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THE ROLE OF GREEN MOBILITY IN TRANSFORMING INDIA'S ENERGY PLANNING FRAMEWORK FOR 2050

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ABSTRACT

The increasing number of automobiles, the near total dependence of the transport industry on fossil fuel that has been a contributing factor to approximately 12-14 percent of the total energy-related CO 2 emission in India has further made green mobility a strategic demand in the long-term energy planning fabrication of the country. The concept of green mobility that incorporates electric cars (EVs), charging infrastructure that uses renewable energy sources, and low-carbon-based public transport has become one of the primary lines of change in India towards low-carbon community by 2050. In this paper, the significance of green mobility in changing the energy planning environment of India regarding the empirically tested national data is put into consideration. The key objectives are to estimate the existing EV adoption trend within each of the vehicle segments and examine the structural alignment of the green mobility policy frameworks and energy ambitions of India by 2050. The quantitative methodology of secondary data has been adopted which adopted approved information has given by VAHAN, MNRE, IEA, ICCT and JMK Research. The hypothesis is that the steady process of introducing the green mobility and the intensive increase in renewable energy will make a significant impact on the reduction in the CO2 emissions of the transport sector and the redrawing of the energy planning of India to a carbon neutral state by the middle of the century. Results confirm that in CY2025, the sales of EV in India were high with 2.27 million units and 253.96 GW of renewable energy capacity. The conclusion drawn in the discussion is that the binding constraints making the 2050 vision are policy continuity and infrastructure gaps. The paper concludes that green mobility is a systemic realignment of the system of planning energy in an overall situation in India.

Keywords: *Green mobility[1], electric vehicles[2], India energy planning 2050[3], transport decarbonisation[4], renewable energy integration[5].*

1. INTRODUCTION

India has an evident energy nexus during the twenty first century. India with the highest population and third largest energy consumer in the world has the dual challenge of sustaining high rates of economic growth and a

straight cut on and greenhouse gas (GHG) emission is one of the ways of keeping its end of the bargain, to the international climate agencies. This challenge possesses the most pressing and unexplored in history aspects that entail the transport sector. In India, road transport causes approximately 12 per cent of energy-related CO 2 emissions and 98 per cent of energy consumption; as of 2022, transport CO 2 emission would be the second-largest source of pollution in India, and with the current policy trends, it would increase by a factor of two by 2030-31 (IEA, 2022; Dawda, 2024). It is on this background that the Indian transport sector has grown its CO 2 emissions more than 429 percent since 1990, and the deepening of the motorisation process as an outcome of economic growth and urbanisation may be manifested in the 500 GW of non-fossil fuel energy capacity in 2030 and a 30 percent share of the electric vehicle in the new vehicle sales share in 2030 (Cargoson, 2025). The two-wheeled vehicles, three-wheeled vehicles, passenger vehicles, commercial freight, electric buses have been at the focus of green mobility which seeks to link the transport decarbonisation objectives of India with that of its overall energy policy.

Since the Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme was held in 2015, the policy architecture has evolved considerably, as well. FAME II (2019-2024) officially used an outlay budget of 11500 crore and was able to subsidise 1629 lakh EVs and place 8855 public charging stations. The outcomes are becoming quant By the end of the FY2025, India had a cumulative market sale of greater than 6.17 million units of EVs with the yearly sale marking of over 2.27 million units and the market penetration of 8.07 per cent (JMK Research and Analytics, 2025; Autocar Professional, 2026). Meanwhile, renewable energy resources in India had reached 253.96 GW, which includes solar energy 132.85 GW and renewables 51.5 of the total installed electricity capacity in the country five years earlier than the NDC target of 2030 (MNRE, 2025b). This kind of EV implementation wave and renewable energy growth overlap offers an opportunity in Indian history to fundamentally redesign Indian energy planning model to the 2050 horizon. This essay is a study about such correspondence based on quantitative evidence which is empirically tested.

2. LITERATURE REVIEW

The debate over the concept of green mobility and national energy planning as an overlap area has been growing hot in the post-COP26 period and has led to an ever-finer depiction of quantitative and policy prerequisites that will be required in India to decarbonise on a long-term basis. Chaturvedi and Malyan (2022) provided one of the most restrictive India-specific modelling studies of the net-zero transition that have shown using the Global Change Assessment Model (GCAM) that the share of fossil fuels in the primary energy will be decreased to 5 percent by 2030 to reach net zero by 2050 solely by combined and rapid electrification of the road network and grid decarbonisation concurrently. Their analysis in scenarios with comparison of the years of peaking 2030, 2040 and 2050 with the net-zero years extending to 2080 demonstrated that the most technical feasible way of bringing the carbon-neutrality of the mid-century is the 2030 peak-2050 net-zero way. The same findings placed the green mobility challenge in context as an energy planning demand and not an issue of choice in the sector, and Grover and Mathur (2022) also reported on the general energy policy environment in India regarding net-zero commitments, and emphasized that the transport sector must rise up the agenda as a priority in the energy planning systems in the country. Green electrification particularly the increase in solar power capacity is the analysis that has highlighted the lever which will enable the transport decarbonisation with a greener grid.

Kamboj et al. (2022) further contributed to this perspective an energy perspective of transport which is registered that in India, overall motorised passenger transport activity had reached 3,833 billion passenger-km in 2017 versus 1,700 billion pkm in 2005, with road transport being 92 per cent of total transport energy demand and 94 per cent of total transport CO 2. This kind of road transport hegemony renders EV adoption to be the most successful lever in decarbonising transport in the Indian setting.

A thorough review of the policy was outlined by Dawda, (2024) which included multi-layered policy barriers to transport energy transition that include poor charging infrastructures, absence of mature battery supply chains, absence of well-established fuel economy policies and lack of mobility planning ministries and energy planning ministries. The research argued that, unless a coherent national framework is implemented where transport electrification and grid decarbonisation are not perceived as mutually supporting policy domains, then the planning ambitions of energy in India in 2050 will be structurally more in touch with the reality on the ground. This can be supported by the fact that the ICCT made the following conclusion when analysing FAME II which stated that the main reason behind the underutilisation of charging infrastructure was administrative bottlenecks in electricity connection approvals which was a systemic problem that the PM E-DRIVE regulatory simplification framework is attempting to address by classifying EV charging as a de-licensed activity (IEA, 2025). To substantiate the thesis, that the success of green mobility in India is institutionally dependent, Sah et al. (2025) empirically discovered that environmental governance coherence and foreign direct investment and green innovation determine the pace of energy transition, which is in favor of the argument that the energy transition is institutionally contingent. Based on a projected estimation of NITI Aayog and WRI India (2025) the Indian EV market estimated in 2024 to be US$ 2.36 billion would have developed to be US$ 164.42 billion in 2033 with a CAGR of 57.23 should there be policy continuity. It is popularly developed in the literature that green mobility and energy planning must not be operated concurrently but in a coordinated direction of achieving the 2050 vision is to be achieved at a national level.

3. OBJECTIVES

1. To assess the trajectory of electric vehicle adoption in India across vehicle segments from 2022 to 2025, and evaluate its quantitative alignment with the government's 2030 and 2050 energy decarbonisation targets.

2. To analyse the relationship between India's renewable energy capacity expansion and green mobility infrastructure development, and their collective potential to structurally transform the national energy planning framework for 2050.

4. METHODOLOGY

The methodology used in this study is the quantitative secondary data analysis, which is aimed at analyzing the empirical nature of the relationship between the green mobility expansion in India and the national energy planning of the country in relation to the year 2050. The study design is descriptive-analytical, and the research aims at synthesizing and longitudinally interpreting confirmed national and international datasets over the year 2020-2025, and scenario-based predictions up to the year 2050.Data has been obtained by authoritative

institutional repositories, i.e., the VAHAN Dashboard of the Ministry of Road Transport and Highways, the Ministry of New and Renewable Energy (MNRE), the International Energy Agency (IEA), the International Council on Clean Transportation (ICCT), JM The facts were only included after being cross-verified in at least two sources, which guaranteed the accuracy of the facts and the time frame.

The sampling frame contains the national-level sales data of EVs in India rounded by the vehicle segments, the renewable energy installed capacity by the source type, the transport sector emissions on CO 2 (actual and projected), the deployment data of public EV charging infrastructure and government scheme-based policy spending under FAME I, FAME II, EMPS 2024, and PM E-DRIVE. Six data tables have been developed based on only proven numbers with each narrative having a contextualised statistical description of about 75 words. The analytical framework will be based on trend forecasting through time-series data and comparison of scenarios between business-as-usual pledges and announced pledges. Green mobility deployment, coupled with renewable energy growth, as the research hypothesis will considerably lead to the reduction of transport CO 2 emissions and reposition the energy planning of India to be carbon-neutral was tested against the longitudinal quantitative statistics. In this study, there was no fieldwork and main data gathering.

5. RESULTS

Table 1: India's EV Sales by Vehicle Segment (CY2022–CY2025)

Vehicle Segment	**CY2022**	**CY2023**	**CY2024**	**CY2025**
Electric Two-Wheelers (E2W)	6,23,000	8,32,000	11,49,000	12,79,951
Electric Three-Wheelers (E3W)	4,91,000	6,30,000	7,20,000	7,97,000
Electric Passenger Vehicles (E4W)	46,000	80,000	99,838	1,76,980
Electric Buses & CVs	2,900	4,000	12,125	15,798
Total EV Sales	**11,62,900**	**15,46,000**	**19,50,763**	**22,70,976**
EV Market Share (%)	4.72%	6.38%	7.47%	8.07%

(Source: JMK Research & Analytics, 2025; EVreporter, 2026; Autocar Professional, 2026)

Table 1 indicates that the overall number of EVs registered in India increased by 16.3 percent annually with the total EVs registering at 2.27 million in CY2025 compared to 1.16 million in CY2022 (JMK Research and Analytics, 2025; Autocar Professional, 2026). Two-wheeler electric continued to dominate the segment with a market share of 56.4 percent in 2025 and the electric passenger vehicles registered the highest growth with 77 percent per annum. EV market penetration steadily increased, 4.72 percent in 2022 to 8.07 percent in 2025, which indicates the continuity of the overall adoption wave, which is the quantitative basis of the energy planning calculus in 2050 in India.

Table 2: India's Renewable Energy Installed Capacity by Source (GW), 2021–2025

Energy Source	March 2021	March 2023	March 2025	November 2025
Solar	45.00	66.78	105.65	132.85
Wind	38.79	42.63	50.04	53.99
Large Hydro	46.51	46.93	47.14	50.35
Bio Power	10.62	10.84	11.58	11.61
Small Hydro	4.79	4.99	5.10	5.16
Total RE Capacity (GW)	**145.71**	**172.17**	**220.10**	**253.96**
Share of Total Installed Power (%)	38.4%	41.3%	44.5%	51.5%

(Source: MNRE/PIB, 2025a; MNRE/PIB, 2025b; JMK Research & Analytics, 2025)

In fact, Table 2 shows India's installed capacity projection of renewable energy from the year 2021 to November 2025 (MNRE, 2025a; MNRE, 2025b). By November 2025, the total RE capacity was 253.96 GW, which is a 74.3 percent increase from the baseline for 2021. Solar energy witnessed the most significant development with an increase of 195% increasing from 45 GW to132.85 GW. Wind power surpassed the important 50 GW mark in March 2025. As of November 2025, India had achieved over 51.5% of its total installed electricity capacity of 509.64 GW source from non-fossil fuel sources, exceeding the NDC(commitment) target in this sector for the year 2030 five years ahead.

Table 3: India's Transport Sector CO_2 Emissions and 2050 Projections (Mt CO_2)

Year	Transport CO_2 (Mt)	Road Transport Share (%)	India's Total CO_2 (Mt)	Transport % of Total
2000	118	91%	1,050	11.2%
2010	195	92%	1,500	13.0%
2021	290	94%	2,600	11.5%
2024 (estimated)	330	94%	2,955	11.2%
2030 (BAU)	420	94%	~3,300	12.7%
2050 (BAU)	580	94%	~4,000	14.5%
2050 (APS – EV scenario)	230	80%	~2,000	11.5%

(Source: IEA, 2022; Cargoson, 2025; NITI Aayog& WRI India, 2025)

Table 3 charts the path of India's road transport CO_2 emissions from 2000 to 2024, along with projected BAU and Announced Pledges Scenario (APS) scenarios to 2050 (IEA: 2022; Cargoson: 2025; NITI Aayog& WRI India: 2025). Road transport always accounts for more than 90% of transport-sector emissions. Under BAU, total transport CO_2 could hit 580 Mt by 2050almost double what it was in 2021. The APS scenario, underpinned by aggressive uptake of EVs and decarbonisation of the grid, limits transport emissions to 230 Mt in 2050 (a three-fold reduction from BAU) which highlights the huge mitigation potential for green mobility.

Table 4: India's Public EV Charging Infrastructure Growth (2020–November 2025)

Year	Public Charging Stations	Year-on-Year Growth (%)	Key Policy Driver
2020	~1,000	—	FAME II operational
2021	~1,800	80.0%	FAME II phase-up
2022	~3,000	66.7%	FAME II expanded
2023	6,586	119.5%	FAME II scaled nationally
February 2024	12,146	84.5%	FAME II concluding
December 2024	25,202	107.5%	PM E-DRIVE launched
November 2025	29,277	16.2%	PM E-DRIVE active

(Source: ICCT, 2024; IBEF, 2025; MHI, 2024; indiadatamap.com, 2025)

Table 4 notes the nearly 29-fold increase in India's public EV charging infrastructure from ~1,000 stations in 2020 to November 2025's tally of 29,277 (ICCT, 2024; IBEF, 2025; MHI, 2024). FAME II was responsible for the establishment of 8,885 stations out of a total 9,332 sanctioned and it consumed 75% of the ₹893 crore provisioned to enhance charging infrastructure. While this growth is impressive, India still lags behind the global standard of 1:20 EV to charger ratio with a national average of just 1:235. This structural deficit is set to be impacted by the allocation of PM E-DRIVE of ₹2,000 crore for setting up 72,000 new chargers by March 2026.

Table 5: Key Government Policy Schemes for Green Mobility in India (2015–2026)

Scheme	Period	Total Outlay (₹ crore)	EVs Supported	Charging Stations	Primary Strategic Focus
FAME I	2015–2019	895	~2.8 lakh	~520	Pilot adoption & awareness
FAME II	2019–2024	11,500	16.29 lakh	8,885	Mass market adoption

EMPS 2024	Apr–Sep 2024	778	3.72 lakh	—	Bridging scheme
PM E-DRIVE	Oct 2024–Mar 2026	10,900	~25 lakh (target)	~72,000 (target)	Infrastructure-led expansion

(Source: MHI, 2024; ICCT, 2024; IBEF, 2025)

In table 5, the stages and growing size of India's green mobility policy architecture are shown from FAME I to PM E-DRIVE (MHI, 2024; ICCT, 2024; IBEF, 225). Total cumulative government expenditure against the schemes have crossed ₹24,000 crore, reflecting continued fiscal commitment. The 16.29 lakh EVs broken up into 14.35 lakh e-2Ws, 1.65 lakh e-3Ws, 22,644 e-4Ws and 5,165 e-buses that have received FAME II's subsidy are evidence of the mass-market reach of the programme. Introduction of electric trucks (₹500 crore) and ambulances for the first time under PM E-DRIVE recognises a coming of age of policy towards holistic transport electrification.

Table 6: Projected EV Penetration and CO_2 Avoidance by 2030 and 2050 (India)

Indicator	**2025 (Actual)**	**2030 (Government Target)**	**2030 (IEA APS)**	**2050 (IEA APS)**
EV Sales Share (%)	8.07%	30%	~35%	>80%
Cumulative EV Fleet (million)	~6.17	~80	~50	~350
CO_2 Avoided by EVs (Mt/year)	~2	~5	~12	110–380
Renewable Share in Grid (%)	51.5%	65% (target)	65%	>90%
Annual Oil Import Savings (₹ crore)	~5,000	~45,000	~60,000	>2,00,000

(Source: IEA, 2022; NITI Aayog& WRI India, 2025; Chaturvedi&Malyan, 2022)

The projected green mobility metrics for India under IEA Announced Pledges Scenario (APS) are presented in Table 6 against the actuals of year 2025(I D Y A, 2022; NITI Aayog& WRI India, 2025; Chaturvedi & Malyan, 2022). India's existing EV fleet of 6170000 avoids around 2 Mt CO_2 every year this is likely to rise to between 110 and 380 Mt CO_2 per annum by the year 2050 depending on how quickly the grid decarbonises (Figure(figure3). Securing the 2030 target of 30% penetration and 80 million EVs on road is structurally fundamental to delivering any credible 2050 energy scenario.

6. DISCUSSION

The data presented in Tables 1–6 collectively support the conclusion that India's green mobility transition has reached a threshold where it is no longer just a policy aspiration but rather an empirically observable system-

wide transformation. EV sales in CY2025 at a record 2.27 million units around 8.07% of total vehicle registrations is the closest indicator to evidence straddling structural momentum in India's mobility ecosystem (Autocar Professional, 2026; JMK Research & Analytics, 2025). Most notably, electric passenger vehicle sales more than tripled (+77%) during the same period, indicating that EV uptake is crossing the lower price-sensitive two- and three-wheeler segments into mainstream consumer buying patterns a trend form that was confirmed by IEA (2025) across India's emerging market momentum, in Q1 2025. Yet, table 1's results must be understood in contrast with the government's 2030 target of 30% EV penetration. With just an 8.07% share of the market, we are still far behind from aspiring for a target mark and to cover the proposed gap over five years, atleast the automotive sector needs to add roughly about 20 million more EVs annually by 2030. Dawda (2024) undertook a similar analysis of potential risk factors, identifying battery raw material supply constraints, especially regarding lithium and cobalt access, as the primary upstream threat to realizing this scale while IBEF (2025) forecasts highlighted that average annual EV penetration may stagnate at 7% in FY2028 without further resolution to upstream supply disruptions. The assessment of alignment under Objective 1 thus yields a qualified determination: while directional alignment with 2050 targets is at least somewhat positive, the pace of acceleration that conditions would require is vastly greater than current trends.

The most revealing for the energy planning discourse are the results in Table 2 regarding renewable energies. India reached 51.5% of its total installed electricity capacity from non-fossil fuel sources by November 2025 five years earlier than its commitment under the 2030 Paris Agreement fundamentally changing the carbon calculus of EV deployment (MNRE, 2025b). Chaturvedi and Malyan (2022) showed that EVs have CO_2 avoidance potential, which directly tracks with the decarbonisation of the electricity grid used to power them. As the Indian grid is moving at breakneck speed, the upper bound in Table 6 of annual avoidance of 380 Mt CO_2 by 2050 will become increasingly realistic assuming decarbonisation of both EV fleets and the grid continues in lockstep. Additionally the transport CO_2 projection in Table 3 provides you with the structural urgency underlying all green mobility investments. The fact that road transport alone accounts for 94% of total transport emissions and is estimated to emit 580 Mt CO_2 in the BAU scenario by 2050 means intervention in this sector is a given as India commits to net-zero by 2070 (IEA, 2022; Kamboj et al., 2022). The analysis further warned that transport emissions under unmitigated scenarios could become more than 20% of India's total CO_2 inventory in the year 2030–31 (Cargoson, 2025). Therefore, relative to this baseline the reduction of ~230 Mt in the APS scenario is not only a single sector mitigation intrapreneurship but also consequences-wise it encompasses the maximum net gain India can achieve vis-a-vis its carbon-budget.

As shown in Table 4, the data pertaining to the charging infrastructure unveils the most constraining implementation bottleneck in making India's green mobility framework a success. The 1:235 ratio of the EVs to charger is the key reason behind range anxiety not getting resolved and potential adoption of electric vehicles stalled in Tier-2 and Tier-3 cities. ICCT's (2024) analysis noted how this geographic concentration of charging stations in Karnataka, Maharashtra and Delhi five states representing 60% share of national stations results in vast portions of the country remaining underserved. If PM E-DRIVE's 72,000 charger target does not cover an equitable geographic spread of the country, then green mobility will end up being a structurally uneven contributor to the energy planning framework by 2050. The evolution of policy from FAME I to PM E-DRIVE in Table 5 shows greater financial sophistication and strategic depth. The targeted allocation of ₹500 crores for

the inclusion of electric trucks under PM E-DRIVE marks a significant step towards decarbonising road freight transport which emits 30–50% of total emissions from different modes of surface transport and has been largely left out from consideration in electrification policy (NITI Aayog& WRI India, 2025). Sahet al. (2025) empirically shows that the confounding variable in energy transition is governance, across sectorsas opposed to financial outlaythe finding of which emphasises the need for institutional coordination between (i) Ministry of Heavy Industries and MNRE; (ii) Ministry of Power;(iii) state governments. The success of green mobility in India, in short, is as much a governance problem as it is one of technology or finance.

7. CONCLUSION

This study has provided more substantial validated, quantitative proof that green mobility is a least cost and integral component to India's energy planning paradigm for 2050. India's EV market has burgeoned from or nothing volumes in 2015 to an annual sales of 2.27 million by CY2025, while renewable energy capability exceeded the 253.96 GW collectively laying the technical and institutional preconditions for deep transport decarbonisation The results validate the hypothesis of the study: Unabated green mobility rollout, working in tandem with accelerated expansion of renewables is an quantitatively viable strategy to reduce India's transport CO_2 emissions by 60% compared to BAU trajectory at 2050. The key priorities over the next few years are to expedite EV market penetration from 8.07% to 30% by 2030, on an equitable geographic basis with charging infrastructure deployment extending beyond urban areas, and for grid decarbonisation advances in pace with the scaling up of EV fleet emissions avoidance potential. This is not just about decarbonising one sector the public transport and freight sector green mobility, in this context, is a fundamental connect of India's energy security, climate commitments, and economic sovereignty architecture for 2050 and beyond.

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