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Introduction

Electric vehicles (EVs) are more efficient and have the potential to be substantially less polluting than internal combustion engine vehicles (ICEVs)[1]. As battery costs have rapidly declined, global adoption of EVs has surged, including in Mexico where sales rose 84% from 2023 to 2024.[2] For EVs to have an impact on reducing Mexico's urban air pollution, energy consumption, and greenhouse gas emissions, their market share will need to continue to rapidly increase. A robust and reliable plug-in EV (PEV) charging infrastructure, including access to charging at home and places people travel to, is needed to support the growth of this market.

At the same time, EV charging infrastructure must meet the needs of EV drivers while minimizing the stress on the electricity grid, therefore requiring careful planning. All EV stakeholders, including automakers, electric utilities, EV drivers, employers, housing developers, and charging station manufacturers and service providers, need to communicate and coordinate on the development of charging infrastructure. Policymakers play a central role in ensuring that infrastructure not only meets consumers' needs, but also serves the broader community, is efficient, thoughtfully planned, and minimizes the impact on the electricity grid.

Lessons from Academic Research and Current Policy Practices

This policy brief aims to offers insights on EV charging infrastructure for the Mexican market. The insights are based on literature review of passenger vehicle EV charging infrastructure deployment experiences across the world. In this brief, a *charging point* refers to a device suited for charging a PEV and that only charges one PEV at a time and uses it interchangeably with EV service equipment (EVSE). A *charging station* may provide one or several charging points, and a *charging site* may offer one or more charging stations.

Importance of Charging Infrastructure to Consumer Adoption

A robust accessible, affordable, and reliable charging infrastructure is needed to support widespread adoption of EVs. Hardman et al [3] review studies conducted in North America, Europe, and Asia and found that a lack of charging access is one of the most substantial barriers for PEV purchase. Lack of access to charging stations while at home is one of the most reported barriers, particularly for consumers without access to a private garage or dedicated parking space. In addition to a

[1] This brief uses the term EV to include battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV).
[2] EMAS Asociación. (2025, April). Barómetro 1T 2025. https://emasociacion.org/wp-content/uploads/2025/04/250904-Barometro-1t-2025.pdf
[3] Hardman, S., et al. (2025). Demand-side challenges and research needs on the road to 100% zero-emission vehicle sales. Progress in Energy, 7(2), 022001. https://doi.org/10.1088/2516-1083/ad2c30

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perceived lack of charging, studies found that consumers can be deterred from purchasing PEVs due to the complexity of charging infrastructure, including the large variety of user interfaces, payment and interoperability issues, and difficulty locating public charging stations. Research is also beginning to highlight issues with public infrastructure reliability, which could impact the experiences of PEV buyers and perceptions of perspective PEV buyers which could in turn impact demand.

Need for stakeholder coordination and planning

In a review of studies of US charging infrastructure requirements, Yang et al[4] concluded that to continuously facilitate an EV transition, EV charging infrastructure buildout needs to be planned with a holistic strategy and coordinated actions. This requires policymakers and the industry to have a common understanding of how many EV chargers will be needed and how much investment for EV charging infrastructure is anticipated as adequate. The review found that a well-planned EV charging infrastructure can help reduce EV drivers range anxiety and incentivize EV adoption[4].

Accurately planning for the most appropriate ratio of EVs to charging points can prove challenging due to the varying conditions within individual countries. Insufficient public charging infrastructure (high EV to EVSE ratio) could slow market adoption, while excessive infrastructure could result in an inefficient use of public and private funds. Finding an appropriate balance is important to ensuring optimal utilization and satisfaction among EV users.

Jenn et al.[5] reviewed studies on EV charging needs and found that studies indicated a structural, long-run relationship between number of chargers and EV registrations. However, some studies found that generalizations regarding the necessary charging infrastructure cannot be made across different countries. The population density and the housing conditions vary greatly, and this strongly affects the requirements for public charging infrastructure. However, reaching 100% penetration of EVs will likely require chargers to be broadly deployed beyond single-family residential locations. Slow and fast chargers are needed in cities for those that lack access to home charging. In more densely populated areas with the high degree of multi-unit dwellings, studies have found that residents of these locations have disproportionately lower adoption of EVs.

In California, the California Energy Commission (CEC) is the lead state agency for EV charging infrastructure deployment and works closely with the California Public Utilities Commission, the California Air Resources Board, and the California Department of Food and Agriculture's Division of Measurement Standards. The CEC is mandated by law[6] to produce a biennial report that is a comprehensive estimate of the charging infrastructure needed to meet the state's zero-emission vehicle targets by 2030 and 2035, including light duty vehicles, medium- and heavy-duty trucks, and drayage trucks. Based on forecasting models, the CEC report assesses the need and location of charging ports at the countylevel. This detailed assessment is fundamental for stakeholders to

[4] Yang, H., Fulton, L., & Kendall, A. (2024). A review of charging infrastructure requirements for US electric light-duty vehicles. Renewable and Sustainable Energy Reviews, 200, 114608. https://doi.org/10.1016/j.rser.2024.114608

[5] Jenn, A., Chakraborty, A., Hardman, S., Hoogland, K., Sugihara, C., Tal, G., ... & Refa, N. (2025). Supply-side challenges and research needs on the road to 100% zero-emissions vehicle sales. *Progress in Energy, 7*(2), 022002. https://doi.org/10.1088/2516-1083/ad2c31

[6] California Energy Commission. (2024, February). *Assembly Bill 2127 second electric vehicle charging infrastructure assessment* (CEC-600-2024-003-CMR). https://www.energy.ca.gov/publications/2024/assembly-bill-2127-second-electric-vehicle-charging-infrastructure-assessment

plan and coordinate on EV charging deployment.

Mexico can benefit from adoption of a similar "whole of government" approach to coordinate action among the Federal Electricity Commission (CFE), the Secretariat of Environment and Natural Resources (SEMARNAT), the Ministry of Communication and Transportation of Mexico (SCT) as well as among sub-national governments to jointly plan and design a comprehensive roadmap for the development of charging infrastructure, implementation of smart charging solutions, and integration of EV charging with the national grid. This collaborative approach will be essential to ensuring efficient infrastructure deployment, grid resilience, and the widespread adoption of EVs. A comprehensive 2030 and 2035 EV charging needs assessment based on clear EV deployment targets by segment is an important foundational activity that these agencies should be responsible for conducting.

Importance of prioritization of home charging

According to Hardman et al[7], priority should be given to home charging since it is the most influential charging location in the decision to purchase an EV, is the most used, and is the most cost effective and convenient place to charge. With long dwell time, home charging can be low power (Level 1 or 2) and should be encouraged to occur overnight or during off-peak hours to minimize grid impacts. Countries and densely populated cities without widespread access to home parking can work to ensure charging stations are available for overnight charging with innovative solutions including installing charging in apartment parking lots, publicly accessible chargers in residential areas, and curbside charging. Research also shows that charging access at places of work or frequent destinations can also influence EV purchase.

US based studies reviewed by Yang et al[4] agree that residential charging will remain the backbone of EV charging infrastructure in the country with nearly 95 percent of private charging sessions happening at home and 91% of all chargers being installed at residential locations.

Based on EMA data from 2024, we estimate almost 74% of the charging ports in Mexico are at residential locations, suggesting that home charging is also important to the Mexican EV market at this phase of its development.[8] To potential early adopters that have access to home charging, it will be important for Mexico to ensure that installing EV home infrastructure is as convenient as possible.

Building codes to require new single and multi-family buildings to be pre-wired for EV charging stations is an important, relatively straightforward policy step which Mexico could also potentially consider. For instance, California's Green Building Standards Code requires pre-wiring for EV charger installation in parking spaces at one- and two-family housing units with attached private garages, multi family dwellings, commercial facilities, and public building, thus reducing the cost and a potential barrier to adoption.[9]

[7] Hardman, S., et al. (2018). *Driving the market for plug-in vehicles: Developing charging infrastructure for consumers* [Policy guide]. UC Davis International EV Policy Council. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://publications.lib.chalmers.se/records/fulltext/254344/local_254344.pdf

[8] Electro Movilidad Asociación México. (2025). *Barómetro Primer* Trimestre 2025. https://emasociacion.org/wp-content/uploads/2025/04/250904-Barometro-1t-2025.pdf

[9] U.S. Department of Energy. (n.d.). Electricity laws and incentives in California. Alternative Fuels Data Center. Retrieved April 26, 2025, from https://afdc.energy.gov/fuels/laws/ELEC?state=CA

Importance of Public Charging

According to Hardman et al[10], studies show that experience from other jurisdictions indicates that the need for public charging will likely grow as the adoption rates increase due to later adopters being less likely to have any capacity for home charging, and more PEV drivers taking their vehicles on long distance trips. The need for more public charging infrastructure also increases if there is public policy goal to increase accessibility of EVs to lower income households that tend to live in multi-unit dwellings assuming there is no way to provide home charging access to these households (see Equity Considerations section).

The optimal number of publicly accessible charging stations depends on several factors including average trip lengths, number of battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), average BEV driving range, the number of consumers without their own dedicated charger, access to transit and other travel models, and whether households own conventional vehicles. Additional infrastructure is necessary in regions where a high proportion of PEV owners lack access to a dedicated home charging point.

The ratio of EVs (both BEVs and PHEVs) to publicly available charging stations varies widely among countries with the world average being 11:1.[11] The European Union (EU) in its Alternative Fuel Infrastructure Directive has set a target of 10:1 for its member states.[12] California currently has a ratio of about 9:1 but has a goal of 7.2:1 by 2035.[13]

In Mexico, According to Electro Mobility Association (EMA), as of the first quarter of 2025, there were 3,514 publicly accessible charging ports, with 735 of these being fast chargers. With an estimated 108,739 EVs on the road, Mexico's current EV:EVSE ratio is about 31:1.[14]
As EV adoption rates increase, Mexico will need to expand its public charging infrastructure to serve drivers without access to home charging and those that want to drive longer distances. The Mexico's Federal Electricity Commission (Comisión Federal de Electricidad or CFE) has recently estimated 38,000 EVSEs will be needed by 2041 to support 700,000 EVs, which results in a 18.4:1 ratio.[15] A consulting firm, Roland Berger, estimates 112,000 EVSEs will be needed by 2030.[16]

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[10] Hardman et al (2022). *Potential challenges and research needs in reaching 100% Zero Emission Vehicle Sales – A focus on plug-in electric vehicles*. Institute of Transportation Studies, University of California, Davis. https://escholarship.org/content/qt8dt5b2q6/qt8dt5b2q6_noSplash_434adf63f5ddb0cb4995397338812a71.pdf?t=scur4r

[11] ITS calculation based on data from IEA. International Energy Agency. (n.d.). Global EV Data Explorer. Retrieved April 26, 2025, from https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer

[12] European Parliament and Council of the European Union. (2014, October 22). Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure. Official Journal of the European Union, L 307, 1–20. Retrieved May 8, 2025, from https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014L0094

[13] ITS Davis calculations based on CEC online data. California Energy Commission. (n.d.). Electric vehicle chargers in California. Retrieved April 26, 2025, from https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/electric

[14] ITS calculation based on EMA data Electro Movilidad Asociación México. (2025, April 10). Barómetro de Electromovilidad México: Primer Trimestre 2025. https://emasociacion.org/wp-content/uploads/2025/04/250904-Barometro-1t-2025.pdf

[15] Global Fleet. (n.d.). Mexico EV uptake unveils need for more charging options. Retrieved May 8, 2025, from https://www.globalfleet.com/en/fleet-strategy/latin-america/features/mexico-ev-uptake-unveils-need-more-charging

[16] González, J. (2024, September 8). How many chargers does Mexico need to meet projections? Latam Mobility. https://latamobility.com/en/how-many-chargers-does-mexico-need-to-meet-projections/

Table 1. Estimates of Publicly Available Charging infrastructure by 2040

2040 Scenarios	EV Stock (BEV+PHEV)	CFE Target (18.4:1)	EU Directive (10:1 ratio)	California 2035 Target (7.2:1 ratio)
INECC 2022	861,634	46,774	86,163	119,671
CFE 2022	3,782,438	205,332	378,244	525,339
ITS Davis 2023	8,157,218	442,820	815,722	1,132,947

Table 1 shows the estimated range of public charging ports needed by 2040 based on EV to EVSE charging ratios of 18:1 (CFE ratio), 10:1 (consistent with the EU policy) and 7.2:1 (California's 2035 goal). The first two EV deployment scenarios (INECC and CFE) were adopted from a recent study by Maldonado et al (2024).[17] The fourth scenario, ITS Davis 2023, is based on a recent study by Parés Olguín et al[18] and is consistent with Mexico's current goal of 50% EV sales by 2040 across all segments.

The results show a large range of estimates, ranging from a low of about 47,000 to a high of over 1.1 million publicly available chargers needed by 2040. The very large range highlights the importance for Mexico to narrow the differences between these estimates through more detailed analysis and stakeholder coordination, as recommended in the previous section.

Need for Public Fast Charging

DC fast chargers charge PEVs in the fastest possible time but are considerably more expensive than Level 2 chargers (ten to as high as 100 times more) and therefore should be placed strategically to maximize driver benefit and minimize cost to upgrade the grid. As noted by IEA[19], fast chargers can serve more EVs per day than slow chargers so they can decrease the need for total chargers. Although DCFC can be more expensive and less convenient for EV drivers.

Hardman et al[20] found that costs for DC fast chargers in the US differ between studies, but the body of literature has indicated a wide range of $30,000 on the low end to as high as $150,000 with one study finding costs for corridor charging up to $440,000. According to Hardman et al[20], several studies have also shown that populations of EV drivers place a high value on public fast chargers, particularly in cities and along highways with willingness-to-pay values from drivers as high as $6,500 per additional charger.

According to Hardman et al[7], public and DC fast chargers should be situated at locations where drivers already stop. For example, near rest areas, cafés, restaurants, shopping malls, etc. In addition to being the areas people often visit, these locations correlate with existing grid infrastructure that can support charging, which can lower installation costs. For short-range PEVs (100 miles or less), DC fast charge points

[17] Maldonado, J., Jain, A., & Castellanos, S. (2024). Assessing the impact of electric vehicles in Mexico's electricity sector and supporting policies. Energy Policy, 191, 113068. https://doi.org/10.1016/j.enpol.2024.113068

[18] Parés Olguín, F., Iskakov, G., & Kendall, A. (2023). US-Mexico second-hand electric vehicle trade: Battery circularity and end-of-life policy implications. Transportation Research Part D: Transport and Environment, 125, 103934. https://doi.org/10.1016/j.trd.2023.103934

[19] International Energy Agency. (2024). *Global EV outlook 2024*. International Energy Agency. https://www.iea.org/reports/global-ev-outlook-2024.

[20] Hardman, S., et al. (2024, September). Analyzing the business case & consumer preferences for fast chargers in California. Next 10 & UC Davis Electric Vehicle Research Center.

will be needed mostly at intra-urban locations. For longer range PEVs (200 miles and more), DC fast charge points will also be needed at inter-urban locations. Charge points in public locations and on transportation corridors should be clearly signposted to ensure PEV drivers know where to access them.

Table 2. *Estimates of Publicly Available Fast Charging infrastructure by 2040*

Scenario	EV Stock (BEV+PHEV)	Publicly Accessible Fast Charging Points		
2024	107,633	735		
2040 Scenarios		**Low (6.8 per 1,000 EVs)**	**Mid (10 per 1,000 EVs)**	**High (14:1 per 1,000 EVs)**
INECC 2022	861,634	5,859	8,616	12,063
CFE 2022	3,782,438	25,721	37,824	52,954
ITS Davis 2023	8,157,218	55,469	81,572	114,201

The ratio of publicly available fast charging stations to EVs (both BEVs and PHEVs) varies widely among countries. The world average of about 35 fast chargers to 1,000 EVs is heavily skewed by the very high ratio in China of 55 fast charger per 1,000 EVs (IEA[17]). California currently has a ratio of about 14 fast charger stations per 1,000 EVs[21] and the EU has a ratio of about 10 fast charger stations per 1,000 EVs. The EU's alternative fuels infrastructure regulation (AFIR) requires public fast chargers every 60 km along the European Union's main transport corridors.[22]

As of the end of the first quarter of 2025, Mexico had 735 publicly accessible fast charging stations, resulting in a ratio of 6.8 fast charging station per 1,000 EVs. **Table 2** shows the estimated range of public fast charging ports needed by 2040 based on fast charging ratios of 6.8 (current ratio in Mexico), 10 (current EU ratio), and 14 (current California ratio) fast chargers per 1,000 EVs. Using the four different EV adoption scenarios in Table 1, the results show a very large range of estimates, ranging from a low of about 6,000 to a high of over 113,000 publicly available fast chargers needed by 2040. Again, this very large range highlights the importance for more analysis and coordination with stakeholders.

Standards for Charging Stations

Interoperability, simple payment systems, transparent pricing and reliability are key aspects of a charging station operation to ensure a positive driver experience with publicly accessible charging infrastructure. As noted previously, Hardman et al[3] found that consumers can be deterred from purchasing PEVs due to the complexity of charging infrastructure, including the large variety of user interfaces, payment and interoperability issues, and difficulty locating public charging stations. Consequently, jurisdictions have adopted charging station standards to ensure EV drivers have access to convenient and reliable network charging systems.

[21] ITS Davis calculations based on CEC online data. California Energy Commission. (n.d.). Electric vehicle chargers in California. Retrieved April 26, 2025, from https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/electric

[22] European Parliament and Council of the European Union. (2023, September 13). Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU. Official Journal of the European Union, L 234, 1–47. https://eur-lex.europa.eu/eli/reg/2023/1804/oj

In the US, the federal NEVI grant program requires qualifying stations to meet several requirements designed to enhance interoperability and reliability. Stations must have at least one CCS2/J1772 charging port (NACS ports are allowed). Since this rule was implemented, all automakers have announced they are transitioning to NACS charging ports for all EVs, which may result in CCS chargers being redundant or charging providers retrofitting CCS statins to NCAS. For payments, stations must provide secure payment methods which at minimum is a contactless payment system that accepts major debit and credit cards. There are also requirements for charger-to-EV communication, charger-to-charger network communication, and charging network-to-charging network communication to ensure that chargers are capable of the communication necessary to perform smart charge management. There are also network connectivity requirements for charger-to-charger network communication, charging network-to-charging network communication, and charging network-to-grid communication. To ensure reliability, NEVI requires a charging port to have an annual uptime greater than 97%.[23]

In the EU, the Alternative Fuels Infrastructure Regulations (AFIR)s have similar requirements that encompass pricing, payment, billing, interoperability, and third-party data sharing.[24] Regulations in the UK relating to payments and reliability also aim to improve customer experience.[25]

Universal interoperability requires any EV to charge at any EV charging station, which is currently not the case in Mexico or the US. There are three major types of connectors in Mexico: NACS/J3400, CSS1/J17782, and GB/T. Of the 3,321 publicly accessible charging ports in Mexico, 40% are NACS, 50% are CSS1, and 10% are GB/T.[26] Up until 2025, the NACS standard was used exclusively by Tesla. The GB/T standard is used by the Chinese manufacturers. As noted by Hardman et al[3], the landscape of charging infrastructure in North America is rapidly evolving, especially with recent developments pointing to a transition towards the North American Charging Standard (NACS)—traditionally a standard only being used by Tesla but now officially adopted as the SAE J3400 standards. Since the beginning of 2023, all automakers have announced their intentions to migrate away from the Combined Charging Standard (CCS) for their vehicles to NACS beginning with 2025 model year vehicles. Adapters for the competing CCS1 charging ports to use NACs station are readily available in the marketplace. In the first quarter of 2025, CCS1 posts accounted for 59% of new ports, NACS ports accounted for 31%, highlighting the transition to NACS is still in its initial stages in the US.[27]

On September 10, 2024, Mexico's Energy Regulatory Commission (CRE) published the first regulations for charging infrastructure.[28] The

[23] Federal Highway Administration. (2023, February 28). National Electric Vehicle Infrastructure standards and requirements. Federal Register, 88(39), 12724–12757. https://www.govinfo.gov/content/pkg/FR-2023-02-28/pdf/2023-03500.pdf

[24] AFIR European Parliament & Council of the European Union. (2023, September 13). Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU. Official Journal of the European Union, L 234, 1–47. https://eur-lex.europa.eu/eli/reg/2023/1804/oj

[25] Department for Transport. (2023). *The Public Charge Point Regulations 2023* (UKDsi 2023/9780348249873). https://www.legislation.gov.uk/ukdsi/2023/9780348249873

[26] Electro Movilidad Asociación México. (2025, abril 10). Barómetro de Electromovilidad México: Primer Trimestre 2025. https://emasociacion.org/wp-content/uploads/2025/04/250904-Barometro-1t-2025.pdf

[27] Paren. (2025, April 22). State of the industry report: U.S. EV fast charging — Q1 2025. https://www.paren.app/reports/state-of-the-industry-report-us-ev-fast-charging-q1-2025

[28] Comisión Reguladora de Energía. (2024, 10 de septiembre). Acuerdo por el que la Comisión Reguladora de Energía expide las Disposiciones Administrativas de Carácter General en materia de infraestructura de recarga para vehículos eléctricos. Diario Oficial de la Federación. https://dof.gob.mx/nota_detalle.php?codigo=5738646&fecha=10/09/2024#gsc.tab=0

regulation does not require a specific connector standard or that multiple connector types be installed. It includes a measure requiring charging service providers to clearly display the energy cost. In addition, the Energy Regulatory Commission (CRE) is tasked with developing the Electromobility Platform within 24 months of the regulation's enactment. The digital platform will collect updated data on installed charging infrastructure across the country, including details on charging points' characteristics and availability. It will also display information such as charging modes and electricity pricing.

In its next phase of charging station regulations, Mexico should adopt additional requirements to improve the customer experience and to "future proof" its network. These requirements include standards on payment, communication protocols, reliability and connector standards, potentially based on the US NEVI and EU AFIR regulations.

Charging Management and Grid Readiness

IEA[17] recommends deployment of EV chargers should be coordinated with power grid developments to ensure that new connections are consistent with the wider grid-planning horizon. When not managed appropriately, charging can lead to a surge in peak demand, meaning that it is increasingly important to ensure that transmission and distribution grids are appropriately sized and equipped. Strategies to manage charging, such as through time-of-use (TOU) tariffs and smart charging will become more necessary as EV deployment grows. The most effective charging regime would combine TOU rates with a system that allows drivers to enter a charging completion time. Utilities should provide TOU tariffs with the off-peak period beginning over a range of times.

Smart charging involves managing PEV charging based on real-time electricity supply and electricity demand. Smart charging may not be needed during the early PEV market stage. A long-term strategy would be to future proof the charging network by ensuring that all chargers are smart chargers or they can be converted into smart chargers. This will mean that the infrastructure will be able to better manage stresses on the grid as EV charging load grows.

More opportunities for PEV drivers to charge can help with controlling when charging occurs. Having access to home, work, and public charging increases the spatial and temporal distribution of charging events. This availability of charging points reduces the number of peaking events and reduces strain on local grids.

Well managed EV charging can be a grid asset and create downward pressure on all rate payers by increasing the utilization rate of the grids fixed assets. EV managed charging can also lower the cost of integrating renewable electricity into the grid by matching EV charging with solar or wind production.

Adopting smart charging programs can significantly reduce stress on the grid by reducing electricity demand at peak hours. Li and Jenn[29] found that for the California grid, while the distribution system across California must upgrade its capacity by 25 GW by 2045, corresponding to a cost between $6 and $20 billion, this additional infrastructure cost is more than offset by the downward pressure from the growth of total electricity consumption if the charging is well managed and occurs predominately off peak. Li and Jenn[29] also found that the revenue from the additional off-peak load leads to a reduction in electricity rate between $0.01 and $0.06/kWh by 2045. Mexico has a similar opportunity. In a study of the Mexican electricity system, Maldonado et al[17] found substantial

[29] Li, Y., & Jenn, A. (2023). Impact of electric vehicle charging demand on power distribution grid congestion. *Proceedings of the National Academy of Sciences, 121*(18). https://doi.org/10.1073/pnas.2022337119 (if applicable)

opportunity for EV smart charging to reduce peak load stress on the grid by up to 4.4 GW by 2040.

In California, the CPUC has six main responsibilities to ensure the grid is ready, charging impacts are minimized, and opportunities are captured for EV charging to become a grid asset: electric rates and cost of fueling; timely energization of EV charging infrastructure; proactive planning of grid infrastructure to support transportation electrification; vehicle-grid integration (VGI) policy, pilots, and technology enablement; strategic planning for charging infrastructure deployment and incentives; and program evaluation and interagency coordination.[30]

To minimize stress on the grid and maximize the benefits of EV charging as a grid asset, Mexico's CFE should adopt a similar approach as California, particularly on proactive long-term planning, programs to manage EV charging starting with TOU tariffs, requiring charging stations to be connected and controllable (smart chargers), and adopt charging programs at the utility level.

Financing

The stand-alone private business case for public charging infrastructure is challenging. LaMonaca and Ryan[31] found public funding is needed to support the deployment of charging infrastructure to overcome high installation and maintenance costs. Hardman et al[20] found that the stand-alone business model for fast charging is very challenging and that the revenues from selling electricity alone are insufficient to be able to pay back the capital and operating costs over a three-year period (the typical rate of return for private investment). Yang et al[4] found that high upfront investment costs are a challenge for charging infrastructure.

In the US, the Bipartisan Infrastructure and Jobs Act appropriated $10 billion for charging infrastructure. In Germany, a subsidy of €800 million is provided for each private charging station, including installation costs. Other developed markets are also expanding support for EVSE while reducing funding for vehicle incentives. The United Kingdom has ended subsidies for private cars but maintained incentive for private and public charging installations. Korea has reduced the value of its EV subsidy while committing funding to EVSEs (IEA[17]).

According to Yang et al[4], the significant investment needs for the charging infrastructure and the EV transition provide tremendous opportunities for creative ways to reduce investment costs and build the charging infrastructure efficiently, especially if partnerships and better data are pursued. Reviewed studies by Yang et al[4] agree that there is a lack of understanding and accessibility to adequate data related to charging infrastructure. This makes it challenging for researchers to model the actual charging need, for government and industry to allocate adequate funding or investment, for practitioners to reduce potential soft costs efficiently, and for policymakers to improve the accuracy, transparency, and credibility of the policy-making process. One possibility is to tie infrastructure incentives to data reporting through a third party.

Hoover et al. (2021) also stressed the importance of monitoring and integrating EV-charging forecasts with grid-expansion plans. They found that hidden costs (e.g., power distribution, software, and services) of chargers can represent 50 percent to 75 percent of the

[30] California Public Utilities Commission. (n.d.). *Transportation electrification*. Retrieved April 26, 2025, from https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification

[31] LaMonaca, F., & Ryan, L. (2022). The state of play in electric vehicle charging services – A review of infrastructure provision, players, and policies. *Renewable and Sustainable Energy Reviews, 154*, 111733. https://doi.org/10.1016/j.rser.2021.111733

upfront investment, depending on the type of charger. Of the total upfront investment, grid updates may reach 50 percent for home AC chargers and 30 percent for public chargers, which can be reduced significantly if the charging infrastructure buildout is coordinated and managed well with the grid.

To continue to expand its charging network, California offers substantial incentives to cover the cost of installing public charging infrastructure, up to $100,000 for a fast charging station.[32] The state has provided about $318 million in rebates to install over 82,567 level 2 and DC fast charging ports. The average cost is $69,288 for a DC charging port and $13,279 per level 2 port.[33]

To get an approximation of the scale of investments that Mexico will need by 2040, we use the range of estimates for Level 2 and fast charging ports from Table 1 and 2 and apply the same average costs from the CALeVIP program. The result is US$1.0 billion to US$22.7 billion in total investments needed by 2040 (both private and public). Given the evidence that the standalone private business model for large scale deployment of a public charging station network is challenging, Mexico should assess the need for public and private funds that will be required to support its EV deployment targets.

Equity Considerations

According to Hardman et al[10], studies have found that disadvantaged communities, underserved communities, and communities of color have fewer public charging stations and fewer home types associated with home-charging access. California's CALeVIP program requires 50% of the overall funding to be used for charging stations in low-income and disadvantaged communities.[34]

In addition, Hardman et al[10] notes that charging in public locations can be more expensive than home charging, which may mean PEVs deliver less financial benefit to those without home charging access. For the PEV market to include more renters living in apartments, more efforts may be needed to increase lower-cost charging access for consumers without access to at-home charging.

To address the equity challenges of accessibility and affordability, Mexico will need to focus specifically on the needs of low income and apartment dwellers to understand what types of charging may best serve them.

Policy Implications

Consumer EV adoption is growing rapidly in Mexico. To sustain strong sales growth, Mexico needs a comprehensive, coordinated charging infrastructure plan to support and guide the necessary investments in a cost-effective infrastructure system that is accessible by all, reliable, and affordable.

As shown in this brief, there is a wide range of estimates of the number of public charging stations needed, with the largest being lack of clear, national goal by market segment for EV sales. A high priority therefore is for Mexico to adopt a clear and binding target for EV sales to provide the regulatory certainty necessary for long-term planning and investments by key stakeholders, including government incentives at the national and subnational level, proactive grid planning by CFE, and private investment decisions by charging companies.

[32] California Energy Commission. (n.d.). *California Electric Vehicle Infrastructure Project (CALeVIP) 2.0*. California Energy Commission. Retrieved May 7, 2025, from https://www.energy.ca.gov/programs-and-topics/programs/california-electric-vehicle-infrastructure-project-calevip-20

[33] Center for Sustainable Energy. (n.d.). *CALeVIP rebate statistics dashboard*. Retrieved April 26, 2025, from https://calevip.org/rebate-statistics

[34] CALeVIP. (n.d.). About CALeVIP. Retrieved April 26, 2025, from https://calevip.org/about-calevip#:~:text=CALeVIP%202.0,disadvantaged%20communities%20%E2%80%93%20to%20focus%20on

Other key recommendations are as below:

- Consider home charging or charging at frequent trip locations (work, school, etc.) as the foundation of a charging network.
- Adopt a "whole of government" approach (similar to California) to coordinate action among sub-national governments, the Secretariat of Environment and Natural Resources (SEMARNAT), the Ministry of Communication and Transportation of Mexico (SCT), and the Federal Electricity Commission (CFE) to jointly plan and design a comprehensive roadmap for the development of charging infrastructure, implementation of smart charging solutions, and integration of EV charging with the national grid.
- Prioritize home charging or charging at frequent trip locations (work, school, etc.) as much as possible, while also developing a clear target for installation of public charging stations (numbers, types, locations) based on a more refined long-term EV stock forecast and the best modeling tools possible.
- In its next phase of charging station regulations, adopt additional requirements to improve the customer experience and to "future proof" Mexico's network. These requirements include standards on payment, communication protocols, reliability and connector standards, potentially based on the US NEVI and EU AFIR regulations.
- To minimize stress on the grid and maximize the benefits of EV charging as a grid asset, adopt similar approach as California, particularly on proactive long-term planning, programs to manage EV charging starting with TOU tariffs, requiring charging stations to be connected and controllable (smart chargers), and adopt manage charging programs at the utility level.
- Given the evidence that the standalone private business model for large scale deployment of a public charging station network is challenging, assess the need for public and private funds that will be required to support its EV deployment targets.
- Encourage EV charging providers to pursue public charging business models that are profitable, like a gas station model where most profits come from the convenience store.
- To address the equity challenges of accessibility and affordability, focus specifically on the needs of low income and apartment dwellers to understand what types of charging may best serve them

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