



Challenges to Expanding EV Adoption and Policy Responses

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The expansion of electric vehicle (EV) charging infrastructure is essential to accelerating both EV adoption and the broader decarbonization of the transportation sector. This study investigates the incentives and policies at the federal, state, and utility levels aimed at promoting the widespread deployment of EV charging stations alongside encouraging EV adoption. Despite technological advancements and rising global EV sales, adoption rates in the U.S. remain limited by high upfront costs, range anxiety, and insufficient charging infrastructure. Through an analysis of current programs and funding mechanisms, this study explores the barriers to adoption and ongoing efforts to improve charging infrastructure accessibility. Additionally, it offers insights into how the U.S. can address these infrastructure gaps and promote a more sustainable and inclusive transportation system.

Electric vehicles (EVs) offer a vital solution in global efforts to combat climate change, especially as the transportation sector accounts for a significant share of greenhouse gas (GHG) emissions. The shift from gasoline and diesel-powered vehicles to EVs is crucial for reducing emissions. In 2022, EVs accounted for 14% of new car sales globally, with rapid growth in countries like China and Norway, where government policies support widespread adoption. However, in the U.S., EVs have been slower to gain market share, representing just 6% of new light vehicle sales in 2022. This is far below President Biden's target of 50% electric vehicle sales by 2030. Achieving higher EV adoption in the U.S. and other lagging markets requires addressing three major challenges: high costs, range anxiety, and insufficient charging infrastructure.

This paper provides a comprehensive review of initiatives, policies, and funding programs crucial for expanding EV charging networks and promoting EV adoption in the U.S. and selected countries. Through an analysis of current programs and funding mechanisms, the study explores the barriers to adoption and the ongoing efforts to enhance the accessibility of EV charging infrastructure. Additionally,

it offers insights into how the U.S. can address infrastructure gaps and develop a more sustainable and inclusive transportation system, ultimately supporting broader decarbonization efforts in the transportation sector.

1. Policy Initiatives on EV Charging Infrastructure

Since 2008, the U.S. federal government has made significant investments in the electrification of the transportation sector. Initially, these programs primarily emphasized the research and development, manufacturing, and deployment of EVs. However, a portion of the funding allocated through these programs, such as the American Recovery and Reinvestment Act of 2009 and the Fixing America's Surface Transportation Act, has also been dedicated to the establishment of charging infrastructure, recognizing the crucial role it plays in supporting the widespread adoption of EVs.

The Bipartisan Infrastructure Law, enacted in 2021, marks a transformative investment in EV charging infrastructure, allocating approximately \$7.5 billion specifically for EV charging stations. A central component of this initiative is

the National Electric Vehicle Infrastructure (NEVI) program, which aims to strategically deploy a nationwide network of EV chargers to enhance accessibility and convenience for EV users. The NEVI program focuses on establishing charging stations along designated Alternative Fuel Corridors, ensuring that EV drivers have reliable access to charging facilities across the country.

In addition to federal efforts, various state and regulated utility policies play a crucial role in expanding EV charging infrastructure in the U.S. Many states have implemented their own programs to incentivize the installation of EV chargers, often complementing federal initiatives. These state-level policies include grants, rebates, and tax incentives for businesses and consumers who invest in charging infrastructure. Furthermore, regulated utilities are increasingly involved in supporting the development of EV charging networks through investments in infrastructure, rate structures that promote off-peak charging, and innovative programs that encourage the installation of chargers in underserved areas.

While establishing direct causal impacts of federal and state incentives on the deployment of EV charging infrastructure can be challenging, the statistics suggest significant progress in the accessibility and availability of charging options for EVs over the past decade in the U.S., aligning with the implementation of major federal initiatives.

Table 1 presents a detailed breakdown of the growth in EV chargers by country and charging levels since 2015. China leads the world in the number of EV chargers, outpacing the U.S. not only in quantity but also in quality. Notably, 40% of public chargers in China are fast chargers, which offer high power output and significantly reduce charging times. In contrast, the U.S. relies heavily on Level 1 and Level 2 chargers—slower charging options—which made up approximately 80% of available public chargers in 2021, while in Europe, this figure was even higher at around 86%. As fast chargers play a critical role in addressing range anxiety and supporting long-distance travel, expanding the U.S. public fast charger network is essential to accelerating widespread EV adoption and making electric mobility more convenient for all drivers.

The availability of EV charging stations across the U.S. demonstrates significant spatial variation. Figure 1, Panel A, highlights that out of the estimated 146,600 public EV charging ports nationwide as of June, 2023, California holds the highest share, with around 41,000 ports, representing approximately 28.1% of the total. Panel B presents the normalized data per 100 EV registrations, providing insights into the number of ports relative to the number of EVs on the road. In this context, California ranks among the lowest, with approximately 7.3 charging ports per 100 vehicles, a result driven by California's large EV population, which exceeds 563,000 EVs—far outpacing other states.

Table 1: Number of Public EV Chargers by Country and Type

Year	Slow			Fast		
	China	Europe	U.S.	China	Europe	U.S.
2015	47	61	28	12	6	4
2016	86	113	35	55	9	3
2017	131	122	40	83	11	3
2018	164	136	50	111	16	4
2019	301	187	64	215	25	13
2020	498	236	82	309	38	17
2021	677	307	92	470	49	22

Notes: This table presents the number of public EV chargers (in thousands) categorized into slow chargers and fast chargers, using data from IEA (2022).

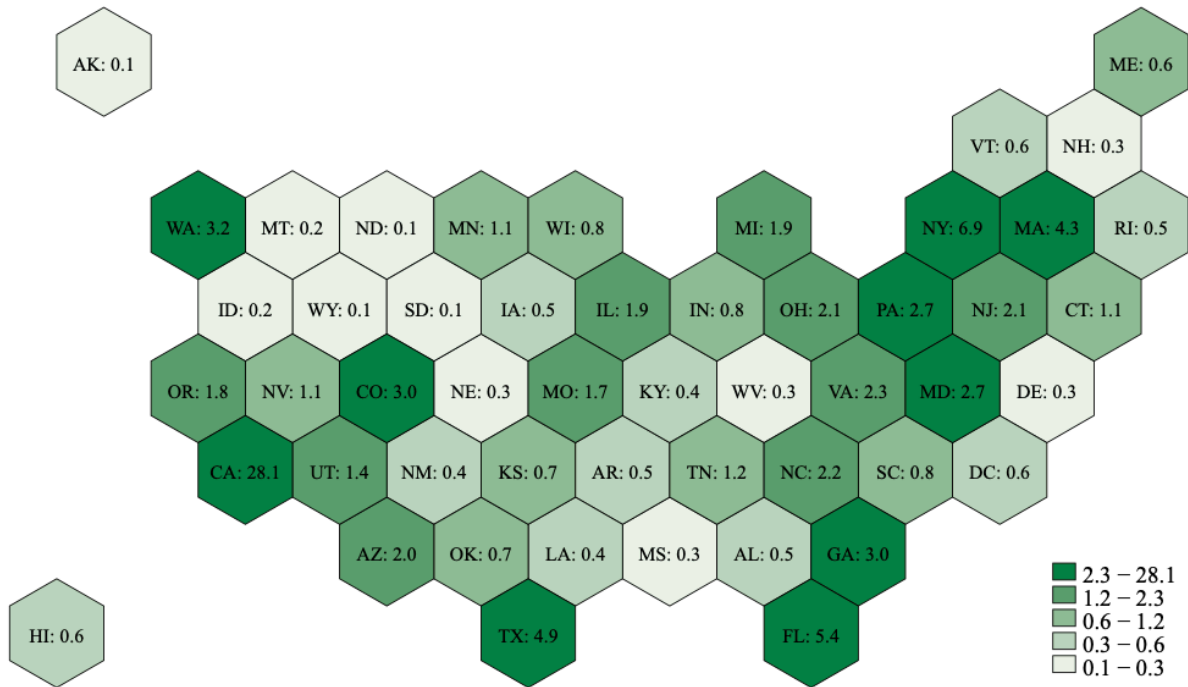


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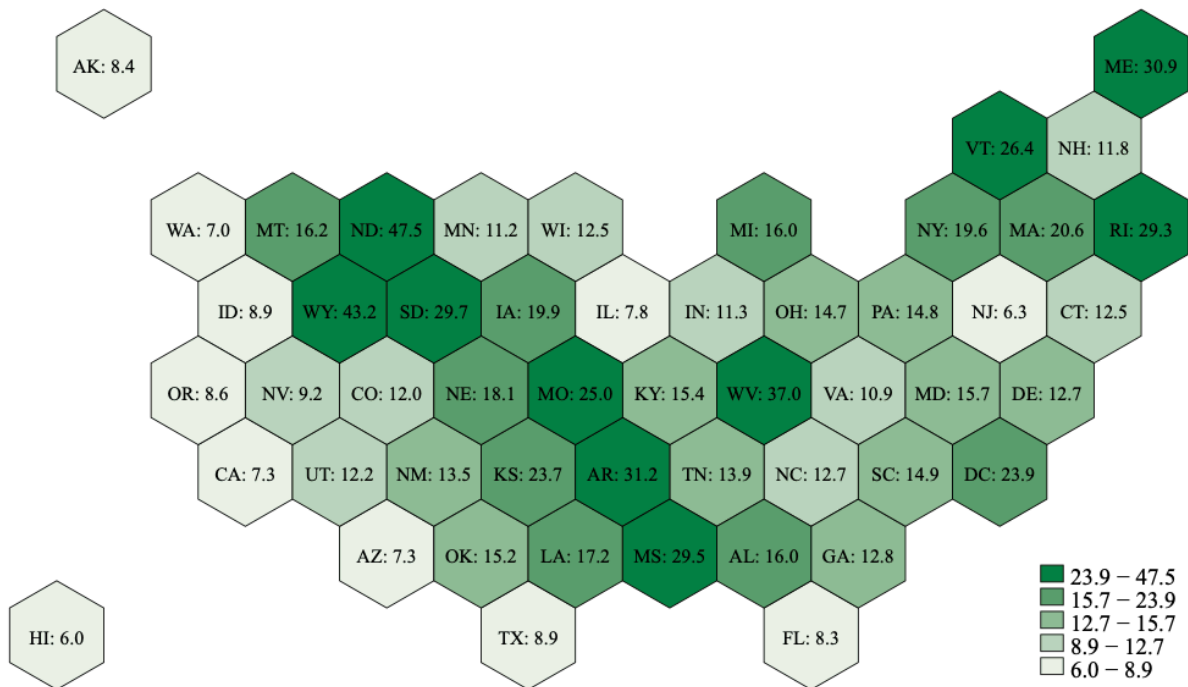
Figure 1: Distribution of Public EV Charging Ports by State

Panel A: Percent Share



Notes: This figure shows the percentage share of public EV charging ports by state, based on data from AFDC Locator.

Panel B: Number per 100 EV Registrations



Notes: This figure shows the number of public EV charging ports per 100 EV registrations, using data from AFDC vehicle registration counts.



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2. Policy Initiatives on EV Adoption

One of the most significant obstacles to the widespread adoption of EVs is their higher upfront purchase cost, particularly when compared to traditional gasoline-powered vehicles. The main driver of this cost differential is the price of EV batteries. Although there has been a substantial decline in battery costs over the past decade—leading to a significant reduction in the purchase price of EVs relative to their battery range—the timeline for achieving cost parity with gasoline-powered vehicles remains a subject of debate.

A key piece of legislation aimed at addressing this barrier is the Inflation Reduction Act (IRA) of 2022. Widely regarded as a historic step in the advancement of transportation electrification, the IRA extends tax incentives for all types of electric vehicles, including light-, medium-, and heavy-duty vehicles. These incentives are designed to offset the higher upfront costs of EVs, making them more accessible to consumers. The light-duty EV tax credit, which provides up to \$7,500 per vehicle, is now extended through 2032, helping to promote a cleaner, more sustainable, and equitable transportation future.

Beyond federal incentives, individual states and numerous local utilities have introduced a variety of additional financial and non-financial measures to encourage EV adoption. These incentives range from rebates and tax credits to discounted electricity rates for EV charging, exemptions from High Occupancy Vehicle lane restrictions, and reduced vehicle registration fees. Some regions also offer free Smart Electric Vehicle Chargers or exemptions from sales and use taxes, further enhancing the economic viability of owning an EV.

However, despite these incentives, the market penetration of EVs remains modest in many countries. Globally, EVs accounted for 9% of total car sales in 2021—a fourfold increase from their market share in 2019. In the U.S., EV sales represented 5% of new car sales in 2021 (Table 2), yet they made up only 0.5% of the total registered vehicles nationwide. This growth, while encouraging, lags behind the rapid advancements seen in other regions, notably China (16%) and Europe (17%). This disparity underscores the need for continued refinement of policy strategies to accelerate EV adoption. Europe's success is particularly exemplified by Norway, where EVs captured 86% of the market share for new vehicle sales in 2021, with 152,000 electric vehicles sold.

Table 2: Number of EVs around the World, 2021

Country/region	Sale (1,000)	EV sale share
China	3,334	16%
U.S.	631	5%
Europe	2,284	17%
U.K.	312	19%
Norway	152	86%

Notes: The table presents EV sales and sale shares for battery electric and plug-in hybrid vehicles in 2021, using IEA (2022) data.



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3. Policy Challenges

We have identified four key challenges that must be addressed to create an inclusive, reliable, and sustainable charging network.

1. Understanding the interdependency between EV charging station deployment and EV adoption is essential, as both function as two-sided markets. Evidence suggests that subsidizing charging station development is more cost-effective than subsidizing EV purchases, particularly among early adopters who tend to be wealthier and less price-sensitive. As the EV market diversifies, policymakers must focus on establishing reliable estimates of network effects to optimize resource allocation and enhance EV uptake.
2. The standardization of charging connectors presents challenges, especially in the U.S. The industry is gravitating toward a dominant connector type, Tesla's NACS, which enhances compatibility but raises concerns regarding federal regulations mandating the use of CCS. Policymakers must strike a balance between fostering uniformity and encouraging competition to ensure consumer choice in an evolving market.
3. The uneven distribution of EV charging stations disproportionately affects low-income and environmental justice communities, exacerbating existing inequities. Addressing these disparities is vital, particularly as EV adoption expands

beyond wealthier neighborhoods. Ongoing collaboration among federal, state, local authorities, and private stakeholders is necessary to ensure equitable access to charging infrastructure, especially in underserved areas.

4. Reliability, load balancing, and grid stability are critical concerns as EV charging infrastructure expands. Strategies to mitigate grid stress during peak charging times include deploying workplace chargers, incentivizing off-peak charging, and promoting innovative charging technologies. Thoughtful planning and consideration of these challenges are essential for sustaining EV adoption and infrastructure growth.

To accelerate the electrification of the transportation sector, it is crucial to evaluate the effectiveness of federal and local initiatives, address areas for improvement, and promote public-private partnerships to develop a reliable and inclusive EV charging network. This review highlights key regulatory insights. First, continued governmental support for EV charging infrastructure through federal fiscal policies and local incentives is essential. Second, beyond incentivizing home charger installation, regulations mandating the expansion of charging stations in new and existing buildings, workplaces, and parking areas are necessary for a more inclusive transition to electric mobility, as the EV consumer demographic broadens. Lastly, strategic initiatives—such as grid expansion, the adoption of digital technologies for smart charging, and the implementation of pricing mechanisms—are pivotal in enhancing the efficiency and effectiveness of the EV charging infrastructure.



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References

International Energy Agency (IEA). 2022. "Global EV Outlook 2022".

Link to the full working paper discussed in this brief:

Knittel, Christopher R. and Tanaka, Shinsuke (2024), "Challenges to Expanding EV Adoption and Policy Responses," [MIT CEEPR Working Paper 2024-16](#), October 2024.

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