

Transition to Electric Vehicles across all spectrums is not just environmentally friendly but also cost effective in the long run

Arin Sharma

Independent Researcher, Gurgaon Haryana, India

Author Email: sharmaarin332@gmail.com

Abstract—India is the world's third largest emitter of greenhouse gases and the second largest importer of crude oil, and its transport sector sits at the center of both problems, which makes the shift to electric vehicles a question of national interest as much as an environmental one. This paper examines whether that shift is both environmentally beneficial and economically viable, and whether the case holds across all five vehicle segments, being two wheelers, three wheelers, four wheelers, trucks, and buses. Using registration data from 2022 to 2026 alongside primary data collected from the commercial vehicle sector, and applying regression analysis to identify trends across segments, the paper finds that EV adoption in India does not behave as a single market but as five distinct ones. Two and three wheelers are the most mature and are approaching the point where they no longer need subsidy to compete, four wheelers are growing quickly but remain constrained by upfront cost and a charging network well behind China and the United States, trucks are accelerating sharply though mostly in small urban cargo vehicles rather than heavy freight, and buses are growing in irregular batches because they are bought through government tenders rather than by individuals. The paper also finds that the environmental benefit of EVs in India is real but conditional on grid decarbonisation, since roughly 70% of the national grid still runs on coal, and that the economic case is strongest wherever vehicle utilisation is highest. Drawing on the experience of countries further along the adoption curve, including Norway, China, Ethiopia, and Nepal, the paper concludes that India's 2030 target of 30% EV penetration will depend less on momentum and more on how well policy, infrastructure, and grid decarbonisation are managed together.

Keywords: Electric vehicles, India EV adoption, vehicle segments, regression analysis, sustainability, economic viability, charging infrastructure

I. INTRODUCTION

India is currently the world's third-largest emitter of greenhouse gases and the second-largest importer of crude oil, having imported over 232.5 million tons in 2023 alone [1]. The transportation sector is one of the primary contributors to this crisis, adding a significant share of vehicular emissions. Pollution from vehicles accounts for 51% of air pollution in India, and up to 80% in metropolitan areas between 2014 and 2018 [1]. With India being the fourth-largest automobile market in the world, growing at a compound annual growth rate of 7.01% [1], the environmental and economic consequences of its mobility choices are enormous, and the need for an alternative is thus quite important. In 2021 alone, nearly 3 billion tons of CO₂ were produced by passenger cars globally, with the transportation industry contributing to 41% of global carbon emissions [1].

Globally, the transition to electric vehicles is gaining significant momentum. EV adoption is following an S-curve trajectory of growth across many nations, driven by falling battery costs, policy support, and growing environmental awareness [7]. Countries like Norway, China, and many developing nations such as Ethiopia and Nepal are already seeing rapid EV growth [7]. Developing countries in particular are seeing EV adoption rise rapidly, driven by cheaper EV imports, especially from China, which could significantly impact India's global oil demand [6]. India has similarly set an ambitious target of 30% EV penetration

by 2030 across all vehicle segments, backed by government initiatives such as the Faster Adoption and Manufacturing of Electric Vehicles in India (FAME) scheme and the Production Linked Incentive (PLI) scheme [2].

EV sales in India have risen sharply, from 95,198 units in 2017-18 to 1,670,736 units in 2023-24 [2], suggesting that while the transition is underway, it remains far from the scale required to meet these targets. The case for EVs is often made primarily on environmental grounds, focusing on emission reductions and climate action. *However, this research paper argues that the transition to EVs is equally significant from an economic standpoint, both at the macro level in terms of reduced oil import bills and energy security, and at the individual level through lower long-run operational costs* [5]. Research shows that a 1% rise in petrol prices leads to approximately a 0.85% increase in EV sales, underlining how pricing dynamics are central to the economic case for EVs [11]. The economic calculations, however, differ significantly across vehicle segments. Two-wheelers, three-wheelers, four-wheelers, trucks, and buses each present distinct cost structures, usage patterns, adoption barriers, and infrastructure requirements, and thus need to be examined separately rather than as a homogeneous category [8].

While existing literature has examined EV adoption broadly, or focused on specific vehicle segments or policy frameworks in isolation, few studies have compared the economic and environmental impact of EVs across all vehicle segments using regression-based quantitative analysis on Indian data [8]. Studies using patent data across 19 countries confirm that policies such as subsidies, fuel standards, and Research & Development (R&D) support to boost EV innovation, but also highlight that these policies must work in coordination rather than in isolation [10]. Additionally, the role of infrastructure limitations such as the availability of charging stations is often treated descriptively rather than being economically quantified, with research on Indian highways pointing to significant gaps in the financial sustainability of public EV charging infrastructure [13]. These gaps are what this paper seeks to address.

II. LITERATURE REVIEW/BACKGROUND OF RISE IN EV DEMAND

The move towards electric vehicles has been widely written about in both research and policy spaces over the past decade. Most of the existing work agrees that what drives EV adoption is the battery costs that have declined. To make things more accessible, a large number of charging points have been built, and governments have pushed the transition through the provision of subsidies that have been given in terms of road tax, etc. on purchasing of EV vehicles. Jaeger [7] tracks the manner in which EV sales in almost every country follow the same pattern. The start is slow, but then it grows quickly once market share crosses around 1%, before eventually leveling off. The IEA [16] adds to this, reporting that 22% of all passenger vehicles sold in 2024 were electric, which is eight times higher than five years before. Norway and China come up most often in this literature. Norway reached over 92% EV share in new car sales in 2024, which resulted from three decades of government support including tax breaks, investment in charging, and benefits like bus lane access for EV drivers. The turning point came around 2012 when owning an EV became cheaper than owning a petrol car for the same period [7]. China took a different path, putting an estimated \$230 billion into subsidies and research between 2009 and 2023 to build the largest EV market in the world. It now sells more EVs than any other country put together [7], reducing dramatically their demand on fossil fuels. What both cases show is that EV transitions do not happen by themselves. *They are the result of governments making deliberate choices, and how fast this adoption grows depends on how well the incentive infrastructure, and pricing are put in place.*

As EVs have become more affordable, developing countries have started coming up with larger research projects. Fosu and Achinah [8] note that while the benefits of EVs exist everywhere in theory, getting there in lower income countries involves a different set of problems, mainly that infrastructure is not yet in place, vehicles cost too much relative to what people earn, policy support is inconsistent, and there are not enough trained workers to support the industry. A more specific problem is raised by the ASEAN Centre for Energy [4], which uses data from Indonesia to show that unmanaged EV charging in developing countries can actually increase emissions rather than reduce them. The problem comes down to timing. Most people charge their vehicles at night after returning from work, which is also when electricity demand is at its highest. In countries where the grid still runs mostly on coal or gas, the extra electricity needed to meet that demand can produce enough emissions to cancel out what was

saved by not burning petrol [4]. This matters for India, where roughly 70% of the grid is still coal based [1], meaning the environmental benefit of EVs here depends significantly on what happens within the grid itself.

India's EV market has attracted more research attention since the FAME (Faster Adoption and Manufacturing of (Hybrid & Electric Vehicles) scheme was introduced in 2015. Kaur and Kumar [1] give one of the more complete recent overviews, showing how sales grew from 95,198 units in 2017 to 2018, up to 1,670,736 units in 2023 to 2024, and placing this within the broader policy story going from the National Electric Mobility Mission Plan in 2013, through the FAME phases, to the PM E-DRIVE scheme launched in September 2024 with a budget of Rs. 10,900 crore [18]. Desai [2] and a separate study on India's EV industry [17] add more on how FAME II, battery localisation efforts, and the Production Linked Incentive scheme have shaped the market as it stands today. The NITI Aayog [26] and IBEF [25] reports both confirm the government's target of 30% EV penetration across all vehicle types by 2030, though they also make clear that current numbers are well below the goals that are officially stated. The Economic Times [14] and a Cornell analysis [24] note that growth slowed in 2025 to 2026, with FAME II subsidies ending, price gaps between EVs and petrol vehicles persisting, and charging infrastructure remaining limited. This is a useful counterpoint to more optimistic forecasts and shows that some of the problems holding back adoption have not been resolved by policy alone.

At the segment level, the Bain India EV Report [21] provides the most detailed breakdown. Two wheelers make up 85 to 90% of all EVs sold in India and have the most room to grow, with projections of over 45% penetration by 2030 under the right conditions. Three wheeler EVs, particularly e-rickshaws, have already passed 50% penetration, helped by lower running costs and government restrictions on petrol alternatives in cities like Delhi. Four wheelers remain at around 1 to 1.5% penetration, with comparable EVs still costing roughly 50% more than petrol cars, and with India having around 200 EVs per charging point compared to 20 in the US and fewer than 10 in China [21]. Trucks and buses have barely started the transition, with buses at around 3% and trucks below 0.1% [21]. This variation across segments shows up consistently in the research [1], [17], but the different segments have rarely been studied together in a single piece of work, which is one of the clearer gaps in the existing literature.

The research on the cost side of EVs is thinner, particularly for India. The SSRN paper on price sensitivity [11] finds that petrol prices have more influence on EV sales than electricity prices do, with a 1% rise in petrol prices linked to roughly a 0.85% increase in EV sales. The ScienceDirect study [5] covers the general case for EVs, noting that high purchase costs and limited charging access continue to hold back adoption in practice. The EY report [19] points out that EVs are cheaper over the full life of the vehicle but that most buyers, especially in smaller cities, are not aware of this. On charging stations, Gupta, Singh, and Saini [13] look at public charging infrastructure on Indian highways and find that while it can work financially over time, early stage support from the government is needed because stations do not get enough use in the beginning. They also find that putting one operator in charge of a stretch of infrastructure works better than dividing it between several.

The policy side of the research adds the final piece. A study using patent data from 19 countries between 2010 and 2021 [10] finds that policies work better when they are put together as a package rather than introduced one at a time. Subsidies, fuel standards, and long term targets all help individually, but they have a much bigger effect when they are designed to support each other. The transport policy study [15] and a broader comparative analysis [8] find that when policy is fragmented, which has often been the case in India [1], even well designed schemes do not reach their potential. The life cycle study [27] and the Nature article on India [20] both find that on coal heavy grids, the reduction in emissions from EVs is much smaller than it first appears, and in some cases involving unmanaged charging at night, total emissions can end up being higher than those of the petrol vehicles being replaced.

III. RESEARCH GAP

This paper analyses EV adoption across five vehicle segments in India, namely two-wheelers, three-wheelers, four-wheelers, trucks, and buses, using regression models to show both the environmental impact and the viability of the transition. It also draws

on lessons from countries that have progressed further along the EV adoption curve to assess what India can replicate or adapt [3]. Along with authentic secondary data, primary data from companies would be added to the research, giving a more realistic comparison on the impact of governments aid in achieving their targets and reality. This comparison would help in further streamlining of policy measures for the government at various points of adoption of various EV vehicles.

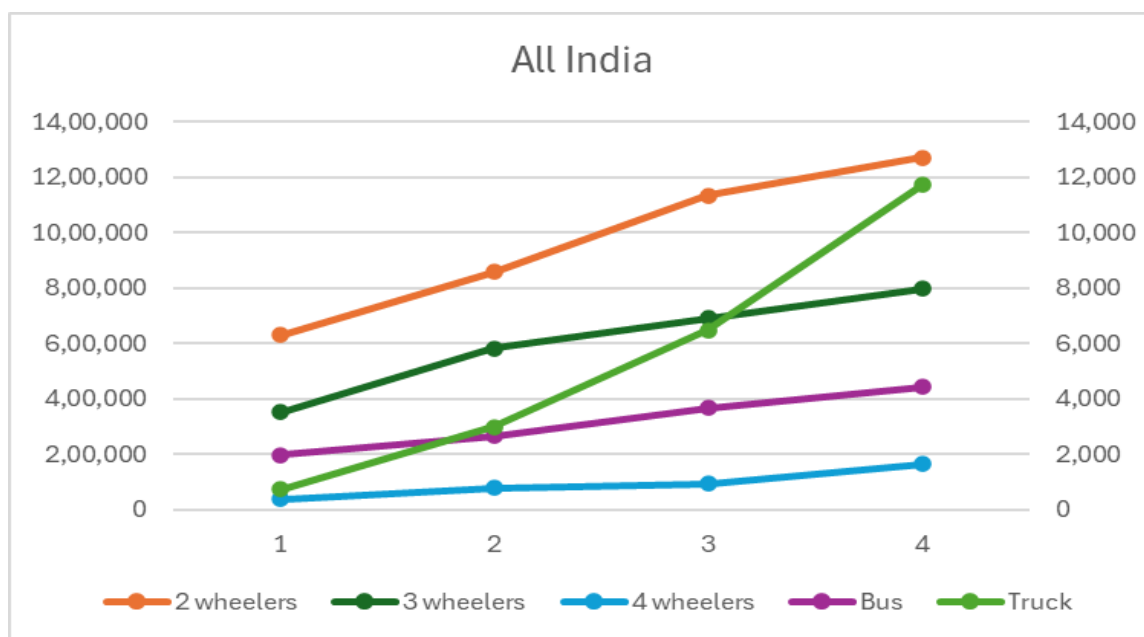
The methodology adopted would be both quantitative and qualitative, as well as primary and secondary. The secondary sources are from authentic government documents and balance sheets of various companies involved in EV production that have been submitted to SEBI (Securities and Exchange Board of India). The primary data has been derived from companies that are involved in EV production. The quantitative data would be substantiated by qualitative analysis.

IV. ANALYSIS FROM INDIA

Table 1: Figures for All India sales of EVs

Year	2 wheelers	3 wheelers	4 wheelers	Bus	Truck
2022	631,090	352,742	38,170	1,988	733
2023	856,839	582,548	80,121	2,666	3,000
2024	1,133,855	690,024	93,551	3,667	6,478
2025	1,270,921	797,947	165,375	4,444	11,704

Source: <https://cleanmobilityshift.com/ev-dashboard/>



Source: <https://cleanmobilityshift.com/ev-dashboard/>

At the national level, two wheelers remain the largest segment by a wide margin, roughly doubling from 631,090 units in 2022 to 1,270,921 units in 2025. Three wheelers grew from 352,742 to 797,947 over the same period, while four wheelers grew fastest among the passenger segments in proportional terms, from 38,170 to 165,375, which is more than a fourfold increase. Buses grew steadily from 1,988 to 4,444, and trucks showed the sharpest proportional jump of all, from 733 to 11,704, though from a very small base [39].

The single biggest driver has been sustained government policy. Targeted schemes like FAME and the PM E-Drive programme have been instrumental in lowering the upfront cost of electric two and three wheelers, making them price competitive with petrol equivalents. FAME II ran until March 2024 and is widely credited with the surge in two and three wheeler sales, and when it wound down it was replaced by the PM E-DRIVE scheme, which aims to accelerate adoption by incentivising the sale of about 2.5 million electric two wheelers and 320,000 three wheelers [18] [42]. This continuity of support meant there was no policy vacuum to stall momentum.

For two wheelers specifically, growth has been driven by affordability, low running costs, and their suitability for short urban trips, along with a rapidly widening choice of models. A large and diverse product lineup, now estimated at nearly 200 models, has enabled wider market penetration across urban and semi-urban India. The rise of application (app) based delivery and last mile logistics has also pushed demand, as delivery riders find the low per kilometre running cost of an electric scooter attractive. The increase in demand for this segment has been driven by the growth of the e-commerce and q-commerce sectors in tier 1,2 and 3 cities [29]. The attractive incentives by the government in terms of generous tax breaks has further accelerated their rising demand [37].

Three wheelers have grown for a slightly different reason. This segment is driven heavily by commercial use rather than personal ownership. Demand is primarily driven by shared mobility, cargo transportation, and last mile logistics, with the rise in e-commerce and fleet electrification acting as a major catalyst [28]. India is now the largest electric three wheeler market in the world, and more than 60% of all three wheelers sold in India are now electric [28]. The strong cost advantage of an e-rickshaw or electric cargo three wheeler over a petrol or CNG equivalent, combined with regulatory pressure in several cities, has made this segment one of the most mature in the country [42].

Four wheelers grew quickly in proportional terms but remain a small share of overall sales. Growth here has come from a wider range of affordable models, better financing options, and rising corporate fleet demand. The electric four wheeler market saw a remarkable 53% year on year growth in the first half of 2025, driven by affordable EV models, expanded financing options, and increasing corporate fleet electrification [30]. The anticipated entry of new manufacturers, including global players, has also widened consumer choice and pushed existing manufacturers to compete harder on price and features [41].

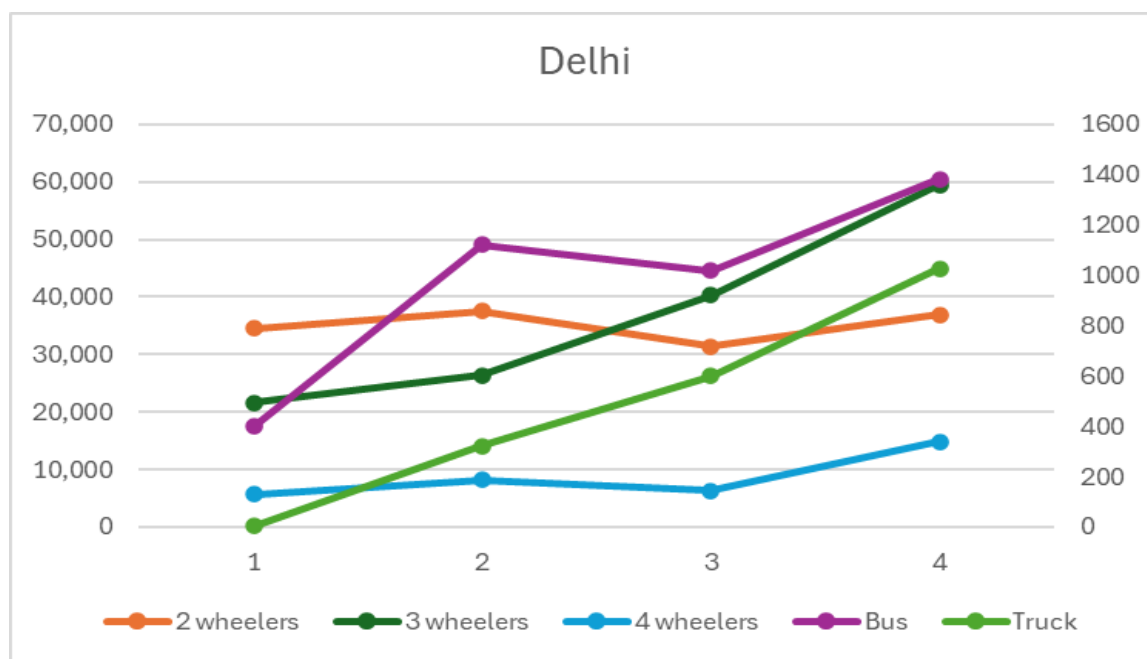
The truck figures deserve a note of caution. The sharp jump from 733 to 11,704 looks dramatic, but the vast majority of these vehicles are small commercial cargo vehicles under 3.5 tonnes used for urban delivery rather than heavy freight trucks. In 2024, only around 6,220 electric trucks were sold out of over 834,000 total truck sales, with 95% of these being under 3.5 tonnes and used primarily for short haul urban deliveries [32]. The growth in this segment has been driven by e-commerce and logistics companies electrifying their last mile fleets, helped along by vehicles like the Tata Ace EV [31]. The heavy truck segment specifically remains tiny, though it received its first dedicated policy support in July 2025 when India launched its first ever e-truck incentive scheme under PM E-DRIVE, offering upfront incentives of up to ₹9.6 lakh per electric medium and heavy truck [32].

Buses have grown more slowly in absolute numbers but represent an important shift because they are almost entirely driven by government procurement rather than private demand. India has seen rapid growth in electric bus deployment since 2020, with stock increasing from less than 3,000 to more than 11,500 at the end of 2024, enabled by favourable economics, incentives, and government support for charging infrastructure [32]. Large aggregated procurement programmes have helped drive down costs, with the PM E-DRIVE scheme supporting the deployment of thousands of additional electric buses through centrally managed tenders [41].

Table 2: Figures for Delhi sales in EVs

Year	2 wheelers	3 wheelers	4 wheelers	Bus	Truck
2022	34,596	21,623	5,642	399	5
2023	37,522	26,344	8,177	1,121	323
2024	31,365	40,251	6,346	1,019	601
2025	36,864	59,543	14,794	1,382	1,028

Source: <https://cleanmobilityshift.com/ev-dashboard/>



Source: <https://cleanmobilityshift.com/ev-dashboard/>

Delhi's data shows a more mixed picture than the national one, which is itself revealing. Three wheelers in Delhi grew strongly, from 21,623 in 2022 to 59,543 in 2025, nearly tripling. Four wheelers grew from 5,642 to 14,794, and trucks jumped from just 5 in 2022 to 1,028 in 2025. Buses grew from 399 to 1,382. Two wheelers, however, are the odd one out, actually dipping from 34,596 in 2022 to 31,365 in 2024 before recovering slightly to 36,864 in 2025, showing almost no net growth. [39]

The reasons behind Delhi's numbers are tied to local policy and pollution policies rather than the national trend. Delhi's central problem, and the main driver of its EV push, is air quality. Internal Combustion Engine (ICE) vehicle emissions contribute nearly 23% of the pollution in the national capital, and two wheelers alone make up about 67% of the total vehicular pollution in the city [35]. This has made EV adoption less of a choice and more of a public health necessity, and it explains why Delhi has been among the most aggressive states on EV policy.

Delhi's original EV policy, introduced in 2020, set a target of having one in four new vehicles be electric by 2024. Despite early momentum it did not meet those goals, with EVs accounting for about 12.7% of vehicle sales as of financial year 2025 to 2026, roughly half the earlier target [34]. Even falling short, this policy still made Delhi one of the highest EV penetration regions in the country and drove much of the growth seen in the data.

The strong growth in three wheelers is the clearest success story. Delhi has actively restricted petrol and CNG autos and prioritised electric ones, and the cost advantage of e-autos for drivers has done the rest. The upcoming policy goes further still, with the proposal that only electric three wheelers will be permitted for registration in Delhi starting January 1, 2027 [35]. The expectation of this regulatory shift has pushed buyers towards electric three wheelers ahead of the deadline.

The relatively flat two wheeler numbers are worth examining because they run against the national trend. Part of the explanation is that Delhi's two wheeler EV market was already relatively developed by 2022, so there was less low hanging fruit to capture. The dip in 2024 also coincided with the transition between FAME II ending and the new schemes taking effect, a gap that would have hit price sensitive two wheeler buyers hardest [42]. The recovery in 2025 lines up with the rollout of PM E-DRIVE and the anticipation of Delhi's new policy, under which the registration of new petrol powered motorcycles and scooters will end permanently on April 1, 2028 [36].

Four wheeler growth in Delhi has been supported by generous local incentives. Under Delhi's policy framework, EV buyers receive purchase incentives, road tax exemption, and registration fee waivers, with 100% road tax and registration fee waivers on electric vehicles priced up to ₹30 lakh [35]. These waivers meaningfully reduce the effective cost of an electric car and have made Delhi one of the more attractive markets for four wheeler EVs.

The truck growth in Delhi, from 5 units to over 1,000, reflects both the small starting base and Delhi's regulatory push on commercial vehicles. The city has moved to restrict fleet aggregators and delivery services from adding new petrol vehicles, and since January 2026, no new petrol, diesel, or CNG two wheelers or light goods vehicles up to 3.5 tonnes can join aggregator based services like Swiggy, Zomato, Ola, and Uber [33]. *This has forced logistics and delivery operators to electrify, driving demand for small electric cargo vehicles.*

V. ANALYSIS OF SURVEY CONDUCTED IN THE BUS AND TRUCK EV SPACE FROM 2025 TO JUNE 2026

Year	2025	2026
Bus	4,444	2,905
Truck	11,704	11,931

Source: Primary data collected from Drivn

Trucks are growing fast. The segment recorded 11,704 units across all of 2025 and has already reached 11,931 units in just the first seven months of 2026 [39]. In other words, it has passed its entire previous year total in a little over half the time. If this pace holds for the rest of the year, the segment is on track to reach roughly 20,000 units, which would be close to double the 2025 figure. This lines up with what is happening in the wider market, where electric goods vehicles across the light, medium, and heavy categories have grown by around 172% year on year in FY2025-26 [41]. The main reasons behind this are the rise of e-commerce and last mile delivery, which has pushed logistics companies to electrify their small cargo fleets [31], and the launch of India's first dedicated e-truck incentive scheme under PM E-DRIVE in July 2025, which offers support of up to Rs. 9.6 lakh per electric medium and heavy truck [32]. It is worth repeating that most of these vehicles are small commercial cargo vehicles

under 3.5 tonnes used for city deliveries rather than heavy freight trucks, so the growth is being driven by urban logistics more than long distance haulage [32].

Buses are moving at a slower and steadier pace. The segment recorded 4,444 units in 2025 and has reached 2,906 units in the first seven months of 2026 [39]. Annualised, that works out to roughly 4,980 units for the full year, which would put 2026 slightly ahead of 2025 but not by much. Buses behave differently from every other segment because they are almost entirely bought by government bodies rather than private buyers [32]. This means their numbers depend on large tenders that come in batches rather than a steady flow of monthly sales. A single procurement programme can lift one year's figures sharply and leave the next looking flat, purely based on when the buses are delivered and registered. The completion of India's largest electric bus tender, under which CESL awarded contracts for 10,900 buses as part of PM E-DRIVE [41], means a large number of buses are due to be delivered over the coming period, so the bus figure is likely to rise again once those orders are registered.

Putting the two together, the truck segment is the clearer growth story of the two, driven by private logistics demand and a new subsidy that only came into effect in mid 2025. The bus segment is growing too, but its progress is tied to the timing of government tenders rather than month to month market demand, which makes its year to year figures look less smooth. Both segments remain small in absolute terms compared to two and three wheelers, but both are important because they represent the parts of the transport system where emissions per vehicle are highest, which means each electric bus or truck removes far more pollution than a single electric scooter.

VI. ANALYSIS OF PRIMARY SURVEY CONDUCTED ON TRUCK AND BUS EVS - A COMPARISON OF INCREASED SALES AND REVENUE EARNED IN THEIR SALES FROM 2025 TO JUNE 2026 (IN CRORE)

Table 3: Primary data for sales and revenue for Trucks and Buses compounded for all-India

Year	2025	2026
Sales	16,148	14,837
Revenue	₹16,874	₹15,740

Source: Primary data collected from Driven.

The table above indicates the sales and revenue of electric buses and trucks across 2025 and the first seven months of 2026 [39]. The 2026 figures run up to July, so they cover only part of the year, which needs to be kept in mind when comparing the two columns. Rather than reading the 2026 numbers as a full year, the more useful approach is to look at the pace each segment is running at and compare it with how it performed in 2025.

In 2025, the two segments together recorded 16,148 units, made up of 11,704 trucks and 4,444 buses. In the first seven months of 2026, they recorded 14,837 units, made up of 11,931 trucks and 2,906 buses [39]. The truck figure is the striking one here, because the segment has already passed its entire 2025 total in a little over half the year. If this pace holds, trucks are on track to reach roughly 20,000 units for the full year, which would be close to double the previous year. Buses have reached 2,906 units so far, which annualises to around 4,980 for the full year, putting them slightly ahead of 2025 but not by much.

Revenue has been calculated by multiplying the number of units in each segment by an approximate price of ₹1.1 crore per electric truck and ₹90 lakh per electric bus. In 2025, trucks generated approximately ₹12,874 crore and buses approximately

₹4,000 crore, giving a combined total of around ₹16,874 crore. In the first seven months of 2026, trucks generated approximately ₹13,124 crore and buses approximately ₹2,615 crore, giving a combined total of around ₹15,740 crore. What stands out is that the 2026 revenue has almost matched the full 2025 figure in half the time, and nearly all of this is coming from trucks. The truck segment alone has already earned more in seven months of 2026 than it did in all of 2025, while buses have brought the total down slightly because of their part year dip.

The growth in these two segments is being driven by two different sets of buyers, explaining the reason behind the difference in behavioral patterns as indicated in the data. Trucks are being bought mainly by the private sector. The demand here comes from logistics firms, e-commerce companies, and small fleet operators who are switching to electric cargo vehicles to cut their running costs [31]. For a business that runs its vehicles all day, the lower cost of electricity compared to diesel adds up quickly, so the switch pays for itself over time. Businesses also benefit from accelerated depreciation of up to 40% on electric vehicles, compared to the standard 15% on regular motor cars, which improves the case further [47]. This is why truck adoption grows in a fairly steady and continuous way, because each business makes its own decision to buy based on its own costs. The rise of last mile delivery and online shopping has pushed this demand further, and the new e-truck subsidy under PM E-DRIVE, introduced in July 2025, has added to it by lowering the upfront price [32].

Buses, on the other hand, are being bought mainly by the public sector. State transport bodies and government agencies are the main buyers of electric buses, usually through large tenders where thousands of buses are ordered at once [32]. Buses are used to run public transport routes in cities, which serves the government's twin goals of reducing urban air pollution and providing affordable public transport. A single tender like the CESL order for 10,900 buses under PM E-DRIVE can shape the figures for a whole year depending on when those buses are actually delivered and registered [41].

The key point is that the two segments are being pushed forward by different forces. Trucks are driven by private businesses responding to cost savings, which produces steady and continuous demand. Buses are driven by public sector procurement, which produces demand in large but irregular batches. Both are growing, but for very different reasons, and this difference in who is buying explains the different shapes their growth takes in the data.

VII. LIMITATIONS

The most significant limitation concerns the truck figures. The Vahan data used here counts all goods vehicles under the N category, which includes light, medium, and heavy goods vehicles together. In practice, around 95% of the vehicles counted as electric trucks are small cargo vehicles under 3.5 tonnes used for city deliveries, such as the Tata Ace EV, rather than heavy freight trucks. This means the truck figures *overstate progress in heavy freight electrification*, which remains very small. Any conclusions drawn about the truck segment should be understood as being mostly about urban last mile logistics rather than long distance haulage.

The revenue figures in this paper are calculated by multiplying unit sales by an approximate price of ₹1.1 crore per truck and ₹90 lakh per bus. These are flat averages and do not account for variation in vehicle size, model, or specification. Because the truck data includes a large number of small cargo vehicles that sell for far less than ₹1.1 crore, the revenue figure for trucks is likely to be overestimated. The revenue numbers should therefore be read as an illustration of the scale of the segment rather than an exact market value.

The 2026 figures cover only the first seven months of the year, up to July. They cannot be compared directly with the full year figures for earlier years. Where 2026 has been discussed, the numbers have been annualised to give a rough sense of the pace, but annualising assumes an even spread of sales across the year, which is not always accurate. Vehicle sales in India tend to cluster around the festive season and the end of the financial year, so the actual full year figure may differ from the annualised estimate.

The Vahan dashboard records vehicle registrations rather than sales. There is often a gap between when a vehicle is sold and when it is registered, particularly for buses, which are bought through large government tenders and may be delivered and

registered months after the order is placed. This makes the year to year bus figures look uneven even when underlying demand is steady, and means a single delayed tender can distort a full year of data.

This paper draws conclusions based on the measured impact of EVs based on existing research and on the grid composition rather than on actual emissions data for the vehicles in question. The real emission figures saved depend on how far each vehicle is driven, how it is charged, and what the grid mix is at the time of charging. None of this is captured in registration data, so the *environmental conclusions are inferred rather than directly measured*.

The primary data collected for this paper comes from a company that operates only in the private sector. This means the truck figures reflect commercial buyers such as logistics firms and fleet operators, while the bus segment, which is almost entirely driven by public sector procurement through government tenders, sits outside the company's market. The data therefore gives a stronger and more direct picture of private sector truck demand than it does of the bus market, where the findings rely more heavily on secondary sources. It is also not a randomised or nationally representative sample, so it may not capture regional variation or the behaviour of buyers outside that network.

The regression analysis in this paper identifies relationships and trends but cannot prove that any one policy caused a change in adoption. Several policies, price changes, and market developments happened at the same time, so it is difficult to separate their individual effects. Where the paper links a change in sales to a specific policy, that link is based on timing and existing research rather than a controlled comparison.

VIII. CONCLUSION

The main finding of this paper is that EV adoption does not behave as a single market, it behaves as five markets that happen to share a technology. Two and three wheelers are the most mature and are close to the point where they no longer need subsidy to compete, driven by high daily usage and running cost savings, with three wheelers having crossed 50% penetration, helped by a cost advantage over petrol and CNG alternatives and by cities like Delhi restricting the petrol option outright. Four wheelers are growing quickly in proportional terms but remain small, held back by an upfront price gap of roughly 50% and a charging network well behind China and the United States, while trucks are accelerating sharply, though the growth is mostly in small urban cargo vehicles rather than heavy freight, and buses are growing too, but in irregular batches.

The bus and truck comparison is worth drawing out, as though they are commercial, their buyers are different. Trucks are bought by private businesses, which produces steady demand, whereas buses are bought by the government through large tenders, which produces demand in uneven batches, and any policy aimed at these segments has to account for that. A subsidy that works on a logistics firm will not work the same way as on a state transport undertaking.

The environmental case is positive but conditional, as EVs in India are cleaner than petrol vehicles, but the gap is smaller than elsewhere because roughly 70% of the grid still runs on coal. The benefit is also uneven, since an electric bus covering 150 kilometres a day removes far more pollution than a private car covering 30, though the useful part is that this benefit grows on its own as the grid decarbonises, without any change to the vehicles themselves.

The economic case is strongest, in the case of two and three wheelers, buses on busy routes, and delivery vehicles recover their higher purchase price quickly, while private four wheelers take much longer. The strongest lever available to policymakers is petrol pricing, since a 1% rise in petrol prices is linked to roughly a 0.85% rise in EV sales, and the biggest bottleneck is charging infrastructure, which is not yet profitable to enjoy economies of scale.

The lessons from other countries point the same way, with Norway showing that consistency matters more than generosity. India's start-and-stop subsidy transitions have hurt the sector. China shows that domestic manufacturing lowers cost and supply risk, which matters given that India still imports most of its battery components.

India is on the right path, where the transition is underway across every segment, and in some it is already self-sustaining, but the 30% target by 2030 will not be reached on momentum alone, it will be reached, or missed, on how well the policy, the infrastructure, and the grid are managed together.

REFERENCES

1. Kaur, S., & Kumar, A. (2026). Electric vehicles as a pathway to India's sustainable development goals. *Discover Sustainability*, 7(1). <https://doi.org/10.1007/s43621-026-02643-w>
2. Desai, A. (2025). *Revolutionizing mobility: An in-depth analysis of India's electric vehicle market and its future trajectory*. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=6253038
3. *The future of electric vehicles in developing countries*. (n.d.). ResearchGate. https://www.researchgate.net/publication/391690265_The_Future_of_Electric_Vehicles_in_Developing_Countries
4. *Potential impacts of EV on developing countries' electricity systems and how to mitigate them*. (n.d.). ASEAN Centre for Energy. <https://accept.aseanenergy.org/potential-impacts-of-ev-on-developing-countries-electricity-systems-and-how-to-mitigate-them/>
5. *Electric vehicles: Benefits, challenges, and future opportunities* [Review article]. (2024). *Cleaner Energy Systems*. <https://www.sciencedirect.com/science/article/pii/S2772671124003334>
6. *The extraordinary rise of electric cars in developing countries*. (2025, September 25). *Bloomberg*. <https://www.bloomberg.com/news/articles/2025-09-25/the-extraordinary-rise-of-electric-cars-in-developing-countries>
7. *Which countries are adopting electric vehicles the fastest?* (n.d.). World Resources Institute. <https://www.wri.org/insights/countries-adopting-electric-vehicles-fastest>
8. Fosu, G. O., & Achinah, S. (2024). *Exploring the prospects and challenges of electric vehicle adoption: Paving the way for a sustainable future in transportation*. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4867809
9. *Electric vehicles: Economic and geopolitical dimensions* [Working paper]. (n.d.). SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5327778
10. *Technology innovation and EV policy: Patent data analysis across 19 countries* [Working paper]. (n.d.). SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=6112590
11. *Fuel vs. electricity prices and EV adoption: Price elasticity analysis* [Working paper]. (n.d.). SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5257652
12. *Review of EV technologies, charging methods, and optimisation strategies* [Review article]. (2024). *Heliyon*. <https://www.sciencedirect.com/science/article/pii/S2405844024153303>
13. Gupta, G., Singh, A., & Saini, V. K. (2023). *Economic sustainability of public EV charging infrastructure: A case of highways of India*. ResearchGate. https://www.researchgate.net/publication/374759656_Economic_Sustainability_of_Public_Ev_Charging_Infrastructure_A_Case_of_Highways_of_India
14. *India EV growth challenges 2026: Electric vehicle market, price, policy issues, EV adoption slowdown analysis*. (2025). *The Economic Times*. <https://economictimes.indiatimes.com/industry/renewables/india-ev-growth-challenges-2026-electric-vehicle-market-india-price-policy-issues-ev-adoption-slowdown-analysis-mahindra-tata-motors/articleshow/130298867.cms>
15. *Transport policy and electric vehicle adoption* [Research article]. (2025). *Transport Policy*. <https://www.sciencedirect.com/science/article/abs/pii/S0967070X25003610>
16. International Energy Agency. (2023). *Global EV outlook 2023: Executive summary*. IEA. <https://www.iea.org/reports/global-ev-outlook-2023/executive-summary>
17. *Electric vehicle revolution in India: A comprehensive and comparative study of EV business in India*. (2024). ResearchGate.

- https://www.researchgate.net/publication/379011623_Electric_Vehicle_Revolution_in_India_A_Comprehensive_and_Comparative_Study_of_Ev_Business_in_India
18. Press Information Bureau, Government of India. (n.d.). *PM E-DRIVE scheme* [Press release]. <https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=151933&ModuleId=3&reg=3&lang=2>
 19. EY India. (n.d.). *Future of hybrid electric vehicles in India*. Ernst & Young. https://www.ey.com/en_in/insights/automotive/future-of-hybrid-electric-vehicles-in-india
 20. *EV adoption and environmental outcomes in India* [Research article]. (2025). *Scientific Reports*. <https://www.nature.com/articles/s41598-025-97679-9>
 21. Bain & Company. (2023). *India electric vehicle report 2023*. <https://www.bain.com/insights/india-electric-vehicle-report-2023/>
 22. *Electric vehicle policy and market dynamics in India* [Research article]. (2024). *Journal of Asian Public Policy*. <https://journals.sagepub.com/doi/10.1177/23210222241304506>
 23. *EV adoption barriers and sustainability transitions* [Research article]. (2022). *Environmental Challenges*. <https://www.sciencedirect.com/science/article/pii/S2665917422002306>
 24. *India's emerging electric vehicle market*. (2025, July). Cornell SC Johnson College of Business. <https://business.cornell.edu/article/2025/07/indias-emerging-electric-vehicle-market/>
 25. IBEF. (n.d.). *India's electric vehicle revolution: Trends, challenges, and opportunities*. India Brand Equity Foundation. <https://www.ibef.org/research/case-study/india-s-electric-vehicle-revolution-trends-challenges-and-opportunities>
 26. NITI Aayog. (2025). *Electric vehicles in India* [Report]. Government of India. <https://www.niti.gov.in/sites/default/files/2025-08/Electric-Vehicles-WEB-LOW-Report.pdf>
 27. [27] *Life cycle assessment and environmental impact of electric vehicles* [Research article]. (2020). *Journal of Cleaner Production*. <https://www.sciencedirect.com/science/article/abs/pii/S0959652619342428>
 28. International Council on Clean Transportation. (2025). *India leads 3-wheeler EV market with 57% of global sales share in 2024: COP30 report*. <https://theicct.org/pr-india-leads-3-wheeler-ev-market-with-57-of-global-sales-share-in-2024-cop-30-report/>
 29. Humans of EV. (2025). *India's EV sales cross 2 million in 2025, driven largely by two-wheelers*. <https://humansofev.info/ev-sales-cross-2-million-india-2025-two-wheelers-lead/>
 30. DIY Guru. (2025). *India's electric vehicle sales trends: EV production volumes and market growth*. <https://diyguru.org/guide/ev-production-volumes-in-india/>
 31. Goodseva. (2025). *Electric trucks in India: Game changer for logistics*. <https://www.goodseva.com/blog/electric-trucks-india-logistics-game-changer/>
 32. International Energy Agency. (2025). *Trends in heavy-duty electric vehicles: Global EV Outlook 2025*. <https://www.iea.org/reports/global-ev-outlook-2025/trends-in-heavy-duty-electric-vehicles>
 33. Down To Earth. (2025). *Delhi EV Policy 2.0: It's bold but not yet beautiful*. <https://www.downtoearth.org.in/energy/delhi-ev-policy-20-its-bold-but-not-yet-beautiful>
 34. International Council on Clean Transportation. (2026). *Why Delhi's new EV policy draft is what Indian states need*. <https://theicct.org/why-delhis-new-ev-policy-draft-is-what-indian-states-need-may26/>
 35. Servotech. (2026). *Delhi EV Policy 2.0 explained: Changes, benefits, subsidies and incentives*. <https://www.servotech.in/blog/delhi-ev-policy-explained/>
 37. AckoDrive. (2026). *Cabinet approves EV Policy 2.0: Delhi to ban new petrol two-wheelers from April 2028*. <https://ackodrive.com/news/cabinet-approves-ev-policy-2-0-delhi-to-ban-new-petrol-two-wheelers-from-april-2028/>
 38. EV Infrastructure News. (2026). *India's EV uptake hits 8.5% in FY2025-26, two-wheelers drive growth: JMK*. <https://www.evinfrastructurereports.com/ev-policies/india-s-ev-uptake-hits-8-5-in-fy2025-26-two-wheelers-drive-growth-jmk>



39. Outlook Business. (2026). *India's EV market hits 2.3mn sales in 2025*. <https://www.outlookbusiness.com/news/indias-ev-market-hits-23mn-sales-in-2025-two-wheelers-drive-adoption-policy-festive-demand-push-year-end-surge>
40. Clean Mobility Shift. (2026). *EV Vahan dashboard*. <https://cleanmobilityshift.com/ev-dashboard/>
41. Business Standard. (2026). *Delhi's EV transition by the numbers: A look at the capital's vehicle fleet*. https://www.business-standard.com/industry/auto/delhi-s-ev-transition-by-the-numbers-a-look-at-the-capital-s-vehicle-fleet-126070100810_1.html
42. JMK Research & Analytics. (2026). *India's EV penetration reached 8.5% in FY2025-26*. <https://jmkresearch.com/indias-ev-penetration-reached-8-5-in-fy2025-26/>
43. Ember Energy. (2026). *India's transition to electric mobility*. <https://ember-energy.org/latest-insights/from-fossil-to-flexible-advancing-indias-road-transport-electrification/indias-transition-to-electric-mobility/>