# The Net-Zero Transition Starts at Home

## Enabling EV-Ready Residences in India


June 2026

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Enabling EV-Ready Residences in India

Jointly prepared by: Alliance for an Energy Efficient Economy (AEEE) and Kazam.

**About AEEE**

Alliance for an Energy Efficient Economy (AEEE) is India's leading policy support and implementation organisation and an enabler of the energy efficiency market with a not-for-profit motive. AEEE promotes energy efficiency as a resource and collaborates with government and industry to transform the market for energy-efficient products and services, thereby contributing to meeting India's energy security goals, clean energy, and climate change. With a vision to "catalyse the responsible use of energy for a climate-resilient and energy-secure future," AEEE works across the ecosystem, building a culture where efficiency becomes the default, powering India's transition to Atmanirbhar and Viksit Bharat. Discover more through our flagship initiatives such as the India Cooling Action Plan, Solar Decathlon India, State Energy Efficiency Index, and G20 energy efficiency support, featured at www.aeee.in.

**About Kazam**

Kazam is a clean energy ecosystem enabler building end-to-end physical and digital infrastructure for electric mobility and grid-connected energy systems. The company operates across the full EV charging stack - from AC and DC charging hardware to intelligent software platforms - that connect EV users, charging assets and electricity networks. Kazam's ecosystem spans residential charging, public charging, fleet charging, and depot infrastructure, enabling EV adoption across two-wheelers, three-wheelers, passenger vehicles, commercial fleets and buses. Its charging network and software platforms support charger management, energy optimization, remote monitoring, interoperability, and user engagement across diverse charging environments. With one of India's largest residential EV charging deployment footprints spanning over 10,000 pin codes, Kazam's on-ground experience provides unique operational insights into how EV charging interacts with homes, buildings, users, and electricity infrastructure across diverse Indian conditions.

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| | |
|---|---|
| **AC** | Alternating Current |
| **BIS** | Bureau of Indian Standards |
| **BLE** | Bluetooth Low Energy |
| **CEA** | Central Electricity Authority |
| **CoS** | Conditions of Supply |
| **CSMS** | Charging Station Management System |
| **DC** | Direct Current |
| **DISCOM** | Distribution Companies |
| **E-2W** | Electric Two-Wheelers |
| **E-3W** | Electric Three-Wheelers |
| **EMC** | Electromagnetic Compatibility |
| **ERP** | Enterprise Resource Planning |
| **EV** | Electric Vehicle |
| **EVCI** | Electric Vehicle Charging Infrastructure |
| **EVSE** | Electric Vehicle Supply Equipment |
| **FAME** | Faster Adoption and Manufacturing of Electric Vehicles |
| **FAR** | Floor Area Ratio |
| **ICE** | Internal Combustion Engines |
| **IoT** | Internet of Things |
| **ITI** | Industrial Training Institutes |
| **KERC** | Karnataka Electricity Regulatory Commission |
| **LED** | Light-Emitting Diode |
| **LEV** | Light Electric Vehicle |
| **MBBL** | Model Building Byelaws |
| **MEDA** | Maharashtra Energy Development Agency |
| **MHI** | Ministry of Heavy Industries |
| **MoHUA** | Ministry of Housing and Urban Affairs |
| **MoP** | Ministry of Power |
| **MSBTE** | Maharashtra State Board of Technical Education |
| **N-E** | Neutral-to-Earth |
| **NOC** | No Objection Certificate |
| **NSQF** | National Skills Qualifications Framework |
| **PC-ABS** | Polycarbonate-Acrylonitrile Butadiene Styrene |
| **PCS** | Public Charging Stations |
| **PM E-DRIVE** | Prime Minister's Electric Drive Revolution in Innovative Vehicle Enhancement |
| **PMAY-U** | Pradhan Mantri Awas Yojana-Urban |
| **PPP** | Public-Private Partnerships |
| **RCD** | Residual Current Devices |
| **RWA** | Resident Welfare Associations |
| **SOP** | Standard Operating Procedure |
| **ToD** | Time-of-Day |
| **ULB** | Urban Local Body |
| **V2G** | Vehicle to Grid |
| **VPP** | Virtual Power Plants |

# EXECUTIVE SUMMARY

India's electric mobility transition has gained significant momentum over the past decade, yet it faces a structural challenge at the very heart of everyday EV use: the ability to charge at home. EV sales have grown from 0.5 lakh in 2016 to more than 23 lakh in 2025, with two-wheelers and three-wheelers together accounting for approximately 91% of total EV sales. Accelerating the transition requires urgent attention to a largely invisible barrier: the readiness of homes to safely, reliably, and affordably support EV charging.

Global evidence consistently shows that 80% of EV charging takes place at homes or workplaces. In India, this pattern is reinforced by the dominance of light electric vehicles, whose low-power AC charging requirements are best met through residential connections. As a result, homes and residential buildings are increasingly becoming a critical part of the country's mobility infrastructure. EV-related electricity consumption is projected to rise from 0.2% of national demand in 2024 to approximately 6% by 2035, making managed residential charging a priority for grid resilience and energy planning.

Yet access to residential charging remains deeply uneven. Only 55% of prospective EV buyers currently have access to home charging, while a further 30% could enable it with electrical upgrades. As barriers related to electrical infrastructure, housing conditions, stakeholder processes, and affordability persist, users resort to informal and unsafe arrangements, plugging into general-purpose sockets, temporary extensions, and shared connections not designed for sustained EV loads. These practices create fire and electrical safety risks, reduce charging reliability, and may contribute to equipment damage and accelerated battery degradation.

India's EV sales have grown to

**23L+**

units in 2025, up from 0.5 lakh in 2016

Two- and three-wheelers account for

**91%**

of total EV sales in India (2025)

**80%**

of global EV charging occurs at residential or workplace locations.

80,000

residential EV charger installations analysed, which is currently one of India's largest real-world residential charging datasets

Nearly

45%

of Indian homes need electrical upgrades to safely charge their EV at home

## The Home Stress Test

EV users charge daily for 4-6 hours continuously. This near-commercial load accelerates infrastructure weaknesses. Hence, the 3W segment is a practical benchmark for residential EV readiness.

## Evidence Base

This report is based on a mixed-methods research approach drawing on a proprietary dataset of over 80,000 residential EV charger installations spanning tier-1, tier-2, and tier-3 cities, covering diverse housing typologies including independent homes, apartment complexes, informal settlements, and shared rental housing. The dataset is supplemented by technician field surveys, consumer interviews, photographic documentation of electrical infrastructure, and structured stakeholder consultations. It is among the most comprehensive empirical assessments of India's residential EV charging ecosystem to date.

## Five Barriers Holding Back Residential Charging

The report identifies five interconnected categories of barriers that collectively hinder safe and scalable residential EV charging.

- **Technical Challenges:** Inadequate earthing, voltage instability, undersized wiring, and overloaded distribution transformers not designed for sustained EV loads. This indicates that many charging issues are linked to underlying electrical infrastructure conditions, underscoring the need to view residential charging as a system-level challenge rather than a charger-only issue.

- **Structural and Spatial Constraints:** Most urban residents live in multi-family dwellings with shared parking and restricted electrical systems; residents in rental or informal housing lack both the authority and financial incentive to invest in charging infrastructure.

- **Legal and Governance Barriers:** Fragmented regulatory frameworks, ambiguous RWA or landlord approval processes, and inconsistent enforcement of the Ministry of Power's 2024 guideline granting residents the right to install private charging points.

- **Social and Behavioural Barriers:** Limited awareness, safety concerns, unclear stakeholder responsibilities, and collective decision-making challenges create resistance to charging deployment and slow the transition to safe charging practices.

- **Economic Barriers:** The cost of achieving charging readiness, including chargers, electrical wire upgrades, and load enhancement, can be significantly high, particularly in older buildings, rental housing, and low-income households.

## Towards a National Framework for EV-Ready Homes

India already has multiple standards, guidelines, and regulatory provisions that address different aspects of residential EV charging. However, these remain dispersed across institutions and do not translate into a single, practical implementation pathway. The gap is not the absence of technical standards, it is the absence of a coordinated implementation framework.

This report defines an EV-ready home as one that can safely deliver sustained electrical load for EV charging, protect users and equipment from electrical faults, operate reliably under variable grid conditions, and accommodate future increases in EV demand. The core elements include:

- Adequate sanctioned electrical load with a dedicated charging circuit
- Compliant wiring and earthing
- Dedicated circuit protection with appropriately rated MCBs and earth-leakage protection
- A dedicated EV sub-meter with Certified EVSE for sustained charging loads
- Safe charger placement with fire safety compliance
- Clear governance arrangements covering approvals, responsibilities, and escalation

**One Size Does Not Fit All**

An EV-ready independent home, apartment, rental accommodation, and low-income settlement will not look the same, but each must meet a common minimum threshold for safe, reliable, and usable EV charging.

## Recommendations: A Roadmap for EV-Ready Homes

The recommendations are structured as a roadmap that addresses the full residential charging journey, from defining EV readiness and ensuring electrical safety to enabling deployment across housing types, integrating charging into utility planning, and preparing homes for future smart energy systems.

| Recommendation Area | Key Actions |
|---|---|
| Establish a National Residential EV Readiness Framework | • Establish a unified framework that integrates existing standards, regulations, and guidelines into a coherent implementation pathway for residential charging.<br>• Introduce residential charging readiness indicators, charger installations, EV sub-meter approvals, load enhancement requests, and electrical readiness assessments, to be tracked alongside EV adoption metrics.<br>• Strengthen coordination across the EV purchase, charger installation, and utility connection journey so that residential charging requirements are addressed earlier in the process, rather than only after users face charging-related issues. |

| Recommendation Area | Key Actions |
|---|---|
| Enable Verified Residential Charging through EVSE and Dedicated EV Metering | • Transition towards a readiness-based approach, with EVSE-based charging supported by a dedicated EV sub-meter as the preferred pathway, where technically and economically feasible.<br>• Require DISCOMs to provide reasons for EV sub-meter rejection with specific corrective actions required, enabling re-application through a simplified process once corrective actions are completed.<br>• Allow assessments by DISCOMs or certified third-party entities, subject to utility verification, to enable scale while maintaining accountability and quality assurance. |
| Embedding EV Readiness Across Housing Typologies through Bye-Laws and Housing Programmes | • Develop guidelines for safe charger placement across all residential typologies, covering parking layouts, cable routing, metering arrangements, safety clearances, and responsibility for electrical upgrades.<br>• Define EV-ready buildings as those capable of supporting actual EV charging into building bye-laws, redevelopment programmes, affordable housing schemes, rental housing guidance, and urban development initiatives, including through building plan approvals and occupancy certification.<br>• Treat residential EV readiness as an issue of access, affordability, and livelihood security, particularly for gig and delivery workers dependent on overnight home charging. |
| Making EV-Readiness Affordable through Targeted Support | • Introduce targeted support mechanisms covering EVSE installation and the electrical upgrades required to make homes safe and reliable for EV charging, with priority for older buildings, rental housing, and low-income settlements.<br>• Deliver support through capital subsidies, concessional financing, utility-led programmes, tax incentives, performance-linked grants, or integration within existing EV promotion schemes. |
| Building a Safe Residential EV Charging Culture through Awareness and Workforce Upskilling | • Develop targeted awareness initiatives to help consumers understand what constitutes an EV-ready home, the importance of electrical readiness assessments, and the role of EVSE-based charging.<br>• Develop standardised training and certification programmes for electricians, contractors, and charging installers covering load assessment, earthing verification, wiring suitability, circuit protection, and EVSE installation. |

| Recommendation Area | Key Actions |
|---|---|
| Preparing Homes for the Future Energy Transition | • Design EV-ready infrastructure to support Time-of-Day tariffs, smart charging, demand response, rooftop solar integration, battery storage, peer-to-peer energy transactions, and Vehicle-to-Grid services as technologies and regulatory frameworks mature.<br>• Select metering systems, communication protocols, charging equipment, and digital platforms using interoperable, standards-based approaches with future compatibility in mind, to support the broader energy transition accompanying large-scale electrification. |
| Institutional Ownership for Residential EV Readiness | • Establish a coordinated national platform bringing together MoP, MoHUA, MoRTH, MNRE, CEA, CERC, SERCs, DISCOMs, standards bodies, vehicle OEMs, charger OEMs, RWAs, consumer representatives, and civil society organisations.<br>• Align policies, standards, regulations, utility processes, safety requirements, consumer awareness, and long-term planning across mobility, power, and housing sectors.<br>• Establish clear institutional ownership and implementation responsibilities for residential EV readiness, ensuring it evolves into a coordinated national programme rather than a collection of individual initiatives. |

India's EV transition will not be secured by vehicles and public charging infrastructure alone. It requires that homes themselves become part of the mobility infrastructure, safe, electrically ready, and institutionally enabled. The findings of this study consistently point to one overarching message: residential electrical readiness is not a secondary or downstream concern. It is the foundation on which India's EV ambitions must be built.

The question is no longer whether India needs EV-ready homes. It is how they should be defined, financed, built, and governed. This report aims to catalyse that conversation and contribute to a shared national vision for the residential foundation of India's net-zero transition. Achieving India's EV ambitions will ultimately require ensuring that the readiness of homes keeps pace with the adoption of vehicles.


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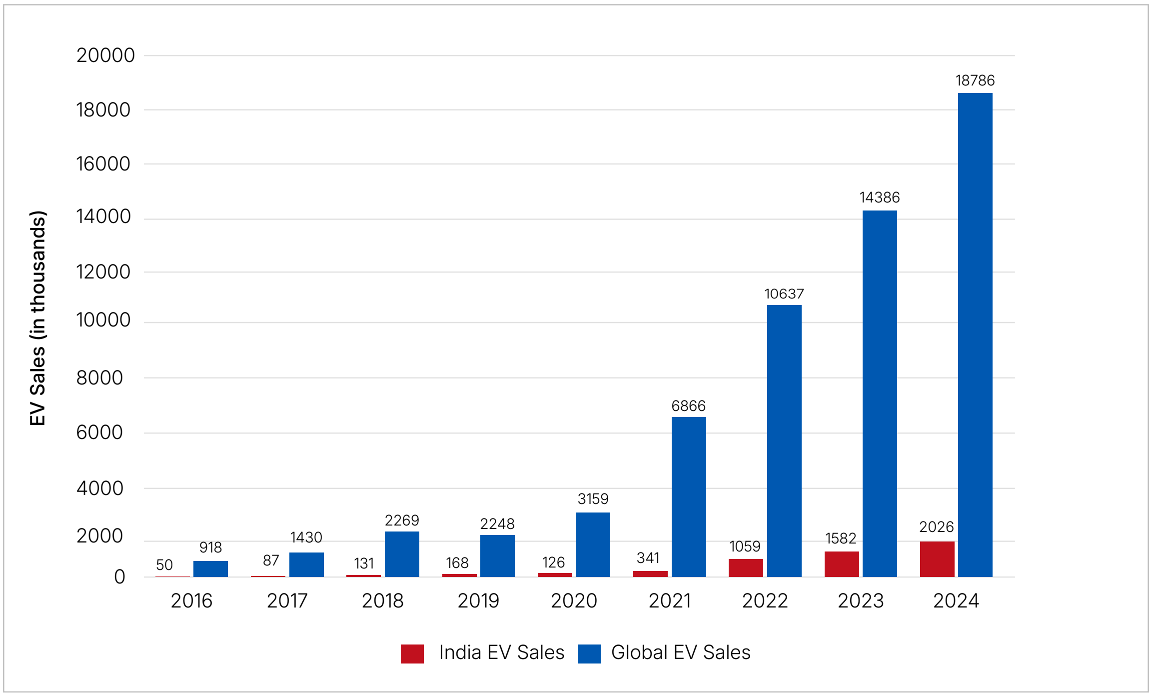
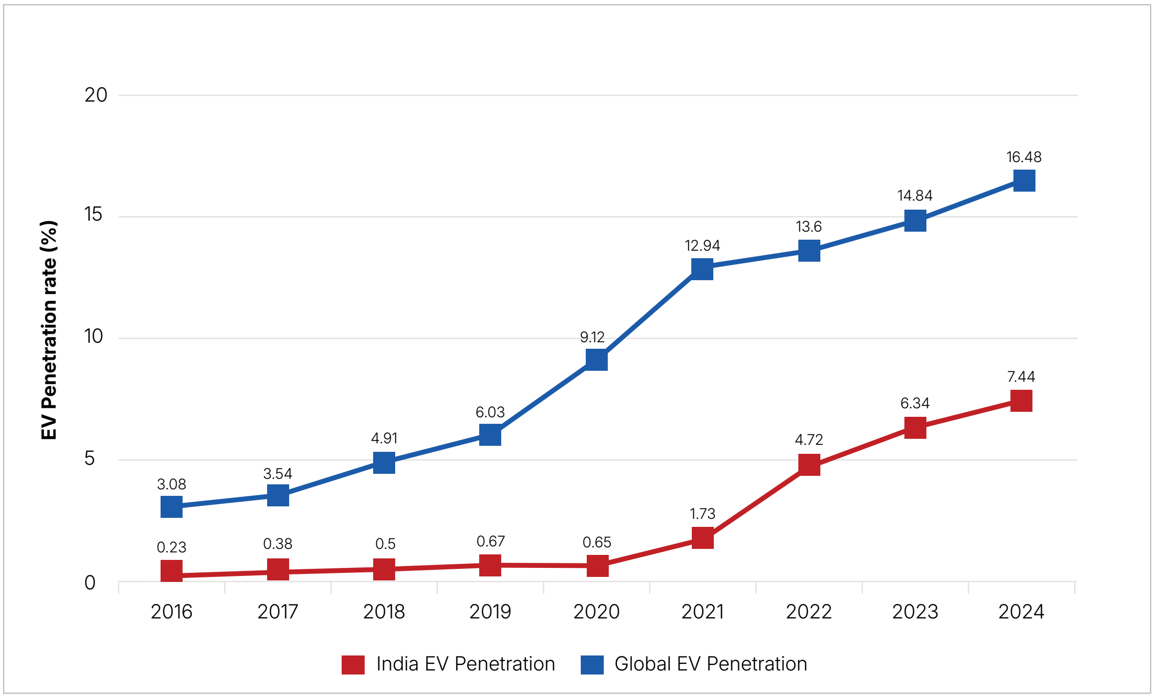
# INTRODUCTION: WHY RESIDENTIAL CHARGING MATTERS NOW

India's electric mobility transition has gained strong momentum over the past decade. EV sales have grown significantly, rising from 0.5 lakh in 2016 to more than 23 lakh in 2025. Globally, EV sales also witnessed rapid growth, increasing from 9.18 lakh units in 2016 to nearly 1.88 crore units by 2024, highlighting the accelerated adoption of electric mobility worldwide (NITI Aayog, 2025).

India's EV market, however, has evolved along a distinctly different trajectory, characterised by the overwhelming dominance of LEVs, with 2Ws and 3Ws together accounting for 91% of total EV sales in 2025 (VAHAN Portal). In contrast, E-4Ws, which dominate in developed economies (Scott, 2025), have relatively modest but steadily rising penetration in India.




(a)




(b)

**Figure 1: (a) EV Sales over the Years and (b) EV Penetration Rate - Global & India**

Source: IEA Global EV Outlook, VAHAN Portal and Niti Aayog

Despite this growth, EVs made up approximately 7.6% of total vehicle sales in 2024, far below the national target of 30% by 2030 (NITI Aayog, 2025). This gap underscores the importance of the coming decade. Accelerating the transition will require addressing one of the system's most persistent and structural challenges: inadequate and underutilised charging infrastructure.

India leads the world in E-2W and E-3W, highlighting the central role of low-power AC charging that aligns with India's residential power supply. LEVs are the backbone of last-mile delivery, ride-hailing, and gig-economy services. Their charging preferences differ sharply from those of passenger-car users, as most LEV users rely on slow AC charging (≤ 3.3 kW) compatible with a single-phase domestic supply, ideally overnight at home or in nearby parking spaces (Rather et al., 2021).

Global evidence suggests that 80% of EV charging takes place at homes or workplaces, a trend increasingly evident in Indian cities as users prioritise convenience and lower charging costs (Residential EV Charging Guidebook, 2022; SIAM, 2025). As a result, homes and residential buildings are increasingly becoming part of the country's mobility infrastructure, making residential charging fundamental to India's EV transition.

However, access to residential charging remains uneven.

A consumer survey indicates that only 55% of prospective EV buyers in India currently have access to home charging, while another 30% could enable it with upgrades to their existing electrical infrastructure (Goswamy, 2023).

In many urban areas, a large share of users live in rental and low income houses where dedicated parking, clear charging pathways, or EV-ready electrical infrastructure may not already exist. Residential charging therefore becomes closely linked to electrical readiness and design of houses, parking access, and local grid infrastructure. Furthermore, the implications extend beyond user convenience. EV-related electricity consumption is projected to rise from 0.2% of national electricity demand in 2024 to approximately 6% by 2035, making managed residential charging a priority for grid resilience (Konda and Karuturi, 2024).

India's EV transition is therefore not just about scaling vehicle adoption, but also about aligning infrastructure with its unique market structure, one shaped by 2Ws, 3Ws, shared mobility, and cost-sensitive users. In this context, the success or failure of residential charging becomes deeply consequential, as it directly shapes user trust. When home charging works seamlessly, range anxiety and operational friction recede into the background, making EV adoption feel intuitive and reliable. However, when it fails due to lack of access, poor installation, or unreliable supply, it becomes a daily source of frustration. This dissatisfaction is often attributed to the vehicle or the charger itself, even though the underlying issue stems from residential electrical installations and the broader grid infrastructure supporting everyday EV charging .

Unlocking residential charging, therefore, is not merely a matter of convenience. It is foundational to enabling equitable EV adoption, ensuring efficient grid management, and supporting India's long-term vision for sustainable urban mobility. This report is undertaken to highlight these gaps and shift the focus toward making homes not just EV-compatible, but safely EV-ready through simple, standardised interventions.

## 1.1 The Centrality of Home Charging in India's EV Transition

The rapid transition of Indian vehicle owners to EVs represents a pivotal shift towards sustainable mobility choices, driven by government initiatives and environmental goals. The charging infrastructure in India has grown rapidly, with 22,753 operational PCS as of March 2026 (PIB release, 2026). Yet, this pace remains insufficient relative to future demand. To achieve the indicative target ratio of one charger for every forty EVs, India will need to install over 400,000 chargers annually, reaching a cumulative total of about 1.32 million chargers by 2030 (CII Press Release, 2023).

There is also a glaring gap between the surge in EV adoption and the underdeveloped charging infrastructure, particularly in residential areas. Residential charging accounts for a significant portion of EV energy needs globally; yet in India, barriers ranging from technical limitations to economic constraints hinder its expansion (NITI Aayog, 2021). In a country where a large proportion of urban residents live in individual homes, low-income houses, apartments and shared housing, the absence of accessible charging options within residential premises continues to deter widespread EV ownership.

The implications of this gap are especially pronounced for gig-economy workers, who form a rapidly growing segment of EV users. For these users, EV adoption is not just an environmental choice but also an economic one. Lower running costs compared to ICE vehicles, coupled with high daily utilisation, make EVs financially attractive. However, this economic viability is highly sensitive to charging access.

A report by NITI Aayog projects 23.5 million workers by 2029–30 (NITI Aayog, 2022). For these workers, access to home charging is not merely a matter of convenience; it is fundamental to income stability and economic resilience.

Through stakeholder consultation, it was found that gig workers typically travel 250–300 kilometres per week, and the availability of a reliable home charging point directly determines their daily income stability. Their operating patterns further complicate the issue. Long working hours, limited downtime between trips, and the need to maximise vehicle utilisation make it impractical to rely on PCS, where queuing and travel time translate directly into lost income. These challenges are not limited to gig workers alone. Across vehicle segments, EV users resort to informal charging arrangements, plugging into general purpose shared domestic sockets, temporary connections, or unregulated extensions, instead of using dedicated EVSE in residential or commercial spaces. These practices raise significant safety concerns, including overheating, circuit overloading, electrical fault risks that can potentially lead to fire hazards. More importantly, such charging activity remains largely invisible to the grid. Addressing this accessibility divide is critical to ensuring that EV users across segments have access to safe, reliable, and affordable charging, regardless of their housing type, parking access, or ownership status. Residential charging underpins India's EV transition, aligned with off-peak nighttime demand patterns that ease grid stress (SIAM, 2025). This alignment offers a unique opportunity to scale EV adoption without significantly stressing peak demand, provided the infrastructure is planned and managed effectively.

Electricity tariffs for residential users are lower than commercial public charging tariffs, making home charging typically three to four times more cost-effective per kWh, thereby reducing the total cost of ownership for EV users (BEE, 2026). Consumer behaviour further reinforces this preference. Research indicates that cost, speed, and safety are the primary determinants of charging choices, with 49% of users prioritising speed and 41% prioritising cost (Goswamy, 2023).

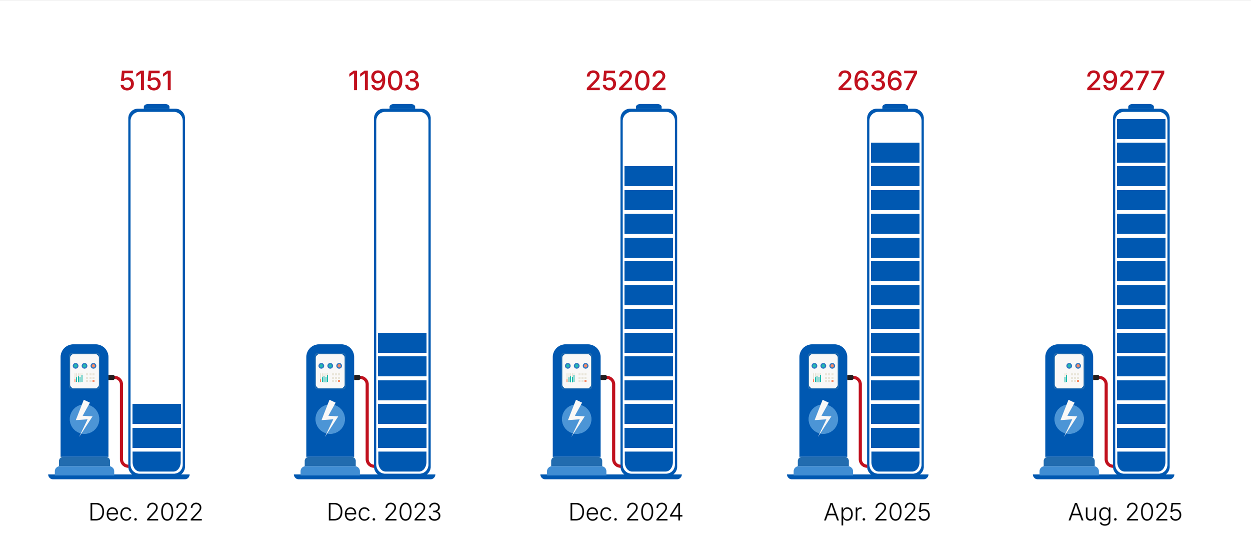



Figure 2: Yearwise Number of PCS in India

As shown in Figure 2, government initiatives have led to the continued expansion of public charging networks, particularly to serve users without access to dedicated parking. However, their scalability in handling high energy throughput remains constrained. This is further limited by parking space availability, especially in dense urban areas, where land acquisition and optimal site planning are key bottlenecks, as scaling up charging infrastructure also requires dedicated parking spaces.

Moreover, the existing public charging infrastructure remains heavily concentrated in urban centres and highways. States such as Karnataka, Maharashtra, Uttar Pradesh, Delhi, and Tamil Nadu account for nearly 60% of the total charging stations, leaving rural and semi-urban regions, which are critical for broader EV adoption, relatively underserved (ORF, 2025). This uneven distribution further reinforces the importance of residential charging as the backbone of daily EV charging needs. As a result, it will remain central to meeting daily EV charging requirements.

In this context, the success of India's EV transition will depend not only on the scale of infrastructure deployment but also on how effectively residential charging ecosystems are enabled, formalised, and integrated into the broader energy system.

## 1.2 Forecast: Why the Trend will Continue for the Next Decade

India's EV stock is expected to surpass 50 million vehicles by 2030, driven by falling battery prices and national targets of 30% of new sales as electric (Electric Vehicle Charging, 2022). The majority of charging demand will continue to concentrate in residential and semi-private locations, especially as LEV penetration deepens in tier-1 and tier-2 cities.

Recent monthly data from September 2025 confirm that the structural trends observed over the last three financial years are persisting: E-2W remain the largest category by volume, followed by e-rickshaws and other 3Ws, while four-wheelers and buses continue to grow from a smaller base. This reinforces the expectation that India's EV stock over the coming decade will be heavily skewed towards LEVs, whose charging requirements are best met in residential and semi-private environments. In the E-3W and E-4W segment, nearly 90% of vehicle sales are accompanied by home charging infrastructure, reinforcing the central role of residential charging. Projections indicate that India will need about 1.9 million public chargers and 275,000 battery-swapping stations by 2040 (RMI, 2025; Kush, 2025). This rapid expansion in public charging and swapping infrastructure is a direct indicator of growing EV uptake. At the same time, given that a significant share of EV charging currently takes place at homes and workplaces, this growth implies that millions of private charging points will play a critical role in handling overall energy demand.

> Residential charging is now critical to EV adoption, and it must be supported by coordinated planning across stakeholders to mitigate safety risks. Without proactive measures, recurring safety incidents could significantly slow the pace of the EV transition.
>
> **-EV Charging Expert**

## 1.3 Data Insights: Housing Types and City Tiers

Housing patterns play a decisive role in shaping access to residential EV charging. In India, such access is constrained less by user preference than by housing form, ownership, and electrical layout. Approximately 70–75% of urban households reside in multi-family units such as apartments or gated communities (SIAM, 2025). In metropolitan cities like Mumbai and Bengaluru, more than 60–80% of residents live in apartments with shared parking and restricted electrical load capacities (SIAM, 2025). In these settings, residents often lack direct control over parking spaces, wiring, and metering, and charger installation typically depends on approvals from landlords, RWAs, or DISCOMs. Older buildings frequently lack dedicated parking or individual meters, further complicating deployment. Rental and informal housing segments introduce additional constraints, including the need for owner approvals and the difficulty of shifting charging setups during relocation, making limited residential charging access a widespread issue. In contrast, independent houses allow residents direct control over parking and electrical connections, although most still face technical challenges.

These constraints also vary by vehicle class and usage pattern. A dwelling that can support a low-power 2W charger may not accommodate a four-wheeler, which typically requires a dedicated parking bay, higher load capacity, and clearer common-area regulations. For LEV users, especially in dense tier-1 cities and rapidly growing tier-2 and tier-3 regions, the primary barrier is often not the willingness to charge at home but whether their housing arrangement permits a safe, reliable, and enforceable charging solution. Taken together, these patterns highlight that residential charging policy cannot be uniform. Instead, it must be segmented by both housing type and vehicle class.

## 1.4 Implications for Grid Planning and Urban Development

Under the latest Ministry of Power guidelines, DISCOMs must supply electricity for EV charging through either the resident's existing meter or a separate sub-meter, depending on the owner's choice (MoP, 2024). If an EV charging station requires power beyond the current sanctioned load, the owner must apply to the distribution licensee for an increase in the sanctioned load. For community charging, if EV charging pushes the load beyond the society's sanctioned capacity, the RWA must apply to the DISCOM for a load increase. The scale of EV deployment will place significant pressure on DISCOMs, requiring them to assess and upgrade their networks to handle the substantial increase in EV charging demand expected in the coming decades. The rise of residential charging creates both technical and planning imperatives. Local distribution transformers already operate at 80–90% capacity in many urban circuits; unmanaged home charging could exceed safety margins without load management systems.

> A key challenge is that most private EVs tend to charge during peak hours, reducing diversity and placing additional stress on the distribution network, despite the availability of EV-specific tariffs and Time-of-Day mechanisms. However, shifting charging to overnight hours can improve load predictability and thereby reduce stress on the grid.
>
> **-DISCOM**

The amended MBBL by MoHUA recommend that 20% of all parking spaces in new multi-unit buildings, including residential buildings, be equipped with EV charging. However, there are no provisions enabling existing buildings to retrofit charging infrastructure on their premises. Furthermore, for both new and existing residential buildings, challenges remain, including improper wiring, inadequate earthing, lack of awareness, unclear processes, low expected utilisation, and unavailable spare capacity in connected loads, etc.

Strategically, distributed home charging reduces the need for expensive public infrastructure and enables a bottom-up transition to clean mobility. Embedding EV charging within spatial planning and utility investment frameworks will be central to achieving India's net-zero mobility goals, while also preparing DISCOMs for emerging energy use cases, including distributed energy resources, demand flexibility, V2G integration, and VPPs.

## 1.5 National and State Policies Supporting Charging Infrastructure

Over the past decade, the Indian government, along with state authorities and standardisation bodies, has introduced a series of policies, guidelines, regulations and standards to address EV Charging infrastructure needs. These initiatives aim to overcome barriers such as inadequate charging facilities, safety concerns, and integration with existing electrical systems.

**2015: Faster Adoption and Manufacturing of Electric Vehicles (FAME) I**

The first phase of the FAME Scheme (2015–2019) was designed to jump-start India's EV market by focusing on four pillars: demand creation, technology development, pilot projects, and charging infrastructure. During this phase, the government sanctioned approximately 520 PCS, to address early range anxiety and support nascent EV adoption, even though the scheme did not directly subsidise residential charging. By catalysing early EV sales and laying the foundation for broader EV charging norms and standards, FAME I indirectly created a derived demand for basic residential charging solutions and encouraged installers to engage with evolving EV charging requirements (Department of Heavy Industry, Government of India, 2015).

**2016: EV Charging Infrastructure (EVCI) in Model Building Bye-Laws (MBBL)**

The Explanatory Note on EVCI issued under MBBL, 2016, by the MoHUA, provided the first comprehensive guidance on integrating EV charging infrastructure into urban planning and building regulations. Key recommendations for the residential sector include:

- Mandating provisions for EV charging points in new residential buildings, including individual homes and multi-unit dwellings.
- Recommendations for dedicated parking spaces equipped with electrical outlets for slow charging, emphasising safety features such as RCDs to prevent electrical hazards.
- Encouragement for retrofitting of existing residential complexes with charging facilities, considering space constraints in urban areas.

Building on the 2016 framework, the Amendments to Model Building Bye-Laws, 2019, refined and expanded the requirements for EV charging in buildings in response to the growing EV market by making EVCI mandatory in certain categories of residential developments (MoHUA, 2019). Notable provisions include:

- Minimum share of parking spaces be made EV-ready, including necessary conduits and electrical capacity.
- While only a limited number of chargers may be installed initially, at least 20% of parking capacity is expected to be EV-ready.
- The amendments also encourage low-voltage AC charging for residential use and provide enabling incentives such as FAR relaxations.

However, these provisions primarily address building-level readiness and do not explicitly mandate upstream grid upgrades, leaving distribution-level capacity planning to DISCOMs and state regulators (MoP, 2024).

**2019: FAME II Scheme**

Launched in 2019 with an outlay of INR 10,000 crore, the FAME II Scheme expanded India's EV support framework by scaling demand incentives and public charging infrastructure.

- Approximately INR 1,000 crore was allocated for charging infrastructure, leading to the sanctioning of around 7,000 PCS, including 2,877 stations across 68 cities.
- By accelerating the adoption of E-2Ws and E-3Ws, which predominantly rely on overnight home charging, FAME II significantly increased the demand for residential charging solutions and highlighted the need for parallel regulatory support from DISCOMs.
- All of this indirectly expanded the market opportunity for private installers, as more EV owners sought reliable home charging options within a maturing public network (Ministry of Heavy Industries, Government of India, 2022; PIB release, 2022).

**2021: Indian Standard IS 17017 (Part 22/Sec 1) – EV Conductive Charging Systems**

Adopted by BIS, IS 17017 (Part 22/Sec 1) specifically targets LEVs commonly used in residential settings. The standard outlines requirements for a portable, low-cost AC charging point with a rated voltage of 240 V and current up to 16 A, designed for easy installation in homes, small shops, or residential parking areas. Key elements include:

- **General Requirements:** Functional, environmental, mechanical, and electrical safety considerations, including energy measurement and communication protocols.
- **Mode of Charging:** Supports AC charging with in-built protection (Mode-2), primarily using Case B connections, with socket-outlets compliant with IS/IEC 60309-1.
- **User Interface and Billing:** Provisions for user authentication, energy metering (with accuracy per IS 13799), and optional billing/payment integration.
- **Communication:** BLE for vehicle-charger communication, and battery backup for control circuits.
- **Safety:** Includes a RCD with a rated residual operating current not exceeding 30 mA, automatic fault disconnection, electric shock protection, earth continuity and earth presence detection, inbuilt electrical protection such as overcurrent and short-circuit protection, and ingress protection.
- **Environmental and EMC Requirements:** Compliance with tests for cold, dry heat, damp heat, and EMC as per IS 9000 series.

This standard directly tackles technical barriers in residential EV adoption by promoting affordable, safe, and interoperable charging solutions for light vehicles, which dominate India's EV market. It draws from IS 17017 (Part 1): 2018 and incorporates field feedback for practical implementation (Bureau of Indian Standards, 2021).

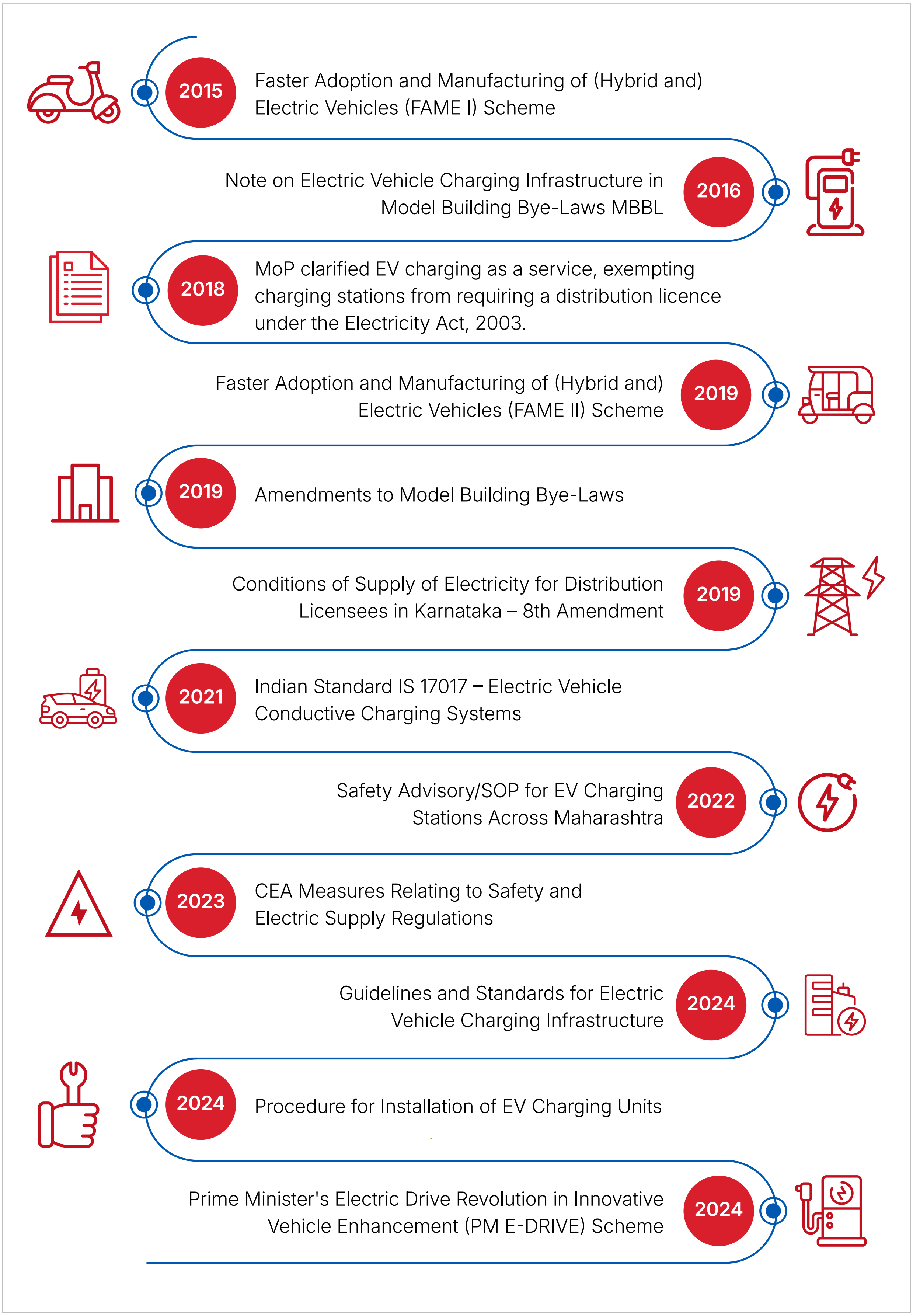



**Figure 3: Key Policies/Schemes for the Promotion of EV Charging Infrastructure in India**

**2023: Central Electricity Authority (CEA) Measures Relating to Safety and Electric Supply Regulations**

At the national level, the CEA introduced the Measures Relating to Safety and Electric Supply Regulations, 2023, updating safety norms for electrical installations, including EV charging. These regulations emphasise grid stability and user safety. Key provisions for residential EVCI:

- Mandates for overcurrent protection, insulation monitoring, grid stability and integration with smart grids for residential chargers.
- Requirements for centralised data management of EV charging loads to prevent grid overloads in residential neighbourhoods.
- Strategic implications for DISCOMs to plan infrastructure upgrades based on EV penetration data.

These regulations build on prior standards by enforcing safety at a systemic level, helping to overcome infrastructure barriers in residential sectors where grid capacity is often limited (CEA, 2023).

**2024: Guidelines and Standards for EVCI and Procedure for Installation of EV Charging Units**

The Guidelines and Standards for EV Charging Infrastructure, 2024, issued by the Ministry of Power, consolidate earlier policy frameworks and provide updated directions for the development of EV charging infrastructure in India.

- Comprehensive structure for public and private EVCI, including residential setups, with mandates for data sharing on charging usage.
- Emphasis on interoperability, fast-charging options in residential complexes, and incentives for green energy integration (e.g., solar-powered chargers) (MoP, 2024).
- Procedure for Installation of EV Charging Units offers a step-by-step guide for setting up chargers, particularly in residential areas, including:
  - Application processes for electrical connections, site assessments, and approvals from DISCOMs.
  - Commissioning guidance, such as load sanctioning and metering, to streamline installations in homes and apartments.

**2024: Prime Minister's Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme**

Announced in the Union Budget 2024–25, the PM E-DRIVE scheme, implemented by the MHI, has an outlay of approximately INR 10,900 crore over two years to accelerate EV adoption. Around INR 2,000 crore is allocated for the development of public charging infrastructure across urban and semi-urban areas.

While the scheme primarily focuses on expanding public charging networks, it indirectly supports residential charging by improving overall ecosystem reliability and reducing range anxiety, particularly for LEVs such as 2Ws and 3Ws. By strengthening public infrastructure alongside demand incentives, the scheme contributes to a more balanced charging ecosystem where home and public charging can coexist efficiently. This transition helps reduce market uncertainty and supports residential charging installations, planning, and integration services as part of a more predictable, larger-scale rollout of charging infrastructure (Ministry of Heavy Industries, 2024).

**State Level Policies**

**2019: Conditions of Supply (CoS) of Electricity for Distribution Licensees in Karnataka – 8th Amendment**

In the same year, state-level initiatives emerged, exemplified by the 8th Amendment to the CoS of Electricity for Distribution Licensees in Karnataka, 2019, notified by the KERC. This amendment focused on tariff and supply regulations to facilitate EV charging in residential contexts. Key aspects include:

- Provisions for separate metering for EV charging loads in homes, preventing disputes over shared electricity bills in multi-occupancy buildings.

- Guidelines for DISCOMs to approve additional electrical load for residential EV chargers without extensive upgrades to existing infrastructure.

This policy addressed economic barriers by making residential charging more affordable and accessible, particularly in states like Karnataka with high urban EV potential. It set a precedent for other states to follow in harmonising electricity regulations with EV needs (Karnataka Electricity Regulatory Commission, 2019).

**2022: Safety Advisory/Standard Operating Procedure for EV Charging Stations Across Maharashtra**

Issued by MEDA, this advisory highlights state-specific safety measures:

- SOPs for installing and operating EVCS in residential societies, including fire safety protocols, earthing requirements, and emergency shutdown mechanisms.
- Advisory on using certified equipment (e.g., compliant with IS 17017) and conducting regular inspections to prevent electrical faults in shared residential spaces.
- Guidelines for training residents and society managers on safe charging practices.

This advisory addressed safety-related concerns among residential users, particularly in densely populated urban areas, by providing clear operational frameworks to minimise risks such as overheating and short circuits. A key limitation is that the advisory appears to focus primarily on operational safety and user practices, but does not sufficiently address deeper structural barriers that often constrain residential charging at scale, such as:

- sanctioned load enhancement,
- separate metering arrangements,
- transformer/feeder capacity limitations, and
- coordination with DISCOMs for multi-dwelling installations.

**States EV Policies**

Many states have implemented dedicated EV policies that include capital subsidies for public and private charging stations, reduced electricity tariffs for EV charging, and mandated EV charging-ready parking spaces in new residential buildings. While national policies offer an overarching framework, state-level EV policies provide the operational mechanisms, including mandates, incentives, tariff structures, and implementation rules that directly influence the feasibility of residential charging.

- **Maharashtra EV Policy 2025**

Maharashtra has unveiled a bold EV Policy 2025–2030 with a budget of INR 1,993 crore, more than double the previous allocation. Key targets include 30% of all new vehicle registrations to be EVs by 2030, with higher goals for specific segments (2- and 3Ws). The policy mandates EV-ready infrastructure in all new residential projects, including at least one community-level charging point in housing societies, and requires RWAs to issue NOCs within seven days. The state offers property tax rebates and capital subsidies for chargers, alongside strict SOPs for safe installations in older buildings. The MSBTE will design specialised EV-focused courses. A comprehensive certification and reskilling framework will be developed to equip the workforce with skills in EV design, battery technology, charging systems, and energy management (Government of Maharashtra, 2025).

- **Extension of Delhi's EV Policy 2026 and Switch Delhi Campaign**

Delhi's EV Policy, originally notified in 2020, has been extended until 31 March 2026, or until Delhi EV Policy 2.0 is notified, whichever is earlier. Delhi's charging action plan requires 20% of parking spaces in new buildings to be EV-ready, and 5% of parking spaces in existing buildings with more than 100 vehicles to be EV-ready. Under Switch Delhi, the government offers a subsidy of up to INR 6,000 per charging point for the first 30,000 charging points, and the consumer tariff for EV charging is INR 4.50 per unit. The DISCOM-led system also uses empanelled vendors and a single-window application process for charger installation (Transport Department, GNCTD, 2025; Government of National Capital Territory of Delhi, 2026).

- **Karnataka EV and Energy Storage Policy and Karnataka Electricity Regulatory Commission Regulatory Framework**

Karnataka supports residential EV charging through its regulatory and policy framework, including provisions in building regulations and electricity supply codes. The state offers a concessional EV tariff under the LT-6 category, typically around INR 4.5–INR 5 per kWh, as determined by the KERC. Group housing societies and RWAs are permitted to install shared or common charging infrastructure, subject to approvals in accordance with local building norms and society bylaws. While urban planning guidelines encourage EV-ready parking provisions in new developments, specific percentage mandates vary across jurisdictions rather than being uniformly fixed state-wide (Commerce and Industries Department, Government of Karnataka, 2017).

Other states such as Uttar Pradesh, Assam, and Rajasthan have notified EV policies that promote the development of charging infrastructure. While financial incentives for charging infrastructure and upstream electrical systems indirectly support residential deployment, these policies do not explicitly mandate EV-ready buildings or provide direct subsidies for home chargers. As a result, residential charging remains largely user-driven, with limited regulatory intervention in building design or grid planning.

There is also an ambiguity surrounding 'EV-ready' definitions, with limited standardisation of technical specifications, safety requirements, and installation protocols. Furthermore, structured mechanisms such as pilot programs, DISCOM-led safety audits, and certified installation frameworks are still evolving. These challenges are particularly pronounced in informal and densely urban settlements, where issues such as inadequate earthing, voltage fluctuations, and unsafe wiring conditions persist. As EV adoption scales, strengthening residential charging guidelines, safety enforcement, and grid preparedness will be critical to ensuring a reliable and inclusive transition.

**Emerging Regulatory Developments**

An emerging barrier to residential EV charging in India is the upcoming fire safety concerns related with installing the EV charging setup in the basements. Maharashtra's Directorate of Fire Services issued a circular in July 2024 prohibiting EV charging points in basement car parking areas of residential buildings (Directorate of Maharashtra Fire Service, 2024). In Haryana, the Fire and Emergency Services department flagged basement chargers as non-permissible in early 2026, stalling fire NOC renewals. However, later a conditional allowance was issued allowing first-basement charging subject to ventilation norms (notified by Revenue and Disaster Management department, 2026). At the national level, BIS proposed amendments to the National Building Code in October 2025 that would further restrict basement EV charging (National Building Construction Standards, 2026). The proposed amendments may significantly impact EV adoption in urban areas, where a majority of vehicles are parked across multiple basement levels in residential and commercial buildings. These developments highlight the need to balance fire safety objectives with the practical realities of urban EV adoption, particularly in dense cities where basement parking forms a significant share of residential vehicle storage.


A-27
SUNCITY


Network Status
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# 02

# METHODOLOGY

This report adopts a mixed-methods research approach to examine the ground-level barriers to residential EV charging in India.

The primary dataset used in this study represents one of the largest continuous, real-world diagnostic records of India's residential EV charging infrastructure. It draws on real installation data and provides rare visibility into on-ground electrical, spatial, and governance challenges that are typically absent from policy discourse.

**The primary empirical foundation of the study is a proprietary dataset comprising over 80,000 EV charger installations located in residential settings**

The dataset is supplemented with qualitative evidence drawn from technician field surveys, structured installation checklists, photographic documentation of electrical infrastructure, and EV consumer interviews conducted during installation, troubleshooting, and post-installation support. Together, these sources enable triangulation between technical site conditions, user behaviour, and institutional processes, allowing the study to move beyond abstract definitions of readiness toward the lived realities of EV adoption.

Geographically, the analysis spans tier-1 metropolitan cities, tier-2 and tier-3 towns, and semi-urban and peri-urban regions. Installations cover diverse housing typologies, including independent houses, apartment complexes, informal settlements, and shared rental housing. Socio-economically, the dataset includes 2W and 3W users such as e-autorickshaw drivers and gig-economy workers, including delivery agents and taxi drivers.

The scope of this study is limited to formal and informal residential charging contexts and excludes public fast-charging stations, highway corridors, and commercial depots. While the dataset is extensive, it is not statistically representative of all Indian households. Rather, it captures real-world conditions encountered by households that have actively attempted to adopt EVs. In that sense, the dataset does not claim to represent every home in India. Instead, it reveals what typically happens, what works, and what breaks when Indian households attempt to integrate EV charging. This makes it particularly well-suited for identifying real-world barriers encountered at the point of EV and residential charging adoption.

### Data sources and foundation

#### PRIMARY DATASET (QUANTITATIVE)

- Over 80,000 residential EV charger installation proprietary data
- Real-world diagnostics & on-ground challenges
- Electrical, spatial & governance challenges

#### SUPPLEMENTARY QUALITATIVE EVIDENCE

- Technician field surveys
- Structured installation checklists
- Photographic documentation of infrastructure
- EV consumer interviews (during installation, troubleshooting, support)

Figure 4: Data Sources & Foundation for the Study


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kazam
EV RANGER
kazam
EV RANGER


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# 03

## UNSEEN BARRIERS

Despite the rapid growth of EV adoption in India, access to safe and reliable residential charging remains constrained by a set of persistent yet often unseen barriers. These challenges are deeply embedded in legacy electrical infrastructure, housing design, governance arrangements, and socio-economic realities. While the transition to electric mobility is frequently framed around vehicle uptake and public charging expansion, the home as a primary charging site presents a more complex and uneven landscape. These barriers can be divided across five key dimensions: technical challenges, structural and spatial constraints, legal and governance issues, social and behavioural barriers, and economic barriers.

Technical barriers stem from limitations in existing electrical systems and safety readiness for sustained EV charging loads. Economic barriers include upfront and retrofit costs that make home charging less accessible, particularly for low-income users. Housing-related barriers emerge from space constraints, shared infrastructure, and design limitations in residential buildings. Governance barriers include regulatory gaps, unclear responsibilities, and coordination challenges among stakeholders. Together, these interconnected challenges shape the accessibility, safety, and scalability of residential EV charging, as explored in detail in the following subsections.

## 3.1 Technical Challenges

Technical challenges in EV charging infrastructure pose fundamental barriers in Indian residential settings, where the primary concerns are electrical capacity and load management in homes and apartment buildings. Most existing residential electrical ecosystems were not designed to support EV charging, and therefore, power grids and vehicle compatibility often fall short of emerging demands. Many residential distribution transformers already operate at 80% to 90% of their capacity during peak hours. The simultaneous addition of multiple EV chargers can easily overload local circuits and transformers if upgrades or control measures are not implemented in a timely manner. The consequences of overloading include frequent tripping of circuit breakers, voltage fluctuations that can damage sensitive electronics, overheating of wires leading to fire risks, transformer failures, and neighbourhood power outages.

A significant share of homes lack formal meter connections and instead rely on informal or shared tapping arrangements that are unsafe and incompatible with EV charging. Discrepancies in wiring and load connections often trigger the charger's built-in safety mechanisms, leading to automatic shutdowns as a protective measure. However, because consumers are often unaware of these underlying electrical issues, they may interpret the shutdown as a device malfunction and assume a faulty charger was sold to them. In reality, the shutdown is a deliberate safety feature, and the root cause usually lies in improper wiring, weak earthing, voltage instability, or metering and distribution infrastructure issues rather than in the EVSE itself. These safety mechanisms are critical to protecting the battery, the grid, and human life.

Earthing gaps remain widespread, especially in informal housing and older neighbourhoods, creating serious safety risks. Elevated N-E voltage conditions are also observed in some locations, indicating potential wiring, grounding, or upstream network issues that can trigger EVSE safety shutdown. Voltage fluctuations, both drops and surges, are common in many regions and often necessitate stabilisers or voltage regulators, thereby increasing cost and complexity. Fire safety risks are exacerbated by the absence of standardised installation layouts and protective clearances (CEA, 2023).

Another technical challenge is ensuring electrical safety and compliance with standards during charger installation, particularly given that lithium-ion batteries are prone to thermal runaway in confined spaces such as garages or basements. As EV chargers draw sustained high currents, improper wiring or substandard equipment, along with poor maintenance and inconsistent electricity supply, further reduce reliability and increase fire hazards. CEA has issued technical guidelines for EV charging infrastructure, and the new National Electrical Code provisions (2023) address EV charging safety; however, implementation on the ground remains uneven.

> Responsibility is clearly demarcated during installation. OEMs or vendors are accountable for installation-related issues, such as loose connections in the provided socket, while customers are responsible for obvious misuse, such as operating with burnt plugs or damaged cables. However, OEMs often face limitations in addressing broader infrastructure issues such as illegal electricity tapping or poor building-level wiring, which they believe require stronger enforcement from DISCOMs or government authorities.
>
> **-Vehicle OEM**

Additionally, the shortage of skilled technicians for installation and maintenance, stemming from outdated curricula in ITIs, limits prompt servicing, especially for software-related issues in home chargers. Many electricians and building managers are still on the learning curve for EV charger installations. This technical know-how gap means some early installations have been makeshift, resulting in inefficient or potentially unsafe systems.

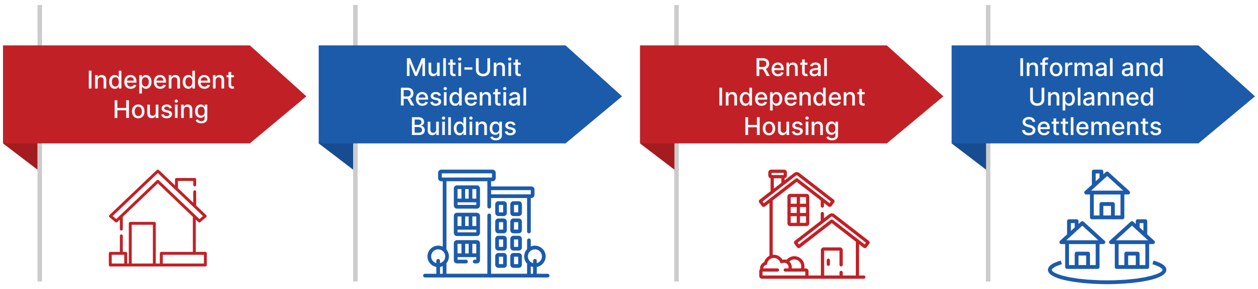
Unreliable grid supply and poor power quality in parts of India create a critical technical barrier to home charging. Frequent outages and voltage fluctuations, especially at night, disrupt overnight charging when many users, particularly in the 3W segment, rely on it. Since these drivers maximise earnings during the day and depend on nighttime charging, unstable grid conditions directly affect charging reliability and income security. Consequently, without a stable and resilient electricity supply, home charging can be less dependable.

## 3.2 Structural and Spatial Constraints

Structural and spatial constraints further complicate residential EV charging. Many homes lack dedicated parking, while apartments depend on shared basements and common electrical infrastructure. Long distances between meter rooms and parking areas increase wiring complexity and cost, and older or informal housing often faces retrofitting limitations due to physical and layout constraints.

Uneven access to charging facilities stems from these structural and spatial challenges in Indian households and communities, particularly in urban settings where space is limited. A large share of urban residents live in densely populated neighbourhoods or multi-unit buildings with limited parking space, and not all residents have access to a private parking spot where a charger can be installed. Particularly in informal housing, spatial and structural challenges are far more acute. A large number of E-2W and E-3W vehicles owned by gig workers and drivers are parked in congested or shared open spaces without designated parking. The absence of fixed parking spots makes it difficult to install permanent charging points. In addition, unclear property rights and landlord-tenant dynamics discourage permanent installations. Since many residents do not own the premises, they are reluctant to invest in electrical upgrades. These overlapping spatial, electrical, and tenure-related constraints make home charging particularly challenging in informal settings.

In gated communities and apartment complexes, structural barriers include insufficient wiring and resistance to reallocating parking spaces for chargers. Retrofitting may require laying conduits across common areas, drilling through walls or slabs, and installing long stretches of cabling, resulting in visible wiring and expensive civil works. Uncertainty around land ownership and weak enforcement of parking regulations further complicate installations, as many on-street parking areas are informal and do not permit activities such as charging (Konda and Karuturi, 2024).




Each of the above categories includes households with parking space and those without access to parking.

## 3.3 Legal and Governance Issues

While evolving, India's legal and governance frameworks pose significant roadblocks to residential EV charging, often due to fragmented policies and delays. The MoP Guidelines (2024) affirm the right of residents to install private charging points in their designated parking spaces, drawing power either from their existing meter or a dedicated sub-meter (MoP, 2024). Despite this clarity, the legal provision is frequently countered by RWA resistance rooted in perceived safety and financial risks rather than compliance, resulting in continued challenges in securing approvals and compliance at the local level (Konda and Karuturi, 2024). In rental housing, tenants frequently lack permission to modify electrical infrastructure, while landlords are reluctant to invest in upgrades that primarily benefit tenants. Ownership ambiguities and inconsistent housing society rules create additional friction, despite national-level EV policy support (NITI Aayog, 2021).

> EV readiness should be integrated at the building approval stage itself, with dedicated space and load allocation similar to transformer provisions. Billing through individual apartment meters is preferable to avoid disputes over common area electricity. Standardisation of charging units across OEMs is also important.
>
> **-Vehicle OEM**

In 2019, MoHUA amended the MBBL Model Building Bye-Laws, 2016, to incorporate provisions for EV charging infrastructure (Amendment in Model Building Bye-Laws 2016, 2019). The purpose of this proactive policy was to "future-proof" new construction for EVs; however, many state governments have been uneven in implementing and enforcing these model clauses. Furthermore, the bye-laws primarily address new construction, while the framework for retrofitting older units remains less defined and frequently depends on unplanned choices made by RWAs or local authorities. This ambiguity surrounding retrofitting has emerged as a significant barrier to residential charging adoption.

At the same time, some corrective measures are emerging. For instance, the KERC has mandated streamlined procedures addressing long-standing difficulties faced by EV owners and RWAs in installing charging points in apartments, disallowing unreasonable objections and ensuring tariff clarity, thereby easing charger installation in both existing and new apartment buildings (Kaggare, 2024).

India's policy and regulatory environment is gradually evolving to support residential EV charging through model bye-laws, MoP directives, and state-level orders, but enforcement remains uneven. Residential charging functions as shared urban infrastructure and requires coordination among DISCOMs, ULBs, and housing departments. In practice, however, institutional roles are often fragmented: DISCOMs oversee connections and load approvals, ULBs regulate building compliance, and housing societies control on-ground access. The absence of clearly defined enforcement authority, weak coordination mechanisms, nonmandatory obligations for housing societies, and single-window clearance processes collectively delay implementation, while cautious safety enforcement further slows adoption.

## 3.4 Social and Behavioural Barriers

Social and behavioural barriers play a significant role in residential EV charging adoption; however, these challenges largely arise from persistent technical and governance uncertainty rather than standalone obstacles. For both EV and non-EV users, apprehension around installing chargers often stems from perceived safety risks, concerns about fire hazards, and ambiguity about liability in the event of technical failure.

In India's community-centric housing culture, decisions are often collective; hence, the mindset of neighbours and managing committees can determine the success or failure of an individual's plan to install an EV charger. Social and Behavioural factors significantly impede EV charging adoption in Indian homes, rooted in awareness gaps and psychological concerns. A prominent issue is the lack of awareness and the prevalence of misconceptions about EV charging among residents and housing societies. These concerns stem from unfamiliarity with the technology, rules, process and liabilities, often creating a hesitation around EV charging within some communities.

Cultural habits and user behaviour patterns also influence charging practices. Range anxiety or the fear of running out of charge remains a top deterrent, particularly in residential settings lacking reliable home charging, where users have limited confidence in public charging alternatives (NITI Aayog, 2021). Adapting to this new routine requires a behavioural shift. Improving the perception of home charging as a simple, automated process no harder than parking the vehicle is important to reduce such anxieties.

The shift from service-oriented refuelling to self-managed charging requires greater awareness, as many residents lack clarity on proper usage. In gated communities, resistance from non-EV owners toward shared costs further adds to social friction.

Addressing these challenges requires sustained awareness and trust-building initiatives. State agencies in India are being urged to conduct campaigns on EV charging safety and benefits. Building confidence will also require clear policies, well-defined rules for shared infrastructure, transparent approval processes, and explicit clarity on ownership and liability among homeowners, housing societies, installers, and DISCOMs. Without such institutional clarity, social resistance in shared residential environments is likely to persist (Konda and Karuturi, 2024).

> Think tanks and civil society organisations can support ecosystem readiness by developing and delivering training modules for electricians, RWAs, and community leaders and creating awareness. Existing solar training frameworks can be adapted to accelerate EV readiness.
>
> **-Policy Expert**

## 3.5 Economic Barriers

Residential charging is typically two to three times cheaper per kWh than public charging, depending on state tariffs and charger type, making it the most cost-effective option for users and a critical determinant of total cost of ownership. However, many Indian households find home EV charging to be unaffordable due to high upfront expenses and unpredictable returns. Hidden costs in residential settings, such as MCB upgrades and voltage stabilisers, further increase the financial burden, particularly for low-income families (NITI Aayog, 2021). When these costs must be borne individually, they can be prohibitive, effectively raising the cost of EV ownership, especially for gig workers and delivery personnel, for whom such additional expenses are significant. Charging becomes even more expensive when safety gaps, housing design limitations, and governance inefficiencies shift further costs onto users.

In multi-unit housing, expenses may include new electrical panels or dedicated meters, long armoured cable runs to parking areas, and retrofitting in buildings not originally designed for EV readiness. Where grid voltage is unstable, households may need stabilisers, even though a stable supply is fundamentally a utility mandate. Similarly, costs related to load enhancement, new meters, and unclear approval processes arise from regulatory and coordination gaps. Housing societies often lack dedicated funds for such infrastructure, making these capital expenditures difficult to absorb. In some cases, the lack of a dedicated sub-meter for EV charging prevents users from availing special discounted EV tariffs offered by DISCOMs (Konda and Karuturi, 2024).

> Post-construction requests for EV charging are becoming common, but upgrading infrastructure later is difficult. If even 30–40% of residents seek charging, it requires upgrading transformers, cables, and space, and increasing sanctioned load from the utility is a major hurdle for older buildings. Current building bye-laws are mostly guidelines, so many projects do not implement EV-ready provisions in practice.
>
> **-Real Estate Developers**

Another economic challenge is the lack of tailored financing options for residential EV infrastructure. Installing chargers in a multi-unit building can be viewed as a long-term infrastructure investment that enhances property values and benefits future residents; however, traditional financing for such projects remains uncommon. Encouragingly, some innovative financing models are emerging. Several Indian states, including Delhi and Maharashtra, provide capital subsidies or financial support for home EV charging infrastructure, though the support varies significantly by state. Yet, without incentives for retraining or upgrades, reluctance persists, especially in societies debating the allocation of costs between EV users and others (NITI Aayog, 2021).

Overcoming these hurdles requires an integrated approach that includes upgrading technical infrastructure, making installations financially viable, strengthening policies and enforcement, adapting building designs, and cultivating a supportive social environment. India can only build EV-ready homes and apartments nationwide by addressing the technical, economic, regulatory, structural, and behavioural aspects simultaneously, enabling customers to conveniently charge and drive the electric revolution forward.

**Table 1: Barriers to Residential EV Charging**

| **Technical Barriers** |
|---|
| **Electrical Capacity and Load Management**<br>Most residential electrical systems are not designed for sustained EV charging loads, leading to potential circuit overloading, voltage instability, and transformer stress, especially at peak hours. |
| **Installation Safety and Standards Compliance**<br>EV chargers draw sustained current, increasing fire and electrocution risk when wiring quality, earthing, or protective devices are inadequate. |
| **Charger Compatibility and Power Quality**<br>Fast charging at home can accelerate battery degradation for most E-2W/ E-3W platforms optimised for slow charging. Grid unreliability and voltage fluctuations further undermine charging reliability. |

### Shortage of Trained Technicians

A lack of trained personnel leads to uneven installer capability, resulting in makeshift or sub-optimal installations that compound safety risks.

## Structural and Spatial Barriers

### Acute Space Constraints

A significant portion of urban households lack dedicated private parking suitable for charger installation.

### Apartment Complex Challenges

Retrofitting existing complexes faces issues like insufficient common area electrical capacity, high costs for long cable runs and civil work, lack of standardised wiring pathways, and resistance to repurposing parking spaces.

## Legal and Governance Barriers

### Fragmented Regulatory Framework

Evolving but fragmented guidelines lead to implementation failures due to resistance from Resident Welfare Associations (RWAs), unclear responsibilities, and coordination gaps with DISCOMs.

### Inconsistent Enforcement

Adoption and enforcement of Model Building Bye-Laws for EV provisions in new construction remain inconsistent across states.

### Process Delays and Uncertainty

The absence of single-window approval processes, inconsistent safety enforcement, and evolving certification standards contribute to significant delays and uncertainty for installations.

## Social and Behavioural Barriers

### Lack of Awareness

Limited awareness of guidelines and available incentives, often leads to the denial of charger installations.

### Collective Decision-Making and Misconceptions

Decisions are often collective in housing societies, where misconceptions about fire risk, cost allocation, and grid impact create resistance.

## Economic Barriers

### High Upfront and Associated Costs

Beyond the charger, significant costs arise from required wiring upgrades, protection devices, stabilisers, and metering.

### Inability to Access EV Tariffs

The inability to access cheaper, EV-specific tariffs due to a lack of sub-metering undermines potential energy savings.

> While home charging remains the ‘peace of mind’ standard, especially for L5 3Ws access to suitable installation locations is still a challenge for nearly 15–20% of customers, particularly those living in rented or shared accommodations. E-autorickshaw drivers often lack dedicated parking, and apartment complexes or RWAs sometimes create barriers for installing chargers even for 2Ws.
>
> **-Vehicle OEM**


kazam

# 04

# CASE STUDY ON RESIDENTIAL EV CHARGING

This chapter examines the ground-level barriers to residential EV charging in India using Kazam's proprietary dataset. This dataset represents one of the largest operational records of home-based EV charging infrastructure globally and provides rare empirical insight into electrical, spatial, and governance-related challenges that remain largely absent from formal policy discourse.

As a leading operator at the intersection of EV charging and energy management, Kazam has enabled tens of thousands of home charging installations across diverse housing types. This on-ground experience reveals a critical insight: the biggest barrier to EV adoption is not lack of infrastructure, but the prevalence of unsafe charging practices. Many users rely on standard home sockets, extensions, or informal setups that are not designed for sustained EV loads, leading to safety risks and unreliable charging.

The analysis is supplemented with structured stakeholder consultations, technician field surveys, standardised installation checklists, photographic documentation, and semi-structured consumer interviews conducted during installation, troubleshooting, and post-installation support. These sources enable triangulation between technical site conditions, user behaviour, and institutional processes, allowing this study to move beyond abstract readiness metrics toward the lived realities of EV adoption.

## 4.1 Field-Level Insights from Kazam's Home Charger Deployments

### 4.1.1 Overview of Kazam's Charger Portfolio

Kazam offers a diversified portfolio of EV charging solutions spanning AC and DC systems. Its flagship product, the Kazam Zip Mini, is a 3.3 kW AC home charger primarily designed for E-2W and E-3W, with increasing adoption among LEVs and select 4W. A significant proportion of newly sold E-3W in India are bundled with a Kazam Mini chargepoint.

The Kazam Mini is a compact, wall-mounted unit equipped with a combination 6/16 A or a 16A three-pin socket compliant with IS 1293:2019 standards. It delivers 230 V AC at 16 A and is housed in a flame-retardant PC-ABS enclosure. Embedded safety mechanisms include a RCD, overcurrent protection, short-circuit cut-offs, and over-voltage and under-voltage safeguards.The device is IoT-enabled, supporting Bluetooth, Wi-Fi, and optional 5G connectivity.

Beyond the Kazam zip Mini, Kazam's portfolio includes a LEV AC charger, a 7.4 kW single-phase AC charger with a Type-2 connector and a 22kw unit three-phase AC charger currently under development, also featuring a Type-2 connector. The portfolio further includes DC chargers ranging from 3–8 kW, with a 12 kW unit for LEVs.

### 4.1.2 Hardware Architecture and Safety-Centric Design

Kazam's hardware design philosophy emphasises safety, reliability, and usability for everyday charging. Each charger integrates multiple layers of electrical protection. In the Kazam Zip Mini, these include a built-in RCD, overload protection, input and output parameters threshold protection, earth presence detection, quality control and short-circuit cutoffs.

In cases of grid instability, the charger automatically pauses operation until voltage parameters normalise. Severe earth-fault events terminate charging entirely. These features are particularly critical in the Indian context, where voltage fluctuations, inconsistent earthing, and ageing household wiring remain common. User-centred design modifications include a physical push-button interface, enabling a "plug-and-charge" experience without reliance on smartphone applications. A colour-coded LED indicator system communicates operational status and fault categories using standardised blink patterns, enabling basic diagnostics without network access. Additionally, an LED blinking status template sticker affixed to the Kazam Zip Mini charger provides clear guidance to users in situations where charging does not occur.

### 4.1.3 Digital Infrastructure: Charger Management System

Kazam operates a proprietary CSMS that enables real-time monitoring, diagnostics, and remote troubleshooting of IoT-enabled chargers. The CSMS dashboard displays device status, firmware versions, uptime metrics, historical charging sessions, and voltage-current profiles.

Support engineers can remotely identify grid-related faults, hardware malfunctions, and abnormal charging behaviour. In certain cases, faults can be reset remotely, reducing downtime and without physical field visits.

Chargers lacking IoT capability are recorded in an internal tool that maintains installation, ownership, and configuration details; however, this information is treated as confidential, with access restricted to authorised personnel and governed by internal data protection protocols.

### 4.1.4 Customer Support Operations

Kazam's customer support is structured as a multi-channel, process-driven system supported by an in-house ERP ticketing platform. Support is delivered through phone, chat, email, and field visits, with agents following hierarchical troubleshooting protocols that begin with basic checks such as power availability, LED fault patterns, and correct vehicle settings. Remote resets and CSMS-based diagnostics are typically attempted before cases are escalated to field technicians.

In principle, residential EV charging should conclude at the point of installation. In practice, however, ongoing user support interactions form a critical layer of the ecosystem, offering real-world insight into how homes, vehicles, and electrical systems interface. Data from customer interactions reinforces this observation. The most frequently reported issues include MCB or breaker trips, earthing and grounding faults, voltage-related problems, and instances of socket burn or melting. Network-related concerns, such as devices going offline, are also reported but are comparatively less dominant.

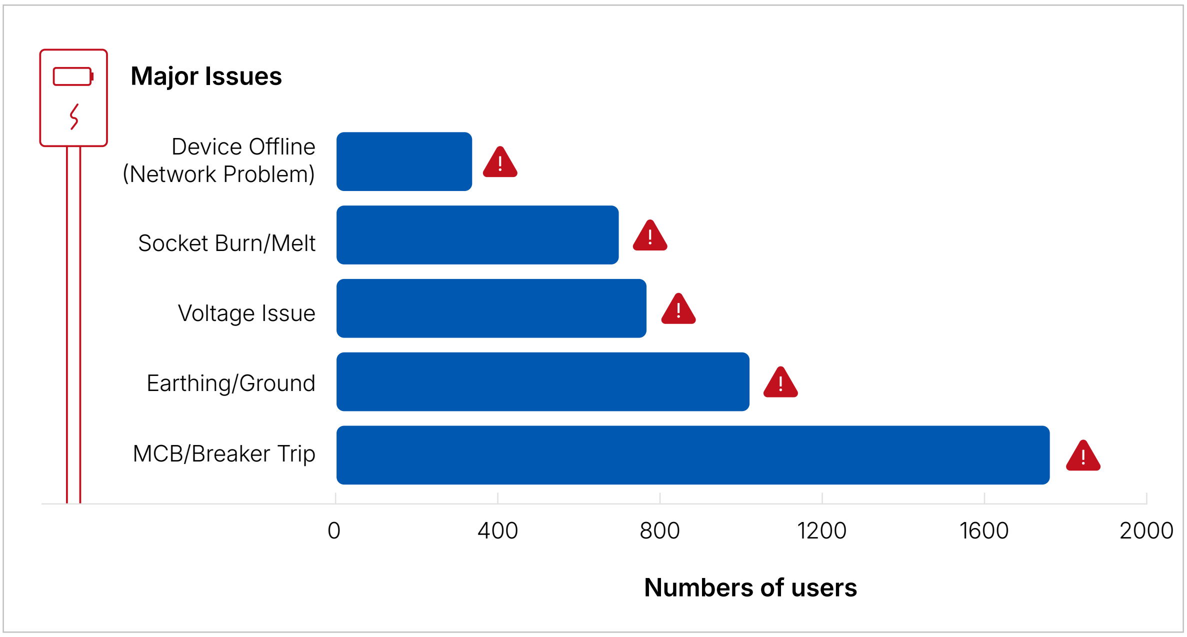



Figure 5: Major Issues Reported on the Consumer Portal

A significant share of these issues arises not from charger hardware failure but from system-level interactions, including unstable voltage conditions, inadequate earthing, household wiring limitations, and safety-triggered interruptions such as breaker trips. These patterns highlight that charging performance is shaped as much by the surrounding electrical environment as by the device itself.

Overall, post-installation engagement suggests that EV readiness extends beyond charger deployment. Reliable charging depends on stable grid conditions, proper earthing and load management within homes, and alignment between vehicle safety systems and real-world electrical infrastructure. These findings underscore the need for improved installation standards and guidelines, clearer coordination across stakeholders and stronger user awareness.

> While charger OEMs are primarily responsible for installing charging equipment, they are often compelled to address underlying grid and housing issues such as inadequate earthing, voltage fluctuations, and load constraints.
>
> **-Technical Expert**

### 4.1.5 Ground-Level Insights from Kazam Zip Mini-Deployments

The residential charging ecosystem is currently navigating a critical inflection point. While the volume of installations is robust, with thousands of successful deployments across diverse states such as Uttar Pradesh, Assam, and Maharashtra, the supporting infrastructure remains under significant stress. This stress arises not from the charging units themselves, which are largely standardised 3.3 kW AC devices, but from the heterogeneous and often non-compliant nature of the legacy electrical infrastructure in Indian households. The analysis of field data indicates that successful charger deployment is frequently impeded by systemic issues such as neutral leakage, absence of earthing, and voltage instability. Consequently, the role of the installation company has evolved from a mere hardware vendor to a critical grid-interface consultant.

### 4.1.6 The Statistical Landscape: Adoption Patterns and Demand Drivers

To understand the operational pressures on the installation ecosystem, it is essential to contextualise the volume and nature of the demand. Kazam's deployment data shows that residential charging rather than public charging constitutes the primary usage mode for E-2Ws and E-3Ws in India. Installations are heavily concentrated in semi-urban and peri-urban districts with high 3W density. For example, Cachar (Assam) and Bareilly (Uttar Pradesh) recorded 4,401 and 3,369 installations, respectively, within the dataset. These deployment trends indicate that primarily a large-scale of E-2Ws and E-3Ws lie outside metropolitan cores. Accordingly, these regions should be treated as an immediate priority for targeted infrastructure interventions.

### 4.1.7 Residential Readiness Before Charging Begins

Despite some supportive national and state EV policies, several implementation gaps continue to affect residential EV charging on the ground. Field observations indicate that EV adoption is often progressing faster than the supporting residential and electricity infrastructure required to enable reliable daily charging.

**Grid Reliability:** The installation logs, especially from urban tier-2 cities, frequently cite "electricity cuts" as a reason for incomplete installations. These observations show that electricity supply interruptions continue to affect residential EV charging readiness in several regions. Despite policies mandating 24×7 power supply, technicians are sometimes unable to complete testing and commissioning because power is unavailable during the installation window.

**Sanctioned-load and metering delays:** Deployment data also show instances where installations remain pending because the "Meter Issue" or "load upgrade" has not been completed by the utility provider. These observations indicate that many households require sanctioned-load upgrades or metering modifications before EV charging can be enabled safely and reliably, particularly as charging demand begins to exceed traditional residential electricity usage patterns.

**Standardisation Enforcement:** Installation observations show that poor domestic wiring and non-standard electrical conditions remain recurring reasons for deferred or rejected installations. These cases indicate that many residential environments are still not fully prepared for sustained EV charging requirements. In practice, installation teams often become the first point at which underlying electrical safety and readiness gaps are identified during the charging setup process.

### 4.1.8 What Charger Faults Reveal About Residential Electrical Readiness

Once daily EV charging begins, the post-installation charging interruptions provide an important diagnostic view of residential electrical readiness. In many cases, what appears to be a charger fault is actually the charging system responding to underlying electrical conditions such as loose contacts, weak earthing, neutral leakage, voltage variation, or upstream supply issues. These early charging interactions reveal how residential electrical systems behave under sustained EV charging conditions and highlight the importance of dedicated EVSE-based charging pathways for managing charging more safely and reliably.

**The "Socket Burnt" Phenomenon:**

Unlike many household appliances where plugs often remain connected for long periods, EV charging involves frequent plugging and unplugging, often multiple times a day. This repeated use can loosen socket contacts, reduce grip strength, and increase contact resistance, especially where socket quality is poor or handling is rough.

Field data indicates that prolonged, high-frequency EV charging on residential circuits can expose underlying weaknesses in wiring and connector quality. Factors such as poor socket grip, dust accumulation, oxidation, worn contacts, loose plug insertion, and repeated mechanical use can increase contact resistance at the charging point. Under sustained charging loads of around 3.3 kW over several hours, even minor resistance at weak contact points can generate significant localised heat, leading to thermal degradation, deformation, or failure of standard domestic sockets.

EV-rated sockets and dedicated EVSE-based charging pathways are better suited to such duty cycles because they are designed for stronger contact integrity, repeated use, and safer long-duration operation. The "socket burn" phenomenon should therefore be understood as a combined outcome of socket quality, charging cycle and frequency, and user behaviour.

**Why EVSE Safety Shutdowns Matter:**

Another recurring pattern across residential charging environments is the presence of issues such as "Neutral Leakage" and "Stray Voltage". In many Indian households, particularly in semi-urban areas, improper grounding of the neutral at the distribution transformer or within the household can result in a floating neutral condition. This situation leads to unstable grounding and voltage references leading to potential charging reliability and safety risks.

Modern EVSE incorporates protective mechanisms that actively respond to abnormal grounding and voltage conditions. They continuously monitor the voltage difference between Neutral and Earth, and if this exceeds a defined safety threshold (typically 5–20V), the charger automatically shuts down. While customers often interpret this as a "Device Fault," it is in fact a deliberate safety response of the EVSE designed to prevent hazardous situations such as electrical shock, overheating, equipment damage, and unsafe charging conditions.

Importantly, these safety-triggered interruptions are not device-level issues but indicators of deeper infrastructure variability. They effectively surface inconsistencies in household wiring and grid grounding practices that would otherwise remain undetected.

Post-installation issues offer a robust "health check" of residential charging systems. The principal categories of issues, observed symptoms, and root causes are summarised below:

Table 2: Charging Interruptions as Indicators of Electrical Readiness Gaps

| User-Reported Issue | Observed Symptoms | Underlying Electrical Condition |
|---|---|---|
| Socket burnt / melted | Physical damage to the charging point; plug stuck. | High continuous current (16 A) through loose contact, dust/oxidation, or substandard domestic sockets, leading to heat build-up under long charging duty cycles. |
| Charger not powering on / no power | LEDs off; Vehicle not charging and Tripped MCB | Loss of power due to protective disconnection, typically linked to circuit overload, undersized wiring, earth fault, short circuit, or upstream supply interruption |
| Earthing / neutral leakage fault | Red blinking LED; Device refuses to start. | High Neutral-to-Earth voltage (>5V). Systemic grid issue or broken neutral wire in the household circuit. |

These issues are not isolated faults. They are indicators of broader electrical readiness gaps in residential environments. Taken together, these patterns show that residential EV charging cannot be treated as a simple plug-point activity. Long-duration charging requires a protected electrical pathway, appropriate connectors, reliable earthing, and visibility into charging behaviour. This is where EVSE plays a critical role: it does not merely supply power, but helps detect unsafe conditions and manage charging more reliably.

### 4.1.9 What Sustained Daily Charging Reveals Over Time

Beyond individual charging issues, the data reveals broader patterns about how residential electrical systems behave under real-world EV charging conditions at scale.

**The 3W Stress Test: Why 3W Charging Should Define Residential EV Readiness?**

Kazam's data introduces the concept of a '3W Stress Test' for residential charging. Commercial E-3Ws typically charge daily for long durations, often overnight for 4–6 hours continuously, day after day, creating a near-commercial charging load within residential environments.

This charging pattern accelerates the manifestation of infrastructure weaknesses, including thermal stress, earthing deficiencies and load-capacity failures. In practice, this makes the commercial 3W segment an important real-world benchmark for assessing residential charging readiness. The findings suggest that residential charging standards, deployment strategies, and connector specifications should be designed around high-utilisation charging environments, rather than occasional personal charging alone.

**Why Many Charging Interruptions Are Misinterpreted**

A significant proportion of reported charging interruptions are ultimately traced to local electrical or operating conditions rather than hardware failure. Common examples include power supply interruptions such as tripped MCBs, unstable voltage conditions, weak earthing, or situations where standard charging conditions are not met.

As a result, many users often interpret these interruptions as charger defects, even though the underlying issue may lie within the surrounding residential electrical environment. This highlights an important aspect of residential EV charging: charging reliability depends not only on the charger itself, but also on the quality and stability of the electrical ecosystem supporting it.

These conditions often remain invisible to users until charging becomes unreliable. For individuals who depend on EVs for daily commuting or income generation, such interruptions directly affect mobility reliability and everyday routines. Conditions such as poor earthing, overheating sockets, or unstable voltage environments can also create broader household electrical safety risks if left undetected. Modern EVSE systems are designed to identify and respond to such abnormal electrical conditions. In this way, EVSE functions not merely as a charging device, but as an important monitoring and protection interface between the vehicle, the home, and the broader electricity system.

## 4.2 Charging Practices of E-3Ws using Kazam Mini Chargers in Tier-2 Cities

**Field Visit 1: Tier-2 City in Assam**

In 2025, Assam recorded approximately 85,000 total EV sales, resulting in an overall EV penetration of approximately 14.3% in the state. Notably, E-3W accounted for nearly 80,000 of these sales, with an exceptional penetration rate of 94.48%, representing the highest E-3W penetration among all Indian states. This remarkable uptake has been driven primarily by lower daily operating costs, improved driving comfort, and fiscal incentives provided under the Assam EV Policy 2021. However, charging practices vary significantly depending on housing type, ownership status, and access to electrical infrastructure.

This section analyses charging arrangements for E-3W in a tier-2 city in Assam based on field visits, technician interviews and driver interactions. The objective is to understand how housing typologies influence charging access, costs, safety practices, and user experience, and to identify key barriers and enablers for scaling E-3W adoption.

### 4.2.1 Technical and Installation Insights

Technician interviews indicate that most households are capable of supporting EV charging at a basic level. However, important technical and safety gaps exist that, affect long-term reliability and operational safety of residential EV charging.

Figure 6: EV Charging Infrastructure Samples in Assam

Key Observations from Installations

- **Earthing:** Proper earthing is often absent or inadequate and is identified by technicians as the most critical missing safety element.
- **Wiring Quality:** Electrical wiring quality varies significantly across households. While 2.5 sq. mm copper wiring is often treated as a minimum benchmark for low-power EV charging, technicians typically recommend 4 sq. mm wiring to handle sustained loads, reduce voltage drop, and minimise overheating risks, especially in Assam's tropical climate.
- **Load Capacity:** Load upgrades are sometimes required for EV charging but are not always pursued by EV users due to cost or procedural barriers.
- **Voltage Fluctuations:** Voltage instability exists in select areas. In such locations, technicians recommend installing voltage stabilisers to protect chargers and vehicle batteries.
- **Charger Capacity:** A 3.3 kW charger was found to be sufficient for most E-3W, aligning well with their battery size and daily usage patterns.

- **Cable Management:** Cable runs from the distribution box are typically limited to a maximum of 5 meters to minimise short-circuit and overheating risks.
- **Installation Height:** Safety standards require chargers to be installed at a minimum height of 1.5 meters from ground level to prevent water ingress and accidental contact.
- **Metering Infrastructure:** Electricity meters are available in most households across the city. In specific housing typologies, such as railway quarters or institutional housing, individual meters may not be present, creating operational challenges.

### 4.2.2 Analysis by Housing Typology:

**Owner-Occupied Houses with Charging Space**

In owner-occupied houses, home charging is relatively straightforward. The availability of a dedicated parking space determines practical access and enables easier adoption of charging. Users typically connect chargers to the main distribution box, often with a sub-meter to track EV electricity consumption. Charging costs are the lowest in this category, averaging approximately INR 50 to 80 per charging session. An additional one-time cost of approximately INR 1,000 to 2,000 is incurred, primarily for the wiring required to connect the main distribution box to the charger.

Figure 7: Owner-Occupied Houses with Charging Space

The main challenge observed relates to missing or inadequate earthing, which often needs to be installed during charger setup. Currently, chargers are used for personal vehicle charging. However, in the future, these chargers could serve both personal and commercial charging needs, depending on the availability of charging space.

**Rented Houses with Charging Space and Owner Consent**

Many EV drivers reside in rented accommodations, where installing a charger typically requires explicit permission from the property owner. In most cases, installations are carried out with minimal structural modifications, ensuring that the setup can be removed or reversed if the tenant relocates. However, additional costs are often incurred, primarily for wiring, depending on the distance from the meter and the condition of the existing electrical infrastructure. Installation and earthing are typically handled by the Kazam team as part of the charger package, ensuring standardised and safe deployment. In some cases, metering clarity also influences costs. Where the owner and renter share the same electricity meter, sub-meters are installed to enable accurate tracking and fair cost allocation. For drivers who relocate, there is an additional relocation cost. This includes expenses for dismantling, reinstallation, and often fresh wiring and earthing at the new location, making portability a practical but additional cost consideration for home charging.


Figure 8: Rented Houses with Charging Space

### Rented Houses Without Charging Space

Drivers living in rented houses in hilly regions or dense housing without parking spaces were unable to install home chargers. These EV users relied on alternative charging locations, such as employer premises or nearby public or semi-public charging points. This group incurred higher charging costs, typically ranging from INR 80 to 120 per charging session. The lack of parking space emerged as a critical non-technical barrier to home charging adoption.


Figure 9: Rented Houses without Charging Space

### Shared Rental Charging Hubs

Shared charging hubs with multiple charging points play a critical role in bridging access gaps for EV users who lack reliable home charging. By offering designated parking along with charging access, they particularly support households without dedicated parking or electrical infrastructure.

These hubs are generally designed with proper internal wiring, busbar distribution systems, and earthing arrangements to ensure safe operation under continuous load, although some installations still lack these essential features. They cater to both personal and commercial charging needs, making them versatile assets within the ecosystem.

Higher installed electrical loads, typically 10-17 kW, enabled multiple vehicles to charge simultaneously. Shared hubs operate on pre-defined charging tariffs, providing cost transparency and predictability for users. Charging tariffs are generally around INR 120 per session, providing a modest margin over electricity costs. At field work, it was also found that some hubs also rely on domestic sockets for E-3W charging. These setups often operate without clear regulatory oversight or adequate safety measures, highlighting the need for stronger standardisation and alignment with electrical safety norms.

Overall, these hubs demonstrate that small, privately operated charging facilities can be commercially viable while maintaining affordable access to charging, if safety and infrastructure practices are consistently improved.

E-3W charging in Assam is technically feasible across most housing typologies, but residential charging readiness remains uneven. Rental housing constraints, lack of dedicated parking, household electrical configurations, and grid reliability continue to shape how and where EV charging can take place. Cost dynamics further shape user behaviour, with home charging emerging as the most affordable and preferred option wherever feasible. In effect, homes and residential buildings are gradually becoming part of the mobility infrastructure supporting India's EV transition. Rental charging hubs, while more expensive, remain a viable and often necessary alternative for users without stable home access.

Addressing these gaps will require improving residential electrical readiness, increasing awareness among landlords, promoting modular and portable charging solutions for renters, and supporting the development of safe, standardised small-scale rental hubs in the neighbourhoods for users without access to reliable residential charging.

Figure 10: Shared Rental Charging Hubs

**Field Visit 2: Tier-2 City in Rajasthan**

In 2025, Rajasthan recorded approximately 114,000 total EV sales, resulting in an overall EV penetration of 6.8%. Notably, E-3W accounted for around 23,000 of these sales, with a penetration rate of 51.63%. There has been significant growth in E-3W adoption since the launch of the Rajasthan EV Policy 2022, driven primarily by the fiscal incentives and policy support measures introduced by the state government.

This section analyses charging arrangements for E-3W in a tier-2 city in Rajasthan, based on field visits, technician interviews, and driver interactions. Significant voltage fluctuations and earthing issues were observed, directly affecting drivers' daily operations and earnings because of their reliance on consistent vehicle use. Earthing challenges are particularly prominent in parts of Rajasthan where many houses are located on rocky terrain or small hillocks. The presence of hard rock, shallow soil depth, and high soil resistivity makes proper earthing both difficult and time-consuming.

**Self-Owned Houses with Parking/ Charging Space**

Most households during the field visit were owner-occupied and had access to charging space. Drivers typically charge their EVs using domestic electricity connections. The applicable tariff structure is INR 4.75 per unit (0–50 units), INR 6.50 per unit (51–150 units), and INR 7.00 per unit (151–300 units), making home charging relatively affordable. Daily usage ranges from approximately 100 to 130 km, with most drivers undertaking one to two charging sessions per day, usually an overnight charge supplemented by a mid-noon top-up when required. They had some form of parking space. Although lanes are often narrow, vehicles are typically parked and charged outside homes.

Field observations indicate recurring earthing issues and elevated phase-to-earth voltage levels across many households. These irregularities can lead to charger malfunctions, overheating of sockets, and potential fire safety risks, necessitating thorough inspection and corrective measures to ensure safe and reliable EV charging.

In one of the households, the driver experienced low voltage issues during initial use, with supply levels frequently dropping to around 180–190 V. Low-voltage conditions can significantly increase EV charging time, reducing charging efficiency and reliability. This challenge becomes particularly critical in shared residential charging scenarios, where multiple vehicles depend on strict charging schedules to ensure uninterrupted daily operations and income continuity. To address this, a stabiliser was installed, which improved the voltage to approximately 210 V, enabling more stable charging.

However, the system continues to face earthing-related challenges, which affect charging reliability and, in turn, disrupt the driver's daily operations and income. In some locations, drivers reported frequent charging issues at night, while charging worked normally during the day. These observations highlight the sensitivity of EV charging to local electrical conditions. While voltage stabilisers can partially mitigate supply fluctuations, inadequate earthing remains a critical safety and performance concern.


**Figure 11: Owner-Occupied Houses with Charging Space in Tier-2 City in Rajasthan**

#### Owner-Occupied Houses without Parking/ Charging Space

Drivers living in dense housing areas without dedicated parking spaces are often unable to install home chargers because of narrow lanes and spatial constraints. Electrical readings showed significant supply irregularities, with Phase-Earth recorded voltage at 283 V and Phase-Neutral at 255 V, both exceeding safe operating levels. These conditions suggest voltage fluctuations or broader supply quality issues. To charge the vehicle, the driver relied on an extension socket connected outside the lane using additional wiring.

The use of extension sockets for EV charging pose significant safety risks, particularly in cases of voltage fluctuation, poor-quality wiring, or electrical overloading. These conditions can lead to overheating and increase the risk of electrical fires. This highlights the importance of connecting EV chargers directly to properly rated, dedicated sockets equipped with adequate electrical protection to ensure safe and reliable charging.


Figure 12: Owner-Occupied Houses without Charging Space

#### Informal Housing

Informal housing segments face significant technical barriers, including voltage fluctuations, inadequate earthing, and limited access to metered electricity connections. Field insights indicate that these issues can disrupt charging operations, with chargers often halting automatically in response to unsafe electrical conditions to prevent vehicle battery damage. Instances of electrical failures, such as MCB burnouts, further add to user costs. In response, some users shift to charging through standard domestic sockets, bypassing built-in safety mechanisms. Such patterns not only increase financial risk but also weaken user confidence in EV technology.


Figure 13: Informal Housing with Charging Space

The Rajasthan field observations show that when residential electrical conditions become unreliable, EV users often adapt by shifting toward informal and potentially unsafe charging practices. Voltage fluctuations, inadequate earthing, lack of dedicated charging space, and charging interruptions were found to push some users toward extension-based charging arrangements or direct domestic socket usage, bypassing built-in safety mechanisms intended to protect the vehicle, the household, and the electrical system.

These patterns highlight an important transition challenge: when safe and reliable charging infrastructure is not consistently available, users prioritising livelihood continuity may adopt charging practices that increase long-term electrical and safety risks. The findings therefore suggest that improving residential electrical readiness and charging reliability is not only a technical requirement, but also critical for preventing the gradual normalisation of unsafe charging behaviour as EV adoption scales.

### 4.2.3 Residential EV Readiness Policy Implications

As EV charging becomes a sustained residential electricity load rather than an occasional appliance load, residential electrical readiness will increasingly need to be integrated into urban electrification, housing, and mobility planning frameworks. This requires a broader discussion on what "EV-ready" residential environments should mean in the Indian context, particularly across diverse housing typologies and electricity conditions.

Field survey findings indicate that the most common failure modes include poor or missing earthing, voltage instability, degraded wiring quality and unsafe charging connections. In some locations, the supply voltage fluctuated between 90 V to 265 V, and in some cases, the N-E voltage reached 65 V. These issues directly affect charging reliability and therefore influence user confidence in relying on EVs for daily commuting and income-generating activities.

Addressing these challenges will require coordinated action across multiple stakeholders, including DISCOMs, local urban bodies, vehicle OEMs, charger OEMs, RWAs, standards bodies, installers, and EV users themselves. This coordination will be important both at the stage of new residential construction through EV-ready building bye-laws, as well as in retrofitting existing residential environments for safe and reliable EV charging.

> Kazam typically provides a dedicated home charging kit, including high-quality wiring, a 16A EV rated socket, an MCB, and earthing components. A pre-installation inspection is part of the standard process, during which Kazam technicians verify phase-neutral voltage and ensure proper earthing before commissioning. In most cases, installation is completed within 48–72 hours of vehicle delivery, with compliance rates of around 85–90%.
>
> In addition, Kazam deploys a network of trained field personnel, often referred to as Kazam Rangers, and conducts structured training and upskilling programs for local electricians. These initiatives strengthen last-mile installation capacity, ensure adherence to safety standards, and enable scalable, decentralised deployment of residential charging infrastructure.
>
> **-Kazam**

# 05

# TOWARDS A NATIONAL FRAMEWORK FOR EV-READY HOMES

India already has multiple standards, guidelines, and regulatory provisions that address different aspects of the residential EV charging ecosystem. These include the Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure, 2024, issued by the Ministry of Power; the Central Electricity Authority Regulations on the measures relating to safety and electric supply, 2023; the Electricity (Rights of Consumers) Rules, 2020; MBBL, 2016 and subsequent amendments; BIS standards such as IS 3043:2018 for earthing and IS 732 for electrical wiring installations; as well as various state-level electricity supply codes, fire safety regulations, and EV policies.

A recent example of this regulatory landscape is the April 2026 amendment to the Haryana Building Code, 2017, which mandates at least one EV charging spot for every five parking slots and requires 100% EV-ready conduit provision in new and renovated residential group housing societies. The amendment also permits charging infrastructure in basements and stilt floors, subject to compliance with fire and electrical safety requirements, and extends provisions to existing buildings where individual allottees wish to install charging equipment. However, while the amendment introduces the term "EV-ready" into the statutory framework, it largely associates readiness with parking provision, conduit availability, and permission to install charging infrastructure. In practice, EV readiness is broader. It must also account for sanctioned load adequacy, wiring quality, earthing, circuit protection, voltage quality, metering arrangements, safe charger placement, fire safety compliance, clearly defined stakeholder responsibilities, and future scalability.

Without a clearer and more practical framework, developers, RWAs, DISCOMs, installers, charging providers, and residents will continue to interpret EV readiness differently. This can result in unsafe charging practices, inadequate electrical upgrades, higher retrofit costs, charging-access barriers in apartments and shared housing, poor visibility into EV-related electricity demand, and a less reliable charging experience for users. Over time, these challenges could slow EV adoption and make it more difficult for utilities and policymakers to plan for the growing electrification of transport.

There is, therefore, a need for a clearer and more practical definition of EV readiness that reflects the diversity of India's residential context. An EV-ready independent home, apartment building, rental home, or low-income settlement may not all look the same in practice, given differences in vehicle type, charging load, parking design, ownership structure, resident preferences, available electrical capacity, power supply conditions, and DISCOM-related constraints. However, each should meet a common minimum threshold for safe, reliable, and accessible EV charging.

The following section identifies the core elements that should be present to support this common understanding of residential EV readiness.

## 5.1 Core Elements of an EV-Ready Home

Residential EV readiness in India cannot be reduced to the mere presence of a plug point. This report uses the sustained charging requirements observed in high-utilisation EV segments, particularly E-3Ws, as a practical stress test for defining residential EV readiness. These vehicles often require long-duration charging at home, exposing whether a household electrical system can safely and reliably support EV loads over several hours on a daily basis. This definition integrates both technical safety and operational usability, reflecting the realities of India's heterogeneous housing stock and power distribution systems.

Core technical requirements for EV-ready homes include:

### 1. Power Supply Readiness

EV-ready homes require an **adequate sanctioned electrical load** dedicated to charging. Most residential EV chargers deployed in India operate at approximately 3.3 kW and draw this load continuously over several hours. In comparison, many urban homes have a sanctioned load of only 3–5 kW on a single-phase connection. As a result, EV charging can place significant additional demand on a household's electrical system, particularly when charging occurs alongside other domestic loads. EV charger installation may therefore require load enhancement and a dedicated charging circuit to ensure safe and reliable operation. The total required electrical load should be calculated as:

*Existing peak household load + (EV charger rating × number of EVs)*

where the EV charger rating is determined by the category of EV to be charged, including 2Ws, 3Ws, and 4Ws.

In many older homes, the existing sanctioned load is insufficient to support continuous charging without tripping protective devices, necessitating a formal load enhancement through the distribution company (CEA, 2023). Additionally, the **quality and reliability of electrical supply** and **voltage** are equally critical for safe and effective EV charging. India's standard for residential single-phase supply is 230V, with a permissible range of 207V to 253V as defined under IS 12360 (Bureau of Indian Standards, 1988). However, there is no real-time enforcement mechanism to ensure utilities comply strictly with these limits, and where supply falls outside this range, equipment including EV chargers bears the consequences through failures and reduced operational lifespan (Bureau of Indian Standards, 1988).

## 2. Electrical Infrastructure Safety and Compliance

**Metering and circuit safety** form a critical pillar of electrical infrastructure readiness. Safe EV charging requires a legal, individually metered connection and the installation of an EVSE with built-in input and output protection features, including short-circuit protection and residual current protection. The system should additionally be supported by a dedicated circuit with appropriately rated Miniature Circuit Breakers (MCBs) and proper segregation from the main distribution board. The MCB safeguards against overloads and short circuits. Chargers should be connected through a standard 16A ISI-certified industrial-grade socket or a hardwired connection, depending on local electrical codes and charger specifications.

**Proper earthing** is a fundamental safety requirement for residential EV charging installations. International standards such as IEC 60364 and related Indian standards, including IS 3043:2018 (BIS, 2018), prescribe protective earthing and equipotential bonding for low-voltage installations. The earthing system should maintain sufficiently low earth resistance for effective fault dissipation, subject to site conditions and utility norms. EVSE installations must also incorporate earth-leakage protection in accordance with prescribed safety standards.

A related concern is **Neutral-Earth (N-E) voltage**, which arises when a voltage difference develops between the neutral and earth conductors due to leakage currents flowing through the earthing path. In residential installations with shared or poorly maintained earthing systems, N-E voltage can cause erratic EVSE behaviour, nuisance tripping, inaccurate metering, and sustained voltage drop at the charger input, reducing charging efficiency and, in severe cases, posing a shock risk to users. Inadequate or absent earthing more broadly can result in improper fault clearance, increased risk of electric shock, equipment malfunction, long-term equipment degradation, and potential fire hazards. The CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023, and applicable Indian Standards identify compliant earthing and earth-leakage protection as foundational requirements for safe electrical installations, including residential EV charging (CEA, 2023).

**Wiring quality and spatial layout** further determine the operational readiness of a residential EV charging installation. The Ministry of Power's Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure, 2024, explicitly emphasise dedicated protection mechanisms and safe wiring practices for residential EV charging installations (MoP, 2024). EV chargers require appropriately rated modern copper wiring in accordance with IS 732, along with short, direct cable routing from the meter point and avoidance of shared or makeshift circuits. Chargers should be installed as close as practicable to the parking location to minimise cable length, voltage drop, and mechanical stress on conductors.

> EV demand becomes visible to the DISCOM only when it is routed through a separate meter under a dedicated EV tariff category. While residential EV charging is generally predictable and scalable, improving planning will require large-scale conversion of legacy meters into smart meters to provide better forward visibility of load patterns.
>
> **-DISCOM**

### 3. Charging Access and Housing Readiness

Electrical infrastructure readiness alone does not guarantee access to EV charging. The practical ability to install and use a charger varies significantly across housing typologies, including independent homes, apartment complexes, rental housing, and shared parking environments, each presenting distinct technical, legal, and governance challenges.

**Independent homes** with dedicated parking present the most straightforward pathway to EV charging. Owners generally have full authority over their electrical infrastructure and parking arrangements, enabling the installation of a dedicated EVSE with a separate metered connection or through an enhanced existing connection, as permitted under the MoP Guidelines, 2024 (MoP, 2024). Although many residential chargers are rated for outdoor installation (typically IP54 or higher), direct exposure to rain, flooding, or prolonged sunlight should be avoided, and a sheltered mounting location with overhead protection is recommended to improve durability and safety.

**Apartment complexes** present considerably greater complexity, as charging access involves multiple stakeholders, individual residents, Resident Welfare Associations (RWAs), DISCOMs, fire departments, and, in some cases, state regulators. The MoP Guidelines, 2024, explicitly permit residents of group housing societies to install private EV charging stations in their designated parking spaces, with electricity supply through the resident's existing meter or a separate sub-meter (MoP, 2024). In practice, however, RWAs generally are reluctant to give permission for installation of chargers, citing fire safety concerns and the absence of clear building-level policies.

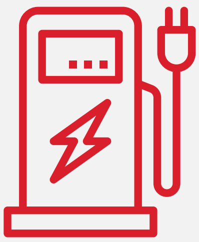
Fire safety in basement and stilt parking remains the most contested dimension of apartment charging access. These restrictions reflect legitimate concerns about fire suppression access and thermal runaway risks in enclosed spaces, but also highlight the absence of a unified national standard for fire safety in residential EV charging environments. EV charging installations in apartments should incorporate fire-rated cable conduits and be subject to periodic inspection by the concerned authority. From a building design standpoint, the MBBL 2016 and their 2019 amendments recommend that at least 20% of parking spaces in new residential developments be EV-ready, with provisions such as pre-laid conduits and adequate panel capacity (MoHUA, 2019). Under such arrangements, shared EVSE units are installed in common areas and operated by a third-party charge point operator. These models reintroduce additional considerations around metering, billing, and cost recovery, along with appropriate load management systems to ensure that simultaneous charging does not overload the local distribution infrastructure.

Further, excessive separation between the distribution panel and the parking bay increases both material costs and fault probability. In cases where the distance is unusually large, such as beyond 20 meters, intermediate junction boxes or secondary metering arrangements may be necessary. However, implementation remains uneven and is largely confined to premium developments in a few leading states.

In **rental housing**, tenants typically lack the authority to modify a property's electrical infrastructure, while landlords often have limited regulatory obligations and few financial incentives to facilitate the installation of EV charging equipment. As a result, access to home charging can become a significant barrier to EV adoption among renters. Standardised provisions addressing landlord responsibilities, tenant rights to install and use charging infrastructure, and sub-metering arrangements would help reduce uncertainty and administrative barriers.

In informal and unplanned settlements, where dedicated parking spaces are often limited, access to residential charging may not always be possible through individual home-based installations. In such environments, community-based, shared, or semi-public charging models may play a more important role. These arrangements introduce additional considerations around charging access, electricity metering, cost allocation, operational responsibility, and load management. As a result, EV readiness in such settings may need to be assessed at the community or neighbourhood level rather than solely at the level of an individual dwelling.

In addition, shared charging installations should incorporate provisions for emergency isolation, routine inspection, and maintenance. Responsibility for periodic safety inspections and compliance should be clearly assigned to a designated entity to ensure the continued safe and reliable operation of the charging infrastructure.



**At a minimum, EV readiness requires**

Four interconnected pillars that together make a home safe and ready for electric vehicle charging

**POWER – Power Supply Readiness**

- **Adequate sanctioned load:** Sufficient capacity for EV charging alongside existing household demand
- **Supply quality and reliability:** Stable, uninterrupted power delivery to the charger
- **Voltage compliance:** Supply voltage within permissible residential limits

**SAFETY – Electrical Infrastructure Safety and Compliance**

- **Metering and circuit safety:** Dedicated circuit with miniature circuit breakers and legal individual metering
- **Proper earthing:** Low-resistance earthing connection maintained to prescribed standards
- **Neutral-Earth (N-E) voltage:** Controlled N-E differential to prevent erratic EVSE behaviour
- **Wiring quality and layout:** Appropriately rated copper wiring with short, direct cable routing

**ACCESS – Charging Access and Housing Readiness**

- **Independent homes:** Owner-controlled installation with dedicated EVSE connection
- **Apartment complexes:** RWA coordination, sub-metering, and fire-safe conduits
- **Rental housing:** Tenant rights and landlord obligations for charger access
- **Informal housing and unplanned settlements:** Community-level shared charging models where individual installations are not feasible

**EQUIPMENT – Certified EVSE and Equipment Readiness**

- **Electric Vehicle Supply Equipment (EVSE):** Purpose-built certified charger sustaining continuous high-current load safely
- **ISI-certified socket or hardwired connection:** Industrial-grade socket compliant with local electrical codes
- **Built-in protection features:** Short-circuit, residual current, and earth-leakage safeguards

Figure 14: EV Readiness Matrix

### 4. Certified EVSE and Equipment Readiness

A common practice among EV adopters in India has been to charge vehicles directly through standard household socket outlets. Indian residential sockets are governed by IS 1293:2019 (BIS, 2019), which covers plugs and socket outlets rated up to 250V and 16A for household and similar purposes. While such sockets are nominally rated at 16A, they are designed for intermittent domestic loads and not for the sustained, high-current draw that EV charging imposes continuously over several hours. Running a residential socket at or near its rated current for extended durations causes significant heat build-up. This thermal stress degrades socket contacts over time, increases contact resistance, and elevates the risk of overheating, arcing, and fire. A certified EVSE is purpose-built to address these limitations. Unlike a standard socket outlet, an EVSE is designed to sustain continuous load delivery safely, using industry-grade materials and is rated for prolonged electrical stress. The use of a certified **Electric Vehicle Supply Equipment (EVSE)** is therefore the final and necessary element of a complete EV-ready residence.

> A clear delineation of stakeholder roles and responsibilities is critical to reducing ambiguity and ensuring effective implementation. This should be complemented by a robust monitoring and verification framework, anchored by a designated authority such as the DISCOM. The framework should incorporate periodic compliance audits, sampling-based inspections, and enforceable penalty provisions to ensure adherence to prescribed standards.
>
> **-Policy Expert**

International experience highlights the benefits of embedding EV readiness into building regulations. In Norway, high EV adoption has been supported by policies that expand residential charging access, including requirements for EV-ready parking in new buildings and strong electrical safety standards. Regulations emphasise the use of dedicated charging equipment, certified installers, and protective systems that automatically disconnect power in case of faults. Similarly, the Netherlands enforces right-to-charge provisions in multi-family housing. China requires pre-installed conduits and electrical capacity in new developments. These policies significantly reduce retrofit costs and normalise home charging as a default infrastructure feature (IEA, 2024).

In contrast, India relies largely on post-construction retrofits. Global evidence shows that pre-wiring during construction is substantially more cost-effective and safer than retrofitting later, particularly in multi-unit dwellings. The absence of standardised retrofit guidance in India creates uncertainty around costs and responsibilities, discouraging adoption among low- and middle-income households (World Bank, 2023).

The elements outlined above represent a starting point for defining what an EV-ready home should comprise in the Indian context. They establish the common foundations required for safe, reliable, and usable residential EV charging, while recognising that implementation may vary across housing types, vehicle categories, ownership models, and local electricity conditions. Codifying these requirements into a simple "EV-ready home checklist" would reduce ambiguity for installers, consumers, DISCOMs, and housing authorities. Such a checklist would also provide a common reference point for financial institutions and insurers assessing residential EV investments (SIAM, 2025).

The following chapter builds on this foundation and explores how such a framework can be operationalised through policy, regulatory, institutional, and market interventions.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# 06

# RECOMMENDATIONS FOR EV-READY HOMES

India's EV transition has largely focused on accelerating EV adoption through targeted incentives, the development of public charging infrastructure, and consumer electricity tariff subsidies. These efforts have contributed significantly to the rapid growth of electric mobility across vehicle segments. However, as EV adoption scales, a new challenge is emerging. While vehicle adoption is increasingly visible through registration databases, policy targets, and market statistics, considerably less attention has been paid to whether homes are prepared to support EV charging safely, reliably, and at scale.

Chapter 5 identified the core elements that define an EV-ready home in the Indian context. Building on that foundation, the recommendations presented in this chapter focus on how those conditions can be enabled at scale through policy, regulation, utility processes, financing mechanisms, and stakeholder coordination. The recommendations presented in this chapter are organised as a roadmap that addresses the entire residential charging ecosystem and guides stakeholders towards the development of EV-ready homes.

## 6.1 Establish a "National Residential EV Readiness Framework"

India's EV transition has reached a stage where vehicle adoption alone is no longer a sufficient measure of progress. As EV ownership grows across vehicle segments and geographies, equal attention must be paid to whether homes are becoming ready to support charging safely, reliably, and at scale.

While India already has multiple standards, regulations, building provisions, and EV charging guidelines that address different aspects of residential charging, there is currently no unified framework that integrates these elements into a coherent approach to residential charging. As a result, utilities, builders, RWAs, installers, charging service providers, OEMs, and consumers often interpret EV readiness differently, leading to inconsistent implementation and varying charging outcomes. India should therefore establish a **National Residential EV Readiness Framework** that aligns stakeholders around a common implementation pathway for residential charging. The framework should build upon the core elements of EV readiness identified in Chapter 5 and translate them into a common implementation pathway for stakeholders across the residential charging ecosystem.

The framework should also introduce a set of residential charging readiness indicators that can be tracked alongside existing EV adoption metrics. While current dashboards primarily focus on vehicle registrations, sales, and public charging infrastructure deployment, they provide limited visibility into the readiness of homes to support EV charging. Indicators linked to the EV-ready home elements identified in Chapter 5 can help policymakers identify readiness gaps, prioritise interventions, and ensure that residential charging infrastructure keeps pace with EV adoption. Over time, stronger coordination across the EV purchase, charger installation and utility connection journey can help create a smoother transition from vehicle adoption to charging readiness. This would allow residential charging requirements to be addressed earlier in the process, rather than only after an EV user faces charging-related issues.

## 6.2 Enable Verified Residential Charging Through EVSE and Dedicated EV Metering

Current guidelines permit residential EV charging through either an existing domestic electricity connection or a separate metered EV connection. While this flexibility was appropriate during the early stages of EV adoption, a more structured approach is required as residential charging scales.

To operationalise the EV-ready home requirements identified in Chapter 5, this report recommends transitioning towards a readiness-based approach, where EVSE-based charging supported by a dedicated EV sub-meter connection is progressively adopted as the preferred pathway where technically and economically feasible. The objective is not only to promote safer and more standardised charging practices, but also to create a formal mechanism through which residential charging readiness can be assessed and verified before charging infrastructure is energised. Under such a framework, installation of residential EV charging infrastructure should be linked to a charging readiness assessment covering key EV-ready home parameters, helping ensure that charging systems are deployed on electrical infrastructure capable of supporting sustained loads safely and reliably.

Where the assessment identifies deficiencies, consumers should receive a corrective action report outlining the specific upgrades required, such as load enhancement, earthing improvement, wiring upgrades, protection system modifications, or documentation updates. In cases where an EV sub-meter application is rejected, the DISCOM should provide these reasons in writing, and the applicant should be able to reapply through a simplified process once corrective actions have been completed. Readiness assessments may be undertaken directly by DISCOMs or by certified third-party entities such as authorised charging installers, licensed electrical contractors, or OEM-approved service providers, subject to utility verification, allowing assessments to be scaled while maintaining accountability and quality assurance.

A dedicated EV sub-meter connection serves a dual purpose: enabling separate billing and tariff administration, while also improving visibility of EV-related electricity demand within the distribution network. This visibility would help DISCOMs assess charging demand, plan network upgrades, design EV-specific and Time-of-Day tariffs, support managed charging programmes, and integrate residential EV charging into long-term grid planning. In this framework, the readiness assessment becomes the primary safeguard, while EVSE deployment and dedicated metering serve as the enabling mechanisms for safe, reliable, and scalable residential charging.

## 6.3 Embedding EV Readiness Across Housing Typologies Through Bye-Laws and Housing Programmes

As discussed in Chapter 5, the pathway to EV readiness differs significantly across independent homes, apartments, rental housing, older buildings, and low-income settlements. A National Residential EV Readiness Framework should therefore support differentiated implementation pathways across housing typologies, vehicle types, and electrical conditions, while maintaining common safety and reliability outcomes.

This differentiation is particularly important for high-utilisation EV users, including gig and delivery workers, who depend on reliable overnight charging for their daily livelihoods. If their homes are not electrically ready, they may be forced to rely on temporary extensions, shared domestic sockets, or informal charging arrangements. Residential EV readiness must therefore be treated not only as a technical or building-compliance matter, but also as an issue of access, affordability, and livelihood security.

To give effect to these differentiated pathways, guidelines should be developed for safe charger placement across all residential typologies, covering parking layouts, cable routing, accessibility, metering arrangements, safety clearances, and responsibility for electrical upgrades. More broadly, this can be strengthened by embedding EV-readiness into building bye-laws, redevelopment programmes, affordable housing schemes, rental housing guidance, and urban development initiatives, including through building plan approvals and occupancy certification where appropriate. This will help ensure that residential charging is not limited to premium housing segments, but becomes a practical and scalable part of India's wider EV transition.

## 6.4 Making EV-Readiness Affordable Through Targeted Support

For many households, the path to safe home charging requires upfront investment in electrical upgrades, including wiring, earthing, metering, and other behind-the-meter infrastructure. For consumers in older buildings, rental housing, low-income settlements, or areas with legacy electrical infrastructure, these costs can represent a meaningful barrier to adoption. The Government of India and State Governments should therefore consider introducing targeted support mechanisms to improve residential charging readiness, ensuring that the benefits of electric mobility are accessible across housing and income segments. Eligible interventions could include EVSE installation and the electrical upgrades required to make homes safe and reliable for EV charging. Support may be delivered through a combination of capital subsidies, concessional financing, utility-led programmes, tax incentives, performance-linked grants, or integration within existing EV promotion schemes. A useful precedent exists under the Delhi EV Policy 2020, where captive charging infrastructure, including private and workplace chargers, was supported through direct financial incentives and simplified installation processes. Similar approaches should be explored more broadly, so that residential charging readiness becomes an integral part of EV policy rather than an afterthought to vehicle adoption.

## 6.5 Building a Safe Residential EV Charging Culture Through Awareness and Workforce Upskilling

A significant awareness gap exists between EV purchase and charging readiness, with many users unfamiliar with the electrical requirements their homes must meet to support safe and reliable charging. Consumer awareness is therefore one of the most important, and often overlooked, enablers of residential EV charging readiness. Targeted awareness initiatives should be developed to help consumers understand what constitutes an EV-ready home, the importance of electrical readiness assessments, the role of EVSE-based charging, and the upgrades that may be required before charging infrastructure is installed.

Alongside consumer awareness, India will need a skilled workforce capable of assessing, installing, and maintaining residential charging infrastructure. While India has a large base of electricians and electrical contractors, EV charging introduces additional technical requirements, including load assessment, earthing verification, wiring suitability, circuit protection, and EVSE installation, and other EV-ready parameters. Standardised training and certification programmes should therefore be developed for electricians, contractors, and charging installers to ensure consistent implementation quality across geographies.

Both awareness and workforce capacity must be underpinned by clear stakeholder accountability. Each actor in the residential charging ecosystem, including EV users, landlords, RWAs, builders, charging providers, installers, DISCOMs, fire authorities, and local bodies, should have clarity on their respective responsibilities across electrical readiness, approvals, installation quality, inspections, maintenance, and safety compliance. Together, these three pillars of awareness, skilled installation, and accountability will be essential for ensuring that residential charging infrastructure is deployed safely, consistently, and at scale across India's diverse housing environments.

## 6.6 Preparing Homes for the Future Energy Transition

The decisions made today regarding metering, communications, charging infrastructure, and electrical upgrades will shape the ability of homes to participate in future energy systems for decades to come. Residential EV charging should therefore not be planned solely around current requirements.

As residential EV adoption grows, EV charging is expected to become an increasingly important source of flexible electricity demand. As the relevant technologies and regulatory frameworks mature, EV-ready homes should be capable of supporting Time-of-Day tariffs, smart charging, demand response programmes, demand flexibility services, rooftop solar integration, battery storage, peer-to-peer energy transactions, and vehicle-to-grid applications.

Achieving this requires residential charging infrastructure to be deployed using interoperable, standards-based approaches that avoid technology lock-in and allow future upgrades without significant rework of underlying electrical infrastructure. This is particularly important given that residential EV charging represents one of the largest controllable electrical loads within the home. If integrated effectively, EV charging can help DISCOMs manage peak demand, improve utilisation of existing network assets, absorb renewable energy generation, and reduce the need for costly infrastructure upgrades. Metering systems, communication protocols, charging equipment, and digital platforms should therefore be selected with future compatibility in mind.

The objective should be to ensure that EV-ready homes built today support not only safe and reliable charging, but also the broader energy transition that will accompany large-scale electrification in the years ahead.

## 6.7 Institutional Ownership for Residential EV Readiness

Residential EV charging sits at the intersection of mobility, electricity, housing, urban planning, consumer safety, and digital infrastructure. Responsibility for enabling EV-ready homes is therefore distributed across multiple stakeholders, each influencing a different part of the residential charging ecosystem. Despite significant progress in advancing EV adoption, there is currently no institutional mechanism that brings these stakeholders together around a shared vision, implementation pathway, and accountability structure for residential EV readiness.

Addressing this governance gap requires a coordinated national effort, bringing together the Ministry of Power (MoP), Ministry of Housing and Urban Affairs (MoHUA), Ministry of Road Transport and Highways (MoRTH), Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), Central Electricity Regulatory Commission (CERC), State Electricity Regulatory Commissions (SERCs), DISCOMs, standards bodies, vehicle OEMs, charger OEMs, RWAs, consumer representatives, and civil society organisations. Such a platform should align policies, standards, regulations, utility processes, safety requirements, consumer awareness, and long-term planning across the mobility, power, and housing sectors, while addressing emerging issues such as EV-ready homes, charging verification, apartment charging models, EV metering, and smart energy integration.

A central objective of this coordination effort should be to establish clear institutional ownership and implementation responsibilities for residential EV readiness, an area where, despite the number of stakeholders involved, accountability remains diffuse. Without defined ownership, residential EV readiness risks remaining a collection of individual initiatives rather than evolving into a coordinated national programme capable of keeping pace with India's growing EV adoption.

# Conclusion

While considerable progress has been made on vehicles, public charging networks, and policy incentives, the residential environment remains a critical yet relatively underexplored component of India's EV transition. Given that the majority of EV charging is expected to occur at home, ensuring that residential spaces are prepared for this shift will be essential to sustaining long-term EV adoption.

The recommendations presented in this chapter are not intended to be prescriptive or final. Rather, they offer a starting point for a broader national discussion on what EV-ready homes should mean in the Indian context, and how residential charging readiness can be achieved at scale. The question is no longer whether India needs EV-ready homes, but how they should be defined, implemented, financed, governed, and measured. Addressing these questions will require sustained collaboration across the mobility, power, housing, regulatory, and consumer ecosystems, with each stakeholder group playing a defined role in shaping this next phase of India's EV transition.

The opportunity is significant. By acting early, India can build a strong foundation for widespread residential charging, enhance charging safety and reliability, strengthen grid preparedness, support innovation in home energy systems, and create a more seamless ownership experience for millions of future EV users. It is therefore hoped that this report will contribute to a constructive dialogue among stakeholders and help catalyse the development of a shared national vision for EV-ready homes in India. Ultimately, achieving India's EV ambitions will require ensuring that the readiness of homes keeps pace with the adoption of vehicles.

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