THE ELECTRIFICATION ROADMAP SERIES

Ending Oil Dependence for Transportation:

A Strategic Framework to Advance Electrification

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Electrification
Coalition

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This report was led, researched, and written by Senior Communications Associate Liam Condon with drafting support from Jeffrey Gerlach, Paul Ruiz, and Maya Zuk. Executive Director Ben Prochazka, Deputy Director Ashley Blackwell, Director of Communications Noah Barnes, Vice President of Policy and Freight Anne Blair, Senior Director of Campaigns Aaron Viles, and Director of Programs Matt Stephens-Rich provided review, recommendations, and editorial support throughout.

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Executive Summary

Although the United States has become the world's largest oil producer, accounting for 15.8% of global production as of 2023, its continued reliance on oil to power transportation exposes the nation to persistent economic and national security vulnerabilities.[1] Global oil markets remain heavily influenced by geopolitical rivals, requiring the U.S. military to spend tens of billions of dollars annually to secure oil supply lines.[2] Yet oil price volatility continues to subject American families and businesses to billions in unexpected, unavoidable costs.[3] Transitioning to electric transportation offers a strategic opportunity to reduce these risks by diminishing oil's monopoly on the U.S. transportation system.

Electric vehicles (EVs) are the only alternatives to gas-powered vehicles that have proven their ability to compete on cost, convenience, and capability. As a result, countries around the world are quickly shifting to electric transportation; however, without swift action, the U.S. auto industry could lose market share while global competitors invest in the technologies that will define the next generation of vehicles. The implications extend well beyond the automotive industry. Transportation electrification is part of a broader global shift from a fossil-fuel economy to a more diverse and secure one powered by electricity, digital infrastructure, and critical mineral supply chains, which will shape our economic competitiveness for decades to come.

The U.S. EV market has grown rapidly because decades of steady improvements in vehicle capabilities and reductions in battery costs were complemented by federal investments in charging infrastructure, supply chain development, and consumer incentives, sending a clear signal to both producers and consumers that the future of transportation is electric. However, the politicization, sudden reversal of, and uncertainty around federal EV policy have obscured market direction and constrained private-sector investment, allowing competitors such as China to entrench and expand upon early advantages.

To mitigate these risks and position the domestic automotive industry for success will require navigating the next phase of EV adoption known as the "messy middle", when the market has moved beyond early adopters but has not yet reached full mass adoption. Experience from these early mass-scale

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[1] "United States Produces More Crude Oil than Any Country, Ever - U.S. Energy Information Administration (EIA)." Accessed March 18, 2026. https://www.eia.gov/todayinenergy/detail.php?id=61545.

[2] secureenergy. "The Military Cost of Defending Global Oil Supplies." *SAFE*, September 20, 2018. https://secureenergy.org/military-cost-defending-global-oil-supplies/.

[3] Stock, Kyle, Alisha Sachdev, Nicholas Lua, Will Kubzansky, and Todd Woody. "As Gas Prices Climb, EVs Are Becoming a More Attractive Option." *Bloomberg.Com*, March 16, 2026. https://www.bloomberg.com/news/newsletters/2026-03-16/gas-prices-rise-fueling-new-interest-in-electric-vehicles.

deployments at home and abroad suggests that success in this endeavor hinges on three enabling conditions:

- **Reliable access to charging**: public charging infrastructure must be common, convenient, consistent, and cost-effective enough to overcome range anxiety.
- **Point-of-sale affordability**: unlocking EVs' fuel and maintenance savings for all Americans requires eliminating the discrepancy in upfront cost between EVs and gas-powered cars.
- **Robust domestic and allied supply chains for EV and battery manufacturing**: The United States must develop secure domestic and allied critical mineral supply chains to reduce dependence on adversaries like China, which has demonstrated its willingness to use that dependence as leverage.

Evidence from leading EV markets shows that durable market growth does not depend on one single policy or technological breakthrough, but on a set of principles capable of mitigating bottlenecks across a wide range of regulatory environments, economic conditions, and technological realities. Investments in vehicles and infrastructure require planning years in advance, necessitating a degree of **basic policy continuity**. Similarly, by establishing **consistent regulatory and technological standards,** businesses will spend less time and energy on compliance, making it easier to innovate and scale.

Scalable infrastructure delivery is critical; as EV adoption accelerates, demand for charging will multiply, so the capacity to plan, permit, build, and energize charging infrastructure must as well. To facilitate this deployment of charging infrastructure, ensure the market develops efficiently, and capitalize on electrification's ability to scale, **market rules should reward utilization and reliability**. Public and private fleets already rely on total-cost-of-ownership—a metric EVs tend to win on—for procurement decisions, so, as some of the best-positioned to take advantage of EVs' benefits today, **fleets should serve as anchor customers for early scale and infrastructure utilization**. Underpinning the other principles is **supply chain resilience**; without reliable access to the materials needed to build and maintain electric transportation systems, nothing else matters.

To secure its economic and strategic future, the United States must keep pace with the accelerating global shift to electric transportation or risk surrendering leadership in the next era of mobility.

Introduction

For decades, electric vehicles (EVs) have existed on the margins of public perception, perpetually one iteration away from market acceptance—enticing but unproven. Today, catalyzed by substantial improvements in performance, reductions in battery costs, and investments in domestic manufacturing and infrastructure, EVs have quickly accelerated into the global market, disrupting oil's long-standing monopoly on transportation, and ushering in a new era of mobility.

Global adoption reflects this momentum. From 2013 to 2024, plug-in vehicle sales grew from a fraction of one percent of global light-duty sales to one-fifth of the auto market, initiating the transition from petroleum-based systems to electrified, critical minerals-based transportation. Concurrently, these critical minerals—the supply chains for which are dominated by the EV market—have become foundational inputs to advanced technologies across the military, energy, medical, and telecommunications sectors. Leading economies have responded by committing significant resources to secure mineral supplies, expand manufacturing capacity, and position themselves competitively in a rapidly changing global automotive landscape.

The implication of these trends is clear: the future of transportation is electric. What remains to be seen is how quickly the transition will occur and how the United States will conduct it: as leader or laggard. Without swift action, foreign automakers—particularly in China, which has rapidly expanded its automotive production capabilities—will continue to crowd out U.S. market share as EV adoption progresses, and the economic and national security vulnerabilities posed by oil dependence will remain. In contrast, a managed transition to electric transportation would shift reliance from a volatile global oil market to a more diverse and domestically powered grid while securing the United States' leading role in the global automotive, energy, materials, and information economies.

While we have made significant headway, the transition remains complex. It will take time. Technologies and companies will continue to evolve, and some will likely fail. But without making a serious effort to modernize and electrify, including policies and incentives that support the transition, there is a significant risk that the U.S. automotive sector may become obsolete in a rapidly electrifying global market.

Electrification has already begun to reduce the U.S. transportation system's century-long dependence on oil, creating an opportunity to revitalize the American manufacturing sector and eliminate significant national security threats—but the window to capture these benefits is closing as foreign competitors entrench their early advantage. For more than 15 years, the Electrification Coalition (EC) has worked with local and state governments, industry partners, and fleets to design and implement policies that accelerate electrification. These efforts have demonstrated the importance of coordination, reliable policy signals, and clear market rules in driving deployment. Rapid market growth following the passage of the Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) demonstrated the impact of policy support, while recent policy reversals have underscored the consequences of volatility: slowed technological innovation, continued supply chain reliance, and lower levels of investment.

The energy crisis triggered by the recent war in Iran has brought the dangers posed by U.S. dependence on oil for transportation back into the public eye, with gas prices rising 30%, impacting consumers and businesses. This conflict demonstrates that, even as the United States has become a net oil producer, it cannot protect consumers and businesses from global supply disruptions because it remains the world's largest consumer of oil. While the country has made great efforts to shore up production, the conflict once again proves that the only solution capable of truly protecting the United States from oil volatility is to diversify how we power mobility. Electricity is produced and sold domestically from a variety of sources, making it the only approach that allows the United States to set its own prices and rules.

Electrification is no longer a theoretical possibility but an imperative in the modern transportation and energy ecosystem. How the United States responds in the coming years will determine its role in the next era of transportation.

Why Electrification Matters

While the EV policy and market landscapes have evolved, the core challenge the Electrification Coalition's 2009 Roadmap addressed remains unchanged.[4] Transportation's dependence on oil exposes the U.S. economy to price volatility and external influences that improvements to the efficiency of internal combustion engine vehicles (ICEVs) alone cannot solve. Electrification fundamentally reshapes this vulnerability. By shifting transportation energy demand from a globally priced, volatile commodity to a largely domestic and diversified electricity system, it reduces exposure to price shocks, strengthens economic resilience, and expands national security options. Electrification also transforms the economics of power systems, enabling vehicles, which are parked most of the time, to flex charging demand and even balance the demands of the grid. With time-based pricing and managed charging, most charging can shift to off-peak periods when the grid has excess capacity, improving utilization of existing assets rather than requiring proportionate new infrastructure.

In short, electrification alters the economic relationship between transportation and global oil markets, reducing both household and macroeconomic exposure to price volatility. At the same time, it reshapes the foundations of American energy security by moving reliance away from globally concentrated fuel supply chains toward domestically governed electricity systems.

TRANSPORTATION, OIL, AND ECONOMIC VULNERABILITY

Oil has been the lifeblood of the American economy for more than a century, and modern American life remains premised on the assumption that affordable transportation fuel will always be available. Despite decades of policy attention and concentrated efforts to reduce the United States' dependence on oil, the transportation sector remains the country's largest oil consumer.[5] Because transportation oil demand tends to increase alongside population growth and economic expansion, total oil consumption has continued to rise even as vehicle efficiency has improved. As a result, efficiency gains have reduced fuel use per mile, but have not eliminated exposure to oil markets. In fact, the United States has consumed more oil in each of the past five years than it did in 2009.[6]

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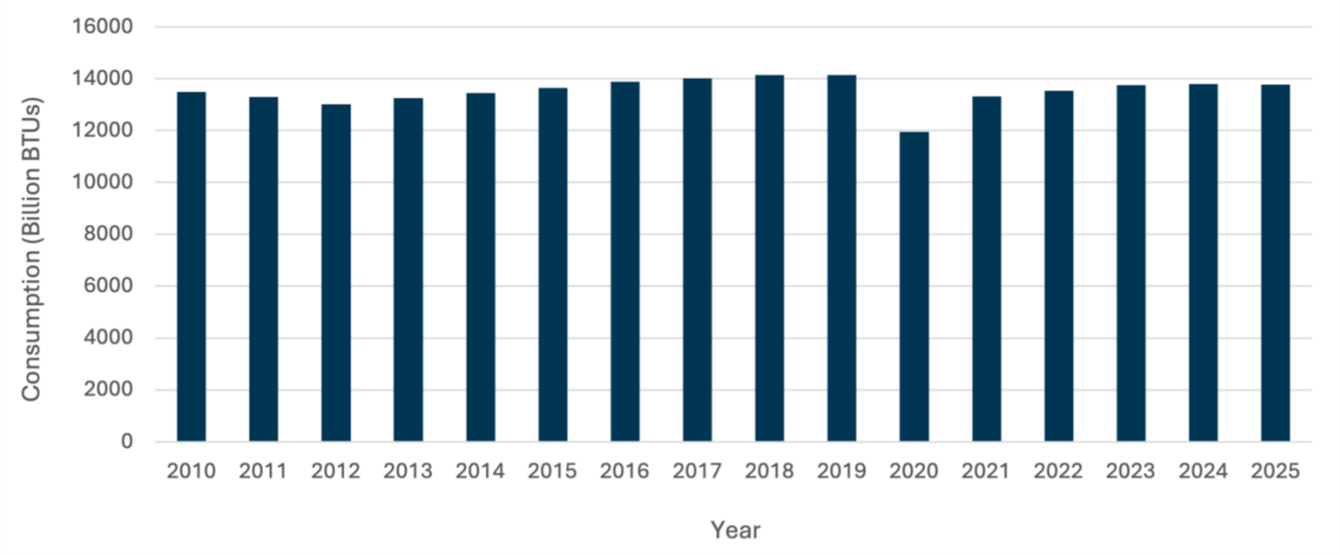
[4] https://electrificationcoalition.org/wp-content/uploads/2024/05/EC-Roadmap.pdf

[5] EIA, "January 2026: Monthly Energy Review," January 27, 2026, at 83-85.

[6] Javier Blas, "What Driving a Tank-Sized SUV Tells Me About Oil," *Bloomberg*, October 22, 2025; and EIA, "U.S. Product Supplied of Crude Oil and Petroleum Products."

FIGURE 1: SHARE OF OIL CONSUMPTION ATTRIBUTED TO TRANSPORTATION IN THE UNITED STATES



Data source: EIA Monthly Energy Review, March 2026; https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf.

Put simply, incremental efficiency improvements reduce exposure at the margins but do not eliminate the structural vulnerabilities associated with dependence on a globally traded commodity. Chief among these vulnerabilities are price volatility and the macroeconomic effects that rapid price fluctuations impose on households, businesses, and regional economies.

THE DANGERS OF OIL PRICE VOLATILITY

Oil is traded on a single, globally integrated market. Volatility is an ever-present condition of oil markets that devastates consumers and producers. Rapid fluctuations in oil prices—both upwards and downwards—wreak havoc on the U.S. economy. Even in countries that produce more than they consume, prices can move sharply over short periods; when supply is disrupted or expectations shift, consumption cannot adjust quickly, and price swings propagate across the economy, delaying investment, forcing costly reallocations of capital, reducing productivity, and slowing job growth.

Increased domestic production can reduce net import exposure, but it does not eliminate volatility. Instead, it exposes the economy to the full cycle of price swings. When prices rise, costs increase across energy-intensive sectors; when prices fall sharply, oil producers face bankruptcies, loan defaults, job losses, and abrupt cuts in capital spending. As the United States has become a leading oil producer, these countervailing effects have grown more pronounced, reducing the net economic benefit of price fluctuations. This dynamic reflects structural features of the global oil market. Oil is fungible, production costs vary widely, and economically recoverable reserves are highly concentrated. Low-cost producers, particularly those controlling large reserve bases, retain market power across price cycles, while higher-cost producers adjust output more quickly.[7] These asymmetries sustain volatility and limit the extent to which any single country can insulate itself from global price movements.

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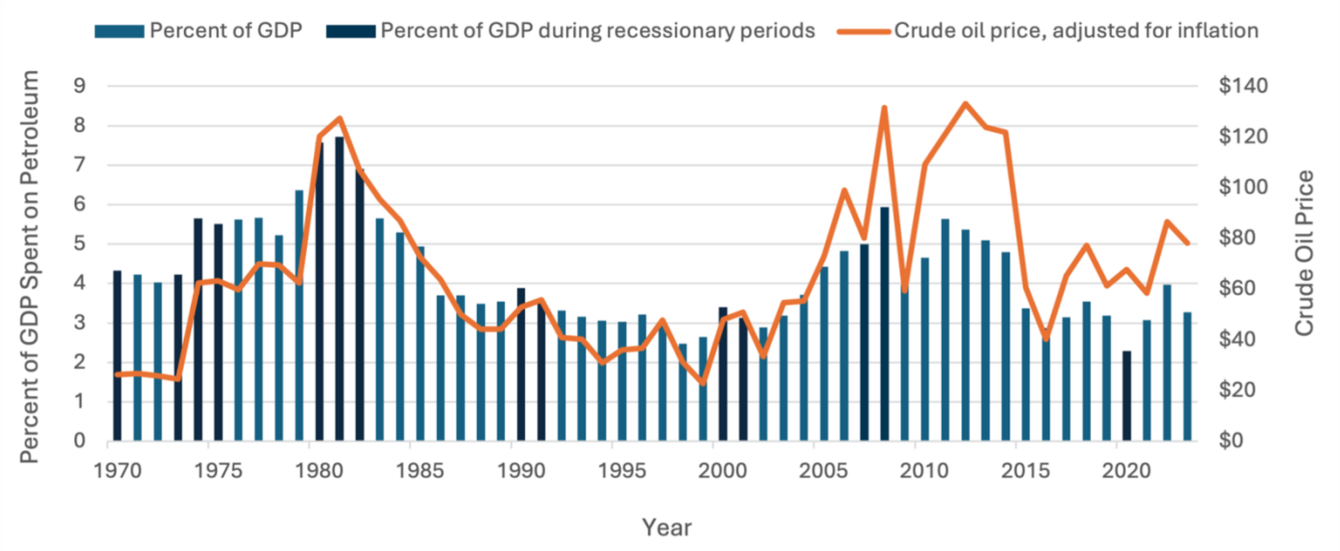
[7] EIA, "What drives crude oil prices: Supply Non-OPEC"; and EIA, "What drives crude oil prices: Supply OPEC."

The persistence of these dynamics is evident in economic history. Of America's twelve recessions since World War II, ten have been preceded or accompanied by a sharp spike in oil prices.[8] The oil crises of the 1970s and the sharp price increases associated with the First Gulf War in 1990, preceding the Great Recession in 2008, and following Russia's invasion of Ukraine in 2022 each illustrate how geopolitical events and supply disruptions can ripple into economy-wide distortions.[9] Although oil price shocks are often temporary, their effects extend well beyond the immediate disruption, shaping investment decisions, market behavior, and policy choices long after prices stabilize.

FIGURE 2: U.S. CRUDE OIL PRICES, PETROLEUM EXPENDITURES, AND ECONOMIC RECESSIONS, 1970–2022



Data on expenditures sourced from EIA: U.S. Energy Information Administration - EIA - Independent Statistics and Analysis; CPI figures used to adjust nominal oil prices to 2022 dollars: https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1…

These risks are felt directly by households. Because consumers cannot readily substitute away from transportation fuel in the short term, price spikes force rapid adjustments in household budgets. During the 2021-22 period, the share of gasoline and other energy goods in household expenditures grew rapidly, reducing resources available for food, childcare, and other essentials.[10] Fuel demand is relatively inelastic in the short run, requiring households to absorb price increases until markets adjust.

ENERGY AND NATIONAL SECURITY

The same structural features that impose persistent economic costs also create national security risks. Dependence on a globally traded, concentrated fuel supply constrains foreign policy choices, shapes alliance commitments, and imposes long-term strategic obligations that extend well beyond market outcomes. Maintaining access to oil supplies and protecting critical transit routes have influenced the United States' diplomatic relations and defense posture for decades, particularly in regions central to

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[8] Marc Labonte and Gail Makinen, "The Current Economic Recession: How Long, How Deep, and How Different From the Past?," Congressional Research Service, January 10, 2022, at 11; and EIA, "Cushing, OK WTI Spot Price FOB (Dollars per Barrel)."

[9] Federal Reserve Bank of St. Louis, "Spot Crude Oil Price: West Texas Intermediate (WTI)."

[10] Shane Meyers et al., "Consumer expenditures in 2022," Bureau of Labor Statistics, December 2023.

global energy production. By the late 1970s, Middle Eastern monarchies had come to be viewed as the strategic core of American energy security, a reality reflected in President Jimmy Carter's declaration in his 1980 State of the Union address that the United States would use military force, if necessary, to defend access to the region.[11] The subsequent involvement of the United States in the First Gulf War and Iraq War was closely linked to concerns over oil supply security and regional stability. As of 2018, analysis placed the annual cost of U.S. military intervention to secure oil supply lines at $81 billion.[12]

Because oil is traded in a single global market and production is highly concentrated, access to supply and the ability to influence trade flows have long carried strategic significance for both producing and consuming nations. A defining feature of the global oil system is the concentration of reserves among a relatively small number of producing states. Member countries of the Organization of the Petroleum Exporting Countries (OPEC) control approximately 80 percent of the world's proven oil reserves, while accounting for roughly 35 percent of global oil production.[13] More consequentially, OPEC members, and Saudi Arabia in particular, hold the vast majority of the world's spare production capacity, meaning they can adjust output on relatively short notice.

This imbalance has historically enabled coordinated production decisions that influence supply conditions and prices, providing producing states with durable leverage over global markets. While production technologies and market structures have evolved, the fungibility of oil and the concentration of reserves continue to give strategic influence to low-cost producers, including those in OPEC. Analyses by Oak Ridge National Laboratory estimate that the cost of coordinated oil supply manipulation to the U.S. economy between 1974 and 2018 was roughly $10 trillion, of which approximately $5 trillion was transferred out of the U.S. economy, and resulted in an estimated potential GDP loss of $2 trillion.[14] National security experts have long noted the fiscal and military resources required to secure vulnerable international supply lines and transit routes.[15]

Importantly, increased domestic production does not eliminate these strategic constraints. Participation in global oil markets continues to subject the United States to supply disruptions and strategic behavior by producing states. When prices fall, higher-cost producers (such as the United States) must curtail output

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[11] Jim Krane, "Energy Kingdoms: Oil and Political Survival in the Persian Gulf," Columbia University Press, 2019, at 2.

[12] secureenergy. "The Military Cost of Defending Global Oil Supplies." *SAFE*, September 20, 2018. https://secureenergy.org/military-cost-defending-global-oil-supplies/.

[13] OPEC, "2025 OPEC Annual Statistical Bulletin," 2025, at 22, 26.

[14] EC analysis based on Stacy Davis and Robert Boundy, "Transportation Energy Data Book: Edition 40," Oak Ridge National Laboratory, May 2022, at 11-15. Note: Oak Ridge National Laboratory's research breaks down the potential GDP lose, wealth transfer costs, and the dislocation costs by year between 1970 and 2018. Using this information, the United States may have lost roughly $10 trillion between 1974 and 2018. As per Oak Ridge National Laboratory, wealth transfer is the product of total U.S. oil imports and the difference between the actual market price of oil (influenced by market power) and what the price would have been in a competitive market, dislocation losses are temporary reductions in GDP as a result of oil price shocks, and loss of potential GDP results because a basic resource used by the economy to produce output has become more expensive. As a consequence, with the same endowment of labor, capital, and other resources, our economy cannot produce quite as much as it could have at a lower oil price.

[15] Jonathan Chanis and Paul Ruiz, "The Military Cost of Defending the Global Oil Supply," Securing America's Future Energy, September 21, 2018, at 4-6.

more quickly than reserve-rich, low-cost producers (often in the Middle East); when prices rise, importing nations and consumers bear the adjustment burden. This asymmetry sustains geopolitical leverage independent of short-term market conditions.

Electricity fundamentally differs in this respect. Unlike oil, electricity is not a globally traded commodity. It is produced domestically from a diverse portfolio of resources, including geothermal, solar, wind, natural gas, and nuclear power, and is delivered through infrastructure governed primarily by domestic regulation and investment decisions. While electricity systems face real challenges related to reliability, resilience, and infrastructure security, these challenges are principally addressed through domestic policy choices rather than external geopolitical forces.

Electrification is therefore a strategy of risk reduction. By reducing the role of oil in transportation, the United States diminishes exposure to the structural economic and geopolitical vulnerabilities embedded in global oil markets while increasing reliance on energy systems predominantly under domestic control. Over time, this shift can reduce strategic vulnerability, strengthen national security, and expand the menu of available economic and foreign policy options. Whether these benefits materialize depends on the trajectory of the domestic EV market and its ability to meaningfully reduce transportation-related oil demand.

The U.S. Electric Vehicle Market in 2026

Over the past fifteen years, the EV market in the United States has progressed from nascent experiments to broad commercial deployment—a trajectory which largely mirrors that of the global market, though U.S. EV adoption lags significantly behind market leaders such as China and Europe.[16] This progression has been driven by sustained reductions in battery costs, measurable improvements in vehicle performance (largely due to regulations that reward efficient vehicles), incentives to bridge price differentials, and early investment in charging infrastructure. As a result, the central constraint on adoption has shifted. The feasibility of EV technology is no longer the binding constraint on adoption. Rather, it is whether the supporting systems—charging, grid integration, financing, and supply chains—can scale quickly and reliably.

FROM EARLY ADOPTION TO EARLY MAJORITY: WHAT CHANGED

The modern re-emergence of EVs in the United States followed a pattern: periods of heightened policy attention and investment—often linked to energy security concerns—were followed by retrenchment as near-term pressures subsided. Federal research and development efforts beginning in the 1970s, renewed activity in the 1990s, and early consumer incentives in the 2000s established the technical foundations for electrification. However, these efforts did not yet produce a self-sustaining market. Vehicles remained expensive, range was limited, and production volumes were small.[17]

This dynamic began to change materially after 2009. The introduction of early mass-market EVs, including the Tesla Roadster, Chevrolet Volt, and Nissan Leaf, coincided with expanded public investment in battery development and a growing influx of private capital. Over the subsequent decade, technological progress exceeded early expectations. Between 2010 and 2021, battery production costs declined by approximately 90 percent, reducing the cost of a typical 100 kWh battery pack from roughly $120,000 to $13,200.[18] These reductions improved vehicle affordability, extended range, and supported broader performance gains, enabling manufacturers to expand offerings across multiple vehicle classes.

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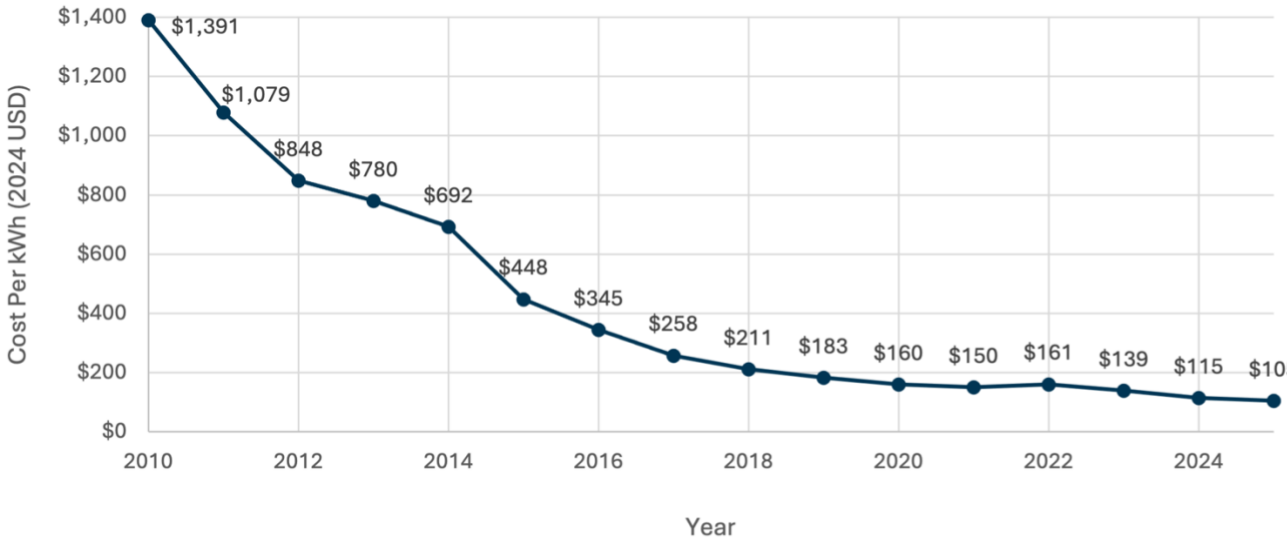
[16] IEA. "Trends in Electric Car Markets – Global EV Outlook 2025 – Analysis." Accessed March 20, 2026. https://www.iea.org/reports/global-ev-outlook-2025/trends-in-electric-car-markets-2.

[17] Congressional Budget Office, "Effects of Federal Tax Credits for the Purchase of Electric Vehicles," September 2012, at 13-14.

[18] BloombergNEF, "Battery Pack Prices Fall to an Average of $132/kWh, But Rising Commodity Prices Start to Bite," November 30, 2021.

FIGURE 3: BATTERY PACK PRICES, 2010–2025



Data source: Bloomberg New Energy Finance, 2025 Lithium-Ion Battery Price Survey.

Concurrently, several technical concerns identified in the original Electrification Roadmap were progressively addressed. Advances in battery chemistry and thermal management improved capacity, speed, and longevity at a much faster rate than most forecasts believed possible. Alignment around charging standards is quickly reducing early fragmentation and improving reliability, and initial deployments of public and private charging infrastructure demonstrated that networked systems could be built and operated at scale. By the early 2020s, more than seven million electric vehicles were operating on U.S. roads.[19]

As vehicle sales climbed well into the millions, the character of adoption began to change. Early buyers were typically higher-income consumers willing to accept higher upfront costs and limited infrastructure in exchange for access to new technology. As costs declined and model availability expanded, electrification became relevant to a broader segment of the market. At this stage, adoption became increasingly sensitive to system performance. The central question shifted to whether charging infrastructure, grid capacity, supply chains, and financing mechanisms could expand in step with demand.

The evolution of charging infrastructure showed progress and gaps. Early deployments emphasized demonstration projects and targeted corridors, often supported by public funding. These efforts confirmed that charging networks could be deployed and operated, but also exposed uneven coverage, permitting delays, and challenges in high-utilization environments such as multi-unit housing and fleet depots. While aggregate charger counts increased, availability remained inconsistent across locations and use cases most relevant to mainstream consumers. The binding constraint is system readiness—the ability to deliver reliable charging, predictable costs, and a consistent user experience across geographies and operating conditions. Charging time has also declined as higher-powered networks expand and vehicles accept higher charging rates, with some new models achieving charging speeds of 350+ kW, providing 200 miles of range in as little as 15 minutes.[20]

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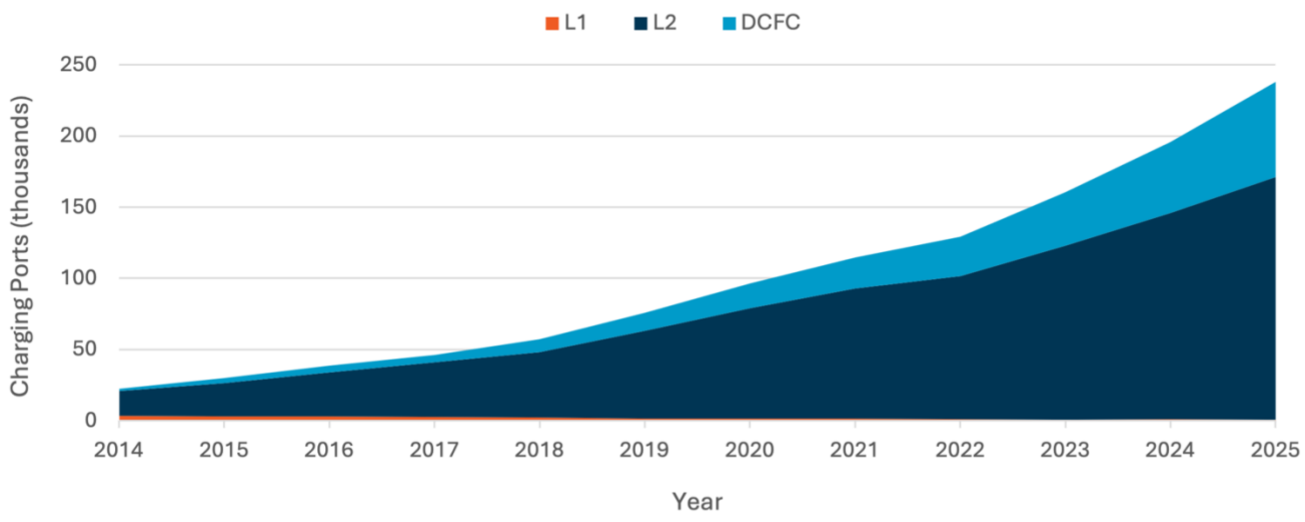
[19] Alliance for Automotive Innovation, “Get Connected: Electric Vehicle Quarterly Report, Third Quarter, 2025,” January 28, 2026, at 15.

[20] Keith Barry, “How Long Does It Take to Charge These Popular Electric Cars?,” *Consumer Reports*, November 5, 2025.

FIGURE 4: U.S. PUBLIC EV CHARGING PORTS BY TYPE, 2014–2025



Data source: Alternative Fuels Data Center Station Locator Historical Data; Alternative Fuels Data Center: Data Downloads.

The pace of future adoption will be determined less by innovation at the vehicle level than by the stability, coordination, and execution of the systems that support large-scale deployment.

THE POLICY ENVIRONMENT AND MARKET VOLATILITY

As the EV market has progressed toward the early-majority phase, the function of public policy has shifted. In the earliest stages of market development, targeted incentives and demonstration programs helped reduce costs, accelerate learning, and attract private capital into an emerging industry. As deployment scales, however, the primary role of policy is no longer experimentation. It is to provide durable, credible signals that enable the planning, financing, and operation of a nationwide EV system that maintains the United States' leading role in global transportation markets.

The American experience with transportation electrification illustrates both the effectiveness of clear policy signals and the risks introduced by politicization and the resulting policy volatility. Over the past decade, periods of coordinated federal support coincided with substantial private investment in vehicle assembly, battery manufacturing, and charging infrastructure. Legislation reinforced this trajectory by pairing demand-side incentives with supply-side support for manufacturing and infrastructure deployment. Approximately four percent of the $1.2 trillion Infrastructure Investment and Jobs Act was eligible for transportation electrification, including funding for charging infrastructure, grid upgrades, and battery development.[21] Within that total, $7.5 billion was allocated to national charging programs—the $5 billion National Electric Vehicle Infrastructure program and the $2.5 billion Charging and Fueling Infrastructure program—designed to cover up to 80 percent of eligible project costs and establish a national deployment backbone.[22]

Complementary incentives expanded the market signal. The Inflation Reduction Act provided approximately $47 billion in EV-eligible support outside of loan programs, including extensions of

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[21] Spencer Burget, "EV eligible funding in IIJA and IRA represents nearly 30 times the total EV funding awarded by U.S. government to date," Atlas EV Hub, September 2, 2022.

[22] U.S. Senate Committee on Environment & Public Works, "Bipartisan Infrastructure Law."

consumer and commercial vehicle credits, incentives for used electric vehicles, and support for charging equipment.[23] Domestic content and sourcing requirements embedded in these incentives were intended to align vehicle adoption with domestic manufacturing investment and supply chain development. Early analyses suggested these tools materially reduced purchase costs and improved adoption prospects. Modeling by the International Council on Clean Transportation (ICCT) estimated that the credits could lower average light-duty EV purchase costs by roughly $3,400 to $9,000 and support EVs reaching approximately half of new vehicle sales by 2030, contingent on timely infrastructure and manufacturing build-out.[24]

At the same time, implementation challenges and the politicization of EVs in the 2024 election exposed the fragility of this progress. Partisan politics led to delays in disbursements, shifting program guidance, and questions about continuity, which complicated project planning and increased investment risk. Analyses conducted prior to subsequent policy reversals underscored the market's sensitivity to early market volatility. Research by Harvard University's Salata Institute found that withholding remaining funds for national charging programs alone could reduce EVs' share of new vehicle sales by roughly three percentage points by 2030.[25] When combined with the removal of vehicle purchase incentives, charging installation credits, and production-related support, modeled outcomes diverged more sharply, with adoption trajectories differing by more than ten percentage points by the end of the decade.[26] These results do not suggest that electrification would reverse, but they demonstrate how conditions during the scaling phase shape the pace of market penetration.

The implications extend beyond vehicle sales. Further analyses by the ICCT estimate that repealing major EV incentives could place more than 100,000 automotive-related jobs at risk, with indirect impacts expanding that figure substantially.[27] Projected losses are concentrated in states that have attracted significant recent investment in EV and battery manufacturing—including Michigan, Texas, Tennessee, Nevada, California, and Kentucky—where individual states face potential losses on the order of ten to fifteen thousand jobs tied to vehicle assembly, battery production, and recycling.[28] Princeton University's ZERO Lab similarly concluded that sustained policy retrenchment could place between 29 and 72 percent of U.S. battery manufacturing capacity at risk and threaten cancellation of much of the planned expansion in EV assembly.[29] These effects would propagate upstream to materials and component suppliers and downstream to installation, maintenance, and service providers.

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[23] Spencer Burget, "EV eligible funding in IIJA and IRA represents nearly 30 times the total EV funding awarded by U.S. government to date," Atlas EV Hub, September 2, 2022.

[24] Peter Slowik et al., "Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the United States," International Council on Clean Transportation, January 31, 2023, at 7.

[25] Elaine Buckberg and Cassandra Cole, "Trump EV Policy Overhaul: What Will Happen to EV Adoption, Emissions, and the Fiscal Balance?," The Salata Institute for Climate and Sustainability at Harvard University, March 18, 2025, at 6.

[26] Ibid.

[27] Anh Bui et al., "How the Inflation Reduction Act is driving U.S. job growth across the electric vehicle industry," International Council on Clean Transportation, April 1, 2025, at 10.

[28] Id., at 16.

[29] Jesse Jenkins, "Potential Impacts of Electric Vehicle Tax Credit Repeal on US Vehicle Market and Manufacturing," ZERO Lab, March 10, 2025, at 5.

Charging infrastructure deployment is particularly sensitive to policy volatility. Public and private charging projects depend on coordinated timelines across permitting, utility interconnection, equipment procurement, and site development. Interruptions in funding or uncertainty about cost recovery can delay projects mid-stream, increase development costs, and discourage investment in harder-to-serve locations such as rural corridors, multi-unit housing, and high-utilization fleet depots. Workforce training programs, such as those for electricians, construction workers, manufacturing technicians, and maintenance personnel exhibit similar dynamics, requiring sustained demand signals to justify curriculum development, apprenticeship pipelines, and hiring commitments.[30] Sudden policy revocations create deployment schedule uncertainty, undermining policy goals and slowing system-wide scaling.

Taken together, volatility defines the current policy and market environment. Technology costs have fallen, performance has improved, and demand has expanded beyond early adopters. What now constrains progress is not primarily innovation at the vehicle level, but the stability and credibility of policies that underpin the long-term investments this transition requires. A timely and durable transition to electric transportation requires that EVs are depoliticized, allowing lawmakers to consider the nonpartisan economic and national benefits of the transition and providing consumers with confidence in the market's long-term trajectory.

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[30] Nyangoma, Daphine, Ejuma Adaga, Ngodoo Sam-Bulya, and Godwin Achumie. "Market Trend Analysis as a Strategic Tool for Workforce Development Programs: A Data-Driven Conceptual Model." *International Journal of Advanced Multidisciplinary Research and Studies* 5 (March 2025): 1239–46. https://doi.org/10.62225/2583049X.2025.5.2.3972.

Three Enablers of the EV Market in the "Messy Middle"

Given established EV technology, outcomes are now determined by how well supporting systems coordinate at scale. This intermediate stage, the "messy middle," is where deployment expands across diverse regions and use cases, and where delays in infrastructure delivery, financing, workforce readiness, and supply chain coordination propagate through the market. Decisions made during this phase have lasting consequences. Once deferred or misaligned, investments are difficult to recover, and the resulting fragmentation can lock in higher costs, uneven access, and continued dependence on external supply chains. Choices about where manufacturing capacity is located, how charging and grid infrastructure expand, which suppliers achieve scale, and how consumers experience the transition will shape the market structure for decades.

Progress depends on execution across multiple fronts. The pace of adoption will be shaped by three interrelated enablers: the readiness of charging and grid infrastructure, the affordability of vehicles at the point of purchase, and the capacity and resilience of supply chains required to support scale. Each affects a different stage of the adoption decision, but failure to address any one of them slows market growth overall.

1) CHARGING AND GRID READINESS

Reliable access to charging infrastructure remains a necessary condition for widespread EV adoption. Though the exact scale of charging infrastructure expansion needed is uncertain, the perception that charging is scarce or unreliable is itself a problem that must be addressed. An estimated 80 percent of charging occurs at home, and while most charging is still expected to occur at home in the coming years, home charging alone cannot support broad market penetration. Drivers without access to dedicated parking, as well as consumers who expect flexibility comparable to conventional refueling, require dependable public charging options. Effective deployment, therefore, depends on the coordinated development of both private and public charging infrastructure.

The central issue is not the absolute number of chargers installed, but whether charging is dependable in common use cases. Network expansion can proceed rapidly in aggregate while still failing to address gaps that affect consumer behavior. Limited access at multi-unit dwellings, uneven corridor coverage, inconsistent equipment uptime, and unclear pricing reduce confidence even as deployment statistics improve. For many potential buyers, the decision to purchase depends on whether charging is available where and when it is needed, rather than on nominal system capacity.

Deployment challenges illustrate the complexity of this enabler. Charging projects require coordination across site control, permitting, utility interconnection, equipment delivery, and commissioning. In many cases, interconnection timelines and distribution upgrades determine project schedules, particularly where transformer or feeder capacity must be increased. Permitting and inspection requirements vary by jurisdiction, adding uncertainty even for standardized installations. As a result, hardware availability is often not the binding constraint—coordination among utilities, local governments, site hosts, and charging providers is. Grid constraints are often local rather than system-wide. Distribution equipment and feeder capacity can become limiting factors at high-utilization sites, particularly where multiple chargers are installed behind a single transformer. Interconnection studies, make-ready work, and transformer upgrades frequently set the critical path for deployment timelines.[31]

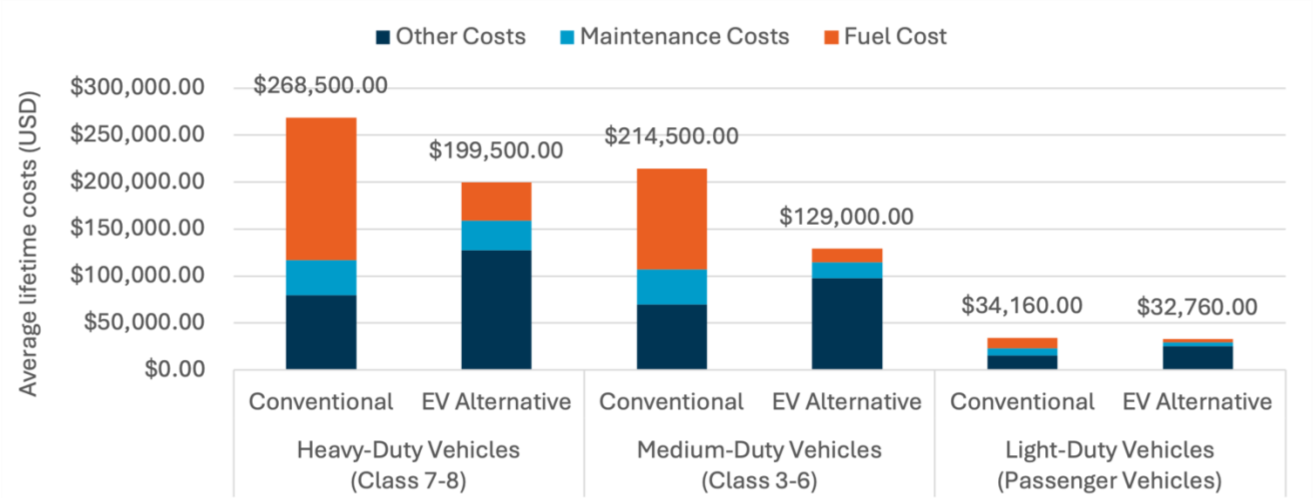
Fleet electrification highlights both the risks and the opportunities associated with charging readiness. Fleet depots concentrate demand and can improve charger utilization, making infrastructure investment more financeable. At the same time, fleet deployments often require high-capacity interconnections, extended upgrade timelines, and clarity on rate design. When timelines or cost recovery are uncertain, fleet operators delay vehicle purchases even when operating costs are favorable. Where these issues are addressed, fleet charging supports infrastructure build-out, accelerates learning, and contributes to the development of a secondary vehicle market.

In the messy middle, charging readiness depends less on expanding hardware counts than on delivering a system that operates predictably. That outcome requires clear delineation of public and private charging roles, more consistent and faster permitting and interconnection processes, and deployment strategies that build user confidence alongside physical coverage.

2) AFFORDABILITY AND TOTAL COST OF OWNERSHIP

Affordability remains one of the primary barriers to adoption among early-majority consumers. While EVs offer lower operating costs than comparable internal combustion vehicles, purchase decisions continue to be driven by upfront price, financing terms, and confidence in resale value. For many households, favorable lifetime economics do not offset higher monthly payments or uncertainty surrounding incentives and charging costs.

FIGURE 5: AVERAGE LIFETIME OWNERSHIP COSTS OF COMMON VEHICLES BY CLASS



Results of EC Dashboard for Rapid Vehicle Electrification (DRVE) tool analysis. Each bar represents averaged lifetime costs of common vehicles per weight class and vehicle type. "Other Costs" includes insurance costs, taxes and fees, and depreciation.

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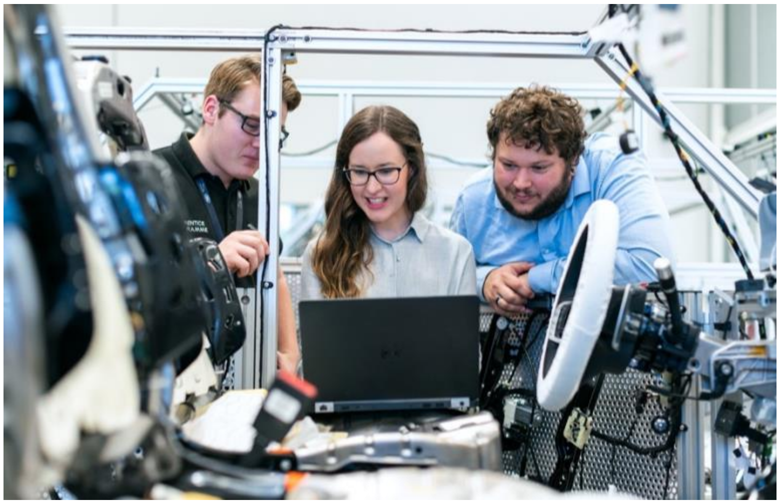
[31] See, e.g., Office of Energy Efficiency & Renewable Energy, "Distributed Energy Resource Interconnection Roadmap," DOE, January 16, 2025.

This dynamic creates a persistent gap between the total cost of ownership and point-of-sale affordability. Even modest uncertainty in incentives, financing, or residual value delays purchases among cost-sensitive buyers. Addressing this gap requires continued reductions in upfront vehicle prices, predictable financing options, and clearer information regarding operating and charging costs. The development of a robust used EV market is central to resolving affordability constraints. New vehicle sales alone cannot support broad adoption without a functioning secondary market that provides lower-cost options for price-sensitive consumers. Fleet turnover plays an important role by supplying late-model vehicles, improving price discovery, and expanding consumer familiarity. Where fleet electrification slows due to infrastructure or financing barriers, the used market develops more slowly and affordability constraints persist.

Consumer certainty is as important as price. Complex or unstable incentive structures reduce effectiveness even when support exists. Buyers delay purchases when they cannot reliably estimate net price, credit availability, or long-term value. Progress in the early-majority phase depends on clear and durable market rules that allow consumers to plan purchases. In this context, affordability reflects the combined effect of upfront cost, financing, charging cost predictability, and confidence in long-term ownership.

3) SUPPLY CHAINS AND INDUSTRIAL CAPACITY

Transportation electrification shifts dependence from petroleum to batteries and the materials required to produce them. As EV demand grows, supply chains must expand and diversify to support manufacturing scale, maintain cost reductions, and limit exposure to concentrated production and processing. Many battery materials and processing steps remain highly concentrated. This concentration introduces economic risk through price volatility and lead times, as well as strategic risk through exposure to trade disruption and geopolitical leverage. It also constrains the ability of domestic manufacturing to scale predictably when upstream inputs remain outside domestic control. Currently, China controls and refines large shares of critical minerals, presenting an economic and national security risk to the United States.



Manufacturing scale remains the primary driver of cost reduction. Battery costs have declined largely due to learning effects and volume production.[32] Sustaining those trends requires continued growth across materials extraction, processing, cell manufacturing, pack assembly, and recycling. Where demand signals weaken or become uncertain, planned facilities face delays or cancellations, and production capacity shifts to jurisdictions with clearer long-term expectations.

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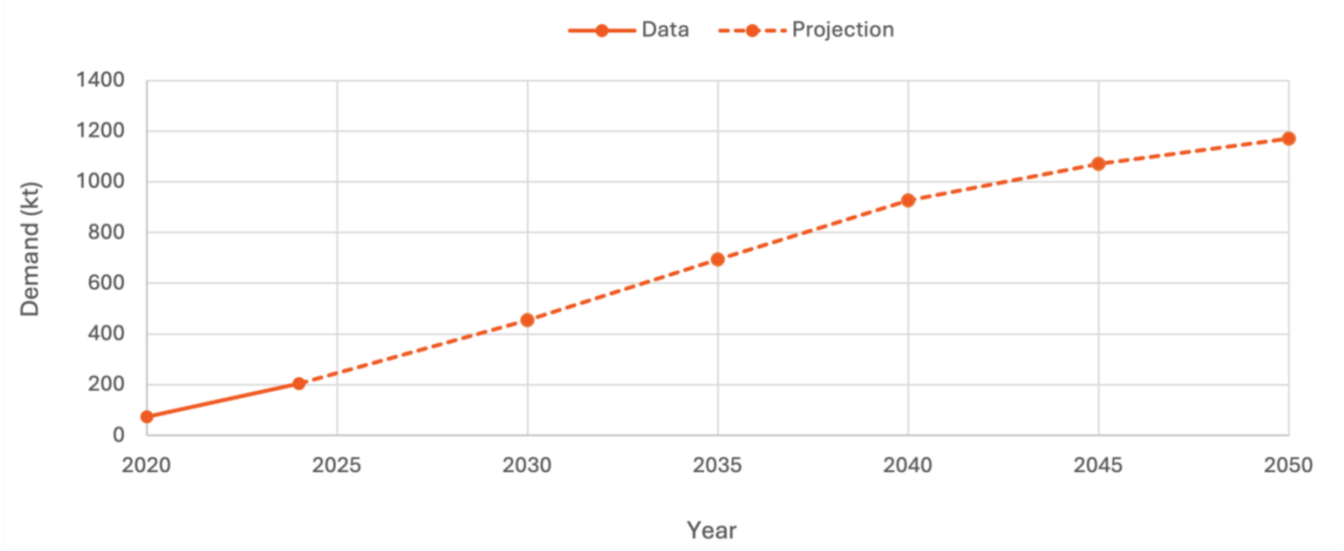
[32] Orangi, Sina, Nelson Manjong, Daniel Perez Clos, Lorenzo Usai, Odne Stokke Burheim, and Anders Hammer Strømman. “Historical and Prospective Lithium-Ion Battery Cost Trajectories from a Bottom-up Production Modeling Perspective.” Journal of Energy Storage 76 (January 2024): 109800. https://doi.org/10.1016/j.est.2023.109800.

FIGURE 6: INCREASES IN LITHIUM DEMAND UNDER IEA ANNOUNCED PLEDGES SCENARIO



Note: 2021 and 2024 values reflects actual demand, values from 2025 on reflect IEA projections.
Data sources: IEA Critical Minerals Data Explorer (Critical Minerals Data Explorer – Data Tools - IEA), and https://www.iea.org/data-and-statistics/charts/total-lithium-demand-by-sector-and-scenario-2020-2040.

Recycling and allied sourcing complement domestic production. Battery longevity and recycling capacity affect both cost and strategic exposure. Newer field data suggest batteries can retain substantial capacity after a decade of use, enabling secondary use and extending the timeline for material recovery.[33] Industrial recycling capacity is also scaling; Redwood Materials reports processing capacity on the order of 20 GWh per year, indicating that end-of-life batteries can become a meaningful domestic source of recoverable materials as volumes increase.[34]

Recycling reduces long-run dependence on virgin materials and stabilizes supply as battery volumes increase. Partnerships with allied producers and processors diversify supply and reduce exposure to single points of failure. Over time, domestic capacity combined with recycling and allied sourcing offers the most credible path to reducing concentration risk while supporting scale. EV demand anchors this system. EVs drive growth in battery materials, cells, and recycling capacity, and sustained adoption justifies investment across the supply chain. If adoption scales reliably, supply chains follow. If adoption scales unevenly, supply chain investment remains fragile and concentration risks persist.

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[33] Geotab. “EV Battery Health: Key Findings from 22,700 Vehicle Data Analysis.” Accessed March 20, 2026. https://www.geotab.com/blog/ev-battery-health/.

[34] Redwood Materials, “Energy Storage,” Webpage.

Principles To Build a Durable EV Market

A durable EV market is defined by the ability of its supporting systems to scale predictably over time. Experience suggests that durability depends on six conditions: policy stability, standards clarity, infrastructure execution capacity, fleets functioning as anchor customers for early scale and infrastructure utilization, market rules that reward utilization and reliability rather than one-off deployment, and supply chain resilience.

Stability is the primary determinant of investment. A durable market requires policy continuity sufficient to support multi-year planning across vehicles, infrastructure, and supply chains, even as program parameters evolve. The operative requirement is a ruleset that remains legible to investors over the life of major assets and does not force recurring redesign of projects already in development. Policy should minimize discontinuities in eligibility, compliance requirements, and program timelines. When updates are necessary, they should be implemented through transparent lead times, clear transition rules, and consistent administrative guidance.

National scale requires clear federal standards paired with decentralized execution. Electrification spans multiple regulatory domains, including vehicle safety, charging interoperability, grid interconnection, emissions performance, and consumer protection. Fragmentation across these domains increases compliance costs and slows deployment, particularly for firms operating across state lines. A durable market depends on consistent federal standards for vehicles and charging systems—such as connector compatibility, safety certification, and interoperability—while allowing states, utilities, and private actors flexibility in siting, ownership models, and service delivery. This division of responsibility reduces duplicative compliance burdens without constraining local execution.

Infrastructure deployment scales with the efficiency of permitting and interconnection processes. Public charging availability has expanded rapidly over the past decade. The number of public charging ports more than doubled between 2017 and 2020, and by the mid-2020s, exceeded 200,000 nationwide.[35] For comparison, the United States has approximately 110,000 gasoline stations.[36] On the Interstate Highway System, drivers already have a high likelihood of being within a short distance of a fast-charging station—an estimated 70 percent chance of being within ten miles—indicating that the backbone of national coverage is largely in place.[37] Corridor coverage is improving, but wider adoption depends on reliability and access in daily use cases. A durable EV market requires predictable, time-bound pathways for permitting, energization, and interconnection, with standardized application processes, defined utility study timelines, and clear responsibility for make-ready work and cost allocation.

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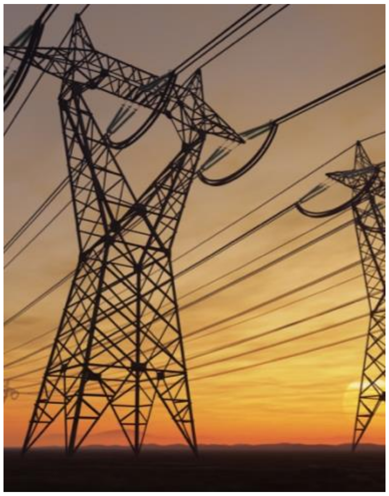
[35] Office for Critical Minerals and Energy Innovation, “U.S. Public Electric Vehicle Charging Infrastructure,” DOE; and Office for Critical Minerals and Energy Innovation, “Alternative Fueling Station Locator,” DOE.

[36] United States Census Bureau, “2023 Economic Surveys Business Patterns: 4471 Gasoline Stations,” June 26, 2025.

[37] M.K. Wildeman, “Nearly 70% of the miles of the 10 longest interstates is now within 10 miles of a fast EV charger, but range anxiety is ‘stuck in people’s heads’,” Fortune, November 1, 2025.

Fleets function as anchor customers for early scale and infrastructure utilization. Public and private fleets typically account for roughly 15–20 percent of new vehicle sales and are deployed in concentrated locations that can support shared charging infrastructure.[38] Fleet operators already rely on total cost of ownership in procurement decisions and are therefore well-positioned to electrify where charging access and financing are available. Once deployed, fleet vehicles raise utilization at shared charging sites and provide predictable load profiles that help right-size infrastructure. Fleet electrification also plays a critical role in market maturation. Vehicles deployed into fleet service enter secondary markets on predictable timelines, expanding access to used EVs and reducing upfront cost barriers for households. At the system level, fleet demand provides a stable anchor for battery manufacturing, recycling operations, and upstream materials processing, reinforcing domestic supply chains.

Market rules must reward reliability, affordability, and efficient scale. For consumers, adoption depends on confidence in charging availability, predictable operating costs, and residual value. For infrastructure providers and utilities, viability depends on utilization rates, cost recovery, and system reliability. Market rules that support off-peak charging, transparent pricing, and efficient use of existing grid capacity align private incentives with system-level efficiency. Vehicle-to-grid capability, where available, extends this logic by allowing storage to support resilience and peak management, but it remains limited by equipment, standards, and rate design, currently functioning as a second-order benefit rather than a core driver of adoption.



Vehicle usage patterns show why managed charging is both feasible and valuable. Vehicles in the United States are parked roughly 97 percent of the time, which allows charging to be shifted to periods of excess grid capacity with relatively simple incentives; analyses suggest that more than 90 percent of charging can occur off-peak under such structures.[39] Between 2011 and 2021, the addition of EVs' flexible load delivered approximately $3.1 billion in cumulative savings to ratepayers by improving the utilization of existing generation and distribution assets.[40] Since that period, the number of EVs on U.S. roads has more than doubled, increasing the scale of these effects. As deployment continues, incremental EV load provides utilities with additional revenue to support grid resilience—both physical and digital—without proportional increases in consumer electric rates.

Supply chain resilience reinforces the case for durability. Electric vehicles anchor demand for batteries, power electronics, and critical minerals that are also essential to semiconductors, clean energy systems, and defense technologies. Concentrated control over these supply chains has proven to be a source of geopolitical leverage. Because EVs account for the majority of demand growth for many battery-related minerals, sustained domestic EV deployment is a prerequisite for establishing diversified, resilient supply chains. Market durability in transportation electrification, therefore, supports broader energy security and industrial resilience objectives.

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[38] https://www.coxautoinc.com/wp-content/uploads/2025/07/June-2025-Fleet-Sales-chart.pdf

[39] Consumer Energy, "Electric Vehicle Readiness Preparing Michigan's Energy Grid for an EV Future," November 2023.

[40] Synapse Energy Economics, Inc. "EVs Are Driving Rates Down For All Customers: State-by-State Cumulative EV Net Rate Impact Summary," June 2024, at 2.

Conclusion

Though the underlying physics, geopolitics, and economics of this industry all point to an electric future, markets are influenced as much by political signals and cultural trends as by technological progress, so the outcome of this race is still undetermined. The next five years—the "messy middle" years—are pivotal. The United States is currently behind China, but intense market competition, rapid technological innovation, and troves of new knowledge from mass-scale deployments present significant opportunities to level the playing field. To take advantage of this moment, the United States must implement a coordinated public policy approach that provides the private sector with enough certainty to unlock investments in the three EV market enablers: charging and grid readiness, vehicle affordability, and critical mineral supply chains.

This series aims to guide the United States' electrification efforts by tackling the various components of the transition one at a time. Following papers will address how to facilitate the deployment of shared charging infrastructure for medium-, and heavy-duty vehicles, how to ensure transportation electrification contributes to the expansion of—rather than being limited by—the grid, how policy can guide the buildout of public light-duty charging infrastructure, how to build the domestic manufacturing expertise and supply chains capable of producing affordable vehicles, and more.

As stated above, transportation electrification is no longer a question of **if** but of **when**. The faster the United States transitions to electric transportation, the sooner the country will eliminate the economic and national security threats posed by dependence on oil, establish a dynamic and resilient domestic energy supply, and create hundreds of thousands of well-paying American jobs. Properly navigating a transition of this magnitude is not easy, but the opportunities it poses are immense.