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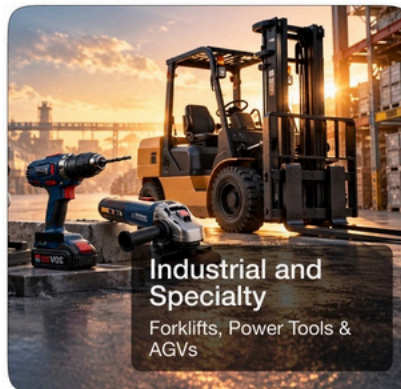
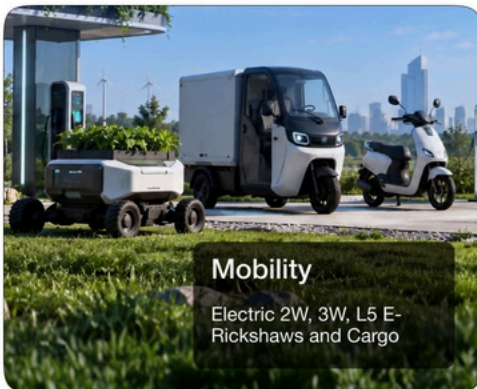


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Electric Bus Charging Depot Design in India

Understanding the Grid Interconnection and DISCOM Engagement Aspects

A robust, streamlined grid interconnection process is essential to enable the reliable, scalable deployment of electric bus charging depots. High-capacity charging requirements of electric buses often mandate dedicated High Tension (HT) connections, timely transformer installation, and dynamic coordination with state distribution companies (DISCOMs).

This excerpt from 'Optimal Charging Depot Design For Electric Buses Handbook 2026' by Grid Integration Lab, IIT Bombay, provides a structured overview of the regulatory, technical, and procedural aspects of establishing grid connectivity for public electric bus depots in India.

High Tension (HT) Connection Process for EV Charging Depots

Electric bus depots typically demand **connected loads exceeding 500 kW**, often ranging into multiple megawatts depending on fleet size and charging strategy. As a result, DISCOMs categorize these depots under HT industrial connections (generally 11 kV or 33 kV). The step-by-step HT connection process is summarized below:

Step 1: Load Estimation and Application Submission

- Calculate peak and aggregate demand based on bus count, charger ratings, and simultaneity factor.
- Submit an application to the local DISCOM along with a load justification report, site plan, and necessary clearances.

Step 2: Feasibility Study by DISCOM

- DISCOM evaluates nearest substation capacity, feeder availability, and augmentation needs.
- Load flow and fault-level studies may be conducted for large depots (>1 MW).

Step 3: Approval and Quotation Issuance

- Upon technical clearance, a sanctioned load is approved.
- Cost estimates for infrastructure (e.g., dedicated feeder, metering, substation bay) are provided.

Step 4: Infrastructure Development and Inspection

- Civil and electrical infrastructure is developed by the applicant or the DISCOM (based on the agreement).
- DISCOM conducts the final inspection to verify safety and compliance.

Step 5: Metering, Agreement Execution and Energisation

- Trivector metering is installed as per HT supply norms.
- Power purchase agreement (HT supply) is executed.
- Connection is energized and regular billing begins.

Role of Flexible Interconnection

If multi-megawatt connection is required, this may take years to be connected to the grid. This time lag may also determine the stage-wise deployment of the vehicles, which may be combined with a stationary battery buffer until the full interconnection capacity is available. In California, they have introduced a flex-interconnect where, after an analysis between the DISCOM and the depot owner, it is determined that a flexible interconnect can be achieved much faster than a full guaranteed capacity interconnect.

For example, the DISCOM can provide the required capacity except for a few days/weeks of the year. If the depot owner can live with that, they can interconnect using the current available grid capacity but observing the limitations a few times a year. This arrangement may also require that the DISCOM installs measurement equipment at the connection point to the depot and has the right to limit the electricity flow to/from the depot if it exceeds the contractual amount.

Adding stationary battery buffer capacity also allows faster interconnect, however this is usually an expensive proposition. If the value of faster interconnection (electrification of the fleet) is higher than battery cost this may be a solution until the grid interconnection capacity is built out.

DISCOM Coordination Requirements

Effective depot commissioning requires proactive coordination with DISCOMs on the following dimensions:

- **Sanctioned Load Upgrades:** As fleets expand, depots must request sanctioned load enhancements well in advance.
- **Infrastructure Synchronization:** Charging infrastructure timelines must be aligned with grid infrastructure readiness.
- **Protection and Metering Standards:** Meter types, CT/PT ratings, and breaker specifications must comply with state electricity distribution codes.
- **Data Sharing and Monitoring:** DISCOMs may require depot-side Energy Management System (EMS) integration to monitor peak demand, load profile, and voltage quality.

Time-of-Day (ToD) Tariff Structures for EV Charging

State electricity regulatory commissions (SERCs) offer preferential Time-of-Day (ToD) tariffs for EV public charging stations. These are designed to incentivize off-peak charging and flatten the demand curve.

Key ToD Features:

- Off-peak tariff (e.g., 11 PM to 6 AM): 15–25% lower unit rates.
- Peak tariff (e.g., 6 PM to 10 PM): Higher tariffs to discourage charging.
- Fixed Demand Charges: Based on sanctioned kVA or maximum demand.

State Examples:

Delhi (BYPL/TPDDL): Dedicated EV charging tariff with off-peak benefits.

Maharashtra (MERC): ToD-based EV supply tariffs notified for HT users.

Depot planners should factor ToD advantages into charger scheduling, especially for night-parking fleets.

Timeline and stakeholder responsibilities

Activity	Stakeholder	Timeline
Load estimation and charger planning	Depot Operator	Day 0 – 10
HT connection application	Depot Operator	Day 10 – 20
Feasibility study and sanction	DISCOM	Day 20 – 50
Infra readiness and site inspection	Both	Day 50 – 90
Load estimation and charger planning	Depot Operator	Day 0 – 10

Timeline and stakeholder responsibilities for Electric Bus Charging Station deployment. Source: OPTIMAL CHARGING DEPOT DESIGN FOR ELECTRIC BUSES HANDBOOK, GRID INTEGRATION LAB, INDIAN INSTITUTE OF TECHNOLOGY BOMBAY 2026.

Checklist for DISCOM Engagement Important Documents:

- ✓ Load sheet and charging simulation
- ✓ Single-line diagram (SLD)
- ✓ Fire and electrical safety NOCs
- ✓ Site access permissions for infra works

An excerpt outlining the critical elements of electrical system design for electric bus charging depots will be included in the next issue.

We would like to thank the Grid Integration Lab, IIT Bombay, for contributing this excerpt from their handbook. You can access the full report [here](#). The publication has been prepared by the Grid Integration Lab, IIT Bombay, under the Vehicle to Grid (V2G) project commissioned by the Federal Ministry for Economic Cooperation and Development (Germany) through Deutsche Gesellschaft für Internationale Zusammenarbeit.

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Exide Commissions 6 GWh Lithium-ion Cell Manufacturing Line in Bengaluru



Exide Energy Solutions Ltd (EESL), a subsidiary of Exide Industries Limited, has completed the commissioning of Phase 1 of its greenfield lithium-ion cell manufacturing facility, with a capacity of 6 GWh, at Devanahalli, Bengaluru.

- The total investment made by Exide Industries in EESL to date stands at ₹5,202.23 crore, as per a Sep 2026 disclosure.
- The project has an initial planned capacity of 6 GWh, scalable up to 12 GWh, with 4 production lines across cylindrical and prismatic cell formats, catering to LFP and NMC chemishes. Equipment across all production lines has been delivered and installed.
- Completed certifications include BIS- IS 16046, IS 16893, IS 16085 & UN 38.3.
- The facility will manufacture cells to serve mobility and energy storage applications. Revenue generation targeted to start during FY27. Key activities, including validation, customer sampling and homolosorption, are at an advanced stage.
- **NMC cylindrical samples have been depatched to potential OEMs, while LFP prismatic samples supplied for e-3Ws & Telecom applications.**
- Exide's existing battery module and pack facility at Prantij, Gujarat has helped the company build early market presence and customer engagement in lithium-ion solutions.

Project Snapshot		Cell Formats and Applications	
Commissioning	23 Sep 2026	Cell formats	Cylindrical and Prismatic
Location	Devanahalli, Bengaluru	Chemistries	LFP and NMC
Phase 1 capacity	6 GWh	Production lines	4
Scalable capacity	Up to 12 GWh	Applications	Mobility and Energy Storage
Investment	₹5,202.23 crore to date	Revenue target	FY27

Amara Raja's 60 MWh Lithium-ion Cell Customer Qualification Plant in Telangana



Amara Raja Advanced Cell Technologies, a wholly-owned subsidiary of Amara Raja Energy & Mobility, commissioned its Customer Qualification Plant (CQP) at its Giga Corridor in Divitipally, Telangana, in July 2026.

- The CQP represents an investment of approximately ₹500 crore, forming part of the company's Phase 1 outlay of over ₹1,500 crore under its ₹9,500 crore Giga Corridor programme.
- It is intended to bridge lab-scale R&D and commercial production, delivering the B samples that validate manufacturability of processes closely mirroring future gigafactory lines.
- The CQP has an initial manufacturing capacity of 60 MWh and is designed to produce cylindrical and prismatic li-ion cells.
- It will feed into Amara Raja's 2 GWh commercial cell manufacturing line, slated to begin production in CY2027, as part of the broader 16 GWh Giga Corridor build-out.
- The 2170 NMC cylindrical cell will be the first mass-production product targeted for commercialisation in 2027.

CQP Summary

Location	Divitipally, Telangana
Commissioned	July 2026
Investment in CQP	Approximately ₹500 crore
Phase 1 outlay	Over ₹1,500 crore
Larger Program	₹9,500 crore Giga Corridor
CQP capacity	60 MWh
Commercial line	2 GWh, production slated for CY27
Broader build-out	16 GWh Giga Corridor
Target Applications	NMC for e-2Ws, LFP prismatic for stationary and automotive applications

- **Cells from the plant have been supplied to customers for validation starting Aug 2026.**
- e-2W OEMs are currently the main customer category. LFP prismatic samples are also being introduced for stationary and automotive applications. Amara Raja's 10 GWh BESS facility also can provide a captive application for future in-house cells.

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Transition VC



Aditya Singh

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Arpit Agarwal

Investment Partner
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Co-founder
Fawkes Energy



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Vice President
Ankur Capital



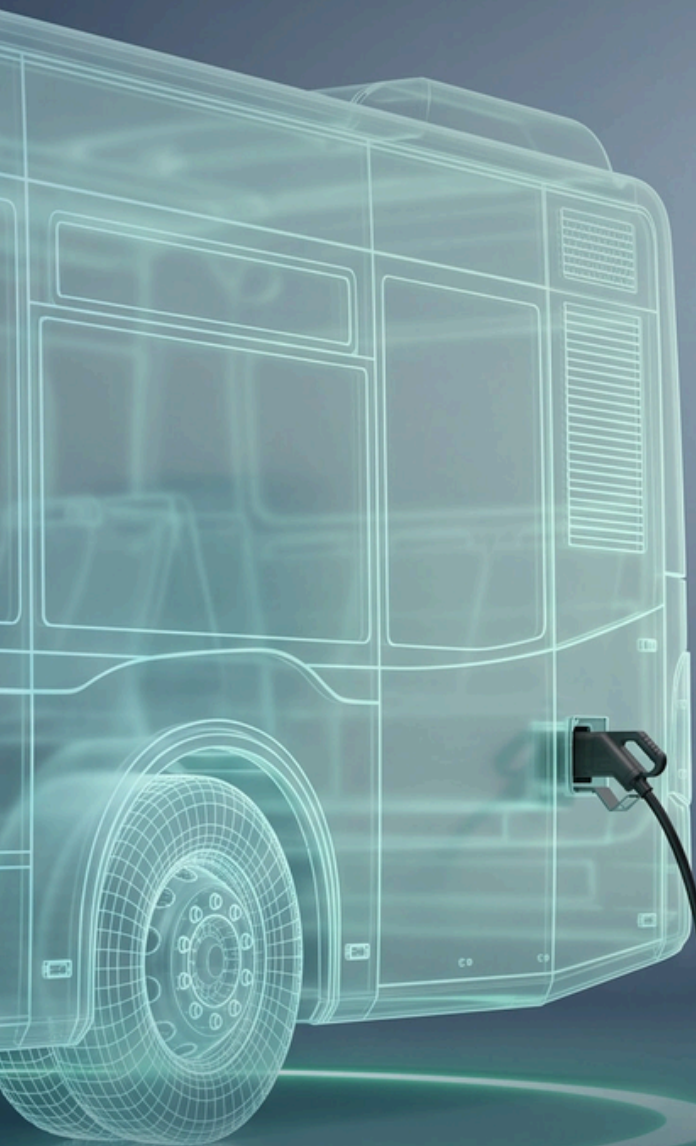
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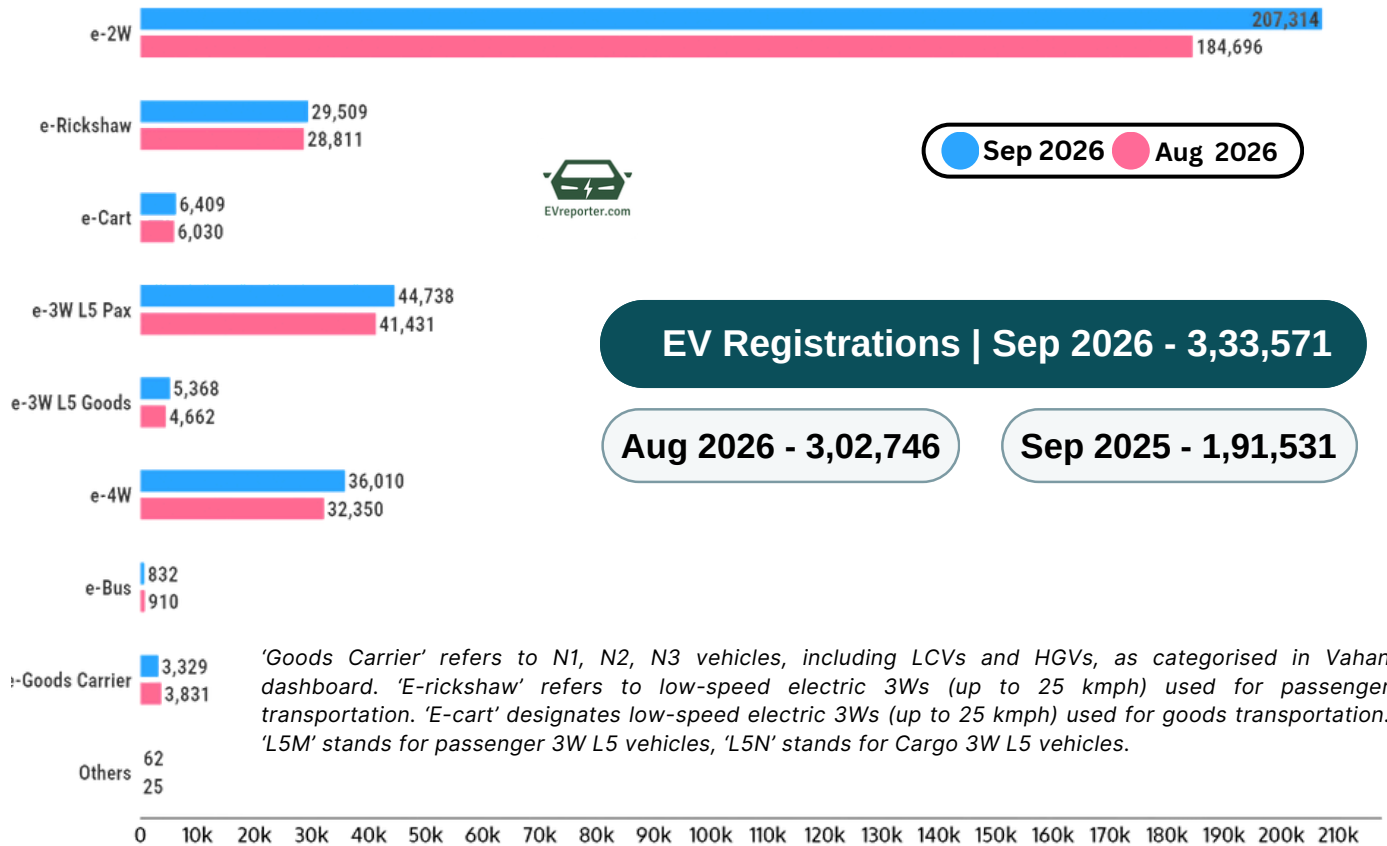
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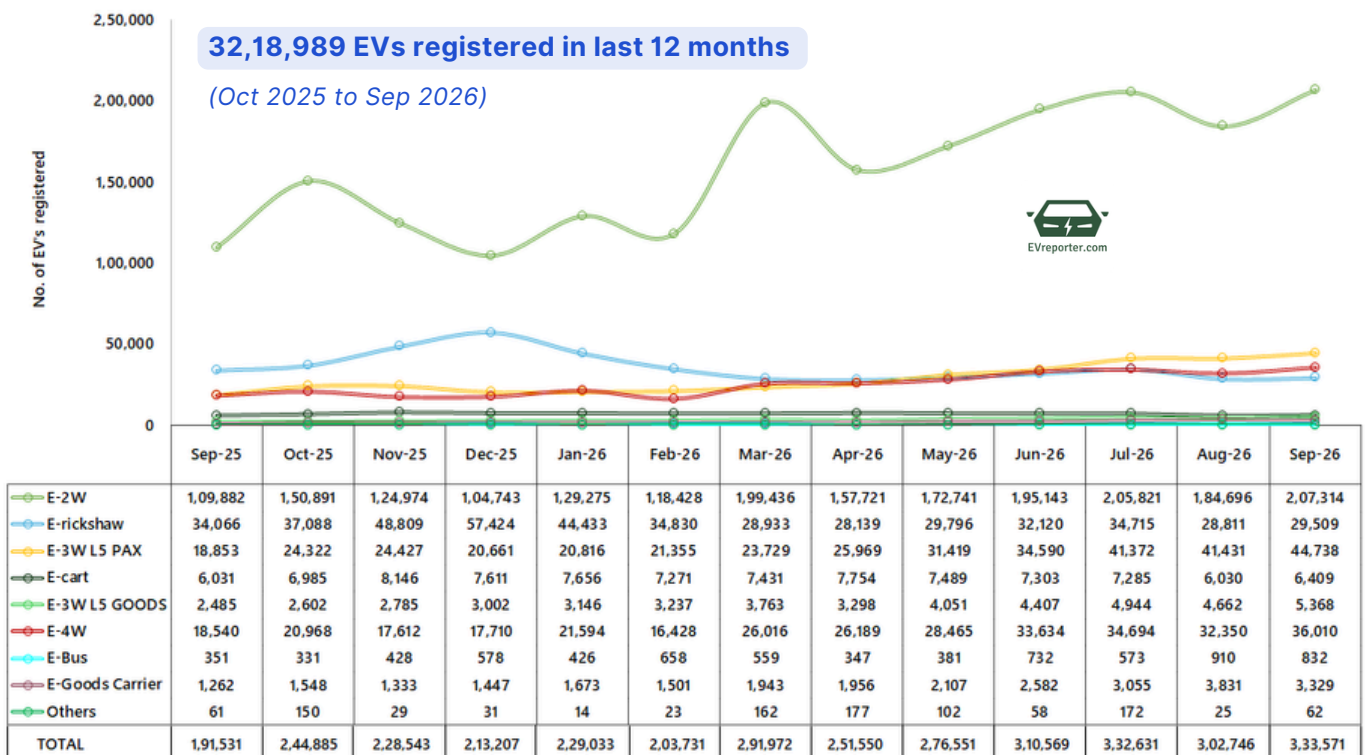
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Category-wise India EV Sales, Sep 2026

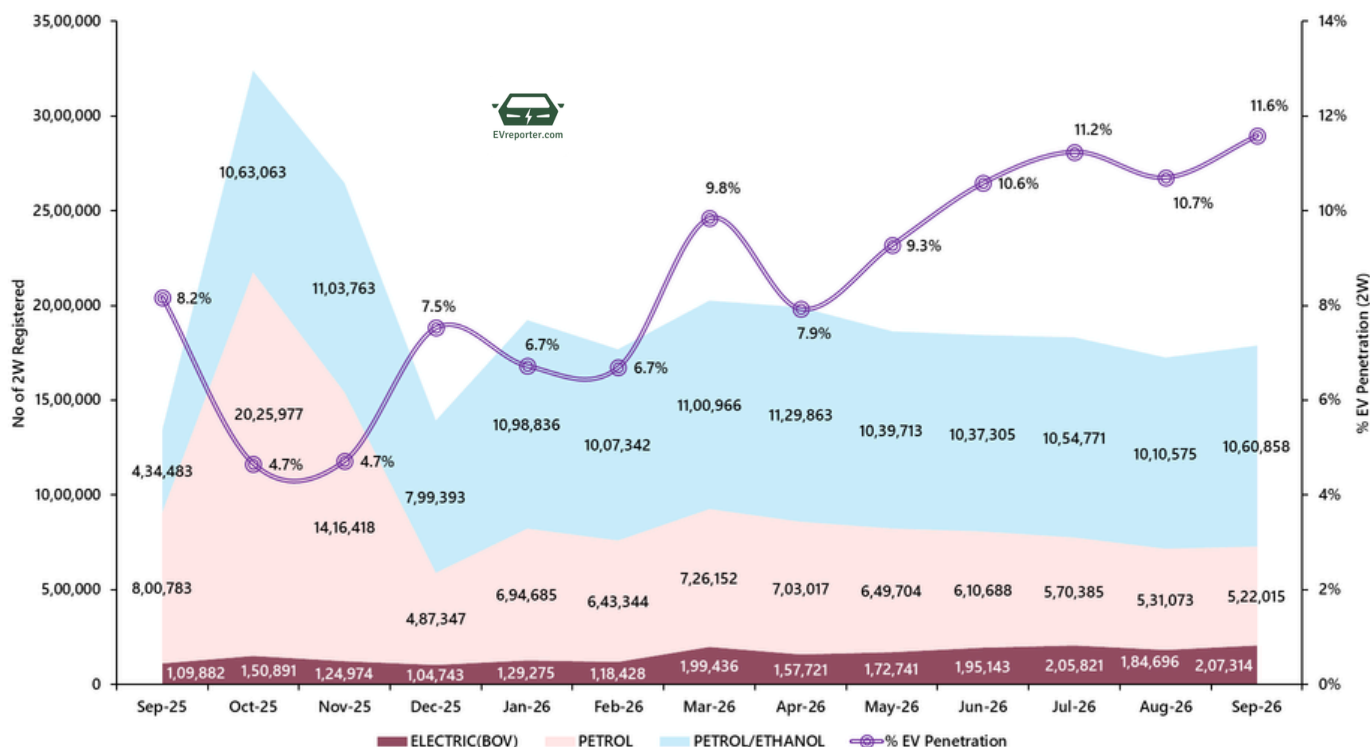


EV Sales Trend from Sep 2025 to Sep 2026

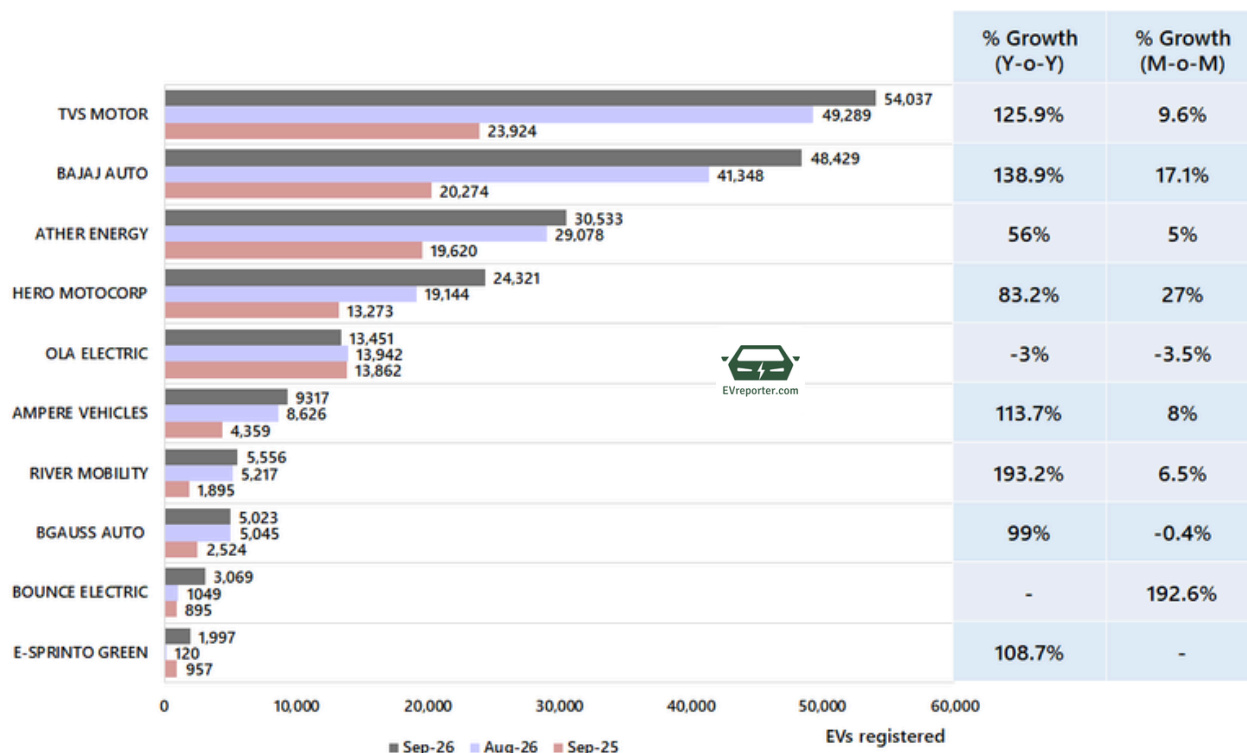


Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data. Low speed e-2W sales data not included.

Fuel-wise 2W Sales Trend, Sep 2025 - Sep 2026



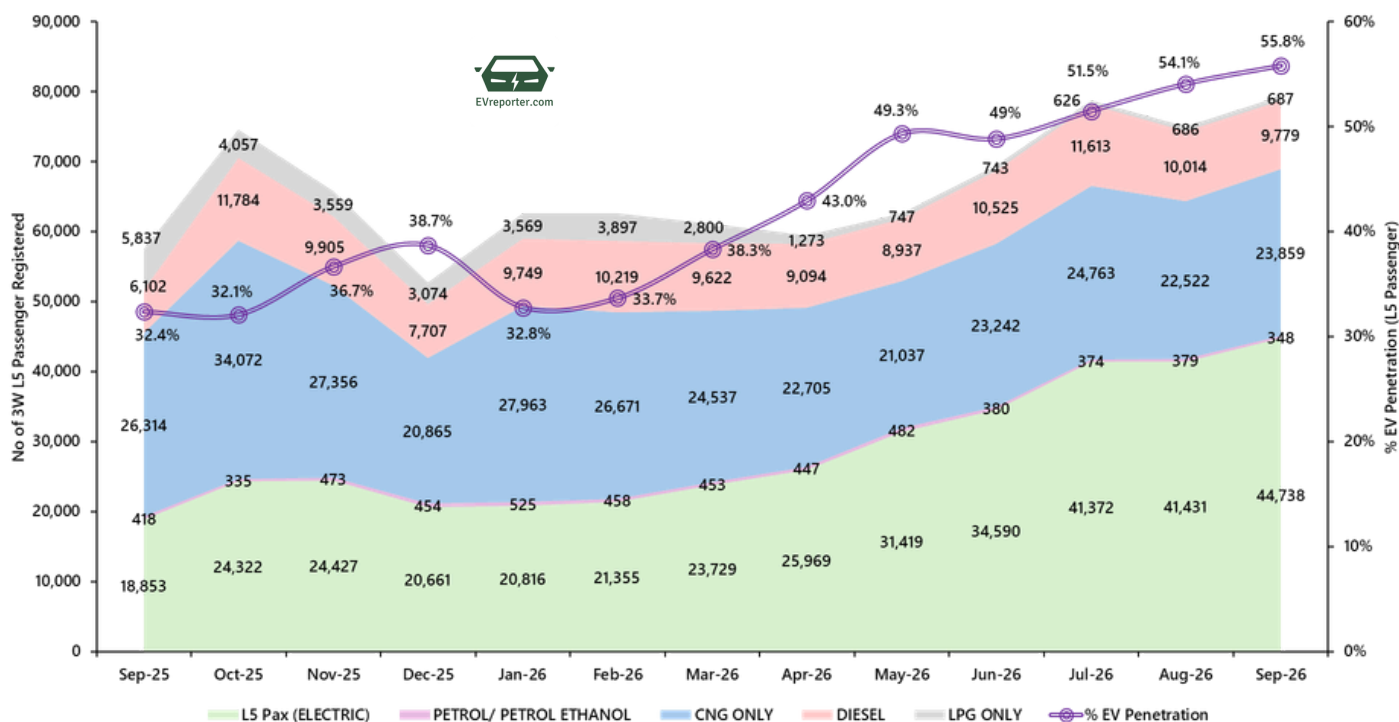
OEM-wise High Speed E-2W Sales Trend | Sep 2026



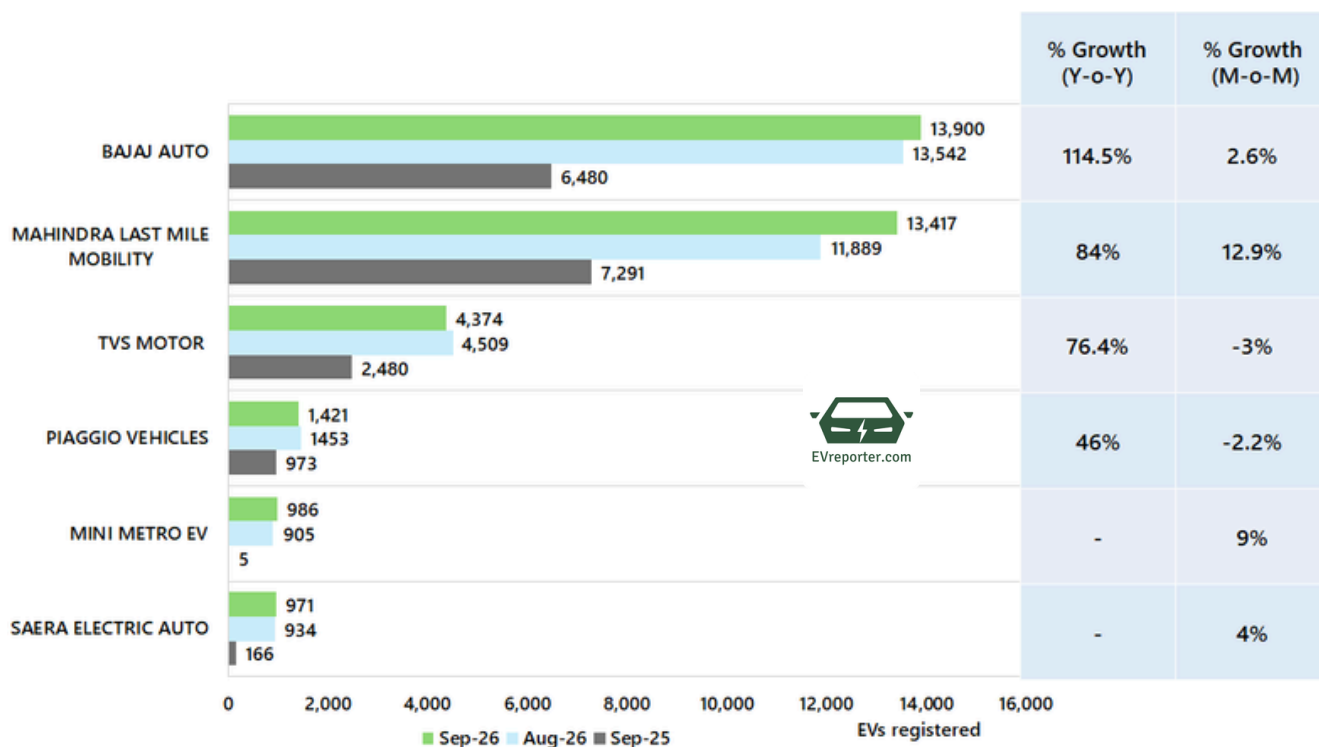
Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data low-speed e-2W sales data not included | Data as per 1468 out of 1469 RTOs across 36 out of 36 state/UTs

For deeper EV sale trends - state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the [EVreporter Data Portal here](#).

Fuel-wise 3W L5 Passenger Sales Trend | Sep 2025 - Sep 2026



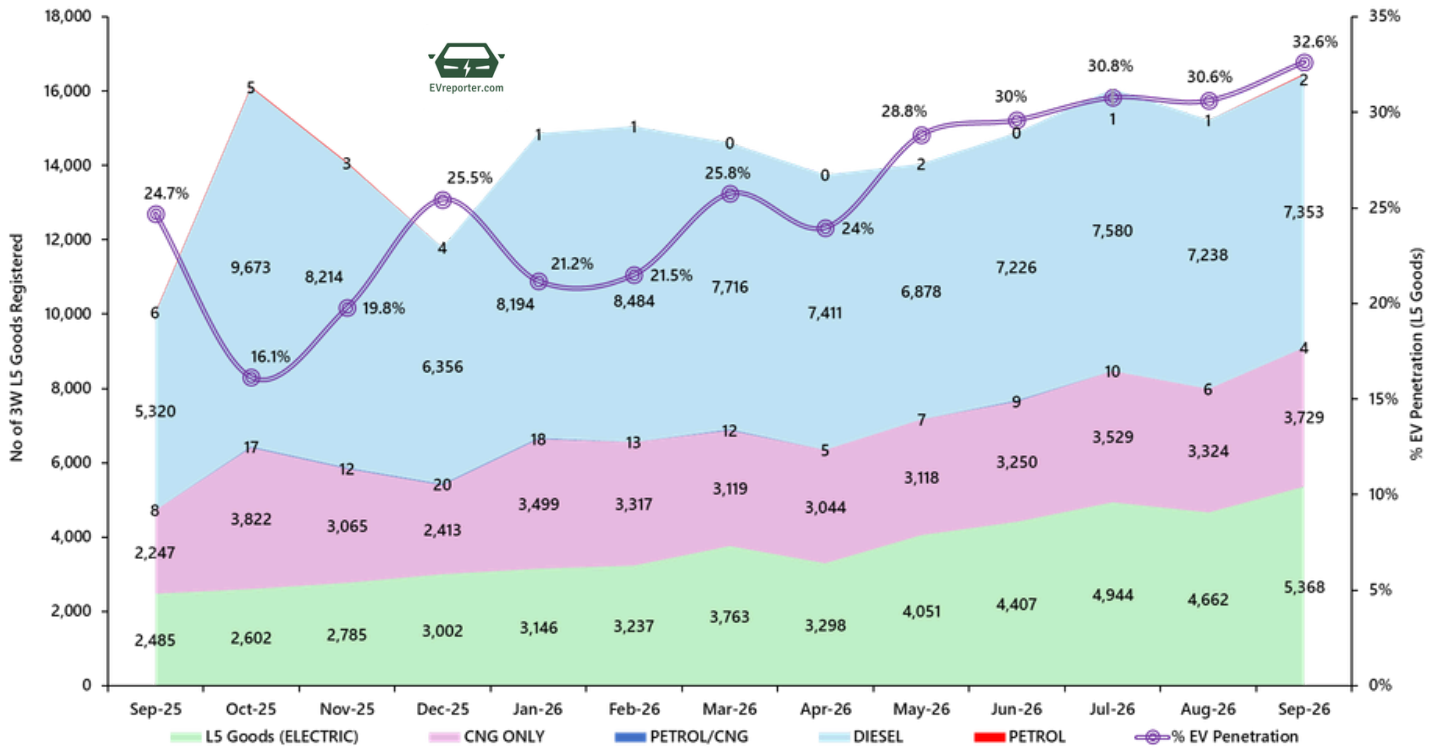
OEM-wise E-3W L5 Passenger Sales Trend



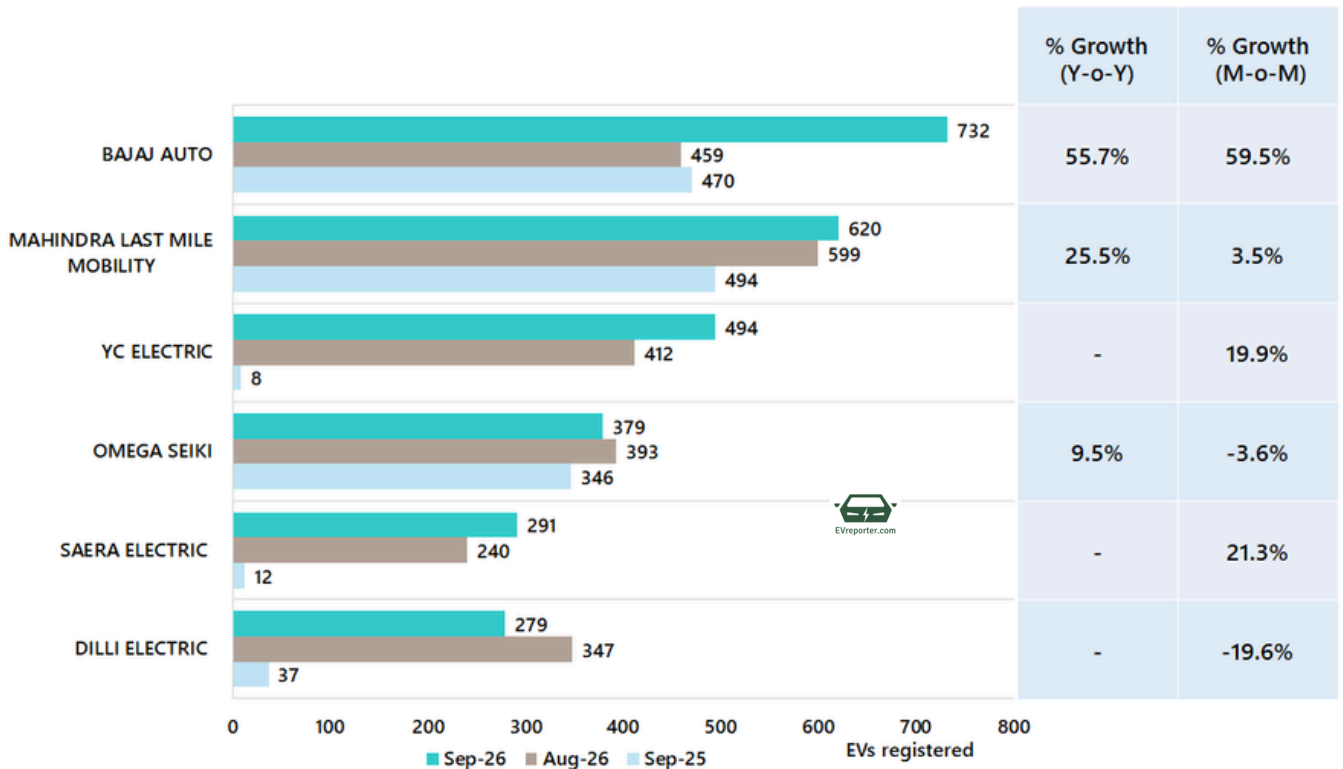
Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data

For deeper EV sale trends - state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the [EVreporter Data Portal here](#).

Fuel-wise 3W L5 Goods Sales Trend | Sep 2025 - Sep 2026



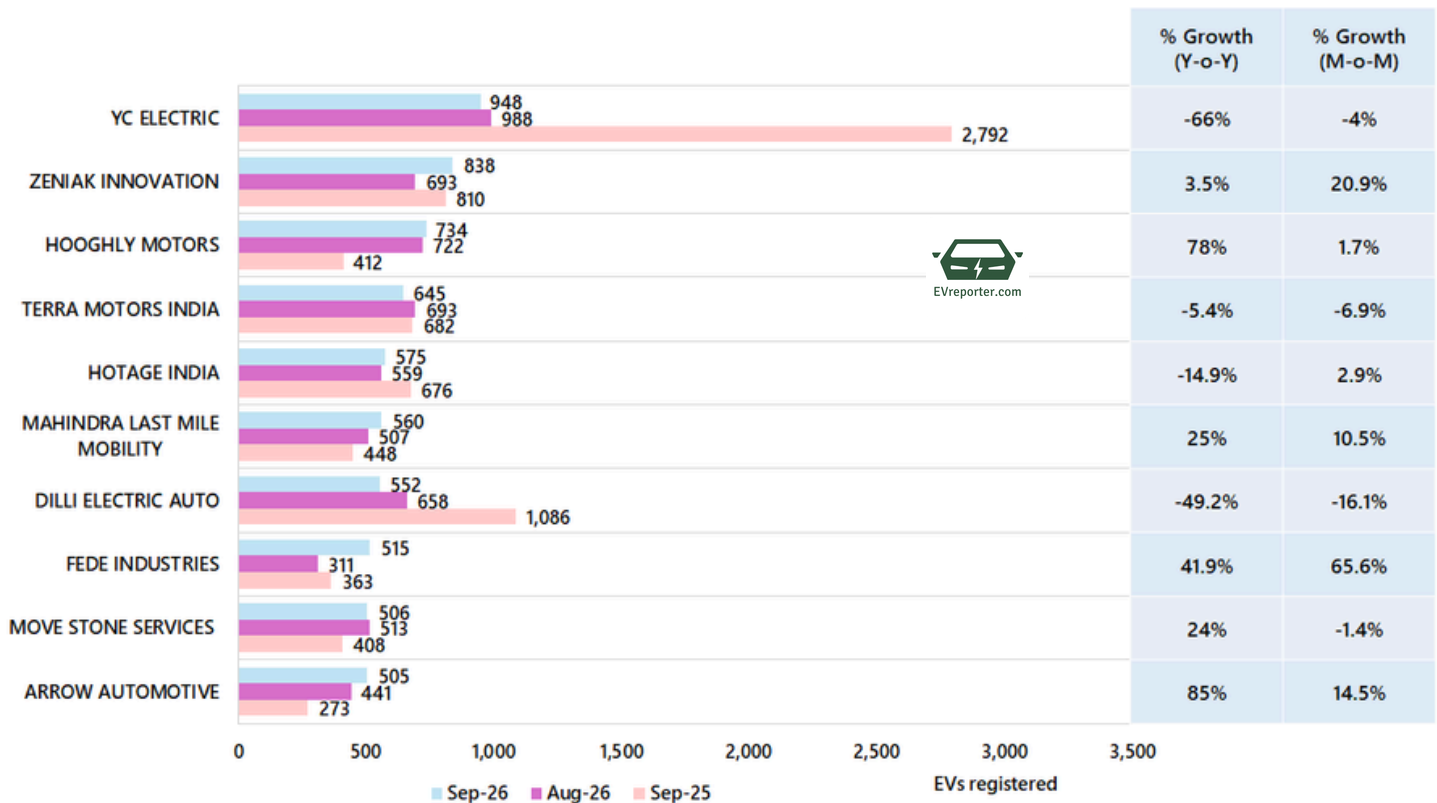
OEM-wise E-3W Goods L5 Sales



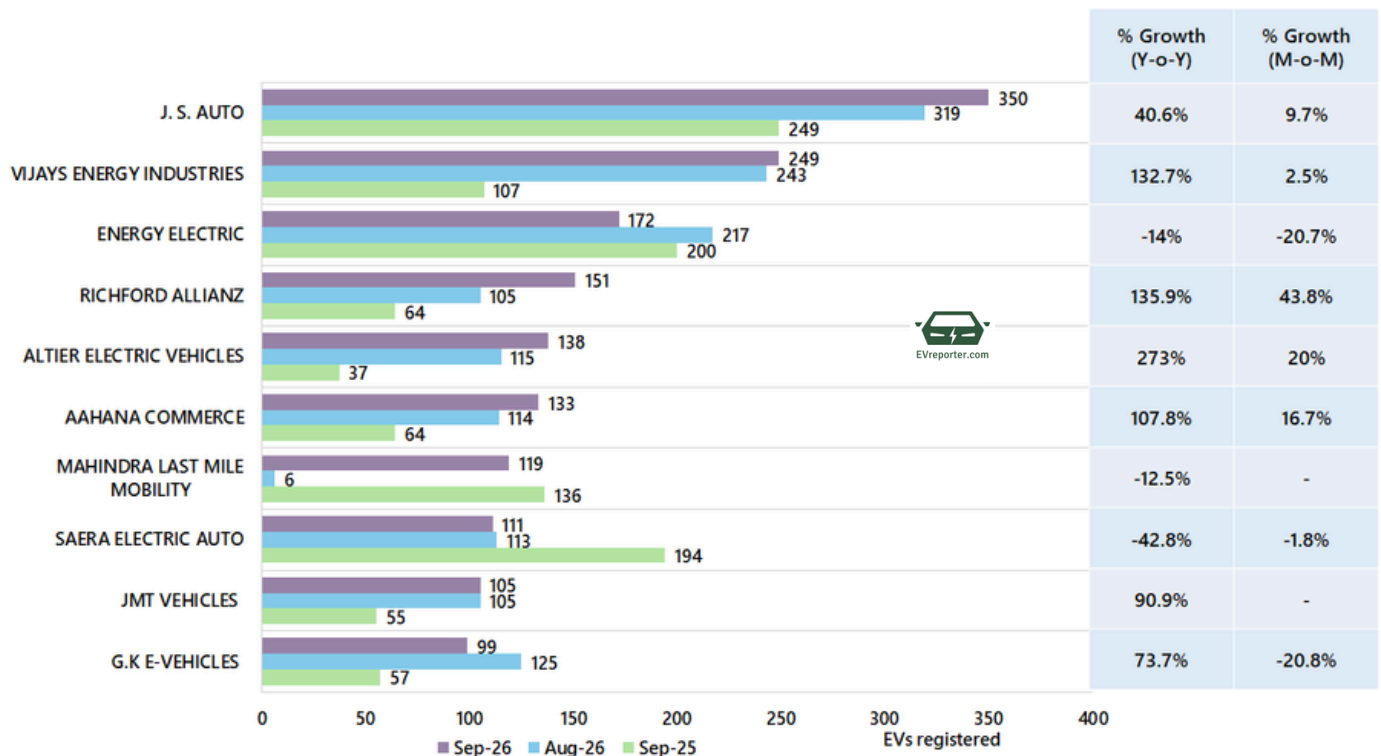
Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data | Data as per 1468 out of 1469 RTOs across 36 out of 36 state/UTs

For deeper EV sale trends - state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the [EVreporter Data Portal here](#).

E-rickshaw Sales | Leading OEMs | Sep 2026



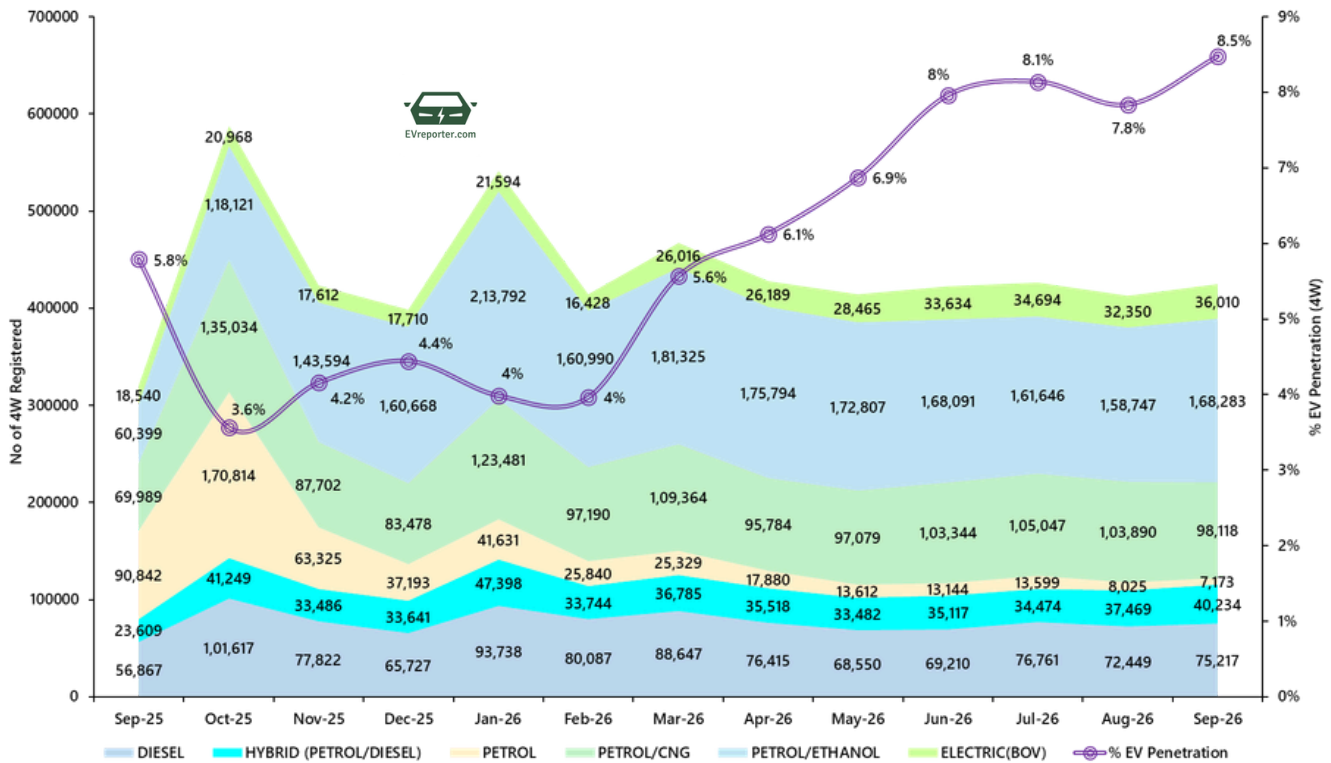
E-cart Sales | Leading OEMs | Sep 2026



Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data | Data as per 1468 out of 1469 RTOs across 36 out of 36 state/UTs

For deeper EV sale trends - state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the [EVreporter Data Portal here](#).

Fuel-wise Car Sales Trend | Sep 2025 - Sep 2026



Electric Car Sales | Leading OEMs | Sep 2026

S No.	Makers	Sep-26	Aug-26	Difference	% Change	Market Share Sep-26
1	TATA MOTORS	14,784	13,820	964	7%	41.1%
2	MAHINDRA & MAHINDRA	7,779	6,827	952	13.9%	21.6%
3	JSW MG MOTOR INDIA	5,242	4,932	310	6.3%	14.6%
4	VINFAST AUTO INDIA	2,963	2,239	724	32.3%	8.2%
5	KIA INDIA	1,262	851	411	48.3%	3.5%
6	MARUTI SUZUKI	1,103	1,472	-369	-25.1%	3.1%
7	BYD INDIA	836	567	269	47.4%	2.3%
8	HYUNDAI MOTOR INDIA	792	840	-48	-5.7%	2.2%
9	BMW INDIA	502	290	212	73.1%	1.4%
10	TESLA INDIA MOTORS	291	117	174	148.7%	0.8%
11	TOYOTA KIRLOSKAR	218	168	50	29.8%	0.6%
12	MERCEDES-BENZ INDIA	125	127	-2	-1.6%	0.3%
13	STELLANTIS AUTOMOBILES	55	47	8	17%	0.2%
14	VOLVO AUTO INDIA	45	35	10	28.6%	0.1%
15	OTHERS	13	18	-5	-27.8%	0.04%
TOTAL		36,010	32,350	3,660	11%	100%

Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data

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OEM wise Electric Bus Sales | Sep 2026

S No.	Makers	Sep-26	Aug-26	Difference	% Change	Market Share Sep-26
1	JBM ELECTRIC VEHICLES	274	163	111	68.1%	32.9%
2	PMI ELECTRO MOBILITY	141	54	87	161.1%	16.9%
3	OLECTRA GREENTECH	129	314	-185	-58.9%	15.5%
4	SWITCH MOBILITY	89	146	-57	-39%	10.7%
5	VE COMMERCIAL VEHICLES	63	51	12	23.5%	7.6%
6	PINNACLE MOBILITY	53	155	-102	-65.8%	6.4%
7	AEROEAGLE AUTOMOBILES	47	8	39	-	5.6%
8	JSW GREENTECH	10	0	10	-	1.2%
9	TATA MOTORS	10	5	5	-	1.2%
10	JPM AUTO INDUSTRIES	6	0	6	-	0.7%
11	VEERA VIDYUTH VAHANA	5	8	-3	-37.5%	0.6%
12	OTHERS	5	6	-1	-16.7%	0.6%
	TOTAL	832	910	-78	-8.6%	100%

OEM wise E-Goods Carrier Sales | Sep 2026

S No.	Makers	Sep-26	Aug-26	Difference	% Change	Market Share Sep-26
1	TATA MOTORS	1,265	1,426	-161	-11.3%	38%
2	EULER MOTORS	1,064	883	181	20.5%	32%
3	MAHINDRA LAST MILE MOBILITY	464	363	101	27.8%	14%
4	SWITCH MOBILITY AUTOMOTIVE	171	134	37	27.6%	5.1%
5	TIVOLT ELECTRIC VEHICLES	142	126	16	12.7%	4.3%
6	VE COMMERCIAL VEHICLES	78	72	6	8.3%	2.3%
7	IPL TECH ELECTRIC	50	174	-124	-71.3%	1.5%
8	SANY HEAVY INDUSTRY INDIA	38	605	-567	-93.7%	1.1%
9	QUCEV TECHNOLOGIES	24	5	19	-	0.7%
10	ENERGY IN MOTION	18	31	-13	-41.9%	0.5%
11	OTHERS	15	12	3	25%	0.5%
	TOTAL	3,329	3,831	-502	-13.1%	100%

Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data

'Goods Carrier' refers to N1, N2, N3 cargo vehicles, including LCVs and HGVs, as categorised in Vahan dashboard



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EV Penetration for Different Vehicle Category Sales in India

Category	Sep-26	Aug-26	Sep-25
2W	11.6%	10.7%	8.2%
3W L5M	55.8%	54.1%	32.4%
3W L5N	32.6%	30.6%	24.7%
4W	8.5%	7.8%	5.8%
Goods Carrier	3.7%	4.8%	2%

Source: Vahan Dashboard as of Oct 2, 2026 | Data as per 1468 out of 1469 RTOs across 36 out of 36 state/UTs
 'Goods Carrier' refers to N1,N2,N3 cargo vehicles, including LCVs and HGVs, as categorised in Vahan dashboard.
 'L5M' stands for passenger 3W L5 vehicles, 'L5N' stands for Cargo 3W L5 vehicles.

ICE vs EV Sales & Penetration Trend

India's EV Sales Trend for Sep 2026 shows a surge in monthly sales volume.

Total **EV registrations in Sep 2026 were the highest to date.**

2W (11.6%), 3W L5M (55.8%), 3W L5N (32.6%), and 4W (8.5%) recorded EV highest penetration levels in respective categories.

The Goods Carrier category is gathering pace, with EV penetration rising to 3.7% from 2% the year before.

Bajaj Auto attributed **over 29.2%** of its Sep 2W sales to EVs, while EV penetration for **TVS 2Ws** was **14.8%**.

Over 98.6% of Mahindra Last Mile Mobility's passenger 3W sales were electric. **Over 63.3%** of TVS Motors' passenger 3W sales were electric.

~81% of JSW MG Motor India's sales in Sep 2026 were EVs.

EV penetration in the car category stood at **25.9%** for Tata Motors, **25.5%+** for BMW India and **13.6%** for Mahindra.

WHAT'S NEW?

EVREPORTER DATA PORTAL

For paid subscribers only



- ✓ India FY25-26 EV sales & investment report
- ✓ E-2W & 4W Sales Forecast till FY 2030
- ✓ Quarterly EV sales reports
- ✓ Top 70 Cities and Top Performing RTO EV Sales Data

- ✓ India Q1 FY26-27 EV Sales Report (Coming soon)
- ✓ E-goods carrier (LCVs and HCVs breakup)
- ✓ EV companies Investment Tracker
- ✓ Telangana Data included
- ✓ Break-up of L3M, L3N, L5M, L5N for e-3Ws





India's Top 2W OEMs | ICE vs EV Sales for Sep 2026

S No.	Maker	Total Sales Sep-26	ICE	EV	% EV
1	HONDA MOTORCYCLE	4,68,789	4,67,688	1,101	0.2%
2	HERO MOTOCORP	4,34,280	4,09,959	24,321	5.6%
3	TVS MOTOR	3,64,640	3,10,603	54,037	14.8%
4	BAJAJ AUTO	1,66,112	1,17,683	48,429	29.2%
5	ROYAL-ENFIELD	1,02,226	1,02,215	11	0.04%
6	SUZUKI MOTORCYCLE INDIA	1,01,926	1,01,273	653	0.6%
7	INDIA YAMAHA MOTOR	64,292	64,060	232	0.4%
8	ATHER ENERGY	30,533	0	30,533	100%
9	OLA ELECTRIC	13,451	0	13,451	100%
10	AMPERE VEHICLES	9,317	0	9,317	100%

India's Top 3W Pax Auto OEMs | ICE vs EV Sales for Sep 2026

S No.	Maker	Total Sales Sep-26	ICE	EV	% EV
1	BAJAJ AUTO	40,036	26,136	13,900	34.7%
2	MAHINDRA LAST MILE MOBILITY	13,607	190	13,417	98.6%
3	TVS MOTOR	6,907	2,533	4,374	63.3%
4	PIAGGIO VEHICLES	6,200	4,779	1,421	22.9%
5	ATUL AUTO	1,383	1,114	269	19.5%
6	MINI METRO	986	0	986	100%
7	SAERA ELECTRIC	971	0	971	100%
8	YC ELECTRIC	871	0	871	100%

Source: Vahan Dashboard as of Oct 2, 2026. PAN India Data

India's Top 3W Goods Auto OEMs | ICE vs EV Sales for Sep 2026

S No.	Maker	Total Sales Sep-26	ICE	EV	% EV
1	BAJAJ AUTO	6,167	5,435	732	11.9%
2	PIAGGIO VEHICLES	2,985	2,878	107	3.6%
3	ATUL AUTO	1,381	1,306	75	5.4%
4	MAHINDRA LAST MILE MOBILITY	956	336	620	64.9%
5	TVS MOTOR	833	577	256	30.7%
6	YC ELECTRIC	494	0	494	100%
7	OMEGA SEIKI	379	0	379	100%
8	SAERA ELECTRIC AUTO	291	0	291	100%

India's Top 4W OEMs | ICE vs EV Sales for Sep 2026

S No.	Maker	Total Sales Sep-26	ICE	EV	% EV
1	MARUTI SUZUKI INDIA	1,69,040	1,67,937	1,103	0.7%
2	TATA MOTORS	57,129	42,345	14,784	25.9%
3	MAHINDRA & MAHINDRA	57,091	49,312	7,779	13.6%
4	HYUNDAI MOTOR INDIA	50,163	49,371	792	1.6%
5	TOYOTA KIRLOSKAR MOTOR	27,828	27,610	218	0.8%
6	KIA INDIA	26,653	25,391	1,262	4.7%
7	SKODA AUTO VOLKSWAGEN INDIA	8,446	8,446	0	-
8	JSW MG MOTOR INDIA	6,474	1,232	5,242	81%
9	HONDA CARS INDIA	5,279	5,279	0	-
10	RENAULT INDIA	3,409	3,409	0	-
11	NISSAN MOTOR INDIA	2,965	2,965	0	-
12	VINFAST AUTO INDIA	2,963	0	2,963	100%
13	BMW INDIA	1,970	1,468	502	25.5%
14	MERCEDES-BENZ INDIA	1,765	1,640	125	7.1%

Source: Vahan Dashboard as of Oct 2, 2026.

WHAT'S NEW?

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- ✓ E-2W & 4W Sales Forecast till FY 2030
- ✓ Quarterly EV sales reports
- ✓ Top 70 Cities and Top Performing RTO EV Sales Data

- ✓ India Q1 FY26-27 EV Sales Report (Coming soon)
- ✓ E-goods carrier (LCVs and HCVs breakup) data
- ✓ EV companies Investment Tracker
- ✓ Telangana Data included
- ✓ Break-up of L3M, L3N, L5M, L5N for e-3Ws



PCBL Chemical Bets on Conductive Carbon and Silicon Anode Battery Materials



Vaneet Kumar,
Chief Executive Director
PCBL Chemical



Headquartered in Kolkata, PCBL is a part of the RP-Sanjiv Goenka Group. In this conversation, we discuss their approach to building a battery materials business in India.

Please give us a macro-level view of PCBL and its focus on battery materials.

PCBL has three main platforms. The first is our legacy product line, **Carbon Black**, which goes into rubber and some specialty segments. The second platform, acquired a few years ago, is **Aquapharm** - again, a specialty business serving areas like water treatment. The third platform is **Conductive and Advanced Materials**, which is where battery materials sit.

Within battery materials, we have started with two material platforms, **Carbon & Silicon**, with an ambition to become a multi-platform player.

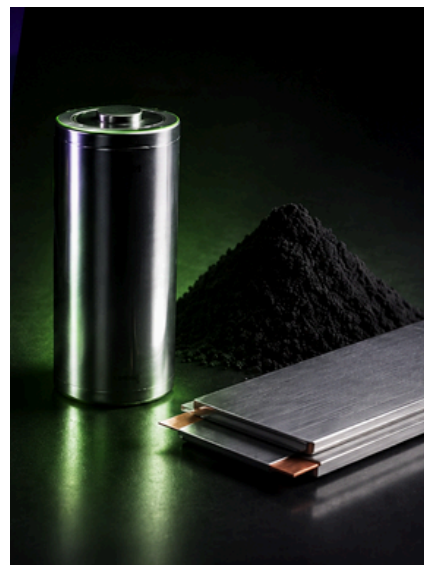
- On carbon, we work with **conductive carbon**, which goes into all cell chemistries — LFP, NMC — as well as dry batteries and lead-acid batteries. Within carbon, we have two products: **Superconductive Black (ready for qualification) & Acetylene Black**, i.e., the purest form of carbon black. To further expand the carbon platform, we're also developing a solution that mixes carbon with CNTs (carbon nanotubes).
- Looking ahead to future battery chemistries, we are focused on **silicon materials** developed with an Australian technology partner. Today, artificial graphite blended with natural graphite is the standard anode material, and it has largely reached its practical capacity ceiling. **Silicon's capacity is five to six times that of artificial graphite**, which offers a real opportunity to improve overall battery energy density. Silicon is a complex material that requires specialized formulation and solutioning. Our current material is pure silicon, and we're expanding into silicon-carbon. **Pure silicon acts as a precursor to silicon-carbon**, whereas silicon-carbon is the mainstream silicon material that can be dropped directly into battery manufacturing.

Conductive carbon black platform — can you help explain its role in a battery?

Carbon provides ionic conductivity to the battery. As charging expectations have moved from roughly 4-hour charging to 15-minute charging, high-conductivity carbon additives have helped make that possible. On the active-material side, we have cathode materials like LFP and NMC, and on the anode side, artificial graphite.

Carbon is mixed with these active materials to act as a conductive agent, helping lithium ions move between anode and cathode.

Physically, this forms a carbon matrix — created when the carbon black is mixed with the anode or cathode material together with a binder — and this matrix structure is what provides ionic conductivity within the active material.



Who are your customers for this product?

Our customers are **cell manufacturers — they use both Acetylene Black and Superconductive Black directly**. Lithium-ion battery makers are our largest customer segment by far, but these materials also go into non-battery applications and other battery types like dry batteries and lead-acid batteries. Carbon is also used as a conductive additive in wires, cables, plastics, and specialty coatings.

What's the current readiness level of your carbon products for cell manufacturing?

For Superconductive Black, we have a **commercial-scale line set in Palej, Gujarat**, with a capacity of about 1,000 MTA. We use this for customer qualification—samples are already with customers. We're close to qualification for lead-acid and dry-battery applications, as most technical challenges are resolved. For lithium-ion, we're still working to improve material purity—it's a continuous cycle of trials, testing, and customer qualification that takes a few months each round. Our most recent trial was in August, and we're waiting on results now.

Acetylene Black is still at the project stage — we're just starting in **Mundra**, and the plant should be ready by the middle of next financial year.

There was a recent announcement about approval under the ECMS scheme for your Acetylene Black project. Can you explain what that approval entails?

It is a subsidy typically given to electronics component manufacturers — this is, I believe, the first time it's been extended to a material supplier. **Two material suppliers in the lithium battery space received it: us and Epsilon.**

Under this, we get up to a **20% subsidy** on capital investment for our Acetylene Black lines, against a **planned capital investment of around ₹329 crore** across different phases. We'll be engaging with the government to access this support.

This matters because Acetylene Black is produced in China at massive scale, and they've built significant overcapacity — so there's a real risk they could undercut on price. We are also seeking additional support to build out the domestic value chain as an integral part of the overall battery materials supply chain—that kind of domestic value addition really only becomes viable with duty support structures and capital subsidy incentives in place.

Acetylene Black vs. Superconductive Black. Two different products on your carbon platform — can you explain the different capabilities of each?

Both are carbon black products, but they differ significantly in **conductivity level and surface area**.

Superconductive Black 	Acetylene Black 
✓ Highest conductivity, High surface area; suitable for very fast-charging applications or where the medium itself has lower inherent conductivity. Difficult to disperse into a slurry and mix with other active materials.	✓ The more mainstream carbon black. Lower conductivity than Superconductive Black; surface area comparable to Super P, i.e., the Industry benchmark for battery-grade carbon black.
✓ Example: Supercapacitors or dry batteries, and some fast-charging mobile phone applications.	✓ It's purer because of the different manufacturing process: Acetylene Black is produced from acetylene gas, while Superconductive Black still uses carbon-based feedstocks.

What's the base source material for both platforms?

- Acetylene Black is based on **acetylene gas, produced from calcium carbide** — a material widely available in India and used across industries, including batteries.
- Superconductive Black uses a carbon-based feedstock — **CBFS (carbon black feedstock oil)**, a byproduct available domestically and through global supply chains.
- On the silicon side, we use silica, which is also locally available in India.

Other global initiatives are working on silicon anode supplementation. What's your technology differentiator?

We have unique, proprietary IP here, developed with our Australian technology partner, which gives us a key advantage. Traditionally, there are two methods used to **produce silicon-carbon**: the **silane-gas-based chemical vapor deposition (CVD) route**, which has seen the widest adoption, and the **milling method**, where larger silicon particles are mechanically broken down.

Instead, **we use a chemical reduction process**. This gives us a lower-cost route than silane-based CVD and higher-quality output than the milling method—performance comparable to silane plus CVD, but at a lower cost and faster to scale.

We're setting up a **50-metric-ton silicon facility**, targeting completion this quarter, with customer sampling starting next quarter. Lithium battery manufacturers typically take six months to a year to qualify a new material, so post-qualification, we'd look to use the same line for commercial supply of pure silicon. Longer-term, we're planning an integrated facility for both nano-silicon and silicon-carbon.

Silicon is used in a few different forms, blended with artificial graphite. There's **SiOx (silicon-oxygen)**, which is already commercialized in some niche EV applications — it's the most common way silicon is used today, though it only raises anode capacity by around 10–15%, not much beyond that.

The next tier is **pure silicon**, which has real technical challenges around expansion/swelling and conductivity — used in its purest form, it creates cycling (cycle-life) challenges. Cell manufacturers can technically use it directly, but it won't deliver the cycle life they want.

The standard way to address this is to mix or coat it with carbon— what's called **silicon-carbon or a silicon-carbon composite**. This becomes a stronger material that can deliver cycle life comparable to graphite/artificial graphite, with only an acceptable, modest reduction.

That's why most players working on silicon anodes are focused on either SiOx or silicon-carbon. Pure silicon in its purest form is really only suited to high-end applications like aerial vehicles, where energy density matters more than cycle life. **Silicon-carbon, by contrast, is what goes into mainstream electric vehicles.**

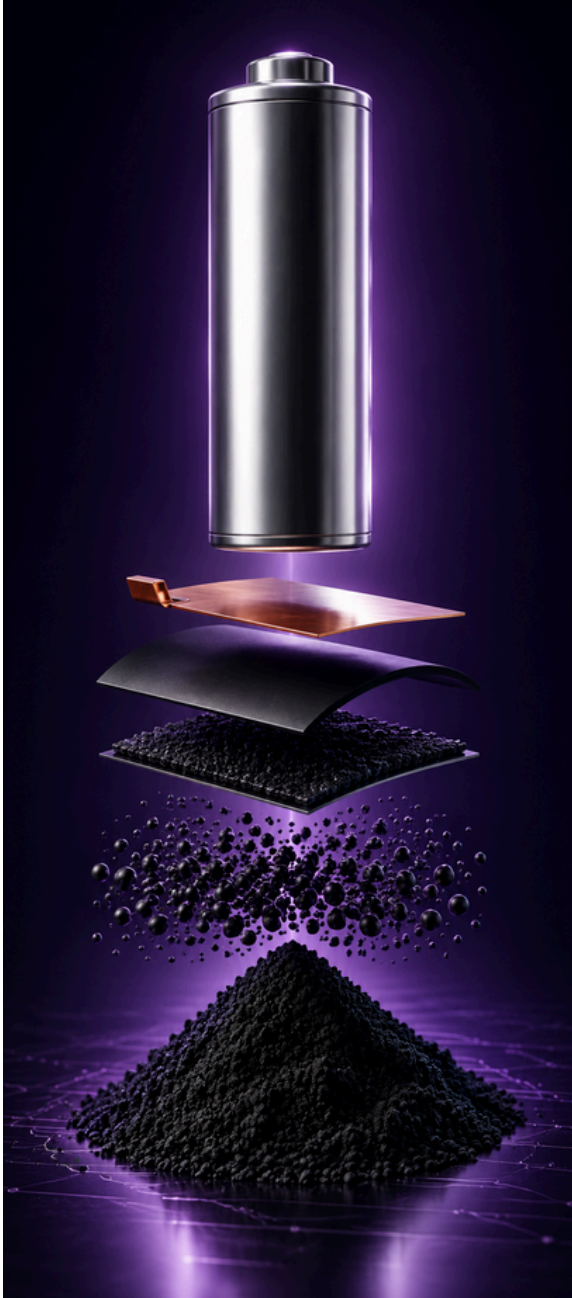
We'll make both — pure silicon and silicon-carbon. For pure silicon, we're developing a proprietary formulation that cell manufacturers can use directly.

Across both the carbon-based and silicon-based platforms, what percentage of a cell's bill of materials (BOM) could you capture?

On the cathode side, carbon makes up 2–3% by weight; with CNT blended in, that can vary slightly, but 2–3% is typical. On the anode side, it's slightly higher — up to around 5% in some applications. Combined, **carbon typically accounts for ~2–3% of total cell weight.**

For silicon, blended with artificial graphite on the anode side, typical concentrations are 5%, 10%, and 15%, with some applications pushing toward 20–25%. At 5–10% silicon content, you'd see a broadly comparable share by weight.

Neither material is used in large quantities. While silicon is a very high-value material, conductive carbon is more mainstream and high-volume.



For your carbon and silicon platforms, do you source your feedstock locally?

Not entirely. In some cases, we already use local feedstock; in others, **impurity levels are still a challenge**, and we're working to improve that. Where local purification technology isn't yet in place, we also rely on imported feedstock.

That's also true for our core carbon black business, where a large share of feedstock is domestic, but we still import some.

What's your view on Na-ion batteries for less demanding applications? Do any of your product lines support these emerging chemistries?

Na-ion is a promising alternative to lithium-based batteries. You can build a Na-ion battery without lithium, cobalt, or even nickel. That said, it still lags behind lithium-based batteries in energy density. Continuous improvement is happening - one cathode chemistry has reached energy density on par with LFP, though that still relies on nickel and manganese.

If we could get a chemistry with the same locally available material base and LFP-comparable energy density, I see strong potential to grow the sodium-ion business.

Today, LFP reaches roughly 180 watt-hours/kg, while NFPP — the sodium-ion equivalent of LFP — is around 120–130 watt-hours/kg. That energy density gap makes it currently unviable for mainstream EVs, since it can't deliver the range customers now expect.

But India has many use cases that don't need long range — last-mile delivery, connectivity vehicles, low-speed vehicles — and sodium-ion could be a viable option there once it becomes commercially competitive. Right now, the cost is high mainly because of limited production scale, not the underlying material cost. I do believe in this technology, and I think India should actively develop this platform.

On PCBL's side, we're actively evaluating what role we could play in sodium-ion. **One initial area of assessment is hard carbon as an entry route into sodium-ion. We're also looking at cathode possibilities.**

For PCBL, our selection criteria for any new material segment come down to two things: first, it needs a sustainable, local supply chain — that's how we chose silicon and carbon — and second, we look for segments that aren't already highly concentrated or hyper-competitive, where there's a genuine opportunity to grow as a global supplier.

Engineering plastics solutions for E-mobility applications

XYRON™ modified polyphenylene ether [mPPE]



Solution for AIS156 Thermal Propagation & Fire Test

Excellent flammability class

Grade/UL94	V-0 (mmt)	5VA (mmt)
XYRON™ 340Z	0.75	2.5
XYRON™ 540Z	0.75	2.5
XYRON™ 443Z	0.75	2.5
XYRON™ G601Z	1.50	2.0

Burn Test for Li-B applications⁴

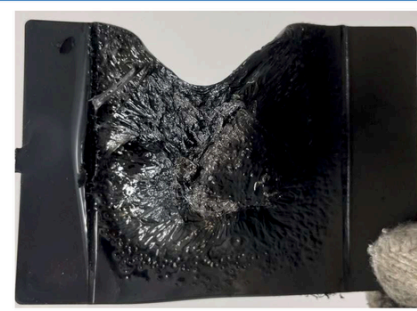
FR PC/ABS



XYRON™ 540Z



XYRON™ 443Z



Burn temp: 850°C
Burn time: 0 min 58 secs
Burn through: Yes
Drip: No

Burn temp: 850°C
Burn time: 2 min 19 secs
Burn through: Yes
Drip: No

Burn temp: 850°C
Burn time: 2 min 58 secs
Burn through: Yes
Drip: No

Burn test method:
Angle of flame: 20°, Thickness: 3 mm
Flame: Blue tip at the center of the plate
Time start: When the fire is turn on
Time stop: When burn through happen

⁵Advantages of XYRON™

Value proposition		Property	XYRON™	PC	PC/ABS
Energy efficiency due to low weight		Low specific gravity	●	●	●
Structural integrity for large and complex designs		Dimension stable	●	●	●
Battery Safety AIS-156	Fire resistance test with thin plate	Thickness ⁴	●	●	●
	1m drop test	Impact strength ¹	●	●	●
	Direct/indirect contact of water	Impact strength (after aging) ²	●	●	●
	Thermal shock test	Impact strength (after aging) ³	●	●	●

Note:
1 – Notched Charpy Impact ISO179
2 – Notched Charpy Impact ISO179 after conditioned using Internal Method: -20°C to 85°C/85%RH for 10 cycles.
3 – Notched Charpy Impact ISO179 after conditioned using AIS-156 – Thermal shock: -40°C to 80°C for 10 cycles.
4 – Asahi Kasei Method
5 – Result shown are estimates comparison conducted by Asahi Kasei

● Excellent
● Good

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India's Electric 2W Sales Volume Grows 60% YoY

Jan-Aug 2026 vs Jan-Aug 2025



Jan-Aug 2025
851,796

Jan-Aug 2026
1,362,909



2W EV Penetration
9.1%

Up From **6.87%**

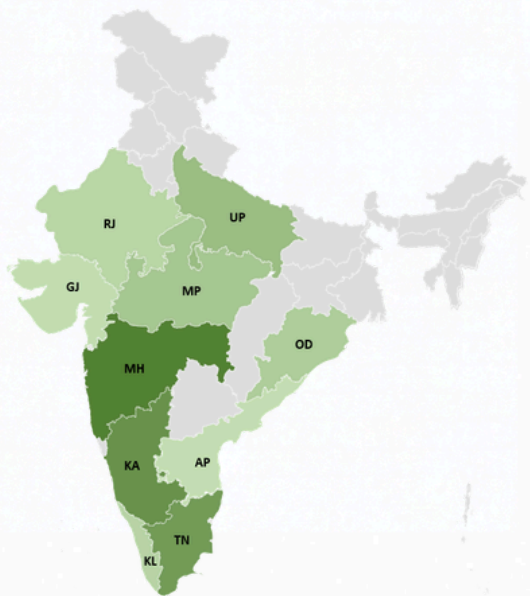


Top 10 States Accounted for
~81%
of Total E-2W Sales

Source: Evreporter Intelligence, Data from Vahan dashboard as on 23rd Sept, 2026. Low-speed 2W data not included.



Top States with e-2W Sales Volume



Powered by Bing
© GeoNames, Microsoft, TomTom

State e-2W Sales

Maharashtra	1,99,869
Karnataka	1,73,221
Tamil Nadu	1,60,759
Uttar Pradesh	1,11,988
Madhya Pradesh	96,501
Odisha	87,947
Kerala	75,273
Rajasthan	74,984
Gujarat	62,170
Andhra Pradesh	61,063
All Other States	2,59,134
Total	13,62,909



Leading Cities in Volume States

Maharashtra

Pune recorded the highest e-2W sales at 25,631 units, followed by **Nashik and Pimpri-Chinwad**. These 3 cities accounted for 25% of Maharashtra's e-2W sales.

Karnataka

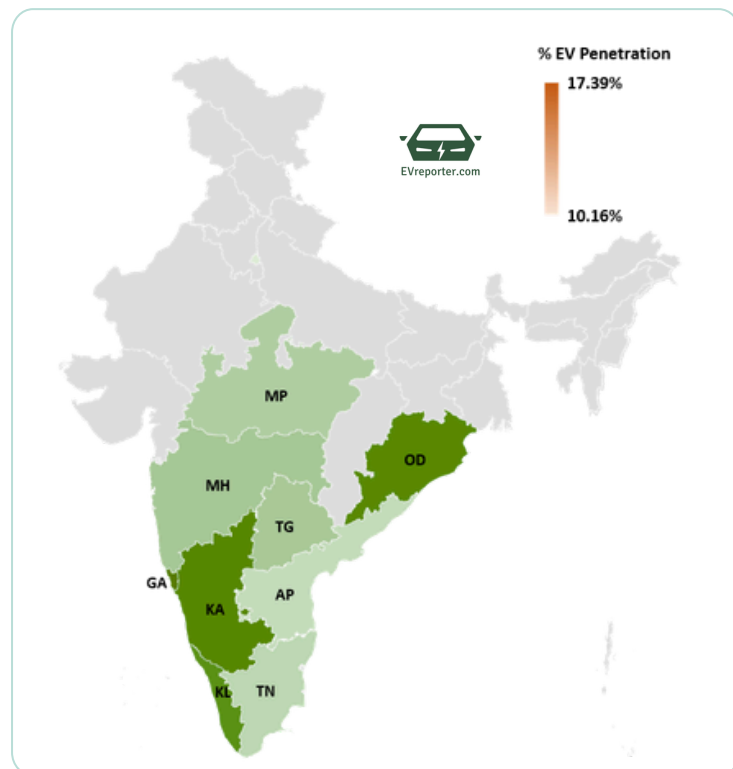
Bengaluru - 92,204 units i.e. 53.2% of the state's e-2W sales.

Tamil Nadu

Chennai, Coimbatore, Tiruppur and Hosur emerged as the major e-2W selling cities, collectively contributing 30% of Tamil Nadu's total sales.

Source: EVreporter Intelligence, Data (Jan-Aug 2026) from Vahan dashboard as on 23 Sept, 2026. Low-speed 2W data not included.

Top States by e-2W Penetration | Jan-Aug 2026



INSIGHT

- Goa recorded the highest EV penetration among Indian states at **17.39%**.
- Karnataka (**16.55%**) and Odisha (**16.45%**) followed closely in second and third position.
- Uttar Pradesh, despite being the 4th-highest e-2W selling state, recorded an EV penetration of just **5.42%** during the period.

State	E-2W sales	Total 2W sales	% EV Penetration
Goa	6,869	39,489	17.39%
Karnataka	1,73,221	10,46,687	16.55%
Odisha	87,947	5,34,772	16.45%
Kerala	75,273	4,74,407	15.87%
Maharashtra	1,99,869	16,45,221	12.15%
Telangana	60,731	5,03,555	12.06%
Madhya Pradesh	96,501	8,20,842	11.76%
Tamil Nadu	1,60,759	14,19,055	11.33%
Andhra Pradesh	61,063	5,52,036	11.06%
Delhi	39,446	3,88,352	10.16%

Source: EVreporter Intelligence, Data (Jan-Aug 2026) from Vahan dashboard as on 23 Sept, 2026. Low-speed 2W data not included.



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Jan-Aug 2026 vs Jan-Aug 2025

India's Electric Car Sales Volume Grows 81+% YoY



4W EV Penetration Reaches 6.2%, Up From 4.2%



Top 10 States Accounted for ~83% of Total E-4W Sales

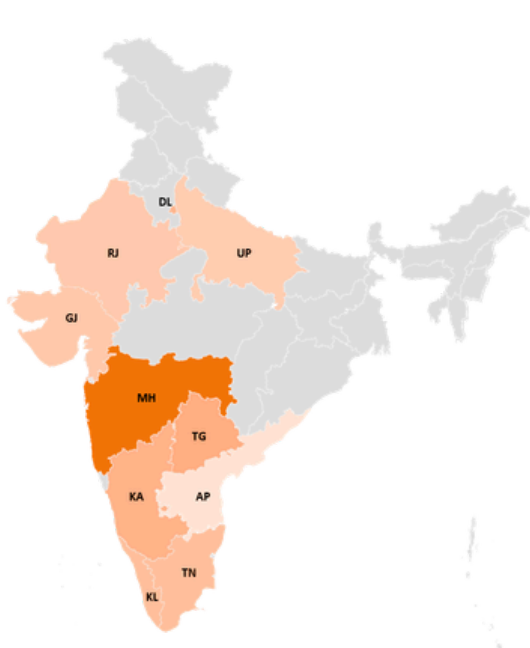
Jan-Aug 2025
121,297

Jan-Aug 2026
219,732

Source: EVreporter Intelligence, Data from Vahan dashboard as on 23 Sep 2026.



Top States with e-Car Sales Volume



e-4W sales	State	e-4W sales
31,204	Maharashtra	31,204
	Telangana	21,532
	Karnataka	20,625
	Delhi	19,876
	Kerala	18,048
	Tamil Nadu	17,982
	Gujarat	15,605
	Rajasthan	15,421
	Uttar Pradesh	14,608
	Andhra Pradesh	7,274
	All other States	37,557
	Total	2,19,732



Leading Cities in Volume States

Maharashtra

Mumbai recorded the highest e-4W sales at 7,916 units, followed by **Pune** and **Pimpri-Chinchwad**. Together, these three cities accounted for **51.58%** of Maharashtra's e-4W sales.

Telangana

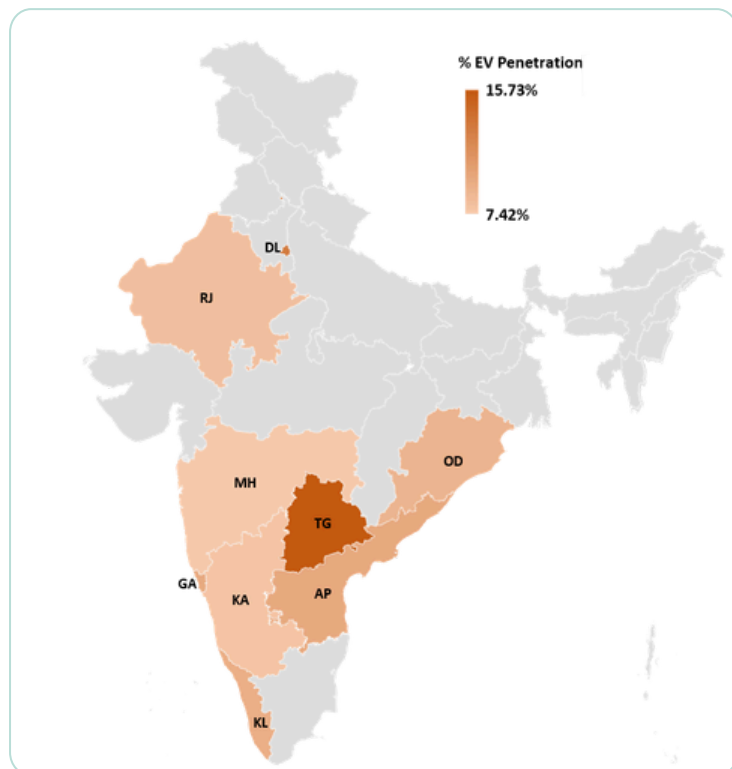
Ranga Reddy and **Hyderabad** led e-4W sales in Telangana, with a combined 10,095 units, accounting for 46.8% of the state's e-4W sales.

Karnataka

Bengaluru led e-4W sales with 13,850 units, accounting for 67.15% of Karnataka's total e-4W sales.

Source: EVreporter Intelligence, Data (Jan-Aug 2026) from Vahan dashboard as on 23 Sep, 2026.

Top States by Electric Car Penetration



INSIGHT

- **Telangana** recorded the highest EV penetration among Indian states at 15.73% during Jan-Aug 2026, **followed by Chandigarh (14.32%)** and **Delhi (13.15%)**.
- **Maharashtra**, despite being the highest e-4W-selling state, recorded an EV penetration of **7.42%**, **ranking 10th among Indian states during the period**.

State	E-4W sales	Total 4W sales	% EV Penetration
Telangana	21,532	1,36,907	15.73%
Chandigarh	2,354	16,444	14.32%
Delhi	19,876	1,51,139	13.15%
Andhra Pradesh	7,274	74,432	9.77%
Goa	1,632	16,819	9.70%
Kerala	18,048	1,91,738	9.41%
Odisha	5,861	65,592	8.94%
Rajasthan	15,421	1,91,347	8.06%
Karnataka	20,625	2,64,289	7.8%
Maharashtra	31,204	4,20,522	7.42%

Source: EVreporter Intelligence, Data (Jan-Aug 2026) from Vahan dashboard as on 23 Sep, 2026.



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The Five Generations of LFP: Everything You Need to Know | PART 2

From Mass-market to Industry's High-Performance Standard

This article by **Dr. Ravindra Kempaiah (CTO) of Zenfinity Energy** concludes the 2-part educational series on LFP's five generations. The first part (September 2026 edition) discussed how LFP chemistry evolved across earlier generations and its role in India's EV ecosystem.

This second part covers **Gen-5 developments, AI-driven process control, CATL's visual AI approach, and what China's export controls mean in practice and for India.**



Gen-5: LFP crosses into NMC performance territory

Industry leaders **CATL and Gotion have both confirmed cell-level energy densities of 205 Wh/kg** with their Shenxing Plus III and G-Ker II batteries, respectively. That number matters because 200 Wh/kg was the threshold the industry associated with mid-nickel NMC chemistries. LFP was supposed to be the safe, cheap, cycle-life-heavy option with a permanent energy-density penalty. Gen-5 breaks that assumption.

But energy density is not what makes Gen-5 remarkable. What makes it remarkable is that the **density gains**, the **fast-charge gains**, and the **cold-weather gains** have arrived simultaneously, from coordinated improvements at four different layers of the cell. An engineering stacking of functional gains.

The four coordinated layers of Gen-5 improvement

Nanoscale LFP primary particles have been standard since Gen-2, and improved carbon coating and doping have progressed through Gen-4. What distinguishes Gen-5 is not any single breakthrough at the material level, but the coordinated integration of incremental gains across four subsystems: cathode, anode, electrolyte, and cell architecture, which together unlock sustained ultra-fast charging without the cycle-life penalty that would have accompanied the same C-rate targets in Gen-4.

1. Cathode: refined nano-LFP with advanced doping and coating uniformity

Gen-5 cathodes build on the nano-primary-particle foundation of Gen-3 but push further on three axes:

- **Hierarchical particle architecture** that combines nano-primary particles with engineered secondary morphology for higher tap density and better electrode processing;
- **Advanced electrolyte additives** for a more stable SEI and more uniform carbon coating coverage at lower total carbon content, freeing mass fraction for active material; and
- **Cation doping strategies** that modify grain boundary conductivity and suppress Fe^{2+} dissolution. These Gen-4 process refinements yield a cathode that maintains rate capability without sacrificing the specific-capacity gains of prior generations.

2. Anode: engineered graphite architecture that raises the lithium plating threshold

This is where the largest Gen-5 gains sit. A cathode capable of delivering high C-rates is useless if the anode cannot absorb the incoming lithium without Li-plating / dendrite formation. Gen-5 anodes use engineered graphite particle morphologies and electrode structures, CATL's Shenxing III anode architecture being the most-cited example, that reduce local overpotentials, improve Li⁺ transport pathways, and raise the current density at which plating would initiate.

Silicon-carbon composite anodes are being scaled in parallel; Gotion's G-Ker II and G-Qing batteries are clear market signals, but flagship Gen-5 fast-charge implementations rely primarily on graphite architecture rather than silicon, because silicon's volumetric expansion and cycle-life penalties remain unresolved at high C-rates and extended calendar ageing during the life of an EV.

3. Electrolyte: formulations engineered to maintain SEI integrity under high-rate stress

The SEI forms at the anode surface during the first cycles of a cell's life. Its mechanical and chemical stability determines both cycle life and safety margin under fast-charge conditions, where the SEI is most vulnerable to fracture and re-formation. Gen-5 electrolyte formulations use **additive chemistry** and, **in some cases, semi-solid architectures** that stabilise the SEI through aggressive cycling, restricting the parasitic reactions that would otherwise consume active lithium and increase interfacial resistance, leading to capacity fade.

4. Cell architecture: internal resistance minimised at every joint

CATL's Shenxing III platform reports a cell-level internal resistance of 0.25 mΩ, roughly ~40 to 50% lower than Gen-3. This is achieved through the accumulation of small gains: current collector geometry, foil selection, tab and busbar design, and systematic elimination of resistive paths across every internal interface. Combined with targeted cooling at the cell's most thermally sensitive regions, the low-resistance architecture is what allows the platform to sustain peak C-rate of 15C without catastrophic heat generation.

Gen-5 differentiation is not just chemistry-driven. The cathode chemistry is a refinement of Gen-3/Gen-4 nano-LFP. What Gen-5 delivers is systems integration, matching cathode rate capability to anode absorption capacity to electrolyte stability to cell architecture thermal budget, so that no single subsystem becomes the limit.

Metric	Gen-5 flagship performance
Peak charge rate	15C (Shenxing Plus III)
10% → 80% SOC	3 minutes 44 seconds
10% → 98% full charge	6 minutes 27 seconds
Internal resistance	0.25 mΩ (50% below prior gen)
Cold-weather retention	>85% capacity at -20 °C
Extreme cold charge	20% → 97% in 12 min at -30 °C (BYD Blade 2.0)
Cell energy density	~205 Wh/kg (CATL's Shenxing Plus III and Gotion's G-Ker II)

Table 2. Gen-5 flagship performance benchmarks. Figures are manufacturer-published; verify against datasheets for procurement.

The invisible enabler: AI-driven process control

None of the numbers in Table 2 are achievable without a manufacturing yield that is high enough to be commercially viable. This may be the most important part of the Gen-4 and Gen-5 story. At Gen-4 and Gen-5 compaction densities, the tolerance for defects in the electrode coating collapses. A pinhole, a scratch, a foreign particle embedded in the coating - any of these can create a local hot spot, a short-circuit path, or a nucleation site for lithium plating during fast charging. **Defects that would have been benign in a Gen-2 electrode become failure-mode initiators in a Gen-5 electrode.**

The problem is compounded by production speed. In high-throughput cell manufacturing, the coating rollers run at approximately 120 meters per minute. No human inspector can process defect information at that rate. Traditional statistical sampling - pulling a coupon every fifteen minutes and inspecting it under a microscope - misses the vast majority of what crosses the line.

CATL's visual AI approach

CATL has responded to this by deploying high-resolution charge-coupled device (CCD) camera arrays combined with visual AI classifiers [[CATL official video](#)] along the coating and assembly lines. The system is trained to identify approximately 500 distinct defect types - pinholes, scratches, foreign particles, edge irregularities, coating thickness variations, adhesion failures, and dozens more - in real time at line speed, in a role similar to that of Thermo Fisher's LInspector device.

The performance target is parts-per-billion (PPB) defect rates. That is not a typo. Achieving PPB-level outgoing quality at 120 metres per minute of coating throughput requires that the inspection system catches defects reliably at rates the human eye cannot even register in a still image. This is what makes Gen-4 and Gen-5 volumes commercially viable rather than academically interesting.

Visual AI is also used further upstream, monitoring particle morphology and metrology directly. The system verifies that the multi-modal particle distribution coming out of the mill matches the target specification - the geometry that Gen-4 and Gen-5 packing depends on. If the distribution drifts, the process is corrected before the drift ever reaches the coating line.

**The advanced particle chemistry enables high compaction density.
Visual AI improves manufacturing yield at scale.**

One distinction the industry consistently conflates

Generation and chemistry are two independent axes. Confusing them leads directly to specification errors.

Compaction generations track a manufacturing trajectory - how efficiently the LiFePO_4 crystal is packed into an electrode. LMFP - lithium manganese iron phosphate - is a chemical substitution in which manganese replaces a portion of the iron in the crystal lattice, raising the voltage platform from 3.2 V to approximately 3.8 V. Higher voltage means higher energy density, achieved through fundamentally different physics.

These are complementary developments, not competing ones. The next inflection point in LFP-family chemistry is expected to combine high compaction densities ($\geq 2.70 \text{ g/cm}^3$) with NMC or LMFP voltage platforms - a Gen-5+ material with an intrinsically higher voltage. Any R&D or engineering team evaluating cells against future specifications needs to understand both axes independently.

Application mapping: where each generation fits

Each generation has a rational application envelope. Specifying above it wastes capital; specifying below it produces field problems that surface only after commissioning.

Generation	Rational application envelope
Gen-2	Entry-level two-wheelers, three-wheelers, low-cost solar storage under 5 kWh, cost-optimised residential systems in developing markets.
Gen-3	Standard passenger EVs, residential and commercial ESS, grid-scale BESS, industrial UPS. The current mass-market default.
Gen-4	800 V fast-charging passenger EVs, commercial and ride-hail fleets, footprint-constrained BESS where volumetric density is a project constraint.
Gen-5	Extreme fast-charge platforms (Shenxing plus-class), premium high-performance EVs, container-integrated BESS where every centimetre of volumetric space is priced.

Table 3. Rational application envelope by LFP generation.

Two amplifiers deserve mention. **Cell-to-Body (CTB) and Cell-to-Pack 3.0 (CTP 3.0) architectures increase volumetric space utilisation from the traditional 65% to approximately 76%**, further raising system-level energy density and reducing non-active component weight by around 27%. When a Gen-5 cell is deployed in a CTB pack, the delivered system-level energy density is meaningfully higher than the cell-level number alone would suggest. Specification benchmarks should therefore always name both the cell generation and the pack architecture.

China's export controls: the geopolitical layer

The entire discussion above assumes a manufacturer can, in principle, build any generation of LFP they have the capital to fund.

Through 2025, that assumption stopped being true for Gen-4 and above.

The July 2025 controls (active)

On 15 July 2025, China's Ministry of Commerce added LFP cathode manufacturing technology to the Foreign Trade Law's catalogue of restricted exports. **The controls target LFP powders with a compaction density of $\geq 2.58 \text{ g/cm}^3$** - a threshold that isolates Gen-4 and above while leaving Gen-2 and Gen-3 unrestricted.

Exports of the covered technology now require a Technology Export License, granted after severe scrutiny of contracts and joint venture agreements by provincial commerce and science departments. Critically, the controls target the manufacturing know-how and specialised equipment - high-precision roller-hearth kilns, particle gradation lines, AI-driven inspection systems - not the sale of finished cells. Chinese cells continue to ship. The capability to make them domestically outside China does not.

The October 2025 expansion (attempted)

On 9 October 2025, **the Chinese government proposed lowering the compaction threshold to $\geq 2.5 \text{ g/cm}^3$** - a move that would have captured Gen-3 as well as Gen-4 - and adding an **energy density threshold of $\geq 300 \text{ Wh/kg}$** for finished lithium-ion cells. This proposal was moved to the Export Control List, which involves oversight by the Central Military Commission and represents a significantly more restrictive tier of controls.

The October 2025 partial rollback

Following the meeting between the US and Chinese leadership on 30 October 2025, the broader October expansion was suspended for approximately one year. Gen-3 technology was released from the export control regime. However - and this is the point that matters for procurement and industrial policy planning - **the July 15 controls targeting Gen-4 ($\geq 2.58 \text{ g/cm}^3$) were not suspended. They remain fully in force.**

What this means in practice

- Any OEM or cell manufacturer outside China attempting to source or replicate Gen-4 technology now faces a licensing hurdle that is, in practice, extremely difficult to clear.
- Even overseas projects fully owned by Chinese companies are reportedly finding it difficult to obtain the necessary export licenses to transfer equipment and process know-how out of China.
- The licensing process itself gives the Chinese government detailed visibility into global battery supply chains and joint venture partnerships.
- **Gen-3 is the ceiling for practical non-Chinese localisation in the near term.** Gen-4 and above will remain a Chinese-manufactured product for the foreseeable future, unless the July 15 controls are also negotiated down in a subsequent round of talks.

What this means for India

India will import a substantial volume of LFP cells over the next twelve months - a figure widely estimated in the industry at around 25 GWh, though the precise number varies by tracker. Projects spanning grid BESS, commercial and passenger EV fleets, industrial UPS, and residential solar storage will all draw from that import volume. The engineers, developers, policymakers, and financiers specifying and financing those systems are largely working without a shared framework for:

- Which generation of LFP is appropriate for their application.
- Which performance characteristics to demand contractually.
- What the supply chain now looks like after the July 2025 controls.
- What premium is justified for Gen-4 versus Gen-3 in each use case.
- How to write a specification that is testable at incoming inspection rather than accepted on datasheet alone.

The most important operational consequence of the export control regime

For procurement teams building grid-scale BESS or commercial EV platforms in India, Gen-3 is now the ceiling for practical localisation, and Gen-4 will remain a Chinese-supplied product.

Both are viable and appropriate for different applications. But they should not be confused with each other, and the price differential between them should be evaluated against a clear-eyed view of what the additional density and fast-charge capability actually deliver in the deployed application.

The technology export control is already happening in India: JSW has put its 50 GWh LFP cell manufacturing plant on hold because of China's export controls.

A closing note

The five generations of LFP represent one of the more remarkable engineering trajectories in the history of commercial battery manufacturing. In roughly a decade, an inexpensive, safe, cycle-life-heavy chemistry that industry consensus dismissed as unable to compete with nickel-based cells on energy density has systematically closed that gap, then closed the fast-charging gap, then closed the cold-weather gap - and done so while maintaining the safety characteristics that made it attractive in the first place.

For an industry accustomed to treating LFP as a single, undifferentiated product, the practical implication is that this treatment no longer works. The generations are informal shorthand. The engineering distinctions they encode are real. And the export control regime that now governs the boundary between them will shape the global battery supply chain through the end of this decade.

The task for anyone specifying, procuring, integrating, or financing energy storage in India is to internalise this framework and use it. That is what technical education infrastructure is for.

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Can India Turn Its Software Strength into Automotive Advantage?



Tesla and BYD have already changed **what a car can become after it leaves the factory**. For India, the Software-Defined Vehicle is more than another technology trend. It could be a strategic opportunity, says **Mamadou Moustapha Ndoye - Consultant at Radical Eneritech**.

Ndoye brings 25+ years of global automotive engineering experience across the entire industry. PSA, with expertise in E/E architecture, EV systems, functional safety and design-to-cost. Radical Eneritech is a technology and techno-commerce consulting firm focused on sustainable energy and mobility, with expertise across EV charging, BESS, RE, smart energy systems and emerging mobility technologies.

Imagine buying a car today and receiving, six months later, a feature that did not exist when the vehicle left the factory. No workshop visit. No new ECU. No rewiring. Just software.

Over-the-air (OTA) updates are not new. Head units and telematics boxes have had them for over a decade. What is new is their reach.

In most cars, OTA stopped mainly at the infotainment screen or urgent bug fixes. The functions that define the vehicle (driving, energy, chassis, body) were frozen at Start of Production (SOP) and changed only in a workshop.

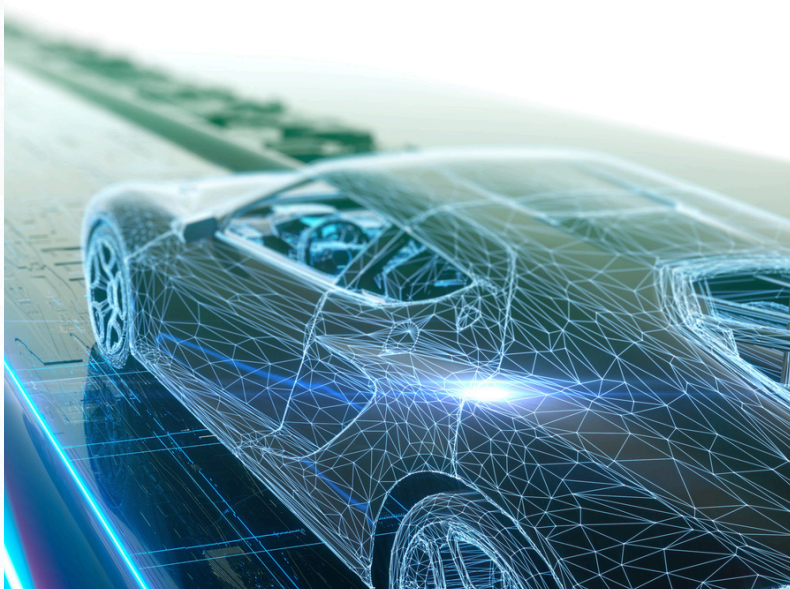
Tesla broke that boundary with the 2012 Model S; its owners have lived with whole-vehicle updates since. Tesla made continuous improvement through OTA updates a normal customer expectation.

BYD is taking a different but equally important route: its e-Platform 3.0 consolidates electronics into domain controllers running BYD OS, which decouples hardware from software. Its XUANJI architecture goes further, integrating electrification and intelligence across the whole vehicle.

That is the real distinction. A connected car can be updated, while a **software-defined car can radically change its core functions**. And India has good reasons to care.

What makes a vehicle "software-defined"?

Cars have run software for decades. A modern car may carry dozens of electronic control units (ECUs), more than a hundred in premium models. However, that alone does not make it a Software-Defined Vehicle (SDV).



In a traditional architecture, software is bound to dedicated hardware. The brake supplier delivers a brake ECU, another delivers the body controller, and a third supplies infotainment. Each box has its own processor, software, signal interfaces, and release cycle, and the CAN signal matrix linking them is frozen at SOP. A function spanning three ECUs means three supplier releases and, usually, a workshop visit.

An SDV breaks the “one function, one box” logic in three ways (see Figure 1).

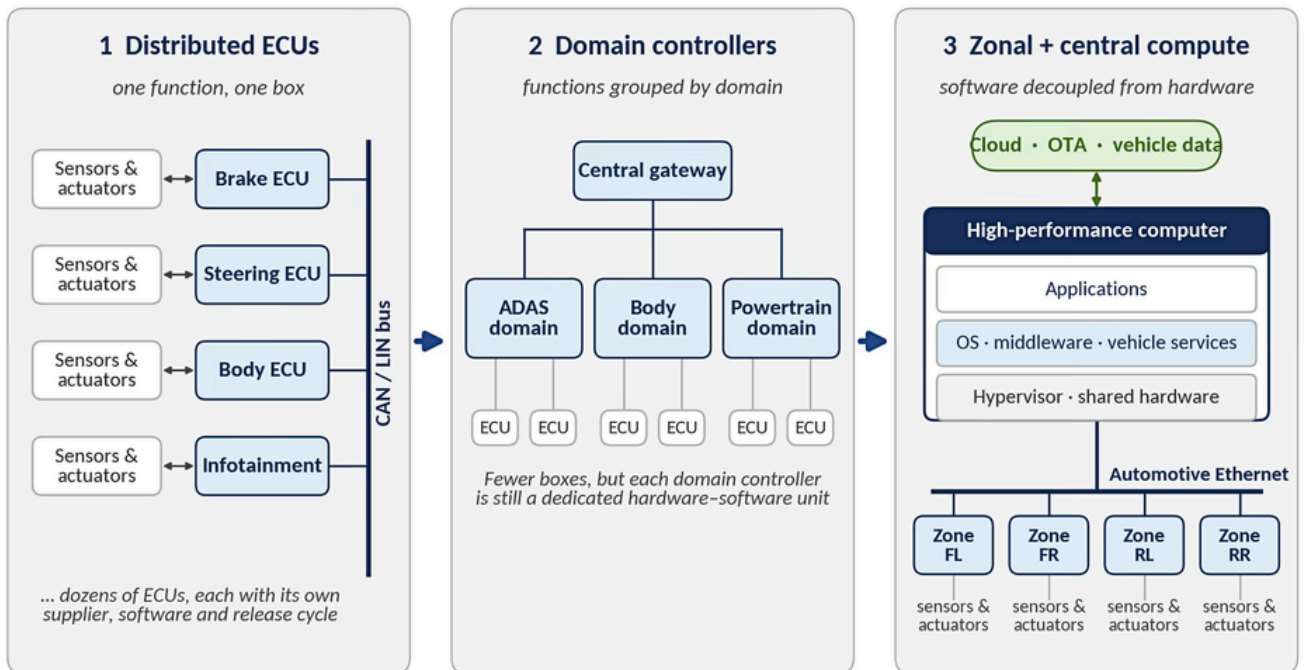


Figure 1. From the early distributed ECUs to the new Zonal/Central compute. The SDV transition is not simply “fewer ECUs”: it separates software from dedicated hardware and moves toward shared compute and common software platforms.

- **Hardware consolidates.** First into domain controllers, then into zonal architectures: zone controllers aggregate local sensors, actuators and power distribution, while one or two high-performance computers (HPCs) run the functions, connected over Automotive Ethernet (IEEE 802.3bw/ch).
- **Software abstracts.** A hypervisor partitions the HPC, service-oriented middleware such as AUTOSAR Adaptive (SOME/IP, DDS) exposes vehicle capabilities as services, and a common data model such as COVESA's Vehicle Signal Specification lets an application request “vehicle speed” without knowing which ECU provides it. Eclipse SDV aims to make these layers open rather than proprietary.
- **The loop closes after production.** Connectivity, OTA, and vehicle data feed the next release, under the software update management system that UN R156 makes a condition of type approval.

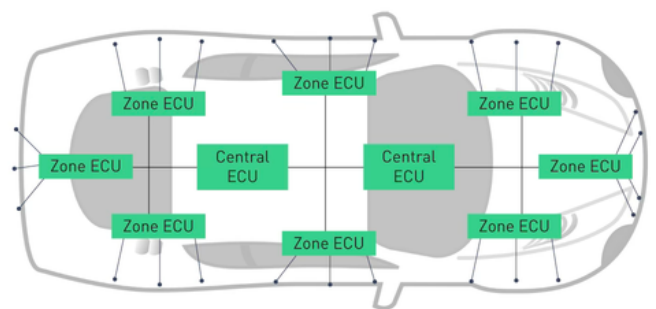


Figure 1-B. Zonal/Central EE Architecture

Tesla proved the vehicle can keep evolving

Tesla's importance to SDV is not the touchscreen. It is the product lifecycle.

The traditional model:

Develop → Manufacture → Sell → Service

The SDV adds a permanent loop:

Develop → Manufacture → Sell → Collect data → Update → Improve → Repeat

SOP is no longer the end of development. A Tesla delivered five years ago does not have the feature set it left the factory with. This is what the customers now expect.

BYD shows the architectural side

BYD illustrates the other half of the shift: which is not the update itself, but the architecture that makes updating cheap. e-Platform 3.0 runs cockpit and body domain controllers on BYD OS, presented as the foundation for continuously evolving vehicle intelligence.

XUANJI goes further than that. BYD describes it as both the “brain” and the “neural network” of the vehicle: consolidating information for central decision-making and applying AI across more than 300 vehicle scenarios, at BYD's volumes, millions of vehicles a year.

The lesson is that the competition is moving from individual ECUs to the whole-vehicle software architecture, industrialised at scale.

India is already moving

Mahindra

- Mahindra calls **MAIA**, its AI architecture, the foundation of its SDV vision.
- When it launched the BE 6 SPORTEQ in August 2026, it committed to rolling new software features out to existing BE 6, XEV 9e and XEV 9S owners through phased OTA updates from January 2027.

Tata Motors

- Sierra EV pairs its N.IO SDV platform with built-in 5G through Tata Communications' MOVE platform, which enables faster OTA updates, real-time remote diagnostics, and provides a backbone for AI-enabled applications.

Ather Energy

- **AtherStack** platform has delivered new functions to electric scooters over the air, including interface upgrades, safety features, and voice interaction.

Ather shows why SDV should not be seen only through the lens of premium cars and proves that India's SDV opportunity is different.

Why India should think “Frugal SDV”

EVreporter counted more than 2.36 million EV sales in India in 2025 (8.36% of all vehicle sales), and electric 2Ws made up more than half of them. This market structure changes the economics.

A premium SUV can absorb a large SoC (a single chip that packs processor, graphics, and AI accelerators together), gigabit Ethernet, and redundant compute. A mass-market scooter or 3W cannot: its entire electronics budget is a fraction of a premium cockpit.

What does SDV look like at ₹1 lakh instead of ₹25 lakh? We are looking for a different design approach that entails:

- **Right-sized compute:** one capable microcontroller or entry-level SoC, not a 500-TOPS processor.
- **Secure, recoverable updates:** secure boot, A/B partitions and rollback protection, as specified by Uptane and ISO 24089.
- **One vehicle API across the range**, so an application written for the scooter also runs on the 3W and the fleet van.
- **A BMS that reports cell-level telemetry to the cloud** enables battery-health analytics, warranty management, second-life valuation, and fleet uptime for optimal commercial operations.
- **A cloud backend built for volume**, enabling onboarding, diagnostics, update campaigns, and fleet services.

*A Frugal SDV needs to offer enough computing, connectivity, cybersecurity and software abstraction to enable OTA updates, remote diagnostics, battery intelligence and continuous improvement, without importing the cost structure of a luxury vehicle. **This is where India has an advantage.***

NASSCOM puts the country's technology workforce at roughly 5.8 million people in FY2025. India already writes embedded and automotive software for most of the world's OEMs and Tier-1s through its engineering-services ecosystem.

But **writing code for someone else's architecture is the low-margin end of SDV.** The real opportunity is to move up the value chain i.e., **FROM supplying software components TO owning platforms, middleware, APIs, integration, and intellectual property.**

The hard part: who owns the integration layer?

SDV looks simpler on a slide than inside a vehicle. Suppose **three ECUs disappear and their software moves onto one HPC.** Suppliers A, B, and C each used to own their hardware and software. Now their code shares one processor, memory, network and operating environment.

- **Mixed criticality.** ASIL-rated vehicle control may share silicon with QM infotainment. Freedom from interference (hypervisor, memory protection, time partitioning) has to be demonstrated under ISO 26262-6.
- **Shared resources.** CPU, GPU, NPU, memory, Ethernet bandwidth and thermal headroom are finite. No function may starve another, and the budget must hold for every future release.
- **Release management.** Supplier A updates today, Supplier B next month. Compatibility, dependencies, configuration control, rollback and OTA validation become vehicle-level responsibilities, and under UN R156 and its RxSWIN traceability, type-approval responsibilities.

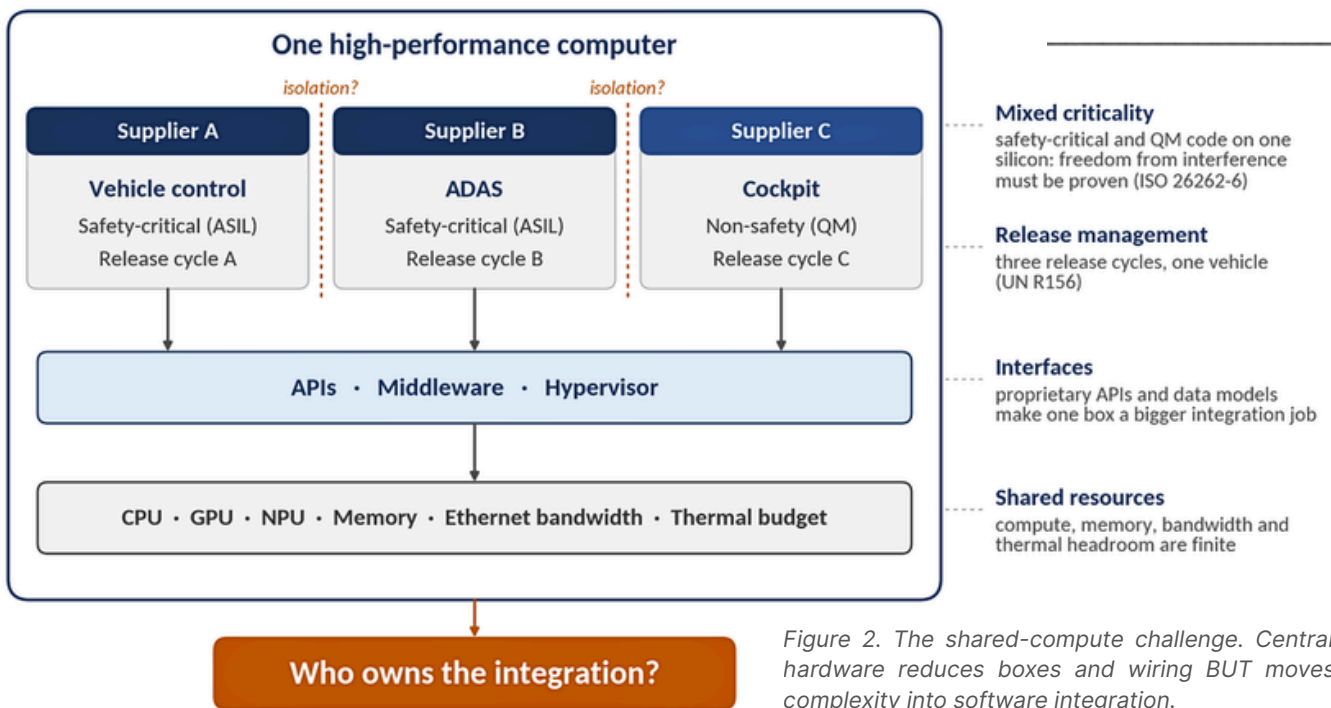


Figure 2. The shared-compute challenge. Centralising hardware reduces boxes and wiring BUT moves the complexity into software integration.

- **Interfaces.** If every supplier brings proprietary APIs and data definitions, centralisation simply creates a bigger integration problem in one box.
- **Cybersecurity.** More connectivity and remote update capability mean a larger attack surface. UN R155 and ISO/SAE 21434 demand a managed process. India is laying its own rails: AIS-189 and AIS-190, adapted from R155 and R156, are in the pipeline.
- **Validation.** Frequent releases make manual vehicle testing impossible to scale. Software-in-the-loop, hardware-in-the-loop, virtual ECUs, automated regression, and CI/CD stop being nice-to-have.

Reducing the number of ECUs does not reduce complexity. It **moves complexity from hardware and wiring into software and integration.**

Ultimately, the **OEM owns that problem.** It can outsource code, not responsibility for how the complete vehicle behaves. That's why every serious SDV player is building an in-house software organisation owning architecture, APIs, integration and the release pipeline.

That is also what India's engineering base could grow into:

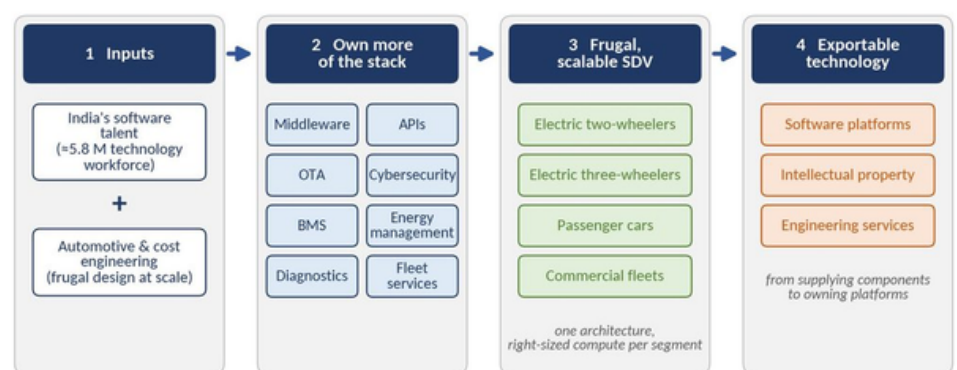


Figure 3. India's SDV opportunity: converting software scale into ownership of higher-value SDV layers.

The opportunity is bigger than developing a cheaper Tesla

The SDV race will be won by companies that can change vehicle functions quickly while keeping the whole system safe, secure, affordable and maintainable, release after release. India can either remain a great source of automotive software talent, or use that base to own more of the layers that define the vehicle itself. The most interesting Indian SDV could be something the world needs: a secure, updateable, cost-efficient software platform that scales across vehicle categories. If we solve that, and India could define the software architecture for the next billion mobility users.

Summary of Investment Commitments | Oct 2026

Company	Amount Raised	Round	Key Investors	Details
Ultraviolette Automotive	\$85 million	Series E	Led by Yali Capital (Deep Tech Fund), TDK Ventures and Lip-Bu Tan (Chairman, Walden International)	Follows the announcement of a new BIGGA manufacturing facility in Hosur, scaling production up to 500,000 units annually. Lip-Bu Tan joins as advisor.
Manba Finance Ltd	₹99.99 crore	Preferential Issue of Securities	Investors and family offices	Equity shares worth ₹67.50 crore to non-promoter investors, convertible warrants worth ₹32.49 crore to promoter group
Leanwatts	\$2 million (₹18.15 crore)	Seed Round (two tranches)	Led by Trivest Partners; angel investors Abraham George and Alok Rungta	Leanwatts is expanding into public charging, rectifiers, power modules, hybrid inverters.
Zelio E-Bikes	₹167.96 crore	Preferential Issue (equity + convertible warrants)	Equity allotment: ₹40.1 crore to Motilal Oswal Financial Services, ₹31.4 crore to Calliope Capital Advisors LLP, ₹8.5 crore to Param Value Investments and approximately ₹3 crore to Hem Growth Opportunities Fund. Promoters: Niraj Arya, Deepak Arya and Kunal Arya	Issued 9.73 lakh equity shares (to non-promoter institutional & private investors) and 9.96 lakh convertible warrants (to promoters) at ₹853 each; funds a new three-wheeler plant in Patan, Haryana
Hero Motors	₹299.99 crore	Anchor Investment (Pre-IPO)	Anchor investors	Combination of fresh issue up to ₹600 crore and offer-for-sale up to ₹400 crore by promoters O P Munjal Holdings and Hero Cycles Limited

Africa Go Green Fund increased its financing commitment to Spiro by \$18 million, doubling the total commitment to \$36 million to support expansion in Uganda & Rwanda. AGG is a climate-focused debt fund managed by Cygnum Capital.



Ultraviolette announced a Big Global Ambition (BIGGA) Factory in Hosur, TN — 250,000 units/year capacity (scalable to 500,000); The facility will build the Tesseract e-scooter and create ~2,000 jobs in phase 1.

Ultraviolette Automotive to launch Shockwave (FUNDURO) in Q1 2027. The lightweight motorcycle will be built on Ultraviolette's new 100V architecture and will deliver 14.5 hp, available in both single- and dual-seat configurations, with a 120 kmph top speed and 505 Nm of rear-wheel torque.

Ather Energy incorporated a wholly owned subsidiary, Ather Energy Hong Kong Limited, to strengthen APAC supply chain resilience.

Creatara Mobility inaugurated its first plant in Faridabad, with 30,000 units/year capacity, for the IN40 and VM4 electric scooters.

EMotorad and Mercedes-Benz India partner to introduce the Mercedes-AMG PETRONAS F1 e-bike range to India. EMotorad will make the e-bikes in India and manage the post-sales customer experience.

Kinetic EV introduced an updated Kinetic DX+ electric scooter with a 3.1 kWh LFP battery, 132 km IDC range, priced at ₹1,27,650 (DX 3kWh at ₹1,18,599).

Electric Agri Updates

Peepul Agri Ventures received GARC type approval for its BloomX 600 electric self-propelled boom sprayer (under the A7 Agricultural Tractor category).

AutoNxt launched an Autonomous Electric Aero Tiller for agricultural use, capable of up to 5 km/h and 1.5 acres/hour field capacity.

Mecwin Technologies developed a 45 HP-class electric tractor powertrain (30 kW, ~400 V) for supply to tractor OEMs.

Policy & Government

- **NITI Aayog** launched Aggregating Clean Transport (PACT) and the Zero Emission Truck (ZET) Marketplace platforms to support freight electrification — only ~800 heavy e-trucks sold in 2025 despite 70% of freight moving by road.
- AIS-156-2020 Amendment No.5, issued by the Ministry of Road Transport & Highways, introduced a new clause 6.12 mandating **cybersecurity tests for BMS units** in rechargeable energy storage systems with wireless interfaces.

Battery Material

E3 Lithium (Canada) and Epsilon Advanced Materials signed an MoU for the long-term supply of battery-grade lithium carbonate over 5 years (40% of E3's proposed Stage 1 output from the Clearwater Project). Epsilon is building a 30,000 TPA LFP cathode active material facility in India, with Phase 1 by early 2028.

TACC (Indore-based business of HEG Advanced Materials) is exploring anode active material collaboration with **Panasonic Energy**, possibly extending to Si-carbon anodes.

HEG Limited completed the demerger of its businesses, resulting in two independent listed entities. The existing HEG entity is proposed to be renamed HEG Advanced Materials. Its graphite electrodes business has moved to the resulting company, HEG Graphite Limited.

TCPL Packaging committed ₹125 crore over the next 18 months to enter the lithium-ion battery separator film business, starting at 70 million sq m/year capacity.

Battery Updates

Exide Energy Solutions (EESL) commissioned Phase 1 (6 GWh capacity) of its lithium-ion cell manufacturing facility at Devanahalli, Bengaluru.

MaxVolt Energy held a groundbreaking for its proposed 10 GWh lithium battery pack facility in Aligarh; a 6-acre site and a planned investment of ₹700 crore.

Exide Industries and ExCom Energy Solutions entered into a long-term strategic cooperation on industrial batteries and energy storage systems across the European Economic Area (EEA), focusing on traction/motive-power and stationary storage batteries, marketed under the ExCom brand.





Components & Powertrain

Bacancy Systems secured a patent for its **CCS2 EV Dispenser Unit** — supports up to 1.92 MW, 375A per gun, dual CCS2 connectors, and 12 output terminals.

Musashi India and Bhago Mobility signed an LOI for **3W e-Axle powertrain supply** for the fixed-battery Bhago Bhim platform; production starts in 2027 at Musashi's Bangalore plant.

Kinetic Engg Limited (KEL) announced an additional investment of **~₹57 crore** across its automotive components and electric two-wheeler businesses. The investment will be made through the final tranche conversion of warrants issued to promoters in March 2025.

Gestamp invested **₹523.7 crore (in two phases)** in a new **Gujarat plant** for body-in-white components manufacturing; now runs 5 India plants; 2025 India revenue: €245M.

Autoline Industries secured an **INR 100 crore SUV components order (ICE and EV)** from **Tata Motors Passenger Vehicles**, expecting this to scale into annual incremental revenue of the same size.

Vimag Labs secured exclusive access to an American high-voltage power-electronics and control platform (up to 1,200V, with V2G/V2V support) to integrate into its Virtual Magnet Motor propulsion systems for e-buses and trucks.

Solterra Technologies and Sinpro Electronics partnered to bring EV motors, controllers, and DC-DC converters to India; Solterra opened a new Bengaluru R&D office.

Uno Minda announced **4 projects (capacity expansion and plant consolidation)** worth **~₹1,415 crore**, including a greenfield aluminium casting facility in Hosur and alloy-wheel capacity relocation/expansion in Kharkhoda, Haryana.

Coforge expanded its automotive engineering practice focused on EVs, connected vehicles, software-defined vehicles and automotive platforms.

Tata Elxsi partnered with **Sarla Aviation** on **Shunya**, a six-seater + pilot eVTOL aircraft with 300km+ range; first flight targeted in 18–24 months. Tata Elxsi handles testing/certification support; Sarla leads design and type certification.



Electric Commercial Vehicles

JSW Greentech launched commercial EV brand AMPSTAR, manufacturing e-buses (7m to 18m) and e-trucks (starting with 55-tonne tractor-trailers) at AURIC, Chhatrapati Sambhajnagar, Maharashtra, with an annual capacity of 15,000 units.

AVG Logistics (a logistics service provider) deployed **30 electric trucks** from IPLTech (Montra Electric) for **Dalmia Cements' Assam project**, with DRIVN financing. Tejas Cargo and Blue Energy Motors deployed an electric truck for Dalmia Cements' cement transport in Rajgangpur, Odisha (following GDL's earlier Blue Energy Motors deployment).

UltraTech Cement and **Putzmeister India** partner to induct **10 iONTRON electric transit mixers** into UltraTech's Ready-Mix Concrete operations.

Hindustan Zinc signed a 6-year contract with MFL India to deploy 30 e-trucks for mine-to-smelter logistics from Rampura Agucha to Rajasthan smelters; HZL already runs 42 EVs (FY26).

UltraTech Cement will deploy 600+ EV trucks by Dec 2026 for clinker and materials transport across Gujarat, UP, MP, Rajasthan, Chhattisgarh, Maharashtra, and Odisha, via contracts with Tata Motors, Ashok Leyland, IPLTech, Energy in Motion, and Sany.

Passenger Vehicle Launch

BMW i5 LWB launched at ₹79.60 lakh (ex-showroom); Chennai-built, 81.6 kWh battery, 669 km range, 0-100 in 6.7s, 160 kW DC fast charging (10-80% in ~33 min).



Charging & Swapping

Yuma Energy, Instamart and Yulu partner to install battery-swapping stations at Instamart delivery points; Yulu supplies EVs, Instamart offers rental cashback to delivery partners, and Yuma provides BaaS.

Exicom and Panus Assembly in Thailand signed an MoU to support EV fleet charging for Panus's electric truck initiatives. Panus Assembly is a Thailand-based manufacturer of truck bodies, trailers, and semi-trailers.

ChargeIndia launched a unified charging platform for car owners, aggregating 40+ CPOs across 1,200+ cities, with station navigation, UPI, and no prepaid wallet requirement.

Tata Power EZ Charge inaugurated a new EV charging hub at Malad West, Mumbai, for public and commercial fleet users, with 4 fast-charging units (one 120 kW, three 60 kW upgradable to 120 kW) and 8 parking bays.

Energy In Motion (EIM) inaugurated its second heavy-duty battery swapping-cum-charging station at Nhava Sheva Distribution Terminal, JNPA, where ~150 EIM electric trucks already operate. The planned EV Megaplex will add 3 swap-cum-charging stations, a service station, a driver training center, and a vehicle simulator, eventually supporting 700+ electric heavy trucks; JNPA targets a full energy transition by December 2027.

E-Bus Updates

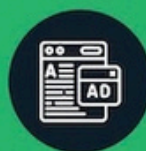
Fresh Bus launched a 600+ km electric intercity route connecting Bengaluru and Hyderabad, using a 13.5m all-sleeper AC e-bus (36 berths) with ultra-fast charging halts; targets ~18,000 passengers/month at ~80% occupancy.

Switch Mobility (a Hinduja Group Ltd company) launched its Eiv9 electric bus in Seychelles, continuing its right-hand-drive market export push (after Mauritius, Nepal, Bhutan deployments).

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