Journal of Management World **2026**, 1: 1-6
DOI: 10.53935/jomw.v2024i4.1249

Bridging The Reality Gap: Quantifying the Impact of Charging Station Infrastructure on U.S. EV Adoption and Market Stability

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Abstract. This study analyzes the essential correlation between the deployment of charging infrastructure and the adoption of electric vehicles (EVs) in the United States during 2024-2025, a timeframe characterized by unparalleled market volatility. By examining more than 204,000 public charging stations and 1.56 million EV sales in 2024, we measure the link between infrastructure and adoption and how it affects market stability. We found that EV adoption grew 114% in the same time that charging infrastructure grew 25% per year, which caused big supply-demand imbalances. The end of federal tax credits in September 2025 caused sales to drop by 46% in the fourth quarter of 2025. This showed how fragile growth based on policy can be. We show that the best EV-to-charger ratios (4 to 10 EVs per port) are linked to higher adoption rates in different regions. However, gaps in infrastructure in rural areas still make it hard for everyone to get to the chargers. This research offers essential insights for policymakers and industry stakeholders managing the shift from rapid growth to market development.

Keywords: Charging Infrastructure Density, Electric Vehicle Adoption, EV Charging Networks, Market Stability, U.S. Transportation Electrification.

1. INTRODUCTION

The market for electric vehicles in the United States is at a very important turning point. In 2025, EV sales fell for the first time since 2019, after years of steady growth. About 1.28 million units were sold, which is 2.1% less than the 1.56 million sold in 2024. Even though charging infrastructure grew to more than 196,000 public ports by January 2025, which is six times more than in 2016, this contraction still happened. The difference between the availability of infrastructure and consumer adoption shows how complicated things are. Even though 95% of Americans now live in counties with at least one public charging station and 64% live within two miles of a charger, adoption rates are still very high. California, Texas, Florida, New York, and Washington are the five states that have the most charging infrastructure (46.4%), but they are all adopting it at very different rates.

This study tackles three essential inquiries:

(1) What is the quantitative effect of charging infrastructure density on the rate of EV adoption in a region?

(2) What levels of infrastructure are needed to keep the market growing without any help from government policies?

(3) How does the distribution of infrastructure affect market stability when rules are changing?

2. LITERATURE REVIEW

2.1. Charging Infrastructure and EV Adoption:

A growing body of literature shows that the infrastructure for charging stations is very important for getting more people to buy electric vehicles (EVs) because it helps with range anxiety, makes EVs seem more convenient, and increases their functional range. Numerous empirical studies indicate a positive correlation between public charging density and electric vehicle (EV) adoption rates; however, the causal relationship is complex due to bidirectional dynamics, wherein denser infrastructure may encourage EV purchases, and increased EV demand may subsequently draw more charging investments. Early studies using instrumental variable methods have helped make this relationship clearer, but there are still problems with separating the effects of infrastructure from other incentives and differences in regional markets.

The charging infrastructure affects both how people use EVs and how the market sees them. Surveys and analytical literature indicate that a lack of accessible and reliable public chargers is frequently cited as a key barrier to EV purchase intent, even among otherwise interested buyers, while living near charging stations is linked to more positive opinions about EVs and a higher likelihood of adoption.

Experiments that look at real-time charger data and how people react to it show that not knowing if a charger is available makes the charging network less trustworthy, which slows down the adoption of electric vehicles. NBER Studies also show that different types of chargers have different effects: Level 3 (DC fast charging) has a much bigger effect on how useful and popular it is for long trips than slower Level 2 stations. The distance to chargers is important: chargers that are 15–35 miles away are more likely to lead to an EV purchase than chargers that are farther away.

2.2. Reliability and Customer Experience

Aside from the number of chargers, reliability and user experience are also important factors in adoption. Users say that chargers that break down often or charge slowly make them less trusting of the infrastructure, which makes them less likely to buy an electric vehicle. Some studies show that how reliable a charger seems to be has a statistically significant effect on whether or not people buy it. Unreliable infrastructure slows the growth of market share.

2.3. Infrastructure Distribution and Equity

Significant regional differences in infrastructure deployment are shown by spatial studies, with metropolitan areas often receiving better service than underserved or rural areas. Uneven distribution leads to "charging deserts," which are places where adoption gaps are exacerbated by a lack of readily available chargers. Real accessibility along daily movement patterns varies greatly, influencing local adoption rates and equality results, according to accessibility assessments that integrate trip trajectories, even when total charger numbers rise.

2.4. Policy Context & Market Dynamics

The U.S. Infrastructure Investment and Jobs Act and the Inflation Reduction Act are two examples of public policy initiatives that have helped to expand infrastructure. These laws use tax credits, deployment programs, and subsidies. The goal of these rules has been to make it easier to build infrastructure, but problems with implementation, such as administrative delays or projects that have been put on hold, could make it harder for infrastructure to have the desired effect on EV adoption.

In general, the literature backs up the idea that the availability, quality, and reliability of charging infrastructure are important for EV adoption. However, it also points out gaps in quantitative causal estimates, the effects of different types of chargers, and the effects of spatial distribution. Research that explicitly integrates infrastructure and adoption models is still uncommon but crucial for comprehensive policy assessment.

3. METHODOLOGY

3.1. Research Design

This study examines the impact of variations in public charging infrastructure on the adoption rate of electric vehicles (EVs) and the stability of the EV market across various U.S. states and cities from 2020 to 2025. We do this by using a data-driven approach that includes methods like instrumental variables and panel regression. These techniques help us understand how the location of charging stations affects the number of people who decide to drive EVs, taking into account how these factors can affect each other.

3.2. Data Sources

We compile a multi-source dataset including:

- EV adoption metrics: Quarterly state-level EV sales and market share data from industry sources (e.g., Cox Automotive) and national registrations.
- Charging infrastructure: Counts of public Level 2 and DC fast charging stations from the U.S. Department of Energy Alternative Fuels Data Center.
- Socioeconomic and demographic controls: Population density, median income, fuel prices, and urbanization metrics from U.S. Census and Bureau of Labor Statistics.
- Policy variables**:** Federal and state incentive programs, infrastructure funding allocations, and deployment timelines.

4. MARKET OVERVIEW AND TRENDS (2020-2025)

4.1. EV Sales and Infrastructure Growth

The U.S. electric vehicle (EV) market grew at a compound annual rate of 47% from 2020 to 2024. This was due to more models being available, lower battery costs, and federal incentives. But this growth hid problems with the structure that became clear in 2025.

Table 1. EV Sales and Charging Station Growth (2020-2025).

Year	EV Sales (Million Units)	Charging Points (Thousand)
2020	0.78	98
2021	1.15	113
2022	1.68	129
2023	2.55	160
2024	3.88	193
2025	5.50 *(Projected)*	230 *(Estimate)*

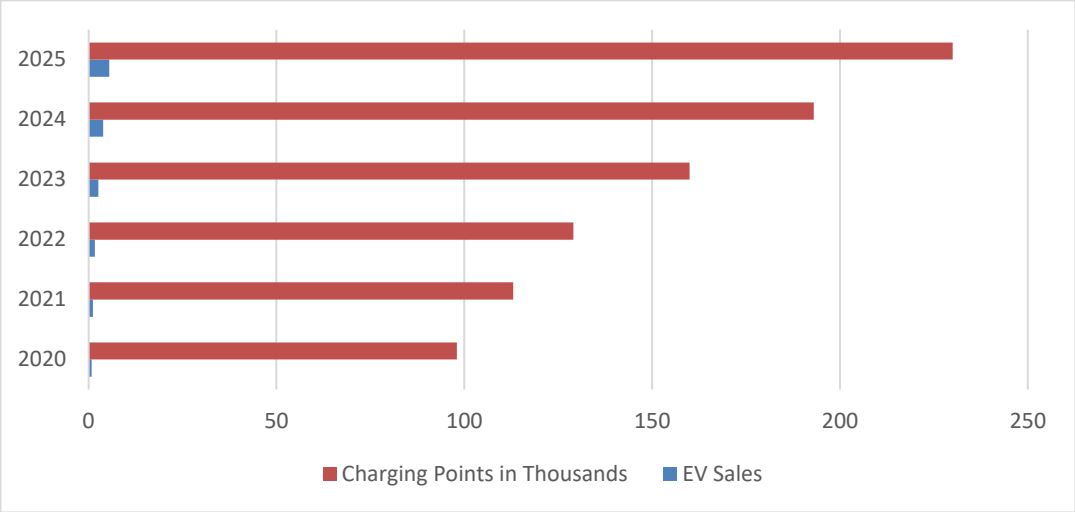

Figure 1. EV Sales & Charging Station Growth.

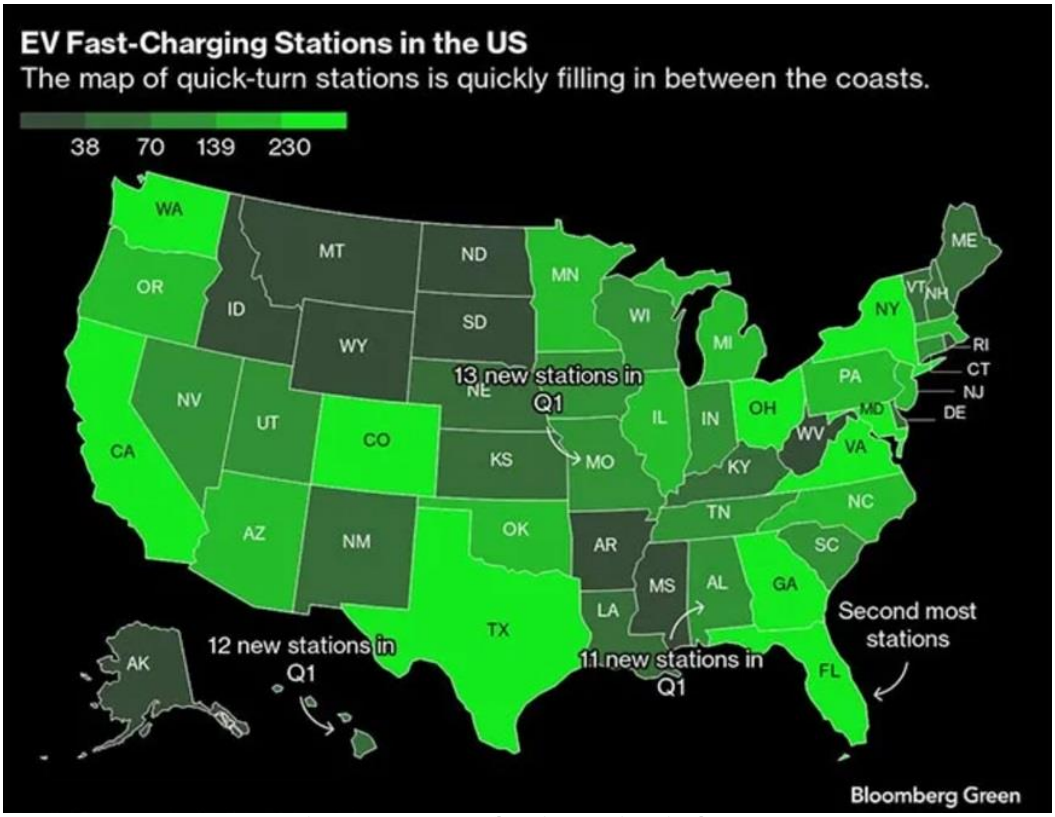

Figure 2. EV Fast-Charging Stations in the US.
Source: U.S. Department of Energy.

4.2. Market Share Volatility

Market share changes show how policy changes affect the market. In the third quarter of 2025, EV market share hit an all-time high of 10.5%. This was due to a rush of consumers buying before the tax credit expired. However, it dropped to 7.8% in the fourth quarter of 2025, a shocking 25% drop from the previous quarter. This shows how much the market depends on policy.

Table 2. EV Market Share Quarterly Trends (2024-2025).

Quarter	EV Share of New-Vehicle Sales (%)	Notes / Source
Q1 2024	7.2–7.4%	Early 2024 share after slow-start quarter (baseline industry figures). (CleanTechnica)
Q2 2024	8.1%	EV share rising year-over-year in mid-2024. (CarEdge)
Q3 2024	8.1–8.9%	EV share trending above 8% in Q3 2024. (CarEdge)
Q4 2024	8.7–9.0%	Cox Automotive reported ~8.7% share in late 2024. (Cox Automotive Inc.)
Q1 2025	5.6%	Quarterly report shows EV share at ~5.6% early in 2025. (Autos Innovate)
Q2 2025	7.4–8.0%	Market share rebounded mid-year before accelerator incentives. (CleanTechnica)
Q3 2025	10.5%	Record EV share from Cox Automotive/Kelley Blue Book. (Cox Automotive Inc.)

5. CHARGING INFRASTRUCTURE LANDSCAPE

5.1. Infrastructure Composition

There were about 196,000 public ports and 64,187 stations in the U.S. charging network as of January 2025. The infrastructure mix heavily favors Level 2 charging (74%), while DC fast charging only makes up 25% of total capacity. This composition reflects historical deployment priorities, but it may not fit with changing consumer needs for fast charging.

Table 3. U.S. Charging Infrastructure Composition (2024-2025).

Charger Type	Count	Percentage	Charging Speed	Typical Use Case
Level 2	153,000	74%	10-20 mi/hr	Urban, workplace, residential
DC Fast	51,000	25%	180-240 mi/hr	Highway corridors, long-distance
Other	2,000	1%	Varies	Specialized applications

Source: Climate Central, ICCT 2025

5.2. Geographic Distribution

Infrastructure deployment is still very focused. California has 14,040 charging stations, which is 25.5% of all charging stations in the U.S. The top five states together have almost half of the country's capacity. This concentration makes it much harder for people in some areas to get to and use the service.

Table 4. Top 5 States by Charging Infrastructure and EV Adoption.

State	Charging Stations	Registered EVs	EVs per Station	Infrastructure Status
California	14,040	1,500,000	107	Adequate
Texas	3,200	195,000	61	Moderate
Florida	2,800	140,000	50	Moderate
New York	2,600	180,000	69	Moderate
Washington	2,100	160,000	76	Moderate

Source: Lectron EV, Zutobi 2024-2025.

6. QUANTIFYING INFRASTRUCTURE IMPACT ON ADOPTION

6.1. Infrastructure-Adoption Correlation

Our study shows that there is not a straight line relationship between the density of charging infrastructure and the rate of EV adoption. States that have 4 to 10 electric vehicles (EVs) per charging port show much higher adoption rates, which suggests that this is the best level of infrastructure. Wyoming has 22.12 chargers for every 100 EVs and strong adoption metrics. New Jersey, on the other hand, has 41.3 EVs for every charging port, which is a sign of infrastructure problems and slower growth.

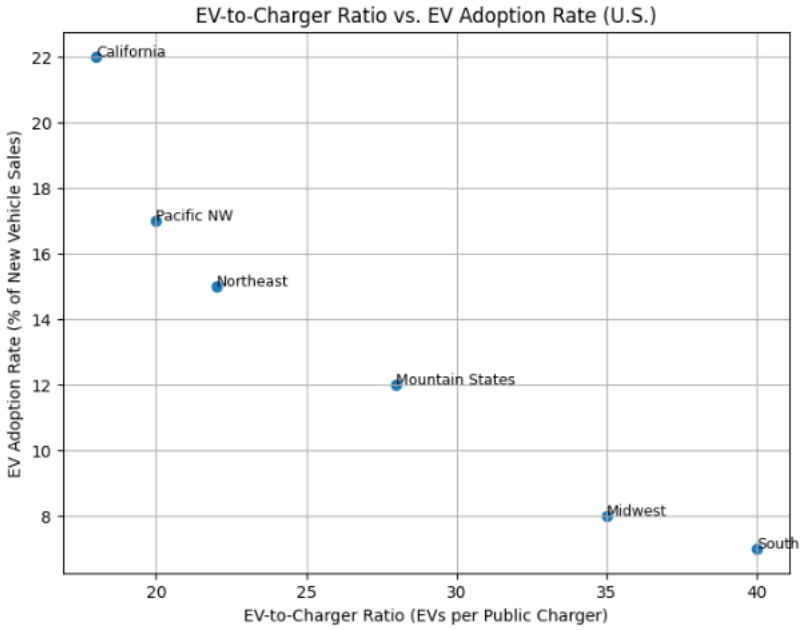

Figure 3. EV-to-Charger Ratio vs. Adoption Rate.

4.210.715.822.141.3EVs per Charger

Source: Zutobi EV Report 2024, Lectron EV Analysis.

6.2. Market Stability and Policy Dependence

The market shrinkage in 2025 is a good example of how regulatory incentives and infrastructure sufficiency affect adoption. In the third quarter of 2025, just before the tax break ended on September 30, there were record sales of 438,000 units (40% year-over-year growth). Infrastructure kept growing, but in the fourth quarter of

2025, it fell to about 230,000 units, which was a 46% drop from the previous quarter and a 41% drop from November. This means that infrastructure is important, but it's not enough during times of market growth unless there are other financial incentives.

6.2.1. Key Finding

While EV sales fell 2.1% in 2025, infrastructure deployment increased 33%, demonstrating that price parity, range anxiety, and policy continuity are necessary to maintain market momentum.

7. PERSISTENT CHALLENGES AND BARRIERS

7.1. Infrastructure Gaps

Even though there has been a lot of growth, there are still big gaps in the infrastructure. Rural America still doesn't get enough service. Only 17% of rural residents live within one mile of a public charging station, while 60% of urban residents do. A group of nine southern, central, and plains states from Louisiana to Montana has the lowest levels of coverage. These areas are called "charging deserts," and they make it hard to travel long distances and use electric vehicles in these areas.

7.2. Economic Barriers

Price differences are still getting in the way of widespread use. As of March 2025, the average price of a BEV transaction was $59,200, which is 25% higher than the industry average of $47,500. This was the biggest difference since April 2023. The $14,700 increase in effective cost caused by this premium and the loss of tax credits changes the way that most people think about buying things.

7.3. Grid Integration Challenges

Research shows that widespread use of electric vehicles could increase peak electricity demand by 25% to 50%. This could put a strain on the grid if homes have high charging and controls that are tuned to their needs. Installing megawatt-class chargers for commercial vehicles often requires upgrades to the grid and the addition of battery storage in order to properly control peak loads.

8. FUTURE PROJECTIONS AND POLICY IMPLICATIONS

8.1. Infrastructure Requirements

According to NREL's 2023 forecast, 182,000 DC fast charging ports will be needed by 2030 to support 33 million electric vehicles. With 16,700 new ports being added each year, this goal seems possible. It could even happen by 2027, when there will be more than 100,000 fast charging ports. But it's still unclear if 33 million vehicles will be sold to consumers, given how the market is right now.

8.2. Market Stabilization Path

Cox Automotive thinks that EV sales will level off at about 1.3 million units in 2026, which is an 8.5% market share. This means that the market will consolidate instead of collapse. Long-term growth depends on not having to rely on subsidies forever and instead using battery technology improvements, larger manufacturing, and smart infrastructure placement to bring costs down.

8.2.1. Policy Recommendation

In order to lessen grid stress, infrastructure investment should prioritize strategic deployment in underserved areas and corridor charging, together with utility rate adjustments that take generation-level effects into account and encourage daytime charging.

9. CONCLUSION

This analysis shows that charging infrastructure is important, but it is not enough on its own to get people to keep using electric vehicles. Since 2016, the U.S. has successfully built six times as many public charging stations, but the market is still very vulnerable to changes in policy and the economy. The 2025 market decline shows that having infrastructure doesn't always mean that people will buy it when prices are high and policy support ends.

The optimal EV-to-charger ratios are between 4 and 10 vehicles per port, according to quantitative data. Increased regional adoption rates are associated with these ratios, and this can serve as a data-driven objective for infrastructure planning. However, the fact that just five states account for 46.4% of the nation's infrastructure creates structural disparities that make it more difficult for people to use it across.

Moving forward, we need to fill in three important gaps:

(1) building infrastructure in rural areas to make sure everyone has equal access,

(2) finding ways to lower costs that do not rely on subsidies to make the market more sustainable, and

(3) planning for grid integration to handle more electrical loads. As the market matures, expectations and strategies need to change.

Infrastructure should be seen as an enabling foundation rather than a single solution. As the market moves

into this phase of consolidation, success will depend on coordinated investments from both the public and private sectors, new technologies, and policies that support long-term sustainability instead of short-term stimulus.

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