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Current Status and Future Scope of EV Charging Infrastructure in India

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Abstract:
India is rapidly transitioning toward electric mobility to reduce greenhouse gas emissions, fuel imports, and urban air pollution. However, widespread EV adoption continues to be limited by inadequate charging infrastructure, high battery costs, grid limitations, and range anxiety. This paper presents an updated overview of the current status of EV charging in India, including state-wise charging station distribution, charging standards, PPP participation models, battery swapping networks, and availability of digital location services. A comprehensive review of challenges and future opportunities is also discussed. The study concludes that fast expansion of public charging stations, battery swapping networks, and renewable grid integration are essential to support India's projected EV market growth by 2030.

Keywords: Electric Vehicles; Charging Infrastructure; Public Charging Stations; EV Policy; Battery Swapping; India; Sustainable Mobility

1. Introduction

Electric vehicles (EVs) are emerging as a key technology to support India's climate goals and reduce dependency on fossil fuels. Government initiatives such as FAME-II, Production Linked Incentives (PLI), and state EV policies have accelerated production and sales. However, a major barrier remains: accessibility and availability of charging infrastructure across urban and rural India. This paper analyzes the current infrastructure, identifies gaps, and highlights future opportunities to strengthen EV adoption.

2. Charging Infrastructure Classification Charging Levels:

Level 1 AC – Slow charging (1– 1.8 kW),
Level 2 AC – Moderate charging (up to 19.2 kW),
DC Fast Charging (Level 3) – Rapid charging (50–350 kW).
Connector types used in India: Type-1, Type-2, Bharat AC-001 for AC; CCS2, CHAdeMO, Bharat DC-001 for DC.

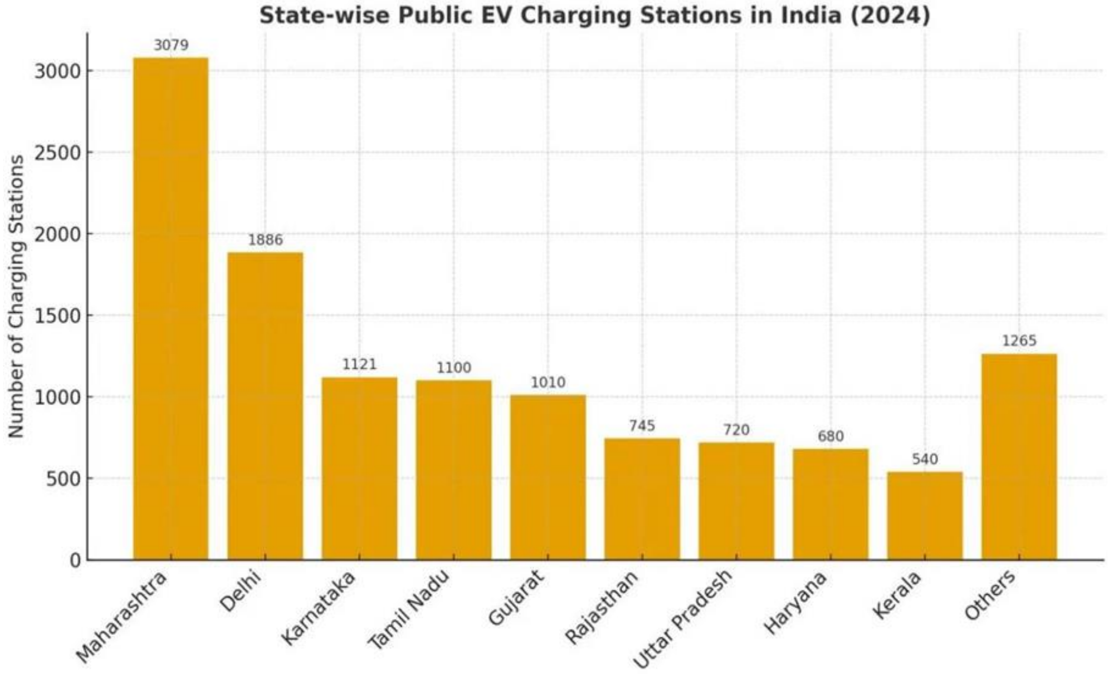
3. State-Wise EV Charging Stations

Table 1: Top EV Charging Infrastructure States State

State Public EV Charging Stations
Delhi 1,845
Karnataka 704

Maharashtra	660
Tamil Nādu	441
Gujarat	195
Uttar Pradesh	406
Others	2,515
Total	**6,586**

Figure 1: – Top EV Charging Infrastructure States in India



4. National Highway EV Charging Stations

National Highway	Number of Operational PCS
NH-10	1
NH-11	3
NH-16	37
NH-44	39
NH-48	11
NH-65	22
NH-66	8
Others	299
Total	**419**

Figure 2: – EV Charging Stations along Major National Highways

State	Public Charging Stations
Delhi	1845
Karnataka	704
Maharashtra	660
Tamil Nadu	441
Gujarat	195
Uttar Pradesh	406
Others	2515
Total	6586

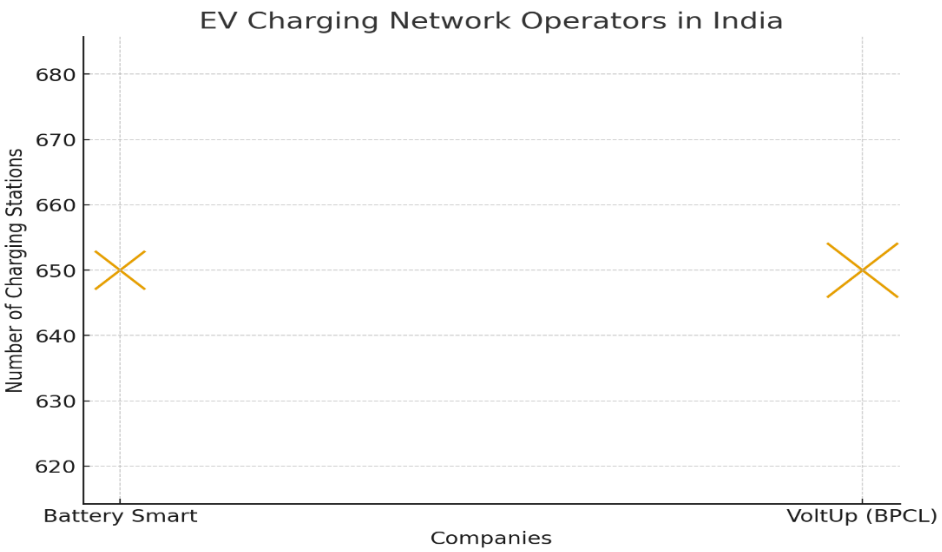
5. Public-Private Partnerships (PPP)

PPP Model	Key Companies / Participants	Notes
BOT	Tata Power, BPCL	Build–Operate–Transfer
BOO	Ather Energy	Build–Own–Operate
DBFOT	ChargePoint, Fortum	Design–Build–Finance–Operate–Transfer
LDO	VoltUp	Lease–Develop–Operate
OMT	Tata Power	Operate–Maintain–Transfer

6. Battery Swapping Network

Figure 3:– Battery Swapping Network Coverage

Company	**Charging Stations**	**Cities Covered**	**Bubble Size (Proportional to Cities)**
Battery Smart	650+	25	Medium
VoltUp (BPCL collaboration)	650	50	Large



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7. Mobile Applications for Charging Station Discovery Apps: PlugShare, ChargePoint, Tata EZ, Statiq, ElectricPe, Google Maps, e-Amrit portal
8. Major Companies & Leaders in EV Charging -Tata Power, Charzer, Ather Energy, ChargePoint, Fortum

Table 5: Charging Levels vs Vehicle Type

Charging Level	AC/DC	2-Wheeler (2W)	3-Wheeler (3W)	4-Wheeler (4W)
L1	AC	✓	✓	✓
L1	DC	✓	✓	✓
L2	AC	✓	✓	✓
L3	DC	✕	✕	✓

Results & Observations

- Increased employment in EV sector
- Reduced fossil fuel dependency
- Improved air quality
- Decreased operational costs for EV users

9. Future Scope & Conclusion

- 2030 Target: 30% EV penetration
- Expansion of renewable-powered charging hubs
- Growth of battery swapping networks
- Smart grid integration (V2G/V2H)
- Coordinated government-private initiatives

India has the potential to become a global EV infrastructure hub with these measures.

AI Disclosure: AI tools were used only for formatting, editing, and visualization. All research findings are the author's own.

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