

THE FUTURE OF TRANSPORTATION: Maximizing Oklahoma's Potential in the EV Supply Chain











Table of Contents

EXECUTIVE SUMMARY	1
INTRODUCTION	2
MINING AND PROCESSING	3
Countries and Firms	4
Infrastructure	5
Regulatory	5
EV BATTERY PRODUCTION	7
Countries and Firms	7
Regulatory	3
EV BATTERY SALES	9

Countries and Firms	10
Infrastructure	10
Regulatory	11
POLICY DIRECTION FOR OKLAHOMA	12
Infrastructure and Human Capital	12
Regulation	13
Policy Incentives	14
WHAT THE FUTURE HOLDS	14
REFERENCES	15



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CITD REPORT

Executive Summary

klahoma stands at a pivotal juncture in the rapidly evolving electric vehicle (EV) battery industry. Our analysis reveals a unique opportunity for the state to establish itself as a key player in this growing sector. The global EV market is experiencing significant expansion, with sales reaching 14% of all new cars sold globally in 2022. In the U.S., Electric car sales surged by 55%, capturing an 8% market share. While china currently dominates the global EV battery supply chain, recent U.S. Policies aim to reduce this dependence and boost domestic production.

Oklahoma's geographical location, existing manufacturing capabilities, energy-literate workforce, and natural resource endowments position it favorably to develop a competitive EV battery industry cluster. The Tulsa Port of Catoosa offers strategic advantages, potentially reducing logistics costs and enhancing supply chain efficiency. Collaborations with native American tribes and targeted training programs present unique opportunities to prepare the workforce for this industry. Balanced regulations promoting sustainable practices while supporting growth are crucial for long-term success.

We recommend implementing a bottom-up industrial support strategy to create a geographical competitive cluster. This involves investing in public goods to foster a connected midwestern cluster of EV manufacturers and supporting firms. Developing efficient infrastructure and expanding the EV charging network is essential. Establishing partnerships between government, academia, and industry will drive innovation and sustainable practices. By creating tailored education programs, adopting balanced regulations, and implementing targeted funding and industrial policies, Oklahoma can position itself as a key global player and enhance its competitiveness in international trade.

INTRODUCTION

he U.S. stands at a critical juncture in expanding use of electric vehicles (EVs), driven by a convergence of supportive government policies and increasing consumer interest. This shift is reshaping the automotive landscape and sparking a global race for dominance in the manufacture of EVs and accompanying supply chains. Correspondingly, EVs reached 14% of all new cars sold globally in 2022 (International Energy Agency, 2023).

Current market dynamics are complex. China dominates the global EV battery supply chain, accounting for approximately 60% of global electric car sales. In 2023, Chinese EV giant BYD surpassed U.S. carmaker Tesla as the world's best-selling EV brand, although Tesla's Model Y was still the best-selling vehicle overall, the first EV to do so, for 2023 (JATO, 2024). Chinese EV manufacturers have also begun to expand their manufacturing presence abroad to capture foreign markets, including in countries which have free trade agreements (FTAs) with the United States, raising concerns that they are using U.S. FTAs as a strategy to gain preferential access to the U.S. market.

Recent U.S. presidential administrations have responded to growing geopolitical tensions and the rapid expansion of China's EV sector by implementing measures to reduce China's influence in the U.S. EV market. In 2019, the U.S. imposed a 25% tariff on all Chinese auto imports. The

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Inflation Reduction Act (IRA), enacted in 2022, aimed to boost the U.S. domestic industry by offering generous tax credits to consumers who buy EVs with primarily U.S.sourced batteries and assembled in the United States. Additionally, the IRA introduced new tax mechanisms like direct payments and credit transfers to broaden the eligi-



bility of energy providers for nonrefundable credits. This initiative has led to a significant increase in clean energy investments in the U.S., with \$239 billion invested in 2023 towards new manufacturing capacity for zero-emissions vehicles, batteries, and critical minerals, marking a 38% rise from the previous year. Most of these investments have focused on the EV supply chain, covering critical mineral production, battery and charger manufacturing, and final vehicle assembly (The Clean Investment Monitor, 2023).

The IRA's tax incentives and funding mechanisms are intended to fill gaps in the EV ecosystem, complementing private investments. These incentives are designed to support various aspects of the EV transition, bolstering manufacturing, adoption, and charging infrastructure, vital for domestic job creation and industry growth. Notably, the Section 45X tax credit promotes clean technology manufacturing onshoring, potentially saving manufacturers up to \$134.9 billion by 2031 (Joint Committee on Taxation, 2023). Additionally, the new Section 30D clean vehicle credit offers consumers

up to \$7,500 for purchasing new EVs, with incentives for meeting battery and critical minerals sourcing requirements. EVs containing battery components or specified

In 2022, US electric car sales surged by 55%, reaching an 8% market share.

critical minerals from "foreign entities of concern", including China, will not be eligible for the credit (Federal Register: The Daily Journal of the United States Government, 2024). The IRA also introduced a commercial clean vehicle credit for leased or commercially used EVs.

Among these incentives is the Domestic Manufacturing Conversion Grants Program, which provides \$2 billion for retooling closed manufacturing facilities to produce EVs or related components. Additionally, the IRA established various other grant programs, such as the Battery Materials Processing Grants Program, the Battery Manufacturing and Recycling Grants Program, and the Advanced Energy Manufacturing and Recycling Grant Program, to further bolster the domestic EV battery supply chain. Similar dynamics have been playing out globally, with competition between significant players intensifying, as governments continue enacting new policies to promote their interests in the global EV market.

In 2022, US electric car sales surged by 55%, reaching an 8% market share (International Energy Agency, 2023). While 2023 EV sales fell short of the 9% forecast (St John, 2023), sales reached 7.6% of all passenger vehicles (Cox Automotive, 2024) aligning with the Biden administration's goal for 50% of new vehicle sales to be electric by 2030. However, sustained growth depends on bolstering manufacturing and EV battery supply chains, crucial for meeting increasing demand and securing essential minerals. This transition may disrupt traditional automotive supply chains but offers opportunities for new global leaders to emerge.

In response to these dynamics, we have developed this policy white paper to evaluate key considerations in the EV battery supply chain ecosystem with a particular focus on state and local policies that attract or hinder investment in this new technology within Oklahoma. When the portion of the supply is heavily dependent on federal policy, federal policy is also examined. First, we outline the supply chain's mining and processing, then the battery manufacturing, and finally the battery sales components. This information sets us up to recommend how Oklahoma can compete in the supply chain. Our recommendations focus on investments in transport infrastructure, regulatory policies, and business and consumer incentives. We argue that the mutually reinforcing nature of these factors can help Oklahoma develop a competitive economic cluster in the EV battery space.

MINING AND PROCESSING

he expansion of the EV market is creating a surge in demand for critical minerals necessary for battery and magnet motor production. Access to these resources is becoming increasingly vital for ensuring the availability of affordable EVs. Consequently, governments and corporations are intensifying efforts to secure supply and processing capacity of these minerals. In the United States, there's a particular focus on strengthening the mineral supply chain due to concerns related to national security and economic dependence on foreign sources (Energy Systems Research Unit,

"... the U.S. is taking steps to reduce its reliance on Chinese mines."

N.D.; Tracy, 2022).

In addition to EVs, increases of renewable energy usage is further putting pressure on demand for these critical min-

erals, whose supply is positioned at risk for disruption (Energy Systems Research Unit, N.D.; Tracy, 2022). Projections from the International Energy Agency indicate a significant rise in demand for rare earth elements (REE) and lithium by 2040. This surge in demand underscores the importance of securing a stable supply of these minerals (World Energy

Outlook, 2021). The process of obtaining REEs involves various methods, including primary extraction, recovery from secondary sources like end-of-life electronics, and extraction from unconventional sources such as industrial by-products. These methods highlight the complexity of securing a reliable supply chain for these critical minerals (Fatunde, 2024).

Countries and Firms

EVs depend on REEs for magnet motors and lithium, cobalt, nickel, manganese, and graphite for their batteries. Rareearth elements comprise 17 raw elements crucial for var-



ious technologies, including EVs, wind turbines, mobile electronic devices, and military hardware. Despite their name, REEs are not rare. They are relatively abundant in the Earth's crust but tend to be dispersed at lower concentrations than ores of more commonly used metals. Two REEs, neodymium (Nd) and dysprosium (Dy), are primarily utilized in EV permanent magnet motors.

China currently dominates the global REE supply chain, producing approximately five times more than the United States in 2023. However, the U.S. is taking steps to reduce its reliance on Chinese mines. For example, USA Rare Earth is constructing a facility in Stillwater, Oklahoma, to produce neodymium magnets. This facility is expected to receive rare

"USA Rare Earth is constructing a facility in Stillwater, Oklahoma, to produce neodymium magnets."

earth feedstock from the company's Round Top property in Texas, aiming to begin operation by late 2025 or early 2026 (Editorial Staff, 2023).

Lithium reserves are mainly concentrated in countries like

Chile, Australia, Argentina, China, and the United States, with Australia producing about 46% to global lithium. However, China plays a crucial role not only in mining but also in processing, handling nearly 60% of global lithium processing. In contrast, the United States has a relatively minor presence in the lithium market, contributing less than 1.5% of global supply (Wood et al., 2021). Oklahoma's emergence as a lithium producer, exemplified by Stardust Power's battery-grade lithium refinery in Muskogee, is working to address this gap, supported by state and federal incentives.

Cobalt, primarily produced in the Democratic Republic of Congo (DRC), poses challenges in the supply chain due to geopolitical issues and ethical concerns. Projects like Westwin Elements' nickel and cobalt refinery in Lawton, Oklahoma, aim to lessen U.S. dependence on international sources, while emphasizing ethical sourcing and environmental standards (Stitt K., 2023).

Similarly, the United States faces challenges in other critical minerals like nickel and manganese, with limited domestic production capabilities. However, emerging opportunities such as polymetallic nodules on the ocean floor offer prospects for enhancing domestic supply (Wood et al., 2021). Graphite mining projects are also underway in states like Alabama and Alaska, aiming to diversify mineral supply chains and reduce reliance on imports (Tracy, 2022).

Infrastructure

Mining operations entail a multifaceted process that spans from deposit discovery, obtaining permits and land rights, and beginning mining operations. This endeavor can be protracted, with mine plan approval averaging around two years and sometimes taking over a decade (GAO). The methods employed in mining vary based on the mineral type, com-

monly involving open pit or underground techniques, or the extraction of compounds from brines. Post-extraction, additional processing is often necessary to yield the commodity mineral substances required for EV batteries (Travis, 2022). Infrastructure, particularly transportation networks, is integral to the extraction and global trade of Rare Earth Elements (REEs).

Infrastructure, particularly transportation networks, is integral to the extraction and global trade of Rare Earth Elements (REEs). Roads, railways, and deep-water ports form the backbone of mining infrastructure, facilitating the movement of raw materials from mines to processing facilities and international markets. Efficient road and rail networks reduce transportation costs and enhance the competitiveness of REE mining operations (Givoni, 2006; Zhang et al., 2024). Deep-water ports serve as crucial gateways for exporting REE concentrates and refined products, minimizing shipping costs and transit times (Zhang et al., 2024). Moreover, reliable power and water supplies are imperative for sustaining mining operations and processing activities. Adequate power infrastructure ensures uninterrupted energy supply, while sustainable water management practices mitigate environmental impacts (Tokarczyk & Dudek, 2020; Yu et al., 2018). However, excessive or poorly planned infrastructure can lead to adverse environmental consequences, underscoring the need for strategic planning and regulatory oversight (Bian et al., 2012).

Regulatory

AGENCIES

In the United States, regulations governing Rare Earth Element (REE) mining and environmental policies are overseen by a variety of federal and state agencies. At the federal level, the Environmental Protection Agency (EPA) is central to monitoring and enforcing environmental regulations related to REE mining operations. The EPA establishes standards for air and water quality, waste management, and remediation efforts to mitigate environmental harm from mining activities. Additionally, the Bureau of Land Management (BLM) manages mineral resources on federal lands, including the leasing and permitting process for REE mining operations, aiming to balance economic interests with environmental conservation. State-level regulatory agencies such as the Oklahoma Department of Mines (ODM) and the Oklahoma Mining Commission also collaborate with federal agencies to enforce environmental regulations and ensure compliance with

At the federal level, the Environmental Protection Agency is central to monitoring and enforcing environmental regulations related to REE mining operations.

state-specific requirements (Bandara et al., 2014).

To reconcile environmental protection with domestic production, regulatory agencies at both state and national levels implement a range of measures, including permitting requirements, environmental impact assessments, and monitoring and reporting obligations. The regulatory framework

encompasses various laws such as the Clean Water Act, Clean Air Act, Endangered Species Act, Surface Mining Control and Reclamation Act, Solid Waste Disposal Act, and Toxic Substance Control Act. Each state may supplement federal regulations with additional laws and regulations tailored to mitigate adverse environmental effects of mining activities. Despite potential delays in exploration and mining processes, these policies aim to safeguard natural environments and ensure safer working conditions (Alonso et al., 2022).

Federal oversight of mining activities on indigenous-owned land is governed by agencies like the U.S. Office of Surface Mining Reclamation and Enforcement (OSMRE) and the Bureau of Indian Affairs (BIA). The Surface Mining Control and Reclamation Act of 1977 (SMCRA) establishes standards for surface mining and environmental protection, including mine reclamation requirements. Tribes may develop and administer their own regulatory programs for mining activities on their lands under SMCRA. In light of the McGirt v. Oklahoma decision in 2020, recent judicial rulings have affirmed federal regulatory authority over surface mining on tribal reservations, limiting state involvement and solidifying federal jurisdiction over such operations (Bandara et al., 2015). As a result, mining activities on indigenous-owned land, particularly in states like Oklahoma, are subject to federal regulations and tribal regulatory programs, with minimal state intervention.

INCENTIVES

In the broader context of national efforts to bolster the domestic supply chain for critical minerals, recent initiatives and incentives led by the Biden-Harris Administration underscore a strategic shift towards reducing reliance on foreign sources, particularly China, while promoting sustainable practices (The White House, 2023). Executive Order 14017 initiated a comprehensive review of vulnerabilities in U.S. critical mineral supply chains, recognizing the over-reliance on foreign sources as a threat to national and economic security. The administration's focus extends to expanding domes-

tic mining, production, processing, and recycling of critical minerals, emphasizing labor, environmental standards, and community engagement.

Recent trends indicate a decline in mine plan approvals, reflecting the increasing complexities of the regulatory landscape.

Major investments have been announced, including the

Department of Defense's \$35 million award to MP Materials to process heavy rare earth elements in California, aiming to establish a complete domestic magnet supply chain. Berkshire Hathaway Energy Renewables is launching a project for sustainable lithium extraction from geothermal brine in California. Additionally, Redwood Materials, in collaboration with Ford and Volvo, is working on recycling end-of-life lithium-ion batteries.

The Department of Energy (DOE) is funding projects such as a \$140 million initiative to recover rare earth elements and critical minerals from coal ash and mine waste, along with \$3 billion for refining battery materials and recycling facilities. Private sector contributions include MP Materials' construction of a rare earth metal manufacturing facility in Texas and its supply agreement with General Motors. Companies like Controlled Thermal Resources and EnergySource Minerals are extracting lithium in California, while Tesla plans to source nickel for EV batteries from Talon Metals' project in Minnesota.

Simultaneously, regulatory and policy updates are underway, encompassing initiatives to update mining laws and regulations, update the Federal list of critical minerals, and strengthen critical mineral stockpiling. Legislative efforts in Congress aim to enhance U.S. access to rare earth elements, with proposed bills focusing on funding research, encouraging domestic development through DOD grants, and providing tax incentives for domestic REE extraction and consumption, among other measures (Tracy, 2022; Young, 2024).

HURDLES

Navigating the hurdles of mining in the United States encompasses various challenges that hinder the industry's growth and development. Permitting challenges loom large, particularly for new mining companies seeking necessary approvals. This process, often taking several years, requires compliance with a myriad of environmental and wildlife protection laws, including those overseen by the Bureau of Land Management (BLM) for mines on federal lands. Recent trends indicate a decline in mine plan approvals, reflecting the increasing complexities of the regulatory landscape.

In addition to permitting challenges, legislative uncertainties add to the industry's woes. Senator Joe Manchin's proposed bill aimed at streamlining the energy and infrastructure permitting process faced bipartisan opposition, casting doubt on the future of such legislative efforts. Despite expressions of support from the White House, the fate of initiatives to enhance energy security and clean energy availability remains uncertain.

Community and environmental opposition further complicates matters for mining companies, even after obtaining permits. Environmental groups, Native American Tribes, and local communities often oppose mining projects, as illustrated by Lithium Americas' experience with the Thacker Pass Mine. Legal battles and the financial commitments required for site revitalization post-mining underscore the challenges faced by companies operating in this sector.

Amidst these hurdles, the regulatory outlook for mining laws remains uncertain, raising questions about the balance between industry growth and environmental protection. Considerations for extraction royalties and reclamation deposits further contribute to the regulatory complexities. Moreover, the effectiveness of new tax credits in incentivizing mining companies is yet to be determined, highlighting the ongoing uncertainties and challenges confronting the mining industry (Connors et al., 2022).

EV BATTERY PRODUCTION

here are three stages to creating an EV battery. The first stage consists of processing previously mined minerals into cathode and anode components, which will be assembled into cells enclosed in an aluminum or steel casing. Next, multiple cells, up to 96, are assembled into groups to form battery packs and are ready to be placed into the EV. Finally, after 12 to 15 years, the EV battery's life cycle will reach its conclusion, where the battery will either be recycled, repurposed, or disposed. Lithium-ion batteries dominate the battery market, offering high energy density and longer

lifespan despite risks like thermal runaway fires and higher costs. Its primary competitor, nickel-metal hydride batteries, are less expensive but offer weaker performance.

Countries and Firms

China, South Korea, and Japan account for 70% of the global battery manufacturing market. In comparison, the U.S. only produces 7% of the world's capacity. Leading countries maintain numerous facilities worldwide, includ-



ing multiple locations within the U.S. Despite having numerous international EV companies within the U.S., just four of the twelve largest EV manufacturing plants in the U.S. belong to American companies: Tesla, Volvo, Ford, and General Motors. The primary concentration of EV manufacturing and battery plants within the U.S. are in California and Michigan. Oklahoma does have its own EV manufacturing firm, Canoo, which recently achieved its employment milestone, creating additional jobs and contributing to Oklahoma's economy. Canoo has also negotiated substantial purchase contracts with NASA, Walmart, the U.S. postal service, and Zeba.



Note: Top global EV-producing firms; locations within the U.S. consist of research facilities and current and future EV-related product manufacturing locations. (Swallow, 2023) https://evmagazine.com/top10/top-10-ev-battery-manufacturers

Regulatory

AGENCIES

The Biden administration implemented new restrictions targeting Foreign Entities of Concern (FEOCs) and their involvement in utilizing EV tax credits within the United States. "Vehicles introduced into service from 2024 onward are required to refrain from utilizing batteries that contain components manufactured or assembled by FEOCs" (Hayes, 2023). By 2025, these rules prohibit the use of batteries containing critical minerals extracted, processed, or recycled by FEOCs. Consequently, EV tax credits necessitate assembly within North America, stipulating that at least 50% of critical minerals used in battery production must be sourced from extraction or processing within the U.S.

INCENTIVES

Oklahoma extended a \$698 million incentive package to Panasonic and allocated \$145 million for site work at Industrial Park when requested \$245 million (Forman, 2023). However, there appears to be a shift in ideology as OK lawmakers are drafting Senate Bill 1358, which allocates \$200 million to the Workforce Development Revolving Fund under the oversight of the OK Workforce Commission (Metzer, 2024). This change comes after Panasonic and Tesla opted against moving to Oklahoma. Instead of solely relying on financial incentives to attract companies, Oklahoma aims to cultivate a workforce with specialized skills to meet industry needs (Metzer, 2024).

In 2023, Canoo began receiving an economic incentive estimated at \$113 million over ten years from the state of Oklahoma and the Cherokee Nation. In turn, Canoo has already begun hiring personnel for its vehicle assembly facility in Oklahoma City and EV battery manufacturing plant in Pryor. The Pawnee Nation of Oklahoma is also partnered with Canoo to enhance job creation and economic development in northeastern Oklahoma (Journal Record Staff, 2023). Rather than provide a cash incentive, the Pawnee Nation will focus on training people to develop the skills required to build zero-emission vehicles and other related clean energy and technology. This partnership also includes obtaining qualified suppliers of parts and services needed for Oklahoma's EV industry.

HURDLES

Competition makes the incentives needed to attract factories or manufacturing plants like Panasonic substantial and could result in a loss for some states. For instance, Kansas offered Panasonic an incentive package worth \$830 million. Additionally, the Kansas power company Evergy is seeking to increase the cost of electricity for residents in Kansas to help pay for the increased demand for energy from Panasonic (Shorman, 2023). Anticipated energy expenses will be twice those of Evergy's current top consumer in Kansas, necessitating the construction of two new substations and enhancing three existing ones. Last, attracting financing to operate at a profitable scale is also a difficulty for EV battery production. Demand for EVs has turned out to be lower than anticipated in the near term and some start-ups have already filed for bankruptcy or face concerns over long-term profitability (Sriram, 2024).

EV BATTERY SALES

G lobal sales of EV batteries have grown significantly in recent years and is set to continue growing. The global EV Outlook 2023 records an 80% increase in battery demand in the United States, outpacing the 55% increase in electric car sales. This disparity underscores the growing importance of EV batteries in the automotive industry. As countries worldwide strive to reduce greenhouse gas emissions and combat climate change, the shift towards electric mobility is accelerating. With a projected \$116 billion market by 2030, EV batteries are not just growing, but poised for significant global expansion. Several factors, including government incentives, environmental regulations, and consumer preferences for cleaner transportation options, have driven the adoption of electric vehicles in the US. Tesla, a prominent

player in the electric vehicle market, has significantly contributed to the demand for EV batteries in the US. The company's Gigafactories, strategically located across the country, have ramped up production to fulfill domestic and international electric vehicle orders (Pressfarm, 2024).

Canoo, with operations spanning California, Texas, and Oklahoma, delivered its first batch of Oklahoma-made EVs

Oklahoma's landscape for electric vehicles and EV batteries differs from other states. While the adoption of electric vehicles has been relatively modest compared to states like California or New York, there is a growing interest in cleaner transportation solutions. As technology advances and infrastructure improves, Oklahoma could see an uptick in EV battery sales and electric vehicle adoption in the coming years (Kadiri, 2024).

Countries and Firms

Globally, electric vehicle (EV) batteries are experiencing substantial demand and makers are ramping up production (Statista, 2023). As the world's largest EV market, Chinese companies like Contemporary Amperex Technology Co. Limited, Build Your Dreams, and SVOLT are among the top battery manufacturers globally, supplying batteries to domestic and

The availability of a robust charging infrastructure is crucial for the growth of EV adoption.

international automakers (Bradsher & Forsythe, 2021). Other major global players include South Korean companies Samsung SDI and LG Energy Solution and Japanese companies Panasonic Corporation and Sony Corporation, with Panasonic acting as a major supplier for US company

Tesl, in addition to Tesla's own Gigafactories (JustAuto, 2023; Carlton, 2023; Tesla, 2017; Kolodny, 2022). European companies are also expanding production with Sweden-based Northvolt building Europe's largest battery factory, aiming to supply batteries for millions of electric vehicles (Mukherjee & Rajagopal, 2023).

Within the US, Detroit's concentration of major automakers has meant early advantages in ramping up EV battery production. The state has prioritized workforce training for producing EV batteries through initiatives like MiREV (michi-

gan.gov, 2021) and the Michigan Department of Labor and Economic Opportunity (LEO) seeks partnerships with three to five organizations, investing up to \$5 million through a competitive process to achieve these goals (michigan.gov, 2021). Also, GM and LG Energy Solution are building an EV battery plant in Lansing (GM Motors, 2024). This joint venture, named Ultium Cells LLC, aims to mass-produce battery cells for GM's Ultium battery platform, which will power a new generation of electric vehicles (GM Motors, 2024; Lambert, 2023).



In addition to Detroit, California hosts major manufactur-

ers like Tesla (Alamalhodaei, 2021) and QuantumScape Corporation, collaborating with Volkswagen Group on next-generation batteries (Volkswagen, 2019) and Tesla is investing over \$770M to establish a Gigafactory in Austin, Texas (Weatherbed, 2023) in addition to the Gigafactory in Nevada.On a smaller, but growing scale, Canoo, with operations spanning California, Texas, and Oklahoma, delivered its first batch of Oklahoma-made EVs to the state government in 2023, marking its manufacturing ramp-up (Canoo, 2023).

Infrastructure

The availability of a robust charging infrastructure is crucial for the growth of EV adoption. In the United States, EV sales have tripled, and the charging infrastructure has increased by at least 40% since President Biden took office. The Bipartisan Infrastructure Law invested \$7.5 billion in EV charging (The White House, 2023). Over three million electric vehicles are now on the road, and there are over 136,500 public EV chargers across nearly 53,800 charging locations (The White House, 2023). ChargePoint, a significant EV charging network player, particularly in North America and Europe, offers hardware, software, and services for commercial, fleet, and residential customers (ChargePoint, 2024).

In Oklahoma, public and private initiatives aim to expand the charging station network. The National Electric Vehicle Infrastructure (NEVI) Formula Program will allocate over \$66 million to Oklahoma for EV charging infrastructure (EVOK,

2024). Federal guidelines mandate EV charging stations every 50 miles along interstates and within one mile of highways, with the capacity to charge four vehicles simultaneously at 150 kW. Oklahoma has identified several highway corridors as Alternative Fuel Corridors, supporting electric and compressed natural gas vehicles, signaling a concerted effort toward sustainable transportation infrastructure development (EVOK, 2023).

To drive higher EV battery sales, more affordable electric vehicle models should be available for middle-income buyers (Crownhart, 2023). Efficient logistics infrastructure is needed to support battery transportation from manufacturers to end-users, including transportation networks, warehousing facilities, and distribution centers (DHL, 2024). Establishing

recycling and disposal facilities for end-of-life batteries is also important. By sharing technology and adopting standardized procedures, battery recycling can be made safer and more cost-effective, contributing to lowering overall EV battery costs and making electric vehicles more affordable (DHL, 2024).

The National Electric Vehicle Infrastructure (NEVI) Formula Program will allocate over \$66 million to Oklahoma for EV charging infrastructure

Regulatory

AGENCIES

EV battery sales are regulated by many of the same agencies as EV battery manufacturing. Some of the additional regulatory agencies include The Occupational Safety and Health Administration (OSHA), which enforces federal regulations for safe battery handling (U.S. Department of Labor, 2024), The Department of Transportation (DOT), which regulates battery transportation (U.S. department of Transportation. 2009), the Environmental Protection Agency (EPA), which sets federal standards for battery production and disposal to safeguard human health and the environment (US EPA, 2023), and the National Highway Traffic Safety Administration (NHTSA), which regulates safety standards for EVs, including battery safety.

INCENTIVES

The Oklahoma Department of Environmental Quality administers state environmental laws and offers rebates for replacing or repowering diesel school buses with alternative fuel models (Oklahoma Department of Environmental Quality, 2024). Incentives also available in Oklahoma to support EV adoption are a EV Charging Station Grant Program, AFV Weight Exemption and Tax Credits, and an Alternative Fueling Infrastructure Tax Credit (U.S. Department of Energy, 2024).

HURDLES

Shipping and storage complexities can impact sales of EV batteries. It is difficult to use name-brand carriers for the transportation of EV batteries. This is due to the size of some batteries. Also, 90% of dealers of EV batteries do not have docks (Mayoral, 2022). A December 2023 report from the US Treasury Department indicates that starting in 2024, electric vehicles eligible for tax credits cannot use battery components from foreign entities of concern. By 2025, qualifying vehicles must not contain minerals extracted, processed, or recycled by foreign companies of concern. This rule may hinder EV acceptance despite efforts by the Biden administration to boost sales (Krisher, 2023).

POLICY DIRECTION FOR OKLAHOMA

or Oklahoma to best position itself for enduring success in the EV battery industry we recommend a bottom-up industrial support strategy to create a geographical competitive cluster. This involves investing in public goods like education, healthcare, and research to foster a connected Midwestern cluster of EV manufacturers and support-ing firms. Developing efficient infrastructure, a specialized workforce, and amenities will attract further investment once

Economic clusters rely on robust infrastructure and a skilled labor pool. Therefore, policymakers and firms must support investment in these areas.

the cluster is established.

This strategy draws on industrial policy principles and geographical clustering theory, adopting a proactive approach to build a competitive ecosystem. Clustering related businesses drives productivity through knowledge-sharing and collaboration (Porter, 1998). Oklahoma can leverage

its location and existing strengths through strategic investments, partnerships between government/academia/industry players, human capital development, infrastructure upgrades, and supportive regulations. Firms and policymakers should work alongside each other to leverage Oklahoma's existing manufacturing prowess, research and development capabilities, and natural resource endowments. Additionally, tailored education and training programs are critical in cultivating a skilled workforce, vital for sustaining innovation and manufacturing excellence in the EV sector.

Paul Krugman's perspective on economic geography highlights how location and spatial factors influence economic activity, with regional industry concentration indicating increasing returns – aligning with Oklahoma's strategy to capitalize on its geographical position and resources for an EV industry cluster (Paul Krugman, 1991). The vision is an innovative EV cluster boosting economic growth while advancing energy independence and sustainability nationally. With the right investments, collaborations, and innovation focus, Oklahoma can become a key global EV player. In the following sections, we discuss in more detail three key elements that will be needed to drive Oklahoma in its next step.

Infrastructure and Human Capital

Economic clusters rely on robust infrastructure and a skilled labor pool. The relationship between developing these inputs and attracting investment can be self-reinforcing. However, interruptions, such as a shortage of skilled labor or inadequate infrastructure, can short circuit development. As these inputs often constitute public goods, there's a risk of

underinvestment. Therefore, policymakers and firms must support investment in these areas. Here, we summarize the state of infrastructure and human capital in Oklahoma relevant to the EV battery supply chain and identify areas needing investment.

... the Port of Catoosa is strategically located and holds immense potential as a catalyst for the state's electric vehicle sector.

INFRASTRUCTURE

Oklahoma's Tulsa Port of Catoosa, strategically located at the head of navigation for the McClellan-Kerr Arkansas River Navigation System, holds strategic potential for the state's electric vehicle (EV) sector. By incentivizing companies specializing in EV components to establish operations at the port, Oklahoma can strengthen the EV supply chain, reduce logistics costs, and enhance overall efficiency. Overall, the Port of Catoosa is strategically located and holds immense potential as a catalyst for the state's electric vehicle sector. By leveraging its existing infrastructure and fostering targeted partnerships, the port can significantly enhance the growth and competitiveness of the EV industry within Oklahoma.

Another policy that can be adopted in Oklahoma is to collaborate with private companies, utilities, and charging network providers to establish a robust charging ecosystem. Leveraging federal funding from programs like the National Electric Vehicle Infrastructure (NEVI) Formula Program, Oklahoma can strategically install charging stations along major highways and turnpike corridors, ensuring convenient access for EV drivers (EVOK, 2024). Also, Oklahoma should continue supporting legislation like Senate Bill 502 (Oklahoma Electric Vehicle Charging Act), which allows for a private market-place for EV charging to develop driving innovation and accessibility.

HUMAN CAPITAL

Oklahoma's workforce is actively preparing for EV manufacturing, with opportunities for collaboration with Native American tribes like the Cherokee Nation and the Pawnee Nation. This partnership presents a unique advantage for Oklahoma compared to other states, potentially mitigating negative perspectives associated with mining and EV production on

native lands. By emphasizing incentives tied to milestones like training and hiring local workers, Oklahoma can further leverage its growing workforce to drive the state's EV industry forward. Specifically, Oklahoma can prioritize training

Oklahoma could develop its own balanced Zero-Emission Vehicle (ZEV) program.

programs to prepare its workforce for the expanding EV market. Oklahoma can implement strategies tailored to its specific needs and opportunities, similar to the Michigan Revolution for the Electrification of Vehicles (MiREV). Investing in training programs, vocational education, and technical skills development ensures that the workforce is equipped to support the EV industry (michigan.gov, 2021). This could include training in areas such as electric vehicle technology, battery manufacturing, charging infrastructure installation and maintenance, and EV-related software development.

SPILLOVER

Oklahoma's neighboring states are making strides in EV and battery manufacturing. Texas hosts Tesla's Gigafactory and LG, while Kansas is building a Panasonic battery plant. Exxon Mobile and UBE Corporation are focusing on mining for battery materials and manufacturing. This situation gives Oklahoma an opportunity to secure access to these materials by forging trade agreements ahead of states like Michigan. Local firms like Westwin Elements are also establishing a foothold in the mining sector. With Canoo already a hub for EV and battery manufacturing in Oklahoma, policies should support and develop these companies to become leaders in the Midwest's growing EV cluster.

Regulation

Regulation works best when actors adopt a holistic approach. For long-term success, Oklahoma will need to adopt policies that ensure sustainable and responsible mining practices covering the entire critical minerals supply chain, from extraction to processing and recycling. This can also include implementing regulations and incentives to promote environmentally friendly mining techniques, such as land reclamation and water conservation measures. Furthermore, the state should invest in research and development of cleaner and more efficient mineral processing technologies, as well as support efforts to improve the recycling and reuse of critical minerals. This research will be most effective through collaborations between the state government, private sector, and academic institutions to drive innovation and sustainable practices in the critical minerals industry. Oklahoma can also promote transparency and accountability in the mining industry by requiring companies to publicly disclose their environmental and social performance, and by actively engaging with local communities to address concerns and mitigate potential negative impacts of mining operations.

...we recommend a bottom-up industrial support strategy to create a geographical competitive cluster.

To continue to attract investment, Oklahoma will need to lead by example. Oklahoma could develop its own balanced Zero-Emission Vehicle (ZEV) program. This program could set achievable electric vehicle targets without

aggressive mandates, while also supporting efficient internal combustion engine (ICE) vehicles. By crafting a program that addresses both environmental goals and economic realities, Oklahoma could position itself as a leader in pragmatic clean transportation policy, potentially attracting investments and fostering collaborations with like-minded states and entities committed to sustainable yet realistic transportation solutions Partnerships with companies like Canoo, and the plan to supply USPS with EVs underscore Oklahoma's emerging role in the EV industry, despite competition from established hubs. This can also lead to affordable EV models for middle-income purchasers as well for wide-spread adoption (Stowe, 2023).

Policy Incentives

First, Oklahoma should secure targeted funding such as state grants and loans for private entities to boost domestic production of critical minerals. This financial support could help businesses overcome challenges related to mineral production and processing through advance technological innovation through collaborative research between academic institutions and private firms. Additionally, financial incentives like grants or tax credits can be provided to encourage private sector investment in sustainable mining practices and the research and development of cleaner extraction and processing technologies.

Second, non-targeted, bottom-up industrial policies should be put in place to develop the industry. While giving firms direct assistance provides immediate, short-term gain, economic studies have shown that this is not an effective long-term solution, nor does it lead to competitiveness for the economy (OSU Wes Watkins Center for International Trade Development, 2022). Bottom up polices should focus on education and infrastructure. Focusing on education can ensure current and future generations are prepared to participate and gain from the transition, further cultivating a pool of skilled graduates prepared to begin their careers in this specialized field. Infrastructure can often suffer from underinvestment as a public-good, so it is imperative that the state take a leadership role in making sure firms have transportation networks to receive and distribute inputs and outputs in the EV battery supply chain.

WHAT THE FUTURE HOLDS

ritical to successful, widespread EV adoption is the advancement of current EV technology. Oklahoma policymakers and actors should pay attention to promising technological advancements such as solid-state batteries, lithium-air batteries, and hydrogen powered vehicles. Decreases in charge times and increases in battery capacity will be vital

for additional consumers to consider transitioning to an EV. Solid-state batteries have a significant increase in volumetric and gravimetric energy densities. This increase enables the battery to charge quickly from 10% to 80% in about 15

To drive higher EV battery sales, more affordable electric vehicle models should be available for middle income buyers. minutes and has a longer lifetime span (Quantumscape, 2024). Additionally, the absence of liquid or gel-like material that causes fires will ensure these batteries are safer than the current lithium-ion batteries.

The lithium-air battery is another new prototype battery created by researchers at the Illinois Institute of Technology and U.S. Department of Energy (DOE) Argonne National Laboratory. These departments have created a solid electrolyte battery that reduces the risk of fire. Lithium-air batteries have four times the energy density of lithium-ion batteries, providing a longer driving range for vehicles. The team indicated that if they received funding, they would know in about three years if lithium-air battery is feasible, and if so, an additional ten years would be needed to bring it to the market (Harmon, 2023).

Toyota and PACCAR have also prioritized the development of hydrogen-powered vehicles and, most recently, commercial trucks. Toyota and PACCAR promised to deliver the first

Through collaborative efforts ... Oklahoma can drive innovation and lead the nation in EV battery production.

production of trucks in 2024, though the biggest issue with this delivery lies in where to fill up. Despite the unpopularity of hydrogen-powered vehicles, two other firms, Honda and GM, have also been experimenting with hydrogen fuel cells.

The EV industry is racing to develop supply chains independent of China, driven by economic and national security concerns. This presents a strategic opportunity for Oklahoma to position itself as a key player in this new landscape. Success in the EV market can be integral to Oklahoma's sustainable development goals. To maintain and further develop its position in the burgeoning EV market, the state should prioritize bottom-up industrial policies, investment in technology and innovation, and the development of a skilled workforce to ensure long-term economic prosperity and global competitiveness in the EV industry. Through collaborative efforts between the government, academic institutions, research organizations, and industry players, Oklahoma can drive innovation and lead the nation in EV battery production.

REFERENCES

- 1. Alamalhodaei, A. (2021, September 23). Tesla's battery-manufacturing "Megafactory" breaks ground in California. TechCrunch. *https://techcrunch. com/2021/09/23/teslas-battery-manufacturing-megafactory-breaks-ground -in-california/*
- Bradsher, K., & Forsythe, M. (2021, December 22). Why a Chinese Company Dominates Electric Car Batteries. The New York Times. https://www.nytimes. com/2021/12/22/business/china-catl-electric-car-batteries.html
- Canoo. (2023b, November 13). Canoo Delivering First Made in Oklahoma Electric Vehicles to State Government. Canoo Inc. https://investors.Canoo. com/news-presentations/press-releases/detail/116/canoo-delivering-firstmade -in-oklahoma-electric-vehicles
- Carlton, R. (2023, December 12). Panasonic's New Powder-Powered Batteries Will Supercharge EVs. Retrieved from Wired.com: https://www.wired.com/ story/panasonic-powder-powered-silicone-ev-batteries/#:~:text=Description-,A%20company%20working%20with%20Tesla's%20main%20US%20 battery%20supplier%20has,percent%20of%20EV%20batteries%20globally.
- ChargePoint. (2024, January 31). ChargePoint Holdings, Inc. Why Invest. ChargePoint. https://investors.chargepoint.com/overview/why-invest/ default. aspx

- 6. Clean Investment Monitor, accessed March 29, 2024, https://www.clean investmentmonitor.org/
- Connors, M., Forrester, J. P., & Shaw, K. L. (2022, September 29). Strengthening the US Supply Chain for Critical Minerals and the Inflation Reduction Act – Opportunities and Challenges. Mayer|Brown. https://www.mayerbrown.com/ en/insights/publications/2022/09strengthening-the-us-supply-chain-for -critical-minerals-and-the-inflation-reduction-act-opportunities-andchallenges
- Cox Automotive, accessed July 28, 2024, https://www.coxautoinc.com/marketinsights/q4-2023-ev-sales/
- Crownhart, C. (2023, February 17). Meet the new batteries unlocking cheaper electric vehicles. MIT Technology Review. https://www.technologyreview. com/2023/02/17/1068814/meet-the-new-batteries-unlocking-cheaper -electric-vehicles/
- DHL. (2024). Challenges Facing the Battery Logistics Industry Part Two–DHL

 DHL. https://www.dhl.com/us-en/home/insights-and-innovation/thoughtleadership/brochures/auto-mobility/battery-logistics/challenges-facingthe-battery-logistics-industry-part-two.html

- Editorial Staff. (2023, July 31). USA Rare Earth Targets 2024 to Begin Magnet Production in Oklahoma. Magnetics Magazine. https://magneticsmag.com/ usa-rare-earth-targets-2024-to-begin-magnet-production-in-oklahoma/
- EVOK. (2023, June 9). National Electric Vehicle Infrastructure Formula Program. Oklahoma Electric Vehicle Infrastructure Program. https://oklahoma.gov/ evok/infrastructure-program-highlights.html
- EVOK. (2024, March 5). EVOK Oklahoma's Electric Vehicle Infrastructure Program. Electric Vehicle Oklahoma. https://oklahoma.gov/evok.html
- Exxon. (2022, August 24). Things you didn't know about hydrogen | ExxonMobil. ExxonMobil. https://corporate.exxonmobil.com/what-we-do/deliveringindustrial-solutions/hydrogen/hydrogen-facts
- Fatunde, M. (2024, January 5). The race to produce rare earth elements. MIT Technology Review. https://www.technologyreview.com/2024/01/05/1084 791/rare-earth-materials-clean-energy/
- Federal Register: The Daily Journal of the United States Government. (2024). Clean Vehicle Credits Under Sections 25E and 30D; Transfer of Credits; Critical Minerals and Battery Components; Foreign Entities of Concern. National Archives and Records Administration, Vol. 89, No. 88, pp 37706-37775.
- 17. Forman, C. (2023, December 21). Panasonic still moving forward with Kansas factory after pulling plans for Oklahoma plant. KCUR Kansas City News and NPR. https://www.kcur.org/news/2023-12-21/panasonic-still-moving -forward-with-kansas-factory-after-pulling-plans-for-oklahoma-plant
- GM Motors. (2024). GM Drives \$7B Investment In Michigan Facilities | General Motors. GM. https://www.gm.com/public/us/en/gm/home/stories/manufacturingultium-evs-trucks.html
- Harmon, J. E. (2023, February 22). New design for lithium-air battery could offer much longer driving range compared with the lithium-ion battery | Argonne National Laboratory. Argonne National Laboratory. https://www.anl.gov/article/ new-design-for-lithiumair-battery-could-offer-much-longer-driving -range- compared-with-the-lithiumion
- Hayes, T. (2023, December 13). New Regulations Create Challenges, Opportunities for EVs in the U.S. | Exponent. Exponent. https://www.exponent.com/article/ new-federal-rules-limit-imports-ev-batteries-feocs
- International Energy Agency (IEA), Global EV Outlook 2023, April 2023, https:// www.iea.org/reports/global-evoutlook-2023.
- 22. JATO. (2024, June 13). Tesla Model Y secures position as world's best-selling car in 2023. Retrieved from JATO: https://www.jato.com/resources/media-and-press-releases/tesla-model-y-worlds-best-selling-car-2023Joint Committee on Taxation. (2023). Estimated Revenue Effects of Division A, Title II of H.R., 2811, The "Limit, Save, Grow Act of 2023," as Amended, Scheduled for Consideration by the House of Representatives on April 26, 2023. In Joint Committee on Taxation (JCX-7-23). https://www.jct.gov/getattachment/1bd2fab7-1a0f-4c30-9a8f-94b98f3b2888/x-7-23.pdf.
- 23. Journal Record Staff. (2023, September 22). Tribe, Canoo partner to promote economy, green energy | The Journal Record. The Journal Record. https://

journalrecord.com/2023/09/tribe-canoo-partner-to-promote-economy -green-energy/

- 24. JustAuto. (2023, December 15). South Korea to support EV battery industry. Retrieved from JustAuto.com: https://www.just-auto.com/news/ south-korea-to-support-ev-battery-industry/?cf-view
- Kadiri, I. (2024). Exploring EV Charging Incentives in Oklahoma–AMPECO. AMPECO. https://www.ampeco.com/ev-charging-grants-incentives/ exploring-ev-charging-incentives-in-oklahoma/
- Kolodny, L. (2022, July 13). Panasonic reportedly building new factory in Kansas to produce batteries for Tesla and rest of EV industry. CNBC. https://www.cnbc. com/2022/07/13/panasonic-new-factory-in-kansas-to-produce-batteriesfor-tesla-evs.html
- Krisher, T. (2023, December 1). New US rules aimed at curbing China could make it harder for EV buyers to claim a full tax credit—CBS Detroit. CBS News. https://www.cbsnews.com/detroit/news/new-us-rules-aimed-at-curbing -china-could-limit-tax-credits-for-electric-vehicles/
- Lambert, F. (2022, February 15). Study confirms what common sense has made clear for years: Hydrogen fuel cells cannot catch up to battery-electric vehicles. Electrek. https://electrek.co/2022/02/15/study-hydrogen-fuel-cells-cannot -catch-up-battery-electric-vehicles/
- 29. Lambert, F. (2023, April 25). GM and Samsung partner to build a new \$3 billion battery cell factory in the US. Electrek. https://electrek.co/2023/04/25/gm-samsung-sdi-build-battery-cell-factory-us/
- Mayoral, A. (2022, July 20). EV Has a Problem: 90% of the Battery Supply Chain 'Does Not Exist.' IndustryWeek. https://www.industryweek.com/supplychain/article/21244607/ev-has-a-problem-90-of-the-battery-supply -chain-does-not-exist
- Metzer, S. (2024, February 20). Bill would put commission in charge of \$200M for workforce development. Tulsa World. https://tulsaworld.com/news/stateregional/government-politics/oklahoma-workforce-development-fundingeducation/article_9b122a44-d032-11ee-9d1c-dff7bfaaa7c8.html
- 32. Michigan.gov. (2021, September 22). Governor Whitmer Launches Two Initiatives to Advance Michigan's EV Infrastructure and Workforce Landscape. Retrieved from Michigan.gov: https://www.Michigan.gov/whitmer/news/pressreleases/2021/09/22/governor-whitmer-launches-two -initiatives-to-advance-michigans-ev- infrastructure-and-workforce-land
- 33. Mukherjee, S., Rajagopal, D., Mukherjee, S., & Rajagopal, D. (2023, September 28). Sweden's Northvolt to build \$5.2 billion battery factory in Canada. Reuters. https://www.reuters.com/business/autos-transportation/ swedens-northvolt-build-52-bln-battery-factory-canada-2023-09-28/
- Oklahoma Environmental Quality. (2024). ChargeOK Oklahoma Electric Vehicle Charging Program.
- 35. Oklahoma Department of Environmental Quality. https://www.deq.OK.gov/ air-quality-division/volkswagen-settlement/chargeok -oklahoma -electric-vehicle-charging-program/

- 36. OSU Wes Watkins Center for International Trade Development. (2022). CITD Nerding Out: Can Industrial Policy Fix Supply Chain Issues and Make the US More Competitive? (Report No. 1) OSU CITD
- Paul Krugman, 1991. "Geography and Trade," Leuven University Press, Leuven, Belgium and The MIT Press Cambridge, Massachusetts London, England.
- Porter, M. E. (1998). Clusters and the new economics of competition (Vol. 76, No. 6, pp. 77-90). Boston: Harvard Business Review.
- Pressfarm. (2024, January 02). The Tesla Effect: Elon Musk is Transforming the Automotive Industry. Retrieved from Pressfarm: https://press.farm/ tesla-elon-musk-transforming-automotive-industry/
- 40. Quantumscape. (2024). Solid State Battery Technology. QuantumScape. https://www.quantumscape.com/battery-technology/
- Shorman, J., & Bernard, K. (2023, July 20). Panasonic plant will require so much power, Evergy will seek rate hike in Kansas. The Kansas City Star. https:// www.kansascity.com/news/politics-government/article277462213.html
- 42. Sriram, A (2024, June 18). EV startup Fisker files for bankruptcy, aims to sell assets. https://www.reuters.com/business/autos-transportation/ ev-startup-fisker-files-bankruptcy-2024-06-18/
- 43. St John, A. (2023, November 23). US EV sales to hit record this year | AP News. AP News. https://apnews.com/article/automakers-electric-vehicles -us -china-sales-d121c09a61f50e7357f5675af4b6056b
- 44. Statista. (2023, May 24). Projected electric vehicle sales in key regions by segment 2030. Statista. https://www.statista.com/statistics/960994/ electric-vehicle-sales-by-segment-selected-world-regions/
- 45. Stitt, K. (2023, July 16). A Mineral Strategy for American Security. The Wall Street Journal. Retrieved from https://www.wsj.com/articles/a-mineral -strategy-for-american-security-permitting-reform-oklahoma-china -8cb 213f0
- 46. Stowe, L. (2023, May 11). Electric Vehicle Policy in the United States: Trends and Legislation.... FiscalNote. https://fiscalnote.com/blog/electric -vehicle-policy-united-states
- Swallow, T. (2023, July 26). Top 10: EV Battery Manufacturers. EV. https:// evmagazine.com/top10/top-10-ev-battery-manufacturers
- Tesla Team. (2017, January 4). Battery Cell Production Begins at the Gigafactory. Tesla. https://www.Tesla.com/blog/battery-cell-production-begins -gigafactory
- 49. The White House. (2022, February 22). FACT SHEET: Securing a Made in America Supply Chain for Critical Minerals. The White House. https://www. whitehouse.gov/briefing-room/statements-releases/2022/02/22/fact-sheetsecuring -a-made-in-america-supply-chain-for-critical -minerals/
- 50. The White House. (2023, February 15). FACT SHEET: Biden-Harris Administration Announces New Standards and Major Progress for a Made-in-America National Network of Electric Vehicle Chargers. The White House. https://www.whitehouse. gov/briefing-room/statements-releases/2023/02/15/fact-sheet-bidenharris-administration-announces-new-standards-and-major-progress-fora-made-in-america-national-network-of-electric-vehicle -chargers/

- Tracy, B. S. (2022). Critical Minerals in Electric Vehicle Batteries (R47227; p. 26). https://crsreports.congress.gov/product/pdf/R/R47227
- U.S. Department of Energy. (2024a, February 15). Alternative Fuels Data Center: Oklahoma Laws and Incentives. Alternative Fuels Data Center. https://afdc. energy.gov/laws/all?state=OK
- 53. U.S. Department of Labor. (2024, February 15). 1926.441–Batteries and battery charging. | Occupational Safety and Health Administration. Occupational Safety and Health Administration. https://www.osha.gov/laws-regs/regulations/ standardnumber/1926/1926.441
- 54. U.S. department of Transportation. (2009, October 7). Advisory Guidance; Transportation of Batteries and Battery-Powered Devices | PHMSA. Pipeline and Hazardous Materials Safety Administration. https://www.phmsa.dot.gov/ regulatory-compliance/phmsa-guidance/advisory-guidance-transportation -batteries-and-battery-powered
- 55. US EPA. (2023, May 23). Our Mission and What We Do [Overviews and Factsheets]. EPA United States Environmental Protection Agency. https://www.epa.gov/ aboutepa/our-mission-and-what-we-do
- 56. Valdes-Dapena, P., & CNN. (2023, November 23). Solid state batteries promise to radically change EVs. But they may not be the only answer | CNN Business. CNN. https://www.cnn.com/2023/11/23/cars/solid-state-battery-techpromises-to-radically-change-evs/index.html
- Volkswagen. (2019, June 21). Volkswagen partners with QuantumScape to secure access to solid-state battery technology. Retrieved from Volkswagen US Media Site: https://media.vw.com/en-us/releases/1044
- Weatherbed. (2023, January 11). Tesla is planning a \$770 million expansion of its Texas Gigafactory. Retrieved from TheVerge: https://www.theverge.com/ 2023/1/11/23549895/tesla-texas-factory-expansion-gigafactory
- Wood, D., Helfgott, A., D'Amico, M., & Romanin, E. (2021). The Mosaic Approach: A Multidimensional Strategy for Strengthening America's Critical Minerals Supply Chain. The Wilson Center (March 17, 2022), 28.
- 60. World Energy Outlook. (2021). The Role of Critical Minerals in Clean Energy Transitions – Analysis (CC BY 4.0; p. 287). https://www.iea.org/reports/ the-role-of-critical-minerals-in-clean-energy-transitions
- Wu, D., Martin, M., & Wilkes, W. (2021, December 2). Apple Partner Foxconn in Talks to Help Saudi Arabia Build EVs. Bloomberg.Com. https://www.bloomberg. com/news/articles/2021-12-02/apple-partner-foxconn-in-talks-to-help -saudi-arabia-build-evs
- 62. Young, T. (2024, January 19). Young, Colleagues Introduce Bill to Secure Critical Mineral Supply Chains, Counter Chinese Dominance | U.S. Senator Todd Young of Indiana. Todd Young U.S. Senator for Indiana. https://www.young.senate. gov/newsroom/press-releases/young-colleagues-introduce-bill-to -secure-critical-mineral-supply-chains-counter-chinese-dominance
- 63. Zhang, W. (2024, January 3). China: New energy vehicle sales by propulsion type 2022. Statista. https://www.statista.com/statistics/425466/ china-annual-new-energy-vehicle-sales-by-type/

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