. In 2021, the lithium-ion battery recycling market alone was $2 billion, with a forecast of $6.55 billion annually by 2028.[50] Creating circular supply chain frameworks using the aforementioned strategies can make

[43] https://www.transportenvironment.org/wp-content/uploads/2022/10/2022_10_Lithium_recycling_factsheet.pdf
[44] https://www.sciencedirect.com/science/article/pii/S0921344922003317?via%3Dihub
[45] https://www.sciencedirect.com/science/article/pii/S0921344922003317?via%3Dihub
[46] https://p2infohouse.org/ref/06/05910.pdf
[47] https://earthworks.org/wp-content/uploads/2021/09/UTS-EV-battery-metals-sourcing-20210419-FINAL.pdf
[48] https://www.sidley.com/en/insights/newsupdates/2022/08/eu-a-step-closer-to-adopting-expansive-new-rules-covering-lifecycle-of-electric-vehicle-batteries
[49] https://calepa.ca.gov/wp-content/uploads/sites/6/2022/05/2022_AB-2832_Lithium-Ion-Car-Battery-Recycling-Advisory-Goup-Final-Report.pdf
[50] https://www.globenewswire.com/en/news-release/2022/10/06/2529169/0/en/Lithium-ion-Battery-Recycling-Market-Size-Worth-USD-6-55-Billion-Globally-by-2028-at-18-5-CAGR.html

reusing and recycling used EV batteries self-sustaining and profitable. Battery collection and transportation represent about 29 percent of battery recycling costs.[51] This cost fluctuates due to the variance of materials, levels of degradation, and degree of hazard.[52] The distance to a recycling facility and the battery volume also influence this price.[53] By requiring battery labeling, we can provide more nuanced waste management storage, transport, and pricing instead of evaluating all batteries as costing the same.[54]

Mandates like extended producer responsibility and other policies will encourage the development of batteries that are easier to disassemble and recycle—dismantling and disassembling an EV battery make up approximately 37 percent of recycling costs.[55] By returning spent batteries to battery manufacturers, it will be in their interest to design batteries that are more cost-effective to recycle. Standards can also be implemented so that EV batteries are manufactured to facilitate more efficient recycling and repurposing while ensuring the costs of doing so are not passed on to insurers and consumers.[56]

Laws like the Inflation Reduction Act (IRA) have already spurred investment in recycling and repurposing facilities.[57] As outlined in the IRA, a vehicle can qualify for a clean vehicle tax credit of up to $7,500 if at least 40 percent of the value of the minerals in the battery were mined or processed in the U.S. or any free trade agreement country *or recycled in North America*. Setting up mining and processing facilities is a lengthy undertaking, leading to increased interest in recycling as a solution for manufacturers who want their vehicles to qualify for the tax credit. Additionally, the IRA offers a 30 percent tax credit under section 48C for manufacturers that invest in facilities that build or recycle renewable energy components. Currently, automakers are working to prioritize the stability of their supply chains by securing recycled materials at stable prices. For example, VW has partnered with Redwood Materials to remanufacture battery materials domestically.[58]

RESPONSIBLE MATERIAL SOURCING

Commit to responsible materials sourcing

Currently, there are no proven “sustainable mining” practices that Plug In America can confidently recommend. However, there are solutions that decrease the need for new mining and emerging practices to mitigate the impacts of mining. While we urge manufacturers to

[51] https://www.sciencedirect.com/science/article/pii/S0921344922003317
[52] https://cleantechnica.com/2022/12/24/ev-battery-recycling-jumping-in/
[53] https://www.sciencedirect.com/science/article/pii/S0921344921003645
[54]https://rmi.org/how-policy-can-advance-a-circular-battery-economy/?gad=1&gclid=CjwKCAjwq4imBhBQEiwA9Nx1BqMwJ8fFzPxm-px2uwy60Yi3GCd7Nqn0VsjJwdd9nchKI7pJ0ArVchoC9CQQAvD_BwE
[55] https://www.sciencedirect.com/science/article/pii/S0921344922003317
[56] https://blog.ucsusa.org/charlie-hoffs/want-clean-energy-then-you-also-want-battery-recycling/
[57] https://www.congress.gov/bill/117th-congress/house-bill/5376
[58] https://media.vw.com/en-us/releases/1695

prioritize the use of in-cycle materials, Plug In America acknowledges that the transition to clean transportation will require material extraction. Mining will continue with or without EVs. We have been extracting minerals from the earth for numerous everyday applications, like producing our phones and laptops, and to power our current fossil-fueled transportation sector long before the rise of EVs. The transition to electrified transportation offers a timely catalyst to rethink our antiquated mining laws.

Impacts of mining

Mining comes with a cost; mining often displaces people, endangers workers, poisons water sources, and devastates ecosystems.[59] Modern mining blasts, excavates, and crushes millions of tons of rock and earth, redirects rivers, and can alter landscapes forever. After the minerals of economic value have been extracted, mine tailings are left behind. These tailings, or byproducts, include blasting chemicals (nitrate, ammonia), chemicals used for separation (cyanide, caustic agents, petroleum byproducts), and other elements and compounds leached from the earth (arsenic, aluminum, copper, lead, sulfate, etc.).[60] These tailings must be sequestered and monitored, often for hundreds of years. The increasing frequency and severity of disastrous tailings containment failures pose a perpetual threat to nearby communities and ecosystems.[61]

Mining law reform

Update the 1872 Mining Law

The transition to electrified transportation offers a timely catalyst to rethink our antiquated mining laws.

Given the projected surge in demand for minerals to fuel the clean energy transition, it is imperative to update our mining laws and regulations to establish the highest possible protections for workers, communities, and the environment. Our mining laws date back to the U.S.'s initial settlement and colonization of the West in 1872 and have not been changed since then. The 1872 Mining Law establishes hardrock mining as the "highest and best use" of public lands. It does not account for the sensitivity of the environment or other land uses such as recreation, hunting, renewable energy, grazing, or sacred sites.[62] Under the 1872 Mining Law, mining companies pay no royalties, whereas other extractive industries typically pay an 8–12.5 percent royalty for extracting resources from federal onshore public lands.[63] Lastly, the 1872 Mining Law features no environmental protections, allowing foreign mining companies to dig where they want, claim their economic gains, and leave the mess. Over 500,000 abandoned

[59] https://www.sciencedirect.com/science/article/abs/pii/S0301479720315486
[60] https://earthworks.org/wp-content/uploads/2022/05/Safety-First-Safe-Tailings-Management-V2.0-final.pdf
[61] https://earthworks.org/wp-content/uploads/2021/09/WHITE-PAPER-Revising-Hardrock-Mining-Regs-2021.pdf
[62] https://earthworks.org/wp-content/uploads/2021/09/FS_1872MiningLaw_EW-EJ-WORC_201903.pdf
[63] https://earthworks.org/wp-content/uploads/2021/09/FS_1872MiningLaw_EW-EJ-WORC_201903.pdf

mines are littered across the country, poisoning communities and costing taxpayers billions for cleanup.[64]

Plug In America recommends mandatory requirements and administrative and legal reform governing mining, such as The Clean Energy Minerals Reform Act of 2023.[65] The bill introduced in Congress by Sen. Martin Heinrich (D-N.M.) and Rep. Raúl M. Grijalva (D-Ariz.) establishes a permitting and leasing system, royalties for new and existing mining operations, protections for special places, required tribal consultation, environmental and reclamations standards, and industry financing for cleanup operations.[66] Some principles that we believe are especially important for mining reform in addition to those listed above are *prioritization* of other land uses over mining, intentional engagement with and integration of community voices into the permitting process, and the opportunity for impacted communities, especially Indigenous Peoples, to influence the outcome and potentially block mining proposals.

Upholding the Rights of Indigenous Peoples

Throughout U.S. history, Indigenous People have suffered the physical, social, cultural, economic, and emotional consequences of development and industrialization. The climate crisis is also a product of this rapid industrialization. Among the minerals necessary for the transition away from fossil fuels, 97 percent of nickel, 89 percent of copper, 79 percent of lithium, and 68 percent of cobalt reserves and resources in the U.S. are located within 35 miles of Native American reservations.[67] Plug In America recognizes the urgency of climate change and the global transition to clean transportation and sees this moment as an opportunity to ensure that the transition does not overshadow the localized impacts of resource extraction on people and places. We can and must balance the need for mineral extraction for the clean energy transition and ensure that Indigenous Peoples' rights are upheld.

Plug In America recognizes the urgency of climate change and the global transition to clean transportation and sees this moment as an opportunity to ensure that the transition does not overshadow the localized impacts of resource extraction on people and places.

[64] https://earthworks.org/wp-content/uploads/2021/09/FS_1872MiningLaw_EW-EJ-WORC_201903.pdf
[65] https://www.congress.gov/bill/117th-congress/house-bill/7580
[66] https://democrats-naturalresources.house.gov/imo/media/doc/clean_energy_mineracts_reform_act_of_2023.pdf
[67] https://www.msci.com/www/blog-posts/mining-energy-transition-metals/02531033947

Reform law and instate protections for culturally significant places

As stated above, we advocate for new mining regulations that feature education, engagement, and consent requirements between mining companies and local communities. They should also incorporate ongoing monitoring requirements and a penalty system for companies that fail to educate communities, protect Indigenous resources, or properly manage waste. Specific protections should also be instated to ensure that new mines are not proposed at sacred or culturally significant sites. Agencies can reference the Memorandum of Understanding for the Protection of Indigenous Sacred Sites as a starting framework for consultation around decisions that may impact places and people.[68]

Adopt free, prior, and informed consent standards

Another way to ensure that Indigenous People can engage in designing, implementing, monitoring, and evaluating the projects that impact them is through Free, Prior, and Informed Consent (FPIC).[69] 'Free' means consent is given voluntarily, without coercion, intimidation, or manipulation; 'prior' means consent is sought well in advance before any activities begin; 'informed' means that information provided for consent should be accessible, clear, consistent, accurate, transparent, and culturally appropriate; 'consent' refers to the collective decision made by rights-holders through customary decision-making processes of the communities.[70]

Plug In America recommends that the U.S. ratify and operationalize the United Nations Declaration On The Rights Of Indigenous Peoples (UNDRIP), which would impose legal requirements for companies to respect FPIC and provide avenues for penalties if they do not.[71] While this is not yet ratified, we encourage individual Federal Departments to require due diligence processes like the UN Guiding Principles on Business and Human Rights, the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, and the World Bank Environmental and Social Framework, that each require some measure of FPIC.[72]

Voluntary standards

Use the Initiative for Responsible Mining Assurance to supplement mining law reform

The global laws and rules governing mining range from absent to inadequate, almost across the board. In light of this, a multi-stakeholder-led organization called the Initiative for Responsible Mining Assurance (IRMA) was created to offer independent, third-party auditing and

[68] https://www.doi.gov/sites/doi.gov/files/mou-interagency-coordination-and-collaboration-for-the-protection-of-indigenous-sacred-sites-11-16-2021.pdf
[69] https://www.fao.org/indigenous-peoples/our-pillars/fpic/en/
[70] https://www.ihrb.org/explainers/what-is-free-prior-and-informed-consent-fpic
[71] https://social.desa.un.org/issues/indigenous-peoples/united-nations-declaration-on-the-rights-of-indigenous-peoples
[72] https://www.ohchr.org/sites/default/files/documents/publications/guidingprinciplesbusinesshr_en.pdf https://www.oecd.org/daf/inv/mne/mining.htm

transparency for extracting raw materials in mining.[73] Plug In America recommends IRMA's standards and audits as a *supplemental* tool to provide transparency and hold mining companies accountable for mine sites' human rights, environmental, and labor conditions. While we consider IRMA to be strategically valuable, IRMA is not designed to be a substitute for regulations or legally enforceable requirements.[74] A primary assertion of IRMA is that mining operations must comply with the most stringent set of criteria wherever they operate, whether those required by local jurisdictions or IRMA. In the absence of global requirements around mining, we see the benefits of companies committing to and implementing criteria to minimize impact on people and the planet.

CONCLUSION

Plug In America believes electric vehicles are an important tool needed to address climate change and create a cleaner, healthier, more equitable transportation system. However, EVs alone won't get us to our climate goals. EVs are one piece of a broader solution set that includes multi-modal transportation, a transition to a circular economy, and the ethical, responsible sourcing of battery and manufacturing minerals.

We advocate for approaching this once-in-a-lifetime transition in a way that minimizes the need for raw material extraction by reducing demand through expanding multi-modal transportation, including increasing investments in transit, active transportation, car share, and micro-mobility. We champion a circular economy and a closed-loop, sustainable supply chain that reuses batteries and recycles battery minerals to maximize battery life and mineral value. Finally, hardrock mining has a long history of damaging communities and the environment. We highlight this information not to slow down the transition to EVs but to emphasize the opportunity to make improvements. We strongly urge mining law reform, including enforceable regulations that protect people and the planet. Creating a just and sustainable future with electric vehicles is our greatest challenge and opportunity; we welcome everyone within the EV industry and supply chain, including battery manufacturers, car manufacturers, policymakers, communities, advocates, and consumers to be part of this sustainable and just transition.

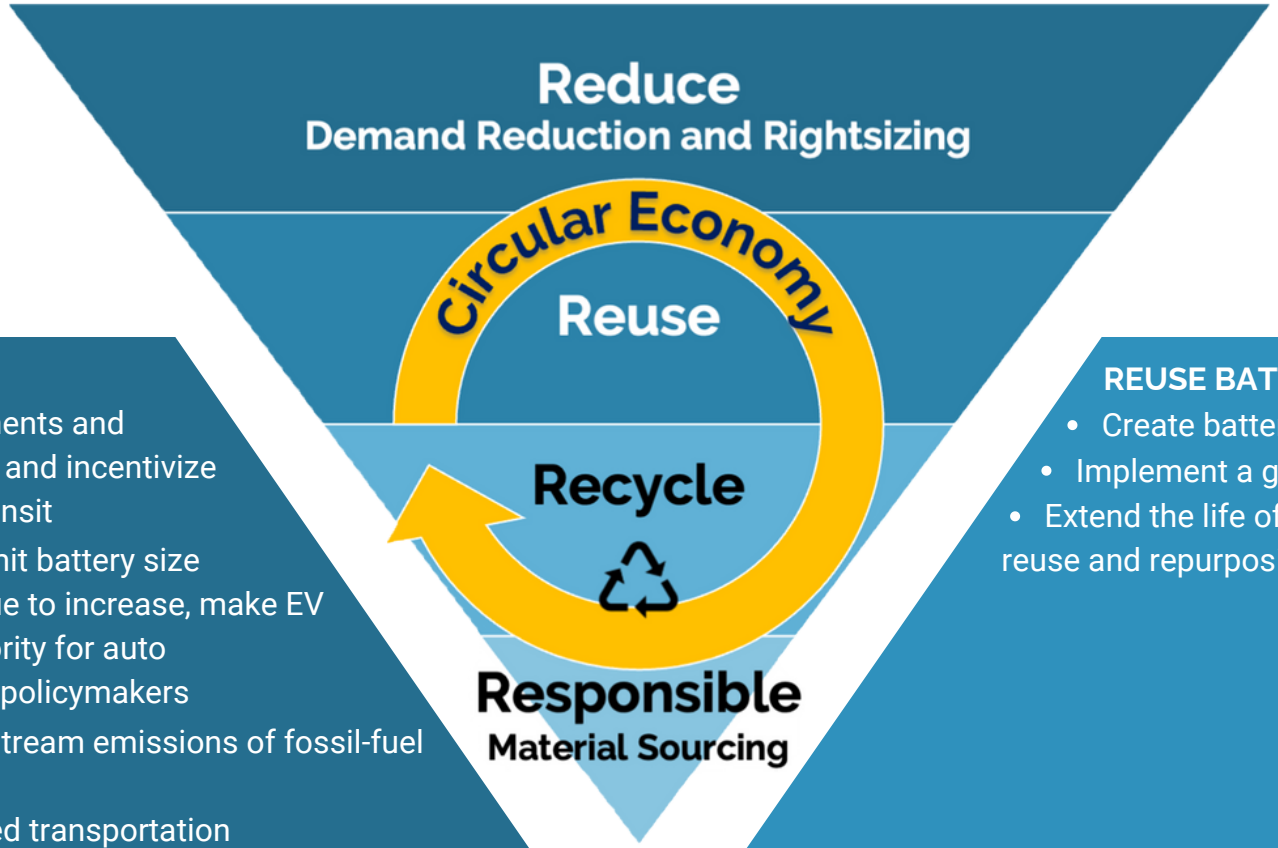
ABOUT PLUG IN AMERICA

Plug In America is the nation's leading nonprofit organization dedicated to accelerating the use of plug-in electric vehicles in the United States. Formed in 2008, the EV advocacy group helps consumers, policymakers, auto manufacturers, and others to understand the powerful benefits of driving electric by providing practical, objective EV information. Its programs include National

[73] https://responsiblemining.net/wp-content/uploads/2018/07/IRMA_STANDARD_v.1.0_FINAL_2018-1.pdf
[74] https://earthworks.org/issues/the-initiative-for-responsible-mining-assurance/

Drive Electric Week, Drive Electric Earth Day, PlugStar.com, and other public outreach events. Learn more at PlugInAmerica.org.

CREATING AN ETHICAL, SUSTAINABLE BATTERY SUPPLY CHAIN



REDUCE

- Shift public investments and policies to increase and incentivize active and mass transit
- Decrease and/or limit battery size
- As EV sales continue to increase, make EV efficiency a top priority for auto manufacturers and policymakers
- Account for the upstream emissions of fossil-fuel vehicles and EVs
- Encourage rightsized transportation
- Support improvements in battery energy density

REUSE BATTERIES

- Create battery labeling regulations
- Implement a global battery passport
- Extend the life of EV batteries through reuse and repurposing

RECYCLE BATTERIES

- Set materials recovery rates and recycling efficiency rates
- Set recycled content standards
- Mandate extended producer responsibility

RESPONSIBLE MATERIALS SOURCING

- Reform the Mining Law of 1872
- Reform law to protect Indigenous people's rights and instate protections for culturally significant places
- Adopt free, prior, and informed consent standards
- Adopt voluntary standards for mining reform