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Charging Ahead: Policy Frameworks and Infrastructure for EVs in India

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Abstract

India is undergoing a significant transformation in its transportation sector as it accelerates the shift toward electric mobility. This transition is being driven by a combination of national and international imperatives - ranging from commitments to reduce greenhouse gas emissions under the Paris Agreement to the urgent need for energy security and urban air quality improvement. As the automotive industry evolves to meet these demands, the development of a comprehensive electric vehicle (EV) charging infrastructure has emerged as a critical enabler for widespread EV adoption. This chapter provides an in-depth analysis of India's EV charging infrastructure landscape and the policy frameworks supporting it. It outlines the growth trajectory of public and private charging stations across the country, examines the impact of key national policies such as FAME II and the PM e-DRIVE initiative, and evaluates the role of the private sector in expanding access and innovation. The chapter also presents a comparative analysis of India's progress relative to global benchmarks, identifying areas of strength and gaps to be addressed. Finally, it discusses the major challenges confronting infrastructure development - including financial constraints, grid capacity, and urban-rural disparities - and explores future pathways and strategic recommendations for India to emerge as a global leader in clean and sustainable mobility.

Keywords: Electric Vehicles (EVs), Charging Infrastructure, EV Policy Frameworks, Sustainable Mobility, India Energy Transition.

Introduction

India stands at a critical juncture in its pursuit of sustainable development, with the transportation sector playing a pivotal role in shaping the country's environmental and energy future. As the third-largest emitter of carbon dioxide globally, India faces immense pressure to curb emissions while maintaining economic growth and improving mobility access for a rapidly urbanizing population. The transport sector alone contributes nearly 10% of the nation's total

greenhouse gas (GHG) emissions, primarily from fossil fuel-driven vehicles. In this context, transitioning to cleaner and more sustainable modes of transportation has become an urgent priority.

Electric vehicles (EVs) have emerged as a cornerstone of India's green mobility agenda. Their adoption promises significant reductions in emissions, enhanced energy security through reduced dependence on imported oil, and the promotion of domestic innovation in clean technologies. However, the success of EVs is intrinsically linked to the development of supporting infrastructure—particularly a reliable and widespread EV charging network. Without such infrastructure, consumer confidence remains low, and the scalability of EV deployment is severely constrained.

Recognizing these challenges, the Indian government has launched a series of policy initiatives and incentive schemes aimed at fostering EV adoption and expanding charging infrastructure. Simultaneously, private sector participation has increased, driving technological advancements and new business models.

This chapter provides a comprehensive examination of India's electric vehicle infrastructure landscape. It begins by assessing the current status of charging networks, followed by a detailed exploration of national policy frameworks and key government initiatives. The chapter also highlights major private sector contributions, compares India's progress with global leaders in EV adoption, and critically evaluates the challenges that must be addressed to realize a sustainable EV ecosystem. The chapter concludes with strategic recommendations and future pathways for strengthening India's EV infrastructure and positioning the country as a global frontrunner in clean transportation.

The Current Landscape of EV Charging Infrastructure in India

India's electric vehicle (EV) ecosystem has witnessed substantial growth in recent years, particularly in the domain of public charging infrastructure. As of December 2024, the country had more than 25,200 public charging stations (PCSs) - a remarkable increase from around 12,000 in early 2024. This doubling in capacity over the course of a single year reflects India's increasing commitment to electrified mobility, bolstered by strategic policy support and growing investment from the private sector.

The exponential rise in the number of public charging stations is not merely a quantitative expansion, but also a qualitative step toward ensuring that electric mobility becomes a viable and convenient option for consumers across vehicle segments. This infrastructure boom is being guided by government schemes such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) and the more recent PM e-DRIVE initiative, which target both demand stimulation and supply-side capacity building.

However, despite this progress, the distribution of these charging facilities remains uneven, with a clear concentration in urban centers and along major national and state highways. This spatial imbalance poses significant challenges for inclusive adoption, particularly in semi-urban and rural areas that lack access to reliable charging options.

Growth and Distribution

The state-wise distribution of public charging stations underscores the uneven geographical development of EV infrastructure across India. As shown in Table 1, Karnataka leads with over 5,700 public charging stations, followed by Maharashtra and Uttar Pradesh.

Table 1: State-wise Distribution of Public Charging Stations (Dec 2024)

State	Public Charging Stations
Karnataka	5,765
Maharashtra	3,728
Uttar Pradesh	1,989
Delhi	1,941
Tamil Nadu	1,413
Kerala	1,212
Rajasthan	1,129
Other States	7,025
Total	25,202

Source: Ministry of Heavy Industries, Government of India (2024)

Karnataka's leadership position can be attributed to proactive state-level policies, robust tech and start-up ecosystems in cities like Bengaluru, and significant private investment. Maharashtra and Delhi have similarly benefitted from early regulatory initiatives and strong public-private partnerships.

However, this distribution also reveals the regional disparity in EV readiness. Several North-Eastern and central Indian states continue to lag behind due to infrastructure constraints, lack of investment, and logistical challenges. This creates a two-speed EV ecosystem where urban dwellers enjoy greater access to electric mobility, while rural users remain excluded from the clean transport transition.

In addition, most of the PCS infrastructure is located in metro cities or along high-traffic corridors, which facilitates intra-city usage but limits the feasibility of long-distance or intercity travel. This, in turn, may hinder the uptake of EVs in logistics and commercial sectors, where range and accessibility are crucial.

Types of Chargers

The nature of EV charging infrastructure in India is heavily skewed toward AC slow chargers. According to the Indian Energy Storage Alliance (IESA), as of late 2024, approximately **85%** of the installed chargers are **AC Level 1 or Level 2 slow chargers**, which are best suited for two- and three-wheelers, and for overnight residential or fleet charging. These are cost-effective and easier to deploy but are not ideal for high-utilization scenarios or users who need quick turnaround times.

The remaining **15%** are **DC fast chargers**, which are primarily installed in highway corridors, public commercial parking zones, and high-traffic urban locations. These are critical for four-wheelers, electric buses, and other commercial EVs that require rapid charging within 30 to 90 minutes. However, DC fast chargers are more expensive to install and maintain due to higher energy loads and infrastructure requirements.

The imbalance in charger types also mirrors the composition of India's EV market. As of 2024, the bulk of EV sales are in the two-wheeler (over 55%) and three-wheeler (around

30%) segments, where charging needs are more easily met by slower, decentralized systems. However, as the market gradually shifts toward private and commercial four-wheelers, there will be a growing need to deploy more DC fast charging stations across both urban and rural areas.

In addition, battery swapping stations - though still in the pilot and early adoption phase - represent an innovative solution to circumvent the limitations of both AC and DC charging, especially for fleet-based operations and high-frequency users.

Charging Infrastructure Manufacturers

Companies that manufacture and sell EV charging equipment play a vital role in developing the charging infrastructure. They can provide standalone charging solutions for home, workplace, or public charging, or partner with vehicle manufacturers to offer charging hardware as part of the vehicle package. Some of the major charging infrastructure manufacturers include:

- Delta Electronics: Known for their high-quality charging solutions, Delta Electronics offers a range of EV charging products, including AC and DC chargers.
- Mass Tech: Mass Tech provides innovative charging solutions, including fast chargers and battery swapping technology.
- ABB India: ABB India offers a range of EV charging solutions, including high-power DC chargers and smart charging systems.
- Exicom: Exicom is a leading provider of EV charging solutions in India, offering a range of products, including AC and DC chargers.
- Okaya: Okaya is a well-known brand in the EV charging industry, offering a range of charging solutions, including AC and DC chargers.
- RRT: RRT provides innovative EV charging solutions, including high-power DC chargers and smart charging systems.

These companies provide complete charging point solutions, including hardware and software installation, maintenance, and additional support services.

Charging Point Operators

Charging Point Operators (CPOs) generate revenue by operating a network of chargers and providing services such as electric vehicle charging, customer support, and network solutions. They can choose from various pricing mechanisms, including:

- Time-based fees: Charging users based on the time spent charging their vehicles.
- Energy-based fees: Charging users based on the amount of energy consumed.
- Fixed fees: Charging users a fixed fee for charging services.
- Membership fees: Charging users a recurring fee for access to charging services.

The Ministry of Power has stated that EV charging is a "service," which means that CPOs do not require licensing under the Electricity Act 2003. Some of the companies working as CPOs include:

- **EESL:** EESL is a government-owned company that provides EV charging solutions, including public charging stations and home chargers.
- **Tata Power:** Tata Power is a leading provider of EV charging solutions, offering a range of charging services, including public charging stations and home chargers.
- **Magenta Group:** Magenta Group is a private company that provides EV charging solutions, including public charging stations and home chargers.
- **Fortum India:** Fortum India is a leading provider of EV charging solutions, offering a range of charging services, including public charging stations and home chargers.
- **Volttic:** Volttic is a private company that provides EV charging solutions, including public charging stations and home chargers.
- **Charge Zone:** Charge Zone is a private company that provides EV charging solutions, including public charging stations and home chargers.

Traction Battery: A Key Component of EVs

Batteries contribute significantly to the overall cost of EVs, making up around 40% of the total cost. Businesses that deliver value in terms of reducing the overall cost of EVs can play a huge role in promoting their adoption. Some potential services and processes related to batteries include:

- **Battery Recycling:** Recycling can reduce the negative environmental impact of battery disposal and help reduce the overall cost of batteries. Companies like Gravita India are working actively in sustainable battery recycling.
- **Battery Subscription:** Battery subscription services can provide customers with reduced upfront costs and address concerns about battery durability. Companies like Sun Mobility offer pay-as-you-go models, where users pay for battery usage on a daily or per kilometer basis.
- **Battery-as-a-Service (BaaS):** BaaS models involve leasing batteries to end-users, such as vehicle owners or energy storage projects. The BaaS service provider can refurbish or recycle batteries at the end of their life, reducing waste and maximizing asset utilization. Companies like NIO, Sun Mobility, and Esmite are already exploring BaaS models in India.

National Policy Frameworks for EV Infrastructure

India has been actively promoting the adoption of electric vehicles (EVs) through various policy frameworks and initiatives. The government's focus on developing a robust EV ecosystem has led to the implementation of several schemes and programs.

FAME India Scheme

The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME) scheme has been a cornerstone of India's EV strategy. Launched in 2015, FAME aimed to provide demand incentives, develop technology platforms, and support charging infrastructure. The scheme has undergone two phases:

- **FAME I (2015-2019):** Laid the groundwork with a budget of INR 895 crore. The scheme provided incentives for the adoption of hybrid and electric vehicles, with a

focus on two-wheelers and three-wheelers. FAME I also supported the development of charging infrastructure, including the installation of public charging stations.

- **FAME II (2019-March 2025):** Significantly scaled up the initiative with a budget of INR 10,000 crore, including INR 1,000 crore for charging infrastructure. FAME II expanded the scope of the scheme to include buses and four-wheelers, in addition to two-wheelers and three-wheelers. The scheme also emphasized the importance of developing a robust charging infrastructure to support the growing number of EVs on the road.

PM e-DRIVE Program

Launched in 2024, the PM e-DRIVE scheme allocated INR 10,900 crore for accelerating EV adoption, of which INR 2,000 crore is earmarked for setting up over 72,000 public charging stations across cities and highways. The scheme aims to promote the adoption of EVs in the public transportation sector, including buses and three-wheelers. The PM e-DRIVE program also focuses on developing a network of charging infrastructure to support the growing number of EVs on the road.

Ministry of Power Guidelines

To support uniformity and safety, the Ministry of Power issued revised guidelines in 2022 and 2023 that:

- **Standardize tariffs for EV charging:** The guidelines aim to ensure that EV charging tariffs are consistent across different charging stations and operators. This will help to promote transparency and predictability for EV owners.
- **Simplify land and electricity access for developers:** The guidelines aim to reduce the bureaucratic hurdles faced by developers in setting up charging infrastructure. This will help to accelerate the development of charging infrastructure across the country.
- **Enable interoperability across networks:** The guidelines aim to ensure that different charging networks can interoperate seamlessly, allowing EV owners to charge their vehicles at any charging station.

Private Sector Initiatives

Private companies have stepped up to complement public efforts in building the EV ecosystem. Some notable initiatives include:

- **Tata Motors:** Has committed to expanding its charging network to 400,000 points by 2027, including 500 “Mega Charger” locations for commercial vehicles. Tata Motors is also investing in battery swapping technology to support the adoption of EVs.
- **Maruti Suzuki:** Plans to install over 1,500 EV chargers at service stations and partner with utilities for home charger installation. Maruti Suzuki is also promoting the adoption of EVs through its dealership network.
- **Hyundai:** Aims to install 600 fast-charging stations nationwide by 2031. Hyundai is also investing in research and development to improve the efficiency and range of its EVs.

- **Other startups and aggregators:** Companies such as Ather Energy, BluSmart, and Statiq are innovating in battery swapping, mobile charging vans, and app-based location services. These start-ups are playing a crucial role in developing a robust EV ecosystem in India.

Challenges in Infrastructure Development

Despite the progress made in developing EV infrastructure, there are several challenges that need to be addressed. Some of the key challenges include:

- **Urban-Rural Disparity**

Charging stations are heavily concentrated in metro cities, leaving vast rural and tier-2/3 regions without access. This limits the viability of EVs for broader demographics. The lack of charging infrastructure in rural areas is a significant barrier to the adoption of EVs, particularly for those who rely on vehicles for transportation.

- **Capital-Intensive Nature**

Setting up charging infrastructure requires significant investment in land, electricity upgrades, and equipment. According to the Indian Energy Storage Alliance (IESA), India needs an estimated USD 30 billion to build the necessary infrastructure for its 2030 EV goals. The high upfront costs associated with setting up charging infrastructure are a significant challenge for companies looking to invest in the EV sector.

- **Electricity Grid Constraints**

India's current power grid is ill-equipped to handle large-scale EV integration without modernization. Voltage fluctuations, peak load issues, and lack of smart grid management pose risks. The grid constraints can lead to reliability issues, which can further discourage the adoption of EVs.

- **Consumer Awareness and Reliability**

Concerns around charging speed, accessibility, and lack of real-time information discourage EV adoption. While apps are being developed to address this, public awareness remains low. Many consumers are still unaware of the benefits of EVs, and the lack of transparency around charging infrastructure can make it difficult for them to make informed decisions.

Global Benchmarking

India can learn from the experiences of other countries that have successfully developed their EV infrastructure. Some key takeaways include:

Infrastructure Density and Deployment

Global Comparison of Public Charging Infrastructure (2024)

Country	Charging Stations	EVs per Station
China	1,200,000+	7
United States	160,000+	18
Netherlands	100,000+	5
India	25,202	113

Source: www.iea.org/reports/global-ev-outlook-2024

India lags behind significantly in the ratio of EVs to chargers, which affects consumer confidence. The lack of charging infrastructure in India is a significant barrier to the adoption of EVs, and the government needs to take steps to address this issue.

- **Innovations and Policy Lessons**

Countries like Norway offer valuable lessons in public-private synergy, while China leads in battery technology and fast-charging infrastructure. The Netherlands' model of decentralized and accessible charging, powered by renewable sources, can guide India's strategy. India can learn from the experiences of these countries and develop its own unique approach to promoting EV adoption.

Future Prospects and Strategic Recommendations

To sustain and accelerate the growth of the EV sector, India needs to address the infrastructural bottlenecks and develop a coordinated national strategy. Some key recommendations:

- **Integrated Planning**

Urban planning must integrate EV ready infrastructure, including mandatory EV provisions in new real estate and public buildings. This will ensure that new developments are equipped with the necessary infrastructure to support EVs.

- **Renewable Energy Integration**

Solar-powered EV charging stations and vehicle-to-grid (V2G) systems can reduce grid stress and emissions. India should prioritize the development of renewable energy sources to power its EV infrastructure.

- **Financing and Incentives**

Blended finance models involving government, private capital, and international climate funds can unlock the required investments. The government needs to provide incentives and financing options to encourage private investment in the EV sector.

- **Technological Advancements**

Battery swapping, mobile charging, and AI-powered demand prediction tools can address range anxiety and infrastructure optimization. India should prioritize the development and adoption of these technologies to support the growth of the EV sector.

Conclusion

The expansion of EV charging infrastructure, driven by a mix of public policy support and private sector innovation, reflects the country's commitment to sustainable mobility. Schemes like FAME and PM e-DRIVE have laid foundational steps, while states like Karnataka have emerged as leaders in infrastructure deployment. However, the landscape remains uneven, with rural and underdeveloped regions still lacking access to adequate charging facilities. The dominance of slow AC chargers underscores the early stage of infrastructure evolution, necessitating a strategic pivot toward more fast-charging options and innovative solutions like battery swapping. Manufacturers and charging point operators are playing critical roles in scaling up the network, yet face capital, technological, and logistical hurdles. Additionally, consumer concerns regarding reliability, cost, and accessibility continue to hinder widespread EV adoption. Looking ahead, India's success in creating a robust EV

ecosystem will depend on integrated urban planning, enhanced grid capabilities, increased reliance on renewable energy, and financial models that de-risk investment in charging networks. Technological advancements must be leveraged to address range anxiety and optimize resource utilization. Ultimately, India's ability to position itself as a global leader in clean transportation will hinge on closing the urban-rural divide, fostering public-private collaboration, and sustaining momentum through adaptive policies and inclusive growth strategies.

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