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MAY 2025 | MAGAZINE

Issue No. 52

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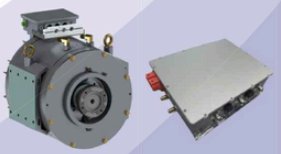

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What's INSIDE

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Quality Assurance for Battery Safety and Performance

Reliable components through inspection and quality data

- Batteries are crucial for range, performance, and longevity in new energy vehicles (NEVs).
- Safety, efficiency, and cost are decisive factors for NEV owners and manufacturers.
- Cells, modules, and trays must comply with tight tolerances during final assembly.

ZEISS uses industrial microscopy such as FE-SEM & SEM, Industrial CT and 2D & 3D X-Ray, CMMs, and optical 3D measurement systems to ensure battery safety and performance for electric vehicles.

ZEISS Gemini FE-SEM For Highest Demands in Sub-nanometer Imaging & Analytics

Full coverage of battery applications:

Battery cells and modules

- Final inspection of the battery module is challenging due to safety risks from individual cells.
- Quality challenges arise from the characteristics of individual cells.

Battery materials

- Key challenges: developing new active materials and ensuring consistent supply.
- Maintaining calendering pressure and observing microscopic aging changes.

Battery electrodes

- Battery electrodes are vital for safety and efficiency.
- Key processes include materials analysis, cutter blade replacement, and 3D deformation visualization.

Battery tray

- The battery tray houses cells, connectors, control units, and battery packs.
- Integrated into the vehicle body, its structure requires inspection at multiple intervals.

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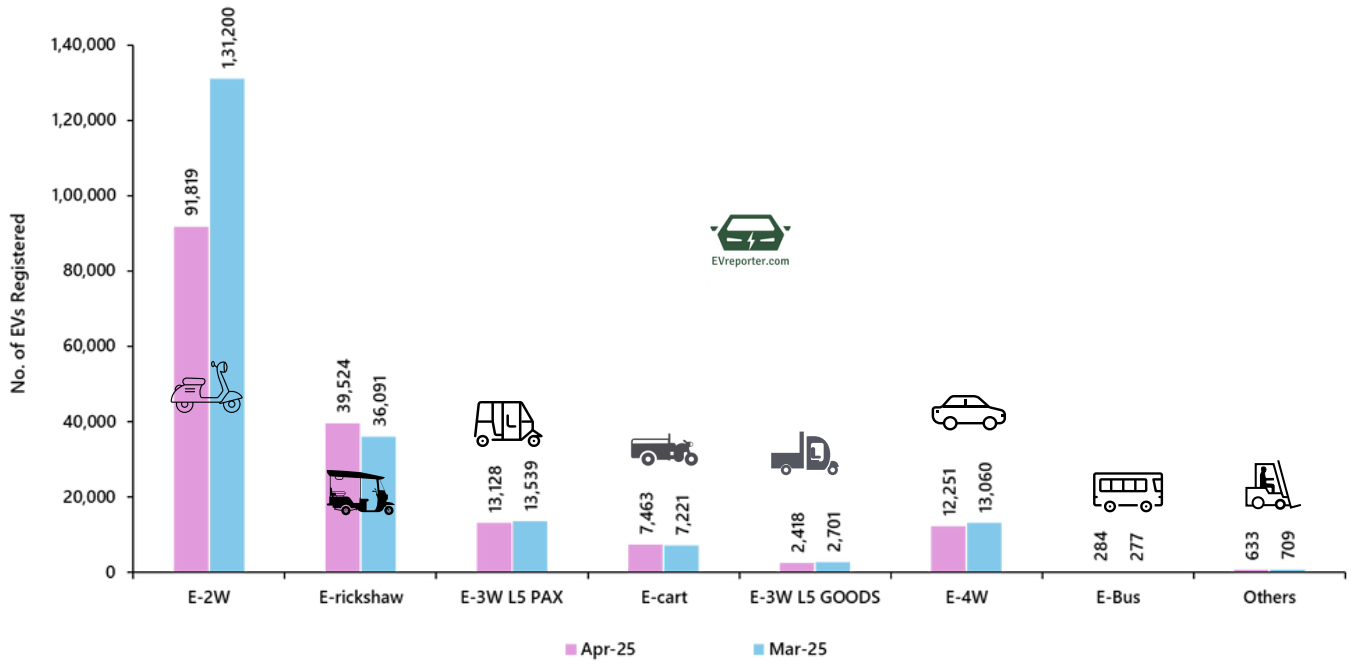
Category-wise Electric Vehicle sales, Apr 2025 | India

Total Registered Electric Vehicle Sales - **Apr'25 - 1,67,520** I Mar'25 - 2,04,798

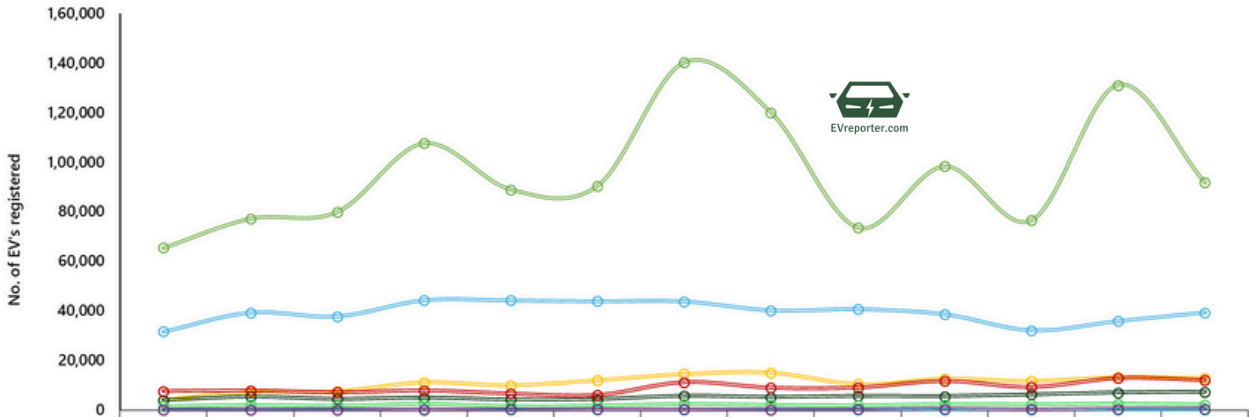


Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included. Low speed e-2W sales data not included.

E-rickshaw refers to low speed electric 3Ws (up to 25 kmph) used for passenger transportation. E-cart designates low speed electric 3Ws (up to 25 kmph) used for goods transportation.

Category wise-Sales Trend from Apr 2024 to Apr 2025

20,18,429 EVs sold in last 12 months from May 2024 to Apr 2025



	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25
E-2W	65555	77328	80003	107654	89077	90542	140221	119989	73754	98410	76672	131200	91819
E-rickshaw	31797	39471	37945	44444	44335	44023	43973	40384	40842	38824	32359	36091	39524
E-3W L5 PAX	4283	7479	7816	11421	10224	12277	14778	15343	10632	12880	11915	13539	13128
E-cart	4212	5534	4609	5185	4394	4573	5889	5422	5826	5761	6403	7221	7463
E-3W L5 GOODS	1747	2247	1932	2622	1790	2029	2540	2266	2131	2492	2449	2701	2418
E-4W	7780	8013	7315	8030	6787	6176	11431	9161	9237	11901	9431	13060	12251
E-Bus	211	221	135	437	243	388	398	161	176	360	307	277	284
Others	324	372	386	384	435	477	485	408	547	640	560	709	633
TOTAL	115909	140665	140141	180177	157285	160485	219715	193134	143145	171268	140096	204798	167520

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included. Low speed e-2W sales data not included.

For EV sales, including Telangana data, state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the EVreporter Data Portal here.

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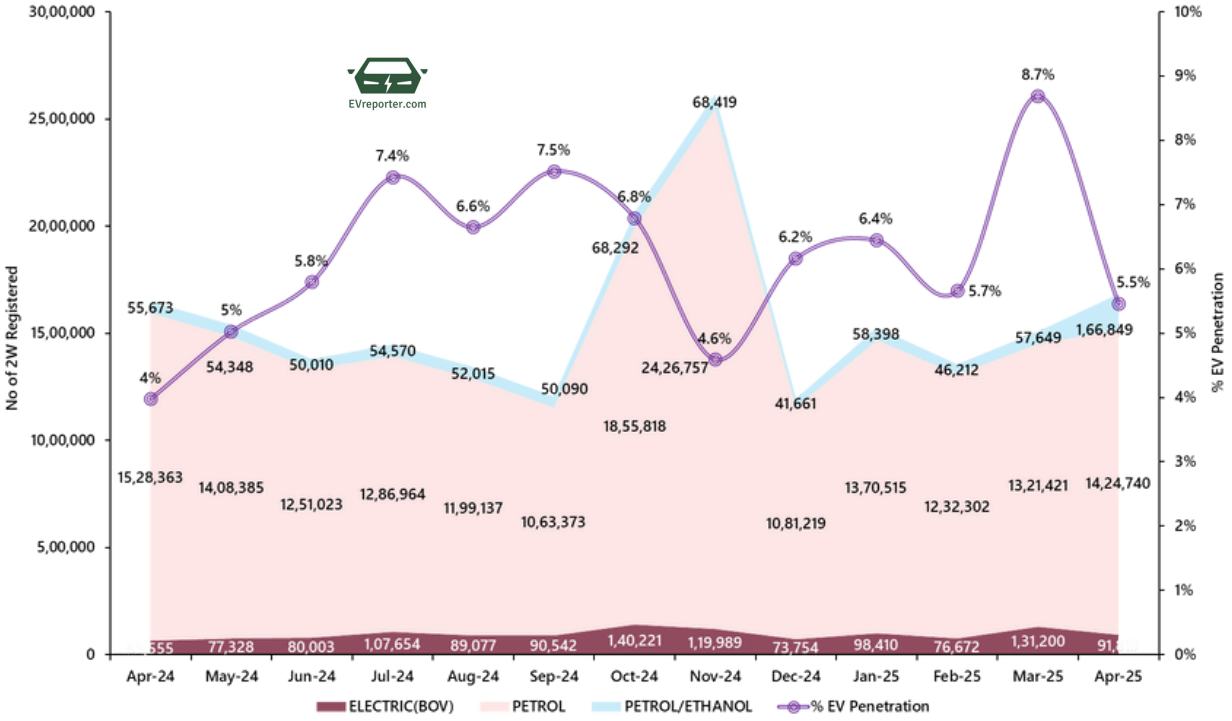
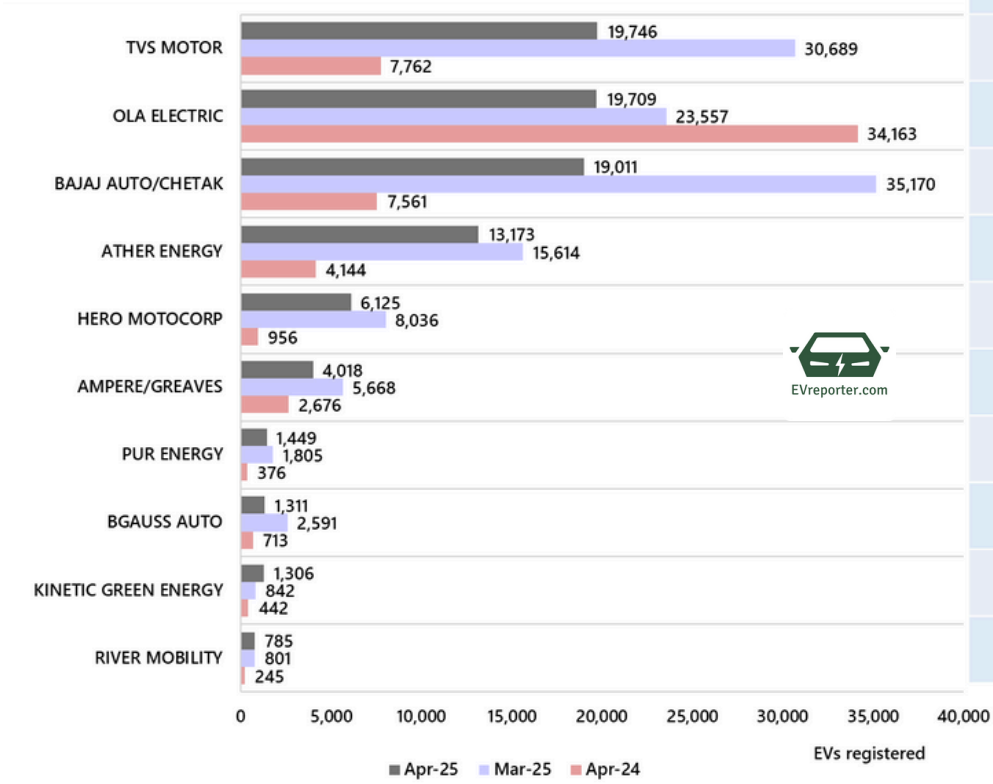
Fuel wise 2-Wheeler Sales Trend, Apr 2024 - Apr 2025



Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included. Low speed e-2W sales data not included.

High Speed E-2W Sales Trend by OEM



	% Growth (Y-o-Y)	% Growth (M-o-M)
TVS MOTOR	154%	-35.7%
OLA ELECTRIC	-42%	-16.3%
BAJAJ AUTO/CHETAK	151%	-45.9%
ATHER ENERGY	218%	-15.6%
HERO MOTOCORP	540.7%	-23.8%
AMPERE/GREAVES	50%	-29.1%
PUR ENERGY	285%	-19.72%
BGAUSS AUTO	84%	-49.4%
KINETIC GREEN ENERGY	195%	55.1%
RIVER MOBILITY	220%	-2.0%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included. Low speed e-2W sales data not included.

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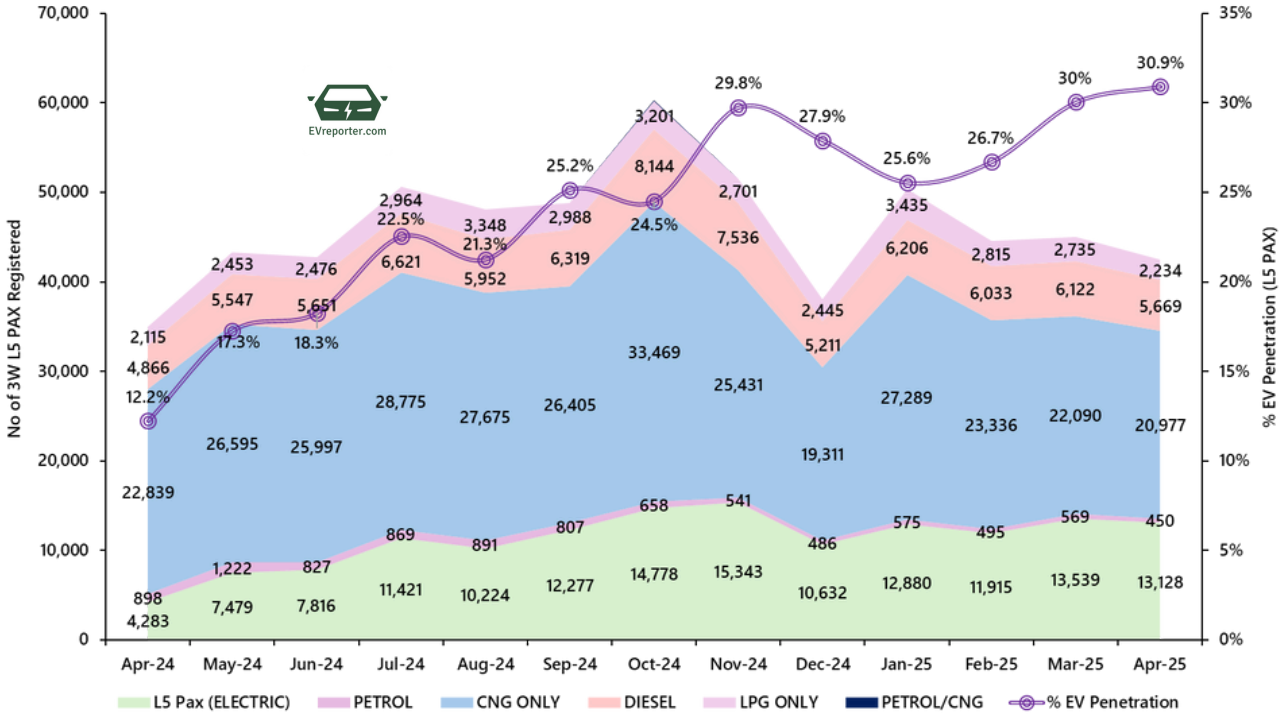
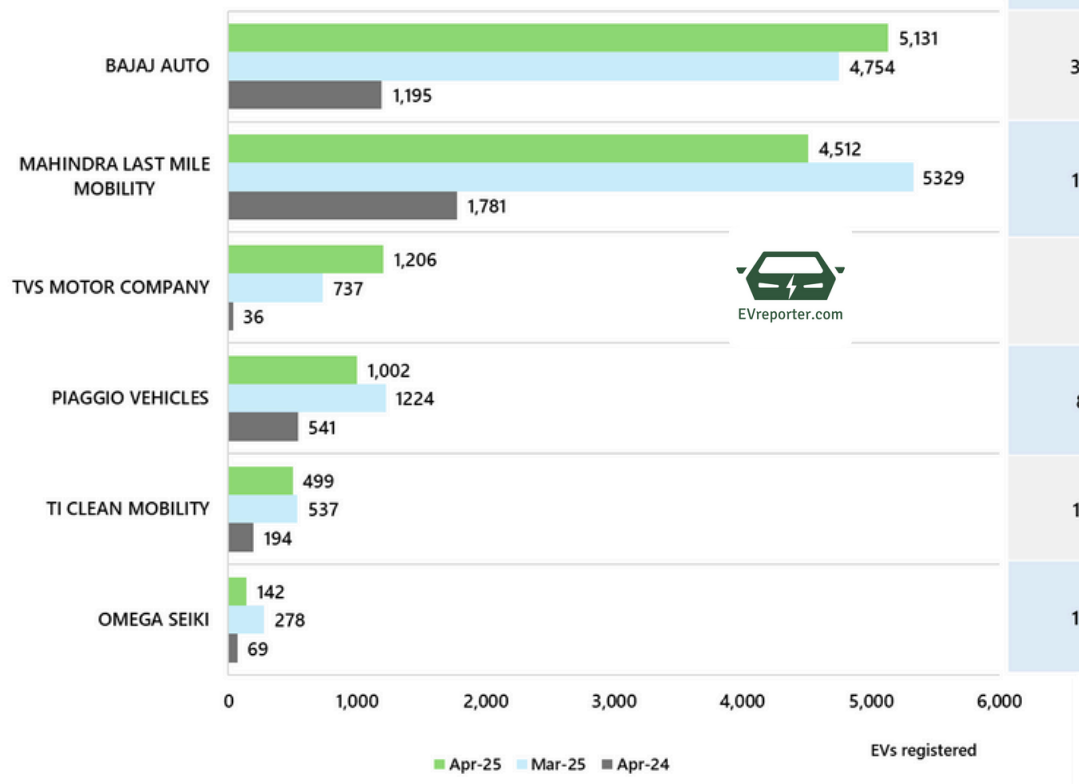
Fuel-wise 3W **L5 Passenger** Sales Trend



Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

E-3W L5 Passenger Sales Trend by OEM



	% Growth (Y-o-Y)	% Growth (M-o-M)
BAJAJ AUTO	329%	7.9%
MAHINDRA LAST MILE MOBILITY	153%	-15.3%
TVS MOTOR COMPANY	-	63.6%
PIAGGIO VEHICLES	85%	-18.1%
TI CLEAN MOBILITY	157%	-7.1%
OMEGA SEIKI	106%	-48.9%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included

For EV sales, including Telangana data, state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the EVreporter Data Portal here.

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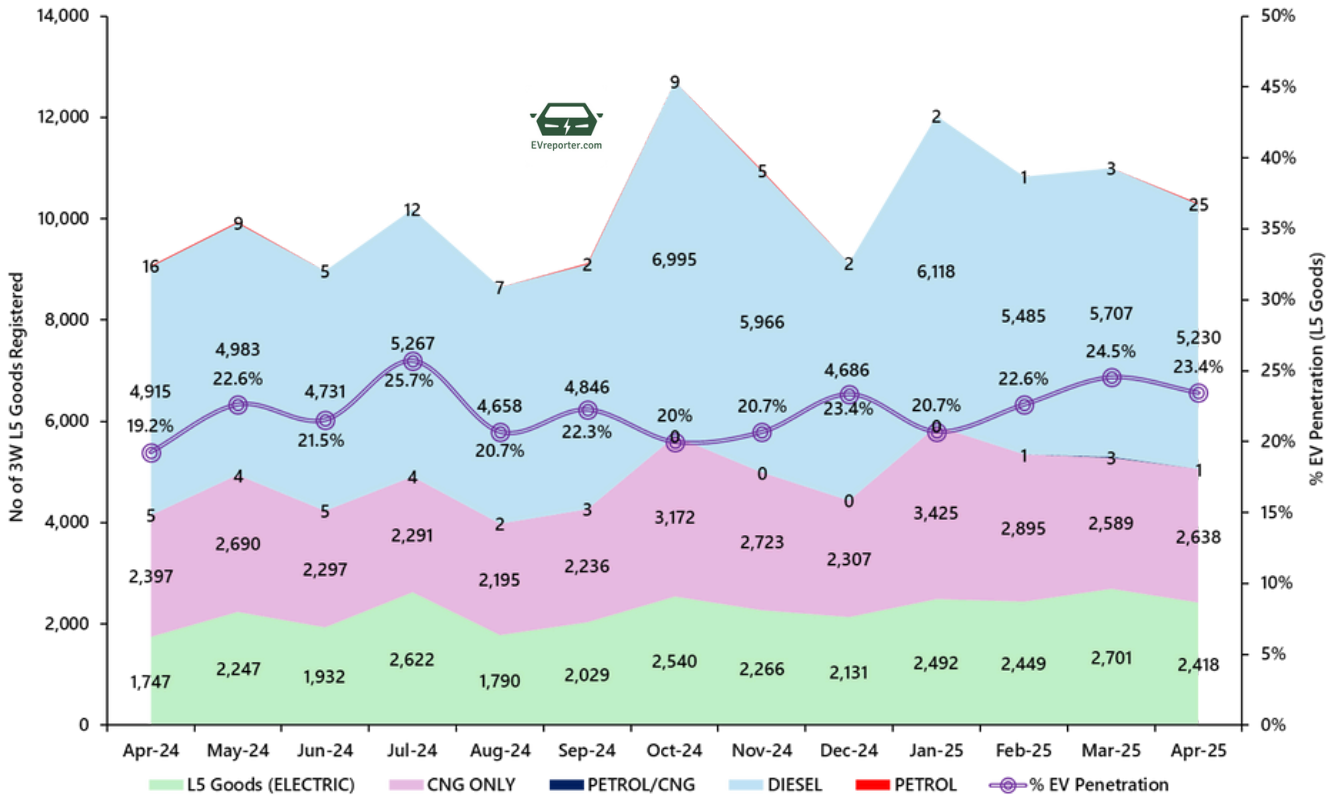
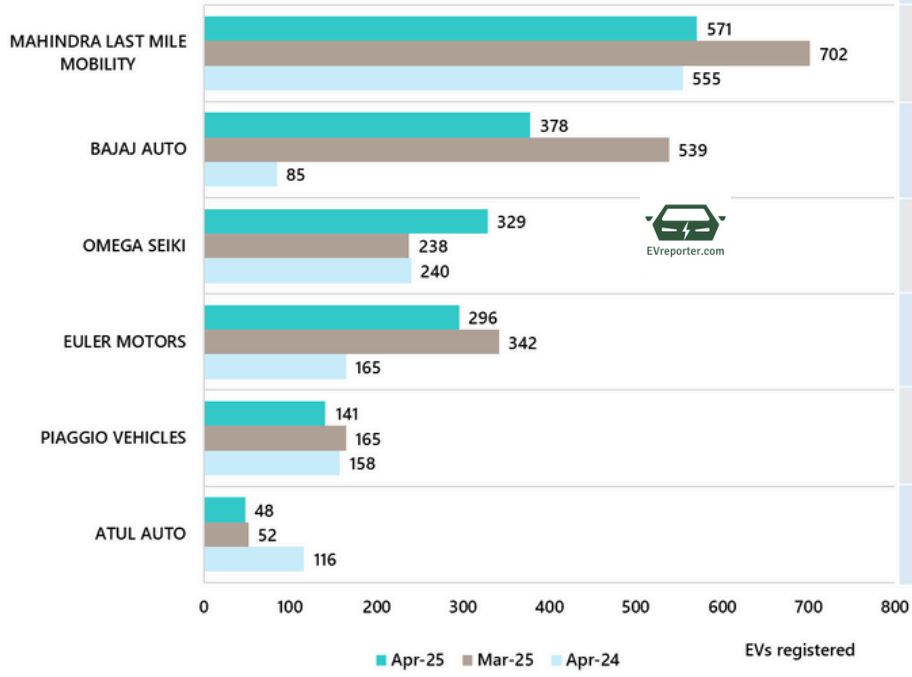
Fuel wise 3W **L5 Goods** Sales Trend



Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

E-3W Goods L5 Sales Trend by OEM



	% Growth (Y-o-Y)	% Growth (M-o-M)
MAHINDRA LAST MILE MOBILITY	2.9%	-18.7%
BAJAJ AUTO	344.7%	-29.9%
OMEGA SEIKI	37.1%	38.2%
EULER MOTORS	79.4%	-13.5%
PIAGGIO VEHICLES	-10.8%	-14.5%
ATUL AUTO	-58.6%	-7.7%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

For EV sales, including Telangana data, state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the EVreporter Data Portal here.

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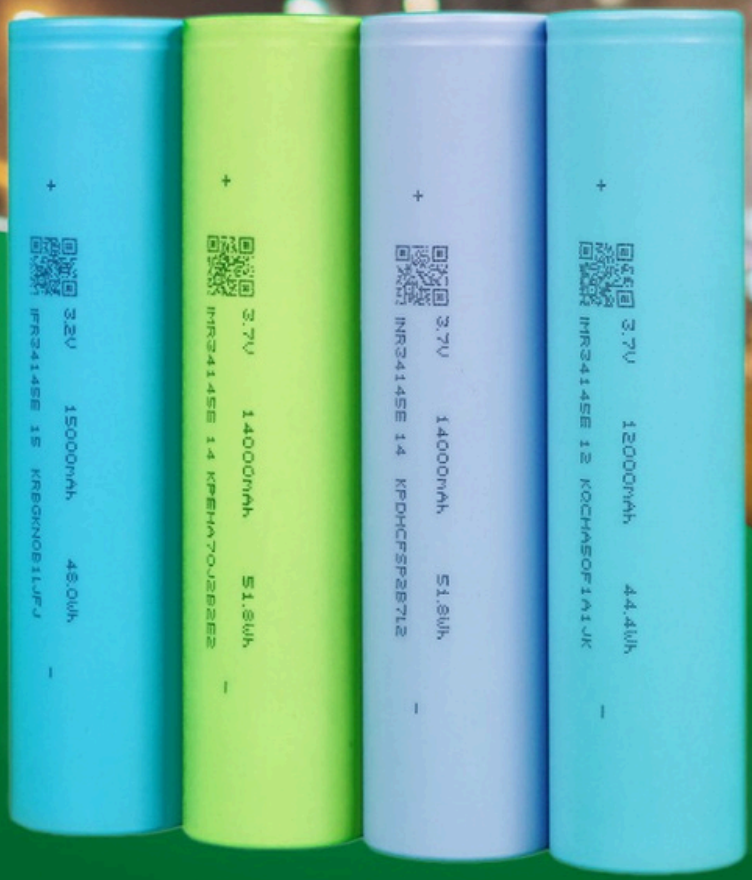

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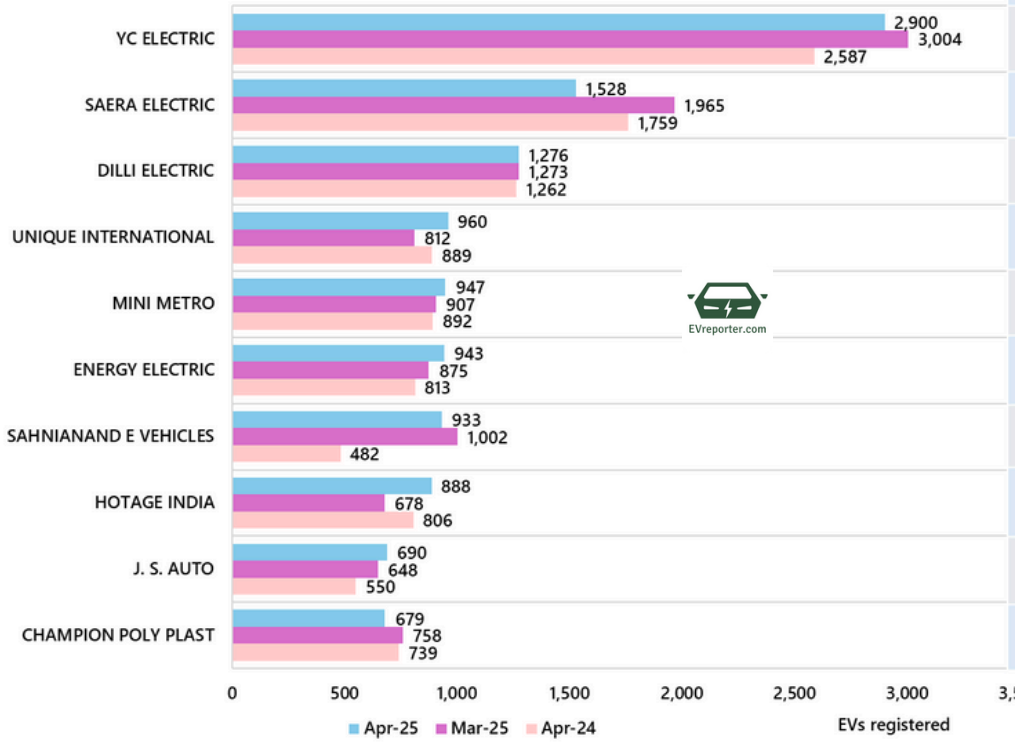
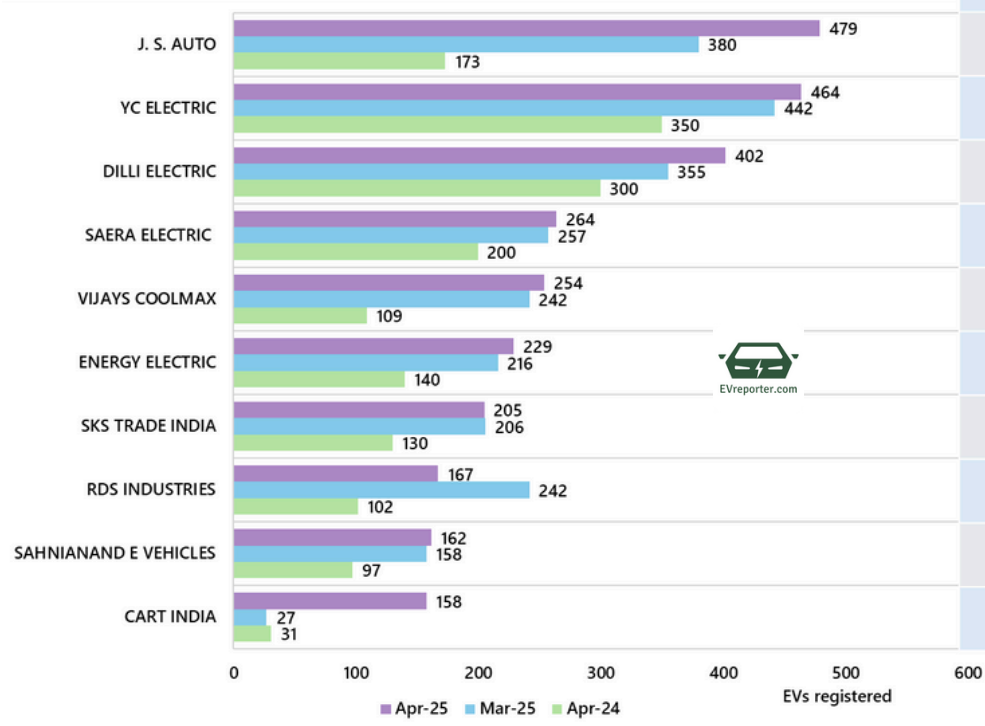
E-rickshaw Sales Trend by OEM



	% Growth (Y-o-Y)	% Growth (M-o-M)
YC ELECTRIC	12.1%	-3.5%
SAERA ELECTRIC	-13.1%	-22.2%
DILLI ELECTRIC	1.1%	0.24%
UNIQUE INTERNATIONAL	8%	18.2%
MINI METRO	6.2%	4.4%
ENERGY ELECTRIC	16%	7.8%
SAHNIANAND E VEHICLES	93.6%	-6.9%
HOTAGE INDIA	10.2%	31%
J. S. AUTO	25.5%	6.5%
CHAMPION POLY PLAST	-8.1%	-10.42%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

E-cart Sales Trend by OEM



	% Growth (Y-o-Y)	% Growth (M-o-M)
J. S. AUTO	176.9%	26.1%
YC ELECTRIC	32.6%	5%
DILLI ELECTRIC	34%	13.2%
SAERA ELECTRIC	32%	2.7%
VIJAYS COOLMAX	133%	5%
ENERGY ELECTRIC	63.6%	6%
SKS TRADE INDIA	57.7%	-0.5%
RDS INDUSTRIES	63.7%	-31%
SAHNIANAND E VEHICLES	67%	2.5%
CART INDIA	409.7%	485.2%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

For EV sales, including Telangana data, state-wise, city-wise (70 cities), Top performing RTO data and OEM-wise performance, check out the EVreporter Data Portal here.

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OEM wise E-4W Sales, Apr 2025

S No.	Makers	Apr-25	Mar-25	Difference	% Change	Market Share Apr-25
1	TATA MOTORS	4,441	4,908	-467	-9.5%	36.3%
2	MG MOTOR	3,464	4,132	-668	-16.2%	28.3%
3	MAHINDRA & MAHINDRA	2,990	2,098	892	42.5%	24.4%
4	HYUNDAI MOTOR	679	891	-212	-23.8%	5.5%
5	BYD INDIA	346	435	-89	-20.5%	2.8%
6	BMW INDIA	126	268	-142	-53.0%	1%
7	PCA AUTOMOBILES	48	47	1	2.1%	0.4%
8	MERCEDES-BENZ INDIA	81	184	-103	-56.0%	0.7%
9	VOLVO AUTO INDIA	35	50	-15	-30%	0.3%
10	KIA INDIA	31	25	6	24.0%	0.3%
11	OTHERS	10	22	-12	-54.5%	0.1%
	TOTAL	12,251	13,060	-809	-6.2%	100%

Others include Skoda, Porsche, JLR etc. Source: Vahan as of May 2, 2025. Telangana Data not included.

MG Motors and Mahindra are catching up with the category leader Tata Motors, with respective April 2025 market shares of 28.3%, 24.4% and 36.3%.

OEM wise Electric Bus Sales, Apr 2025

S No.	Makers	Apr-25	Mar-25	Difference	% Change	Market Share Apr-25
1	PMI ELECTRO MOBILITY	188	25	163	652%	66.2%
2	JBM AUTO	46	4	42	-	16.2%
3	OLECTRA GREENTECH	25	76	-51	-67%	8.8%
4	VE COMMERCIAL VEHICLES	12	0	12	-	4.2%
5	TATA MOTORS	6	24	-18	-75%	2.1%
6	PINNACLE MOBILITY	3	1	2	200%	1.1%
7	VEERA VIDYUTH VAHANA	2	4	-2	-50%	0.7%
8	MYTRAH MOBILITY	1	0	1	-	0.4%
9	VEERA VAHANA UDYOG	1	2	-1	-50%	0.4%
10	AEROEAGLE AUTOMOBILES	0	28	-28	-	-
11	SWITCH MOBILITY AUTOMOTIVE	0	113	-113	-	-
	TOTAL	284	277	7	3%	100%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

For EV sales, including e-goods carriers, Telangana data, state-wise, city-wise (70 cities), top-performing RTO data, and OEM-wise performance, check out EVreporter Data Portal here.

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In Apr 2025, the EV penetration in 2W sales fell to 5.5% from 8.7% in Mar 2025. In the 3W L5 passenger category, Apr 2025 EV penetration was 30.9%, up from 30% in the month before. In the 3W L5 goods category, EV penetration dropped to 23.4% from 24.6% in Mar 2025.

This section aims to showcase the part of EV sales for top-selling OEMs in the two-wheeler, three-wheeler and four-wheeler categories.

India's Top 2W OEMs | ICE vs EV Sales for Apr 2025

S No.	Maker	Total Sales Apr-25	ICE	EV	% EV
1	HERO MOTOCORP	511,761	505,636	6,125	1.2%
2	HONDA MOTORCYCLE AND SCOOTER INDIA	406,202	405,887	315	0.1%
3	TVS MOTOR	309,366	289,620	19,746	6.4%
4	BAJAJ AUTO	183,104	164,093	19,011	10.4%
5	SUZUKI MOTORCYCLE INDIA	91,789	91,789	0	-
6	ROYAL-ENFIELD	80,181	80,181	0	-
7	INDIA YAMAHA MOTOR	52,310	52,310	0	-
8	OLA ELECTRIC TECHNOLOGIES	19,709	0	19,709	100%
9	ATHER ENERGY	13,173	0	13,173	100%
10	AMPERE/GREAVES ELECTRIC MOBILITY	4,018	0	4,018	100%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

India's Top 3W Pax Auto OEMs | ICE vs EV Sales for Apr 2025

S No.	Maker	Total Sales Apr-25	ICE	EV	% EV
1	BAJAJ AUTO	28,114	22,983	5,131	18.3%
2	MAHINDRA LAST MILE MOBILITY	4,762	250	4,512	94.8%
3	PIAGGIO VEHICLES	4,077	3,075	1002	24.6%
4	TVS MOTOR	3,135	1,929	1206	38.5%
5	ATUL AUTO	679	629	50	7.4%
6	TI CLEAN MOBILITY	499	0	499	100%
7	MLR AUTO	356	334	22	6.2%
8	OMEGA SEIKI	142	0	142	100%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

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India's Top 3W Goods Auto OEMs | ICE vs EV Sales for Apr 2025

S No.	Maker	Total Sales Apr-25	ICE	EV	% EV
1	BAJAJ AUTO	4,524	4,146	378	8.4%
2	PIAGGIO VEHICLES	2,279	2,138	141	6.2%
3	ATUL AUTO	988	940	48	4.9%
4	MAHINDRA LAST MILE MOBILITY	960	389	571	59%
5	OMEGA SEIKI	329	0	329	100%
6	EULER MOTORS	296	0	296	100%
7	MLR AUTO	132	130	2	1.5%
8	BAXY	111	106	5	4.5%

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

India's Top 4W OEMs | ICE vs EV Sales for Apr 2025

S No.	Maker	Total Sales Apr-25	ICE	EV	% EV
1	MARUTI SUZUKI INDIA	138,059	138,059	0	-
2	MAHINDRA & MAHINDRA	48,203	45,213	2,990	6.2%
3	TATA MOTORS	43,767	39,326	4,441	10.1%
4	HYUNDAI MOTOR	43,686	43,007	679	1.6%
5	TOYOTA KIRLOSKAR MOTOR	23,203	23,203	0	-
6	KIA INDIA	21,632	21,601	31	0.1%
7	SKODA AUTO VOLKSWAGEN	9,453	9,453	0	-
8	MG MOTOR INDIA	4,876	1,412	3464	71%
9	HONDA	4,836	4,836	0	-
10	RENAULT INDIA	2,827	2,827	0	-

Source: Vahan Dashboard as of May 2, 2025. Telangana Data not included.

WHAT'S NEW?

EVREPORTER DATA PORTAL

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- **India Q4 FY25 sales report**
- CY 2024 India EV sales report
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- FY23-24 India EV sales Report
- RTO level EV Sales
- **Electric goods carrier 4W sales data**
- EV companies Investment Tracker
- **Telangana Data included**
- Break-up of L3M, L3N, L5M, L5N for e-3Ws
- **City-wise OEM sales for 70 Indian cities**

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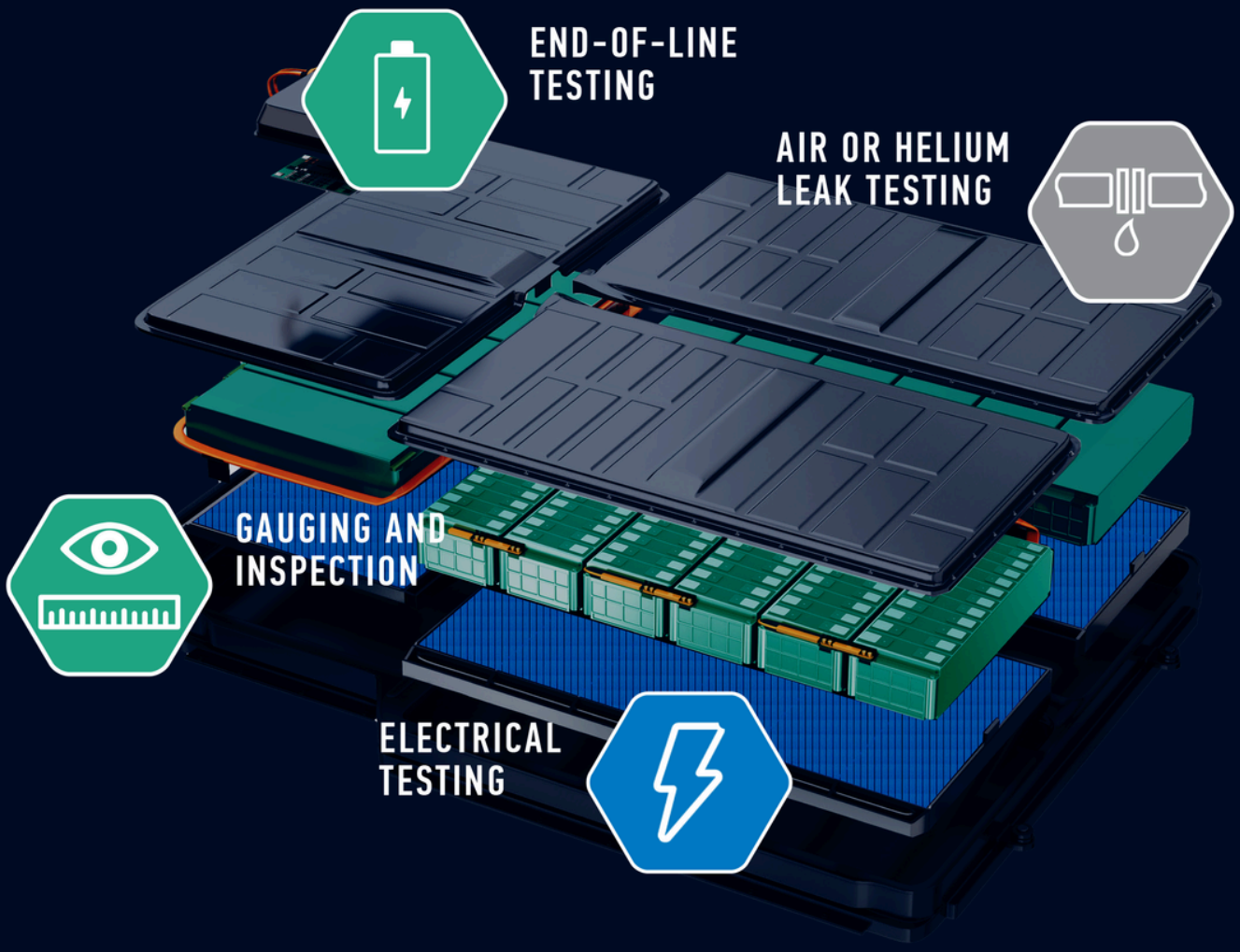

ELECTRICAL AND END-OF-LINE TESTING OF MODULES AND PACKS

Marposs provides complete solutions for battery cells inspection. The cells can be measured to check dimensional characteristic, safety conditions, and electrical functional parameters. Tailored solutions are available depending on the type of cells (prismatic, cylindrical, or pouch) and integration requirements within the manufacturing line.

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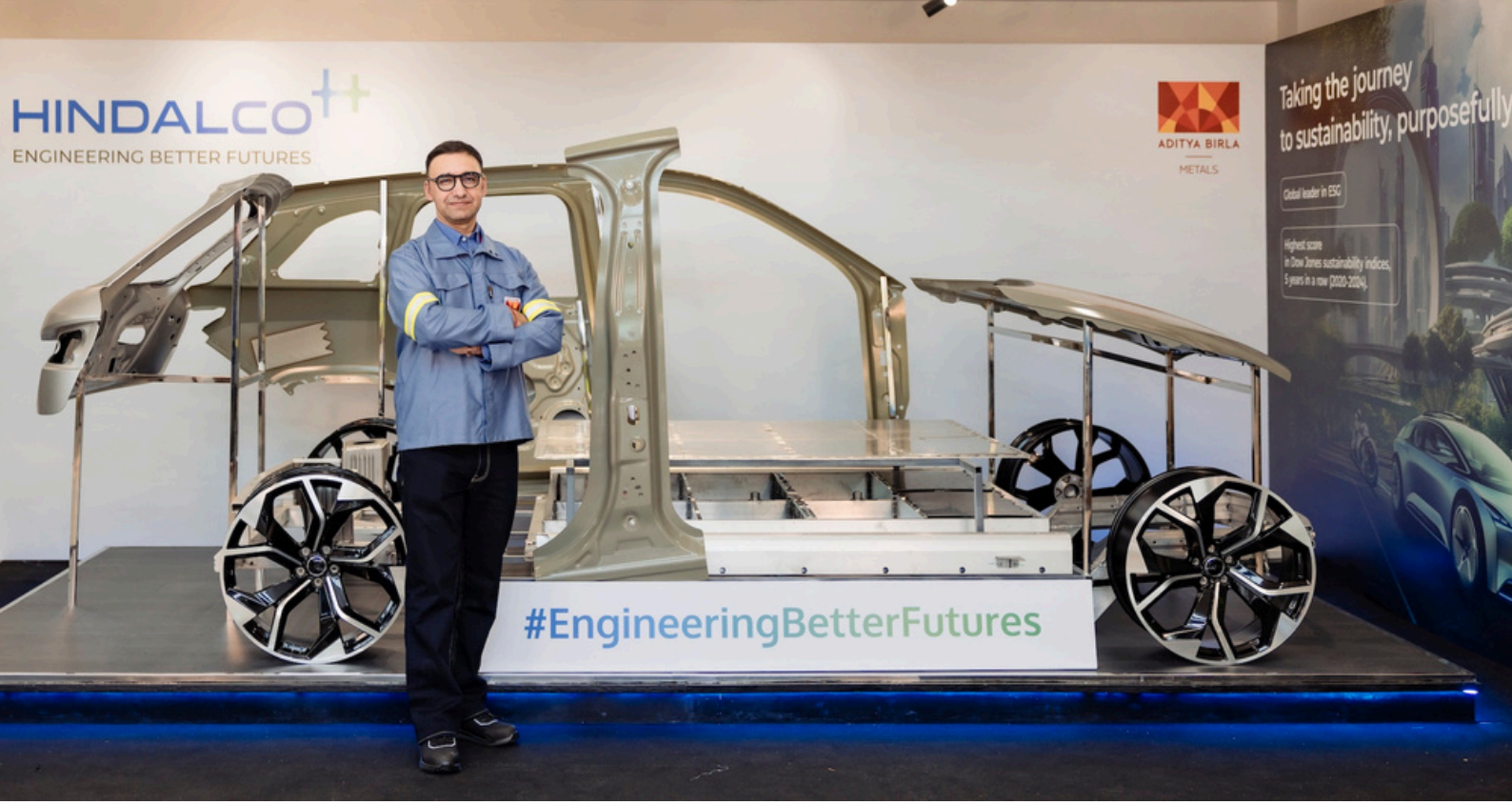
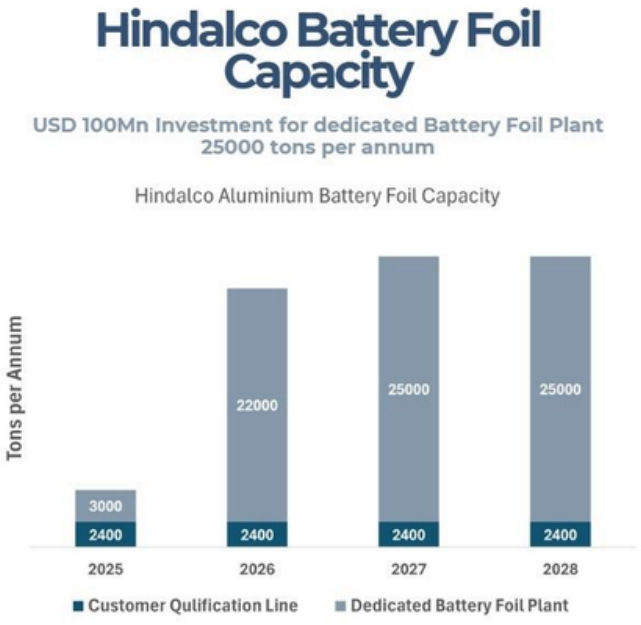


Hindalco Set to Localise Battery Foils for Lithium-ion Cells This Year

*EVreporter's interaction with **Nilesh Koul**, Senior President & CEO – Downstream Aluminium Business at **Hindalco Industries Ltd.***

Hindalco Industries Ltd., the metals flagship of the Aditya Birla Group and one of the world's largest aluminium companies, **is investing INR 800 crores to construct a 25,000-ton capacity plant in Orissa to produce battery-grade aluminium foil.**

This interaction discusses the company's plans for the battery component business.



What are the synergies between Hindalco's metal business and producing components for lithium-ion cells and batteries?

Lithium-ion is a very interesting technology for Hindalco. All three metals that Hindalco works with — **aluminium, copper, and Specialty Alumina** —have applications in lithium-ion batteries. Aluminium foil acts as a cathode substrate, copper foil as an anode substrate, and Specialty Alumina works as a ceramic coating.

Beyond lithium-ion cells, aluminium has immense applications in electric vehicles, primarily due to two key factors.

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It is a very thermally stable material, and the heat dissipation of aluminium is much superior. Aluminium is more malleable and lightweight than most other metals. These factors make it a **metal of choice for battery enclosures and other mechanical components** of the battery pack. So there's a lot of synergy, and lithium-ion batteries is a very logical space to be in.

We also have a highly automated **EV Battery enclosures fabrication line in Pune**.

We have successfully delivered 10,000 aluminium battery enclosures for **Mahindra's new electric SUVs, BE 6 and XEV 9e**.

The delivery marks a significant step in India's clean mobility journey.

Apart from the aluminium foils for the cathode current collector, what other components do you plan to manufacture?

Regarding entry into copper foil or Specialty Alumina / boehmite, both are at an early stage, and it will take some time for the development plans to be formalised.

What parts of the foil manufacturing value chain does Hindalco cover?

Hindalco operates bauxite mines in India. We are a fully integrated company. From these Bauxite mines to the final aluminium foil plant, this is a 100% Make in India product.

What percentage of a lithium-ion cell value can you attribute to the foil?

Depending on the battery chemistry, the battery foil accounts for approximately 4 to 5% of the bill of materials for lithium-ion cells.

Who would be your customers for the battery foil?

Cell manufacturers will be our customers.

Cell manufacturing requires coating of the cathode and subsequent calendaring. Coating involves two steps: creating the slurry and applying it to a substrate. Battery-grade aluminium foil is the substrate.

A cell manufacturer would source the aluminium foil, make the cathode slurry, apply that slurry to the foil, dry it, and subsequently calender it.

What capacity of cell manufacturing will your upcoming Orissa plant be able to support?

Assuming 250 tons of aluminium consumption per GWh, 25,000 tons of battery foil would support nearly 100 GWh of cell production.

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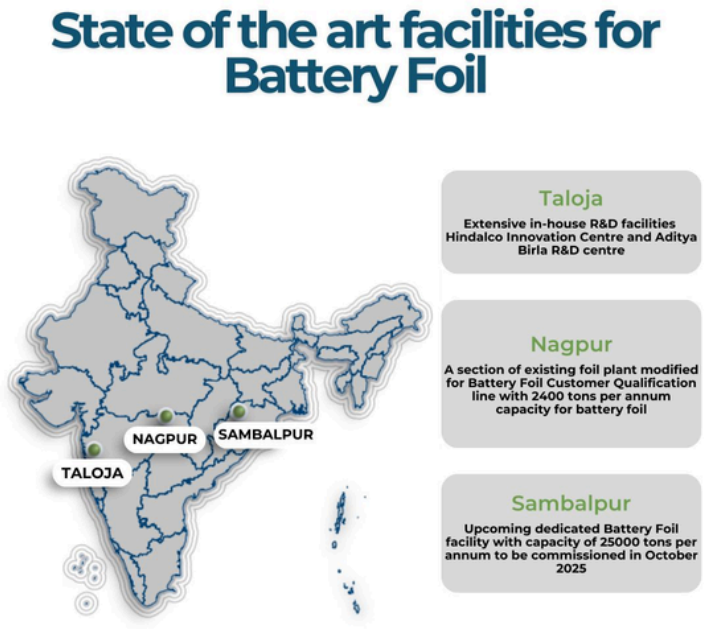
What is the expected schedule for the start of production at the Orissa plant? Please also provide us with an overview of the customer qualification process and timeline.



This project is expected to **start production by the end of October 2025.**

The qualification process depends on the customer. The product must undergo various stages of qualification using different samples, and each sample requires a minimum of a few months.

Early customer qualification is already underway through our plant in Mouda (near Nagpur).

What other localisation opportunities do you see in the cell value chain?

There is a **significant opportunity to localise copper foil.** Aluminium finds applications in the mechanical components of cell, bus bars, EV enclosures, and fabrication trays. There is a considerable amount of localisation possible on the metals side.

Many Indian carbon companies are also actively working on anode materials.

Could you discuss any policy support you have received from the government?

We have been working very closely with various stakeholders as part of industry associations and highlighting the importance of supporting the localisation of these particular components.

Specifically, **regarding this particular project of aluminium foil, there is no PLI at the moment.** However, for subsequent investments, we look forward to engaging further with the government and exploring what can be best determined for the industry.

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AsahiKASEI
Creating for Tomorrow

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 applications[4]

FR PC/ABS

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

XYRON™ 540Z

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

XYRON™ 443Z

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

[5]Advantages 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

AsahiKASEI
XYRON™ LEONA™ TENAC™ TENAC™-C
PRODUCTS

Asahi Kasei Plastics Singapore Ptd Ltd
1 HabourFront Place, #16-03, Singapore 098633
+65 6324 3001
www.asahi-kasei-plastics.com/en/

contact us

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Marposs India Partners with Omega Seiki Mobility for Green Logistics

Marposs India, a global leader in **precision measurement and inspection technologies**, has partnered with **Omega Seiki Mobility** (OSM) to integrate electric three-wheelers into its internal and external logistics operations. This strategic collaboration underscores Marposs' commitment to innovation and sustainability—a vision that aligns with OSM's mission to drive clean mobility solutions.

A Legacy of Precision Meets a Future of Sustainability

With over six decades of expertise, Marposs has played a pivotal role in shaping quality control standards across various industries, including automotive, aerospace, energy, and electronics. Known for its cutting-edge technologies that ensure precision in manufacturing, the company is now redirecting its focus toward environmental stewardship. By integrating electric three-wheelers into its logistics framework, Marposs is not only reducing its carbon footprint but also optimising operational efficiency and cost-effectiveness.

The Power of Partnerships | Benefits of Collaboration

- **Emission-Free Logistics**: Electric three-wheelers significantly reduce greenhouse gas emissions, contributing to cleaner air and a healthier environment.
- **Cost Efficiency**: The transition to electric vehicles slashes fuel expenses and maintenance costs, offering long-term financial benefits.
- **Smarter Supply Chain Practices**: OSM's advanced mobility solutions enable streamlined logistics operations, ensuring faster and more reliable deliveries.

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“At Marposs, innovation has always been at the heart of our operations,” said **Luca Matteucci, Managing Director at Marposs**. “Partnering with OSM allows us to extend this spirit of innovation to sustainability, creating a ripple effect that benefits our clients, communities, and the planet.“

MARPOSS

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Hydrogen Fuel Cells: Clean Energy for the Transportation Sector

Vijayalayan R, Gernot Schraberger, Dr. Dirk Rensink, and Dr. Stephan-Johannes Schnorpfeil.

The development of hydrogen fuel cells is highly complex and cannot be effectively managed with conventional methods and hardware-based prototype testing. However, Model-Based Design can help overcome these challenges.

Electric vehicles powered by **hydrogen fuel cells (HFCs)** as a clean, CO2-free means of propulsion are not a new concept. Although battery-powered electric vehicles dominate the roads, partly due to the simpler charging infrastructure setup, hydrogen requires not only significant energy to produce but also a network of hydrogen fueling stations, which is currently lacking.

Nonetheless, HFC systems have potential, albeit less so in personal transportation. Their advantages include a lower vehicle weight compared to batteries, higher power density, quicker refueling, and longer range. They are also suitable for continuous operation, making HFC drives highly **appealing for heavy-duty trucks, buses, trains, maritime ships, and even airplanes** (Figure 1). Application tests are currently underway in all these areas, facilitated by the fact that hydrogen fueling stations can be more easily centralized in these sectors, eliminating the need for a widespread infrastructure.

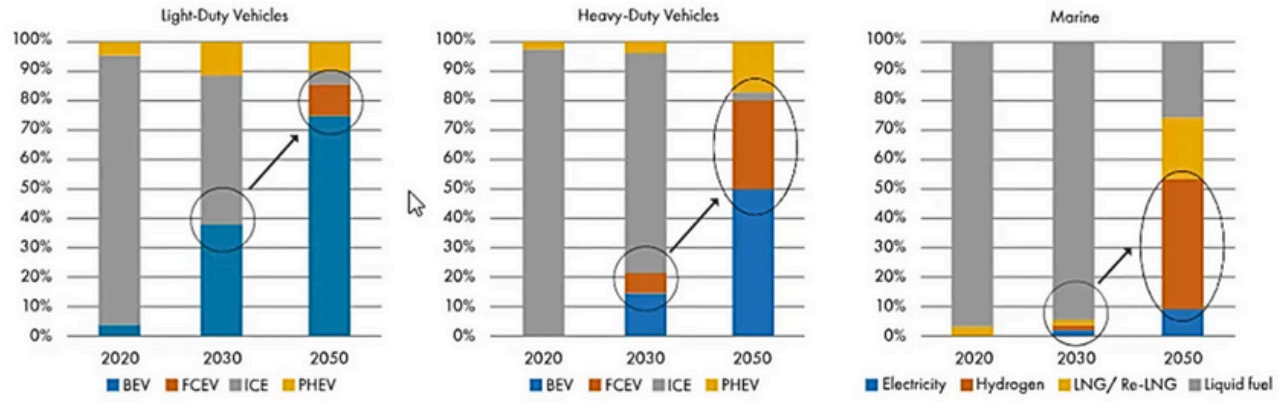

Figure 1: The use of hydrogen fuel cells will increase significantly by 2050, especially in seagoing vessels. © Segula Technologies

Challenges in HFC Development

Polymer Electrolyte Membrane Fuel Cells (PEM-FCs), also known as Proton Exchange Membrane Fuel Cells, are most commonly used in the applications mentioned above. However, modeling them poses a significant challenge for engineers. Despite the seemingly simple concept, PEM-FCs are highly complex in their overall dynamics. They consist of a cell stack with electrodes and a membrane, as well as components like tanks, pressure reducers, compressors, and elements for moisture and thermal management. All these components must be dimensioned, optimized, coordinated, and tested to ensure maximum efficiency and performance over a long lifespan.

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The dynamics of the actual cell stack, which involve electrochemical processes and transport phenomena of gases, water vapor, and water droplets, are particularly complex. Conventional development methods and hardware-based prototype testing are insufficient to handle the sheer number of parameters that require optimization

Segula Technologies relies on Model-Based Design to develop customized HFC applications for the mentioned industries. The company uses MATLAB®, Simulink®, Simscape™, and AI methods as the foundation. Simscape is used to model physical systems within the Simulink environment.

The Simscape Model as a Starting Point

One of the starting points for HFC development at Segula is the **Simscape fuel cell model from MathWorks** (Figure 2). This includes all the peripheral components mentioned above, as well as the cell stack. It features a custom domain created in Simscape that dynamically captures the dynamics of all four involved gases: nitrogen, oxygen, hydrogen, and water vapor. This is crucial for optimizing both the performance and longevity of the cell stack. With the help of this model alone, the engineers were able to shorten the initial development phase by four to six weeks.

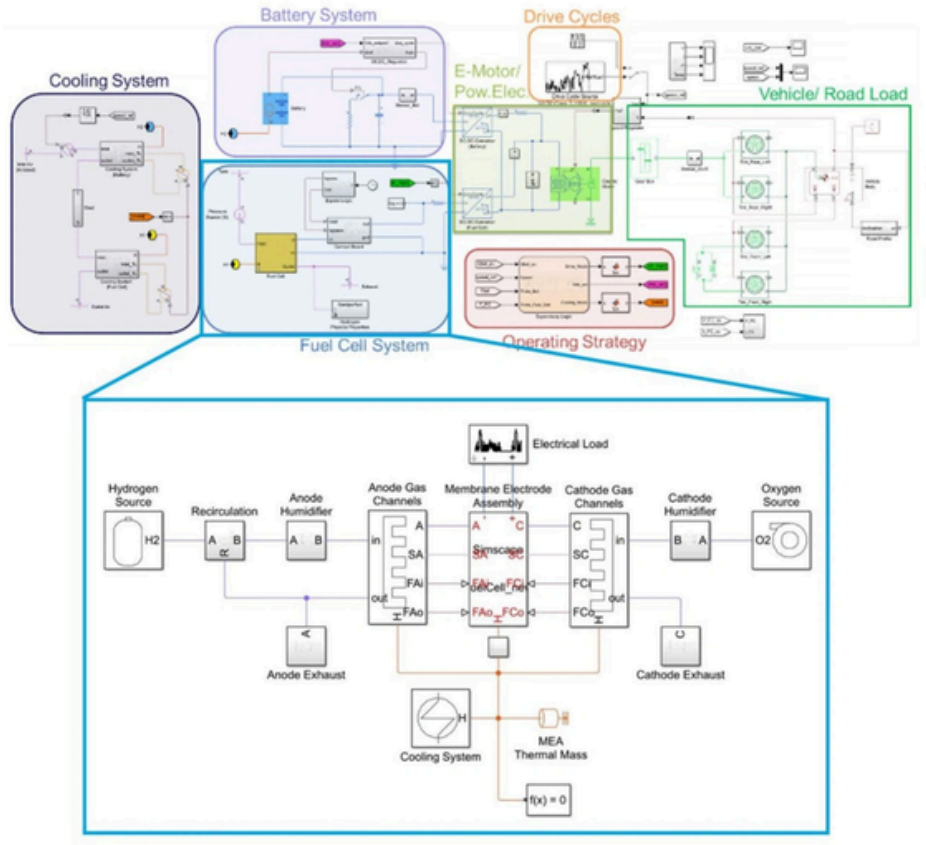

Figure 2. The complete system designed by Segula in the automotive version.

The Simscape model of the actual fuel cell is highlighted in the blue box. © Segula Technologies

Segula engineers chose to use and further develop this model because they were particularly interested in the transport phenomena within the cell stack. The MathWorks model already includes the dynamics of water vapor transport and nitrogen accumulation on the anode side, both of which were further refined.

Additionally, the flow of water droplets within the system and the associated heat flow were considered to further increase the model's accuracy. The physics of the cell interior was represented with 3D modeling tools, allowing for precise capture of water and heat flow. The data was then integrated into the original Simscape model. With these captured dynamics, subsequent simulations at the system level were accelerated and made more flexible.

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Application Range of the Dynamic Model

The extended, more accurate simulation model of the physical HFC system can be used in various ways. Initially, it is used for component selection and dimensioning. Subsequently, parameters and control strategies can be optimized. Control strategies can also be designed and validated against the model as a plant model, such as for energy generation, moisture and thermal management, pressure control, or the regular expulsion of accumulated nitrogen.

Finally, energy flows between the buffer battery, fuel cell, and drive can be analyzed, and the vehicle's range can be determined based on different driving profiles. **All this occurs without building physical prototypes, eliminating waiting times and associated cost**s. Additionally, a broader range of operating conditions can be tested, even in extreme scenarios, without risking hardware damage or overload.

A significant advantage of the created model is its **flexibility in any hydrogen fuel cell application**, whether for road, rail, sea, or air transport. The model accurately determines if component dimensions are correct, cells deliver the required performance, and control functions as desired. "*The interaction of individual HFC components, tested and optimized through modeling and simulation, is crucial for the energy efficiency and longevity of the fuel cell*," emphasizes **Dirk Rensink,** Technical Lead for Fuel Cell Simulation at Segula.

AI-Based Expert System for Variant Parameterization

Given that Segula engineers obtained limited data from real hardware, they developed an AI-based expert system to evaluate previous simulation runs. This AI extracts parameters from the recorded data that can be applied to variants and entirely new configurations of the HFC model. With this approach, the team can avoid starting from scratch for each new fuel cell system and estimating the best values for new configurations. This not only saves time in the initial phase but also allows the models themselves to evolve as the amount of available data grows.

Early Validation and Hardware-in-the-Loop Simulation

Using the models, the Segula team can test the design of a controller before assembling a prototype.

Traditionally, a system prototype is developed on a test bench, and the control software is then tested and calibrated (Figure 3).

Figure 3: A fuel cell stack on the test bench. © Segula Technologies

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In the model-based approach, the Simscape model of the fuel cell system is used to generate code that is loaded into a real-time simulation computer. This is known as **Hardware-in-the-Loop (HIL) simulation**, and the model serves as an environment for testing the fuel cell software used in real systems. Fuel cell controllers are tested and validated with HIL tests to simulate the behavior of the fuel cell during a typical week of operation or even a 30,000-hour service life. The main focus of the tests is on the controllers for the compressor and the humidification system.

"*With these pre-tests, we can calibrate the correct values, and we were very close to the real values. Starting the system on the test bench with the calibrated, pre-simulated model instead of from scratch significantly accelerates the development time*," explains **Stephan Schnorpfeil**, Head of the Fuel Cell Team at Segula.

Together with the AI-supported parameter database, the system models lead to a shorter time-to-market for customers. Based on the developed models and acquired expertise, Segula can also offer its customers specialized solutions that would hardly be feasible without simulations. The system's flexibility enables knowledge transfer for the development of PEM-FCs for a wide range of applications and performance requirements. For example, a ship fuel cell can be adapted for an automotive application. Customers have also used the resources built by Segula to optimally dimension components for their own PEM-FCs.

Synergies of Theory and Practice: More Efficient Hydrogen Synthesis

Some of the fuel cells developed in this way are already in use. As a result, the Segula team increasingly has access to field data, enabling them to further refine their models. Simulation and real operation are increasingly converging through this ever-expanding database, improving the foundation for data- and model-based development of hydrogen fuel cell systems.

The physics behind fuel cells and hydrogen electrolyzers is comparable in essential aspects, as both technologies are based on similar electrochemical principles. Applying the presented results to electrolyzers for hydrogen production and adapting the Simscape model from MathWorks or the refined Segula model could potentially lead to efficiency improvements in the field of renewable energies within the mobility sector. The goal of producing and using hydrogen in a carbon-neutral and economically feasible manner may thus be one step closer.

About the authors

- **Vijayalayan R** heads automotive industry and location field application engineering at **MathWorks India.** He and his team facilitate the adoption of Model-Based Design, revolutionizing engineering processes and steering the industry towards innovative solutions. His efforts are focused on empowering customers to embrace these next-generation technologies in their journey towards electrification, AI, and software-defined vehicle projects. As the secretary of the SAE India Bengaluru section and member of their management committee, Vijayalayan's influence extends beyond MathWorks, impacting the broader automotive industry.

- **Gernot Schraberger** is a Principal Application Engineer at **MathWorks**.

- **Dr. Dirk Rensink** is a Technical Expert in Structure and Thermal CAE, Data Management, and AI methods at **Segula Technologies**.

- **Dr. Stephan-Johannes Schnorpfeil** is the Team Leader for Fuel Cell Systems at **Segula Technologies**.

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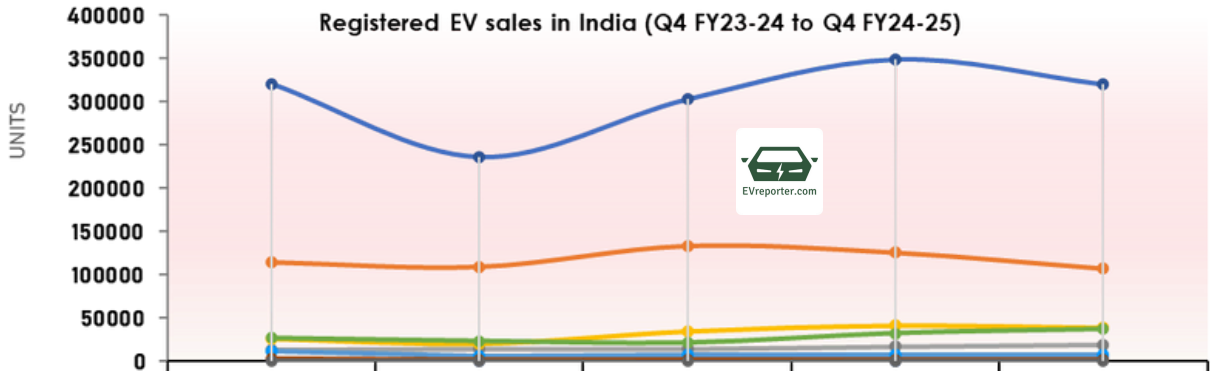
India EV Sales Report Q4 FY 2024-25 | Exceprts

India's total automotive sales in Q4 FY2024-25 were 65,87,766, of which **5,33,254** were EVs, **which accounts for 8.09% EV penetration in the quarter**.

India EV Sales | Quarterly Trend

Trend from last 5 quarters - Q4 FY 23-24 to Q4 FY 24-25 (EV sales - Jan 2024 to Mar 2025)



	Q4 FY 23-24	Q1 FY 24-25	Q2 FY 24-25	Q3 FY 24-25	Q4 FY 24-25
e-2W	320720	235640	302614	349061	320104
e-rickshaw	114431	109213	132804	125199	107281
e-cart	13267	14364	14161	17147	19392
e-3W Pax L5	26223	20611	34656	41174	38837
e-3W Goods L5	11867	6104	6751	7302	7853
e-4W	26762	23422	21482	32248	36871
e-Bus	1267	585	1148	811	948
e-Goods Carrier	2698	990	1278	1402	1795
Others	169	117	67	98	173
Total	517404	411046	514961	574442	533254

Vehicle Category-wise EV Penetration in Q4 2024-25 vs Q3 2024-25

Vehicle Category	EV Sales Q4 FY 2024-25	Total Sales Q4 FY 2024-25	% EV Penetration Q4 FY 2024-25	EV Sales Q3 FY 2024-25	Total Sales Q3 FY 2024-25	% EV Penetration Q3 FY 2024-25
e-2W	320104	4552918	7.03%	349061	6100789	5.72%
e-3W (L5M) Pax	38837	147539	26.32%	41174	159133	25.87%
e-3W (L5N) Goods	7853	35725	21.98%	7302	35092	20.81%
e-4W	36871	1161680	3.17%	32248	1161458	2.78%
e-Bus	948	18917	5.01%	811	15701	5.17%
e-Goods Carrier	1795	222624	0.81%	1402	206098	0.68%

Source: *EVreporter Research, Vahan and Telengana Regional portal*

Note - Low-speed e-2w data not included. 'Others' includes Forklift, Adapted Vehicle, Crane mounted vehicle etc.

'Goods *Carrier' refers to 4W cargo vehicles, including LCVs and HGVs, as categorised in Vahan dashboard. 'E-rickshaw' refers to low-speed electric 3Ws (up to 25 kmph) used for passenger transportation. 'E-cart' designates low-speed electric 3Ws (up to 25 kmph) used for goods transportation. 'L5M' stands for passenger 3W L5 vehicles, while 'L5N' stands for Cargo 3W L5 vehicles.*

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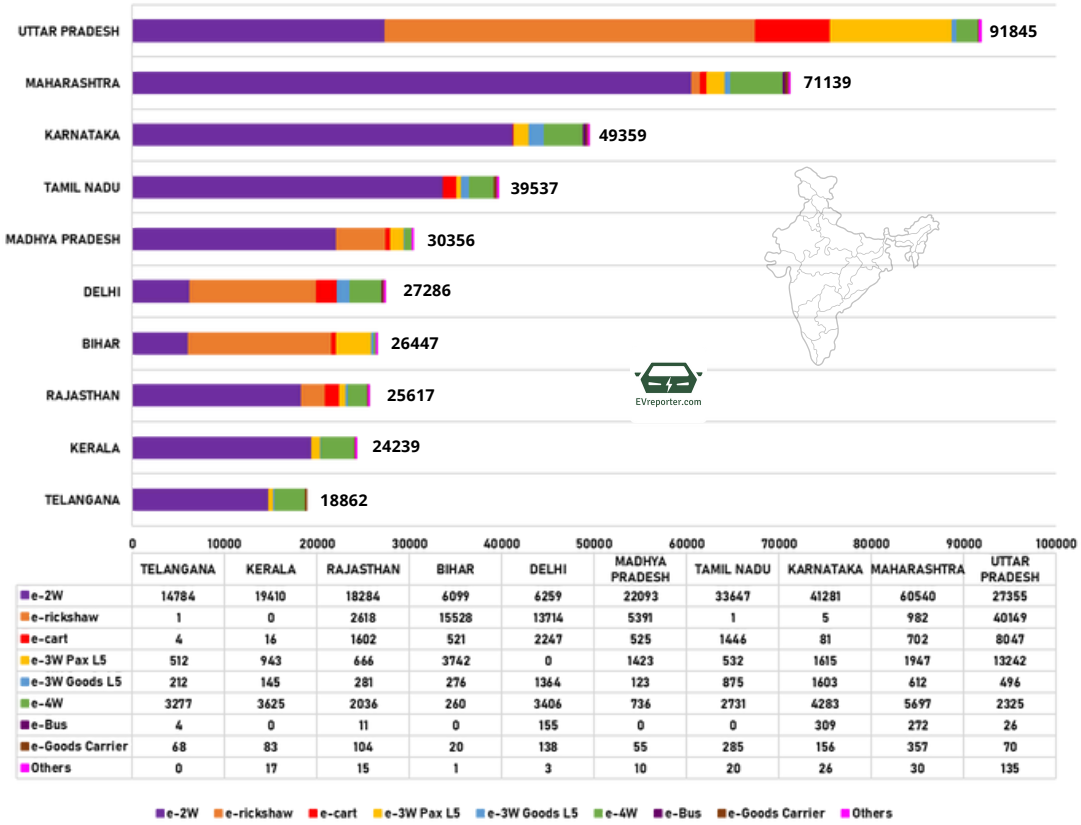
India EV Sales Report Q4 FY 2024-25 | Exceprts

Category-wise Trend in Leading Indian States for Q4 FY 24-25



	TELANGANA	KERALA	RAJASTHAN	BIHAR	DELHI	MADHYA PRADESH	TAMIL NADU	KARNATAKA	MAHARASHTRA	UTTAR PRADESH
e-2W	14784	19410	18284	6099	6259	22093	33647	41281	60540	27355
e-rickshaw	1	0	2618	15528	13714	5391	1	5	982	40149
e-cart	4	16	1602	521	2247	525	1446	81	702	8047
e-3W Pax L5	512	943	666	3742	0	1423	532	1615	1947	13242
e-3W Goods L5	212	145	281	276	1364	123	875	1603	612	496
e-4W	3277	3625	2036	260	3406	736	2731	4283	5697	2325
e-Bus	4	0	11	0	155	0	0	309	272	26
e-Goods Carrier	68	83	104	20	138	55	285	156	357	70
Others	0	17	15	1	3	10	20	26	30	135

Source: *EVreporter Research, Vahan and Telengana Regional portal. Low-speed 2W data not included.*

- Uttar Pradesh accounts for the highest share (17.22%) of EVs sold, with 91,845 units in Q4 FY 24-25. Of the total EVs sold in Uttar Pradesh, 43.7% (40,149 units) are e-rickshaws.
- E-2W sales are highest for Maharashtra, Karnataka, Tamil Nadu, Uttar Pradesh, and Madhya Pradesh, accounting together for 57.76% of high-speed e-2W sales for the quarter.
- Uttar Pradesh, Bihar, and Delhi had the maximum sales in the e-rickshaw category, with a sales share of 37.42%%, 14.47%, and 12.78%, respectively, of all e-rickshaws sold in the country.
- Maharashtra registered the highest sales of e-4Ws, with 5,697 units sold for Q4 FY 24-25, followed by Karnataka and Kerala with 4,283 and 3,625 units, respectively.

Full report is available on EVreporter Data Portal

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- RTO level EV Sales
- **Electric goods carrier 4W sales data**
- EV companies Investment Tracker
- **Telangana Data included**
- Break-up of L3M, L3N, L5M, L5N for e-3Ws
- **City-wise OEM sales for 70 Indian cities**

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Software-Defined Motors Powered by Virtual Magnets

Manish Seth - Founder, Volektra

Volektra, *a Sacramento-based electric drivetrain company, recently secured a new funding round led by Chakra Growth Capital to commercialise its* ***rare-earth-free Virtual Magnet motor technology.*** *This interview discusses their proprietary tech, its readiness and relevance.*

The concept of rare-earth-free motors is not new. What are the main reasons the technology has not been commercialised at scale to date?

You're right - this isn't a new idea. However, the real reason it hasn't scaled primarily stems from **performance compromises and cost inefficiencies**. Most rare-earth-free alternatives—like induction motors, synchronous reluctance motors, or ferrite-based permanent magnet motors—**fail to match PMSMs** in key system-level metrics: **torque density, dynamic response, size, or efficiency**.

Take **synchronous reluctance motors**. While they're magnet-free and relatively efficient in steady-state, they deliver **low torque density**, require complex rotor geometries, and struggle with low-voltage or size-constrained platforms and loss of range due to lower efficiency. They're fine in high-speed applications with ample space and power (like Tesla's use case), but they don't scale down economically or effectively.

Ferrite-based motors try to substitute neodymium with cheaper, low-coercivity materials. However, they still rely on permanent magnets and cannot match the energy product or miniaturisation capabilities of rare-earth magnets. That means more weight, lower range, and less design flexibility.

Then there's the systemic inertia. **OEMs and Tier 1s are risk-averse for good reasons** - they'll pay the rare-earth premium rather than gamble on an architecture that might disrupt production cycles, reliability metrics, or regulatory compliance. The result: entrenched tech, even when the market is hungry for alternatives.

So, despite growing urgency to exit rare-earth dependence, **no one has delivered a drop-in, scalable alternative** that matches PMSM performance **without magnets, without compromise, and without hidden system costs**. That's precisely what we've engineered at Volektra with our **software-defined motor** powered by **Virtual Magnets**.

What is the relevance of 'rare-earth elements' and 'permanent magnets' in motor manufacturing?

Rare-earth elements—especially neodymium and dysprosium—are used to make **high-performance permanent magnets**. These magnets give PMSMs their edge: high torque density, compact size, and excellent efficiency at variable loads. Without them, motors would need to be bigger and heavier for the same output, which is a no-go in many transport and consumer applications.

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The problem is that rare-earths are **supply-chain risks waiting to happen**. They're geographically concentrated (mainly China), price-volatile, and environmentally toxic to extract. The industry is essentially **addicted to a fragile input.**

What is your solution to ending the rare-earth dependency of motors?

At Volektra, we've developed a proprietary architecture called the Virtual Magnet Motor—essentially a **software-defined magnet-free motor that mimics the magnetic behaviour and torque profile of a PMSM**, without using any magnets at all. These virtual magnets are created dynamically through software-defined field control, simulating the behaviour of a permanent magnet without the limitations such as thermal management overload, supply chain issues and so on. The result: **a motor that performs like a PMSM but contains zero magnets.**

What kind of motors are you developing?

We're developing **magnet-free synchronous motors,** powered by **software-defined field patterns.** These motors use what we call Virtual Magnets—magnetic locking effects generated entirely through advanced stator control, eliminating the need for rare-earth materials altogether. This platform is highly modular and designed to scale across:

- **Light electric vehicles** – e-bikes, cargo bikes, scooters, ATVs
- **Automotive systems** – including high-voltage traction motors up to 600 kW
- **Industrial equipment** – such as generators, compressors, and pumps

In parallel, we also offer **high-performance PMSM motors and controls**, which are already commercially validated and being used by OEM partners for near-term deployments. These are available now and serve as a bridge for customers while we scale our magnet-free platform.

Together, these offerings position us to meet immediate market needs while leading the transition to **fully software-defined electric propulsion.**

What is the working principle behind these motors?

Our Software-Defined Motor creates a Virtual Magnet effect by wirelessly energizing the rotor. Unlike permanent magnet machines that rely on rare-earth materials, or externally excited systems that need slip rings or mechanical connections, we use a **proprietary wireless power transfer method to activate the rotor's magnetic field.**

Once energized, the rotor behaves like it has embedded magnets—without having any. The stator then synchronizes with this field through intelligent control algorithms,this software-defined field locks into the rotor dynamically, it's fundamentally a **magnetic simulation engine embedded in real hardware**, using smart algorithms to shape the field in real time delivering the torque and control characteristics of a traditional PMSM.

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How do the performance and cost of these motors compare to other popular motors like PMSM, BLDC, or induction motors?

Performance-wise, our Software-Defined Motor delivers torque, responsiveness, and efficiency on par with **PMSMs**—without using any permanent magnets. Unlike **BLDC** motors, which suffer from torque ripple and limited efficiency at partial loads, our system maintains smooth operation and optimized energy usage across the duty cycle. Compared to **induction motors**, we achieve better torque density and lower losses, especially in compact or low-voltage applications where induction machines become bulky and inefficient.

On cost, our architecture eliminates rare earths, and associated thermal, temperature, and safety related issues prevalent with permanent magnet based motors. At **system level**, this results in:

- Lower BOM cost over time (especially as rare-earth prices remain volatile),
- Lower cooling and shielding requirements,
- Simplified supply chain and recyclability.

What is the current commercial readiness of motors developed by Volektra?

We're actively advancing multiple programs across mobility and industrial sectors. While specific customer names are under NDA, we can share the following:

- A **sub-10 kW Software-Defined Motor** is undergoing final validation and is slated for vehicle-level testing with a **3-wheeler OEM.**
- A **250 kW system prototype** is currently being developed in collaboration with a **major global automotive OEM** for high-voltage applications.
- A **two-wheeler-specific variant** is kicking off shortly with an **established OEM partner**, focused on urban mobility needs.
- In the **industrial sector**, we are co-developing a platform with a **leading global OEM for refrigeration and cooling applications**, targeting sector-specific performance and reliability requirements.

Can you mention any third-party validation received for your tech or successful customer qualifications so far?

Our focus is on **direct integration with OEMs and end customers**. We have prioritized a validation process that is application centric, and customer driven in real world conditions instead of certificate driven in controlled lab settings.

What sets us apart is the caliber of our team, composed of motor and control **experts from Danfoss, ABB, Tesla, and Ford**, who bring deep experience in both innovation and scaling. We've developed internal validation protocols that **match or exceed Tier 1 automotive standards**, enabling us to consistently hit OEM qualification milestones faster than most. Additionally, our **captive data from tens of thousands of PMSMs** deployed in the field provides us with an unmatched benchmark for validating performance, reliability, and control strategy. This gives us the ability to optimize and validate new products based on real-world operational insights - not just lab simulations - which is a significant competitive edge.

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Powering Hyperlocal Quick Commerce Deliveries

Sheetanshu Tyagi, Co-founder and CEO | Emo Energy

Quick commerce *is all the buzz right now, a phenomenon that has become a daily habit for a large chunk of urban dwellers.* ***EV fleets driving Quick commerce require Quick re-fueling solutions.*** *Sheetanshu weighs in on the two popular methods,* ***quick charge vs battery swapping.***

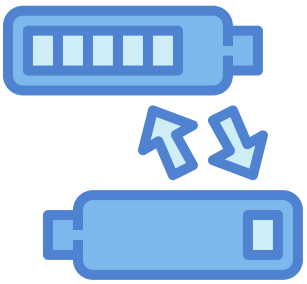
What challenges do traditional charging methods pose for EV fleets in the quick commerce sector, and what solutions are emerging to minimize downtime and optimise operational efficiency?

Quick commerce thrives on delivering goods within a tight 3-5 km radius, often in less than half an hour.

To make this happen, **EV fleets—mostly two- and three-wheelers—need to run for 18-20 hours a day with minimal downtime**. Traditional charging, which can take 4-6 hours, is a non-starter. The industry needs solutions that keep vehicles on the road, delivering more orders and boosting profits.

That's where **fast charging** and **battery swapping** come in, each promising to cut downtime and keep the wheels turning.

What are the dynamics, pros or cons of battery swapping for quick commerce?



Battery swapping is as fast as it sounds. In just 2-5 minutes, a depleted battery is swapped for a fully charged one, enabling drivers to get back on the road almost instantly. There are many companies in India that offer this solution, using automated systems or manual stations.

It's a tempting option for quick commerce, where every minute counts. But it's not all smooth sailing.

- Swap stations need **30-40% more space than fast-charging hubs,** a big issue in metro cities.
- Additionally, stations **must stock extra batteries**—approximately 1.5 for every vehicle—to prevent shortages, thereby tying up money in inventory.
- Setting up a swap station can cost around INR 4 Lakhs for a quick commerce hub, with monthly maintenance from INR 1,200 to 1,500 per vehicle and energy costs of INR 11-13 per kWh.

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Why makes you believe that fast charging is more suitable for quick commerce?

Fast charging takes a different tack. **Instead of swapping batteries, it juices up an EV's battery to 50 km in about 20 minutes**, as seen with our Zen Pac battery coupled with the SWFT Charger.

- Fast charging stations are smaller—50% less space than swap stations—making them easier to fit into urban hubs.
- Energy efficiency is another plus. Fast charging loses just 5% of energy compared to 15-20% for swapping, resulting in savings on power bills.
- Each 6 kW charger is INR 70,000, including setup. Setting up a 6 kW charger is much easier compared to public fast chargers due to its lower power requirement, and it serves 15-20 riders daily. Maintenance costs INR 400-600 per vehicle per month, and energy costs INR 9-10 per kWh. A 20-minute charging session provides 50 km of range, ideal for 4-5 hours of deliveries. After this, riders can use a 20-minute break for idle time or order pickup to recharge and resume.

An internal study of 500 electric scooters revealed that **fast charging enabled 92 deliveries per vehicle daily, compared to 78 for swapping**, resulting in an additional annual revenue of INR 1.2-1.5 lakh per vehicle.

Fast chargers at dark stores leverage on-site integration *and riders recharge while waiting for orders, reducing idle time away from hubs, whereas battery swap stations are constrained by external placement.*

It is curious to note that a typical battery swap station designed to serve 60 riders generally holds only around 30 additional batteries. In high-demand scenarios where more than 30 riders arrive simultaneously, the station can experience significant delays, ranging from 45 minutes to over an hour.

Fast Charging VS Battery Swapping

While the above challenge of delays in a battery swapping set up can be addressed by deploying additional swap stations, it comes with a substantial increase in capital expenditure.

The cost of Infrastructure setup, space rental, and securing an adequate power supply can range between ₹5,00,000 and ₹10,00,000 per swap station.

Metric | Dark Store with 60 Riders	Cost in INR	Quantity
Fast Charging		
Fast Charger	1,50,000	10
Battery	18,00,000	60
Operating Cost	7,000 / month	
Maintenance / Vehicle / Month	400-600	
Battery Swapping		
Swap Station	5,00,000	1 station with 30 slots
Battery	27,00,000	90
Operating Cost	30,000 / month	
Maintenance / Vehicle / Month	1200-1500	

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In contrast, fast charging presents a more scalable and cost-efficient alternative. A set of 10 fast chargers can easily support 60 riders, as each rider typically requires only 15–20 minutes of charging time—often during goods loading or short breaks.

Moreover, if a dark store requires expanded capacity, installing 10 additional fast chargers would cost approximately ₹1,50,000—significantly lower than the cost of deploying a new swap station.

Fast charging's lower costs come from simpler setups—no robotic arms or extra battery stocks—and longer battery life, with replacements needed every 48-60 months versus 18-24 months for swapping. The numbers for total deliveries and cost for deliveries increases exponentially over the span of a year.

As per our analysis, **for a delivery cost of INR 5,00,000, fast charging would power 16,667 deliveries as compared to 10,000 deliveries powered by battery swapping.**

What are the real-world experiences and future prospects of battery swapping and fast charging in the quick commerce market in India?

Various Battery Swap Pilots around India show a similar result, **while two-minute swaps sound ideal, 35% of drivers face delays during busy times, and uneven demand across stations creates inefficiencies**.

On-site fast charging helps streamline operations and boosts delivery numbers. The quick commerce market is projected to grow at a 22.6% CAGR through 2034, necessitating increasingly efficient fleets. While battery swapping offers speed, its higher costs and logistical hurdles make it less practical for scaling up. Fast charging, with its cost savings, smaller footprint, and adaptability, appears to be the smarter bet.

Choosing between fast charging and battery swapping isn't just about tech—it's about what keeps deliveries flowing and profits growing. While both have their fans, evidence suggests that fast charging is the go-to option for quick commerce, especially in fast-growing markets like India.

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BYD's Ultra-Fast Charging Technology

Rahul Bollini, Bollini Energy

Rahul is an R&D expert in Lithium-ion cells with 10 years of experience. He founded Bollini Energy to assist in deep understanding of the characteristics of Lithium-ion cells to EV, BESS, BMS and battery data analytics companies across the globe. Contact | +91-7204957389; bollinienergy@gmail.com.

BYD recently launched the Super e-Platform consisting of:

- 1000kW capable battery system with 10C charging
- 30,500 RPM Rear Motor
- Latest Silicon Carbide (SiC) Power Chips to support high voltage

BYD has introduced a **Megawatt Flash Charger that can deliver power up to 1360 kW.**

However, the BMS of recently launched Han L EV and Tang L EV limits the charging power to 1000 kW. This indicates that more EVs are expected to be launched in the future with the capability to utilize Megawatt flash chargers, and some may even support charging at power levels exceeding 1000 kW.

While discussing the fast charging technology launched by BYD, one must first understand that it's not about using a fast charger (1000kW or Megawatt charger); **it is about the battery's capability to accept a 1000kW charge for a continuous period of 5 minutes** to enable 400 km and 370 km range worth of energy to be added to the battery in just five minutes in Han L EV (Sedan) and Tang L EV (SUV), respectively.

Although a 400 km range is considered under CLTC conditions, it would be more like 300 km in real-world driving conditions and varies depending on driving style, speed, operation temperature and power/energy used by in-vehicle accessories. Hence, **it must be understood that not all BYD electric cars are compatible with the concept of a 400 km range add in five minutes.**

1000kW is equal to 100,000W power, which is 1000V multiplied with 1000A.

This also suggests that this level of fast charging is possible only with EVs with a high-voltage battery platform. Smaller EVs of BYD working on 400V architecture will not be compatible with this charging system, and hence they must be upgraded to a higher voltage in future if they want to be fast-charged.

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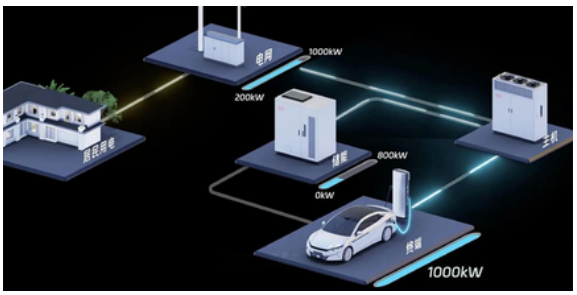
BYD launched Han L EV and Tang L EV with 4WD variants using 810 kW (1086 hp) dual motors for acceleration from 0 to 100 kmph in under 3 seconds and 4 seconds, and top speeds of 305 kmph and 287.4 kmph, respectively. The front motor (230kW) can go up to 21,500 rpm, and the rear motor (580kW) can go above 30,500 rpm.

It is expected that BYD will deploy over **4000 Megawatt chargers across China**, with the first batch of deployment planned in April 2025 **to support the market launch of the two new EVs**. This only indicates that BYD will launch more EVs in future compatible with Megawatt chargers. The idea behind Megawatt charger deployment is to enable EV charging in as much time as it takes to refuel an ICE vehicle, which enables EV users to worry less about charging time and range anxiety.

Today, **Tesla's recently upgraded V4 charger allows for up to 500kW maximum power and BYD's Megawatt flash charger can deliver more than twice that.**

1000 kW power is equivalent to powering more than 300 houses with a 3 kW connected load per house. BYD will deploy **Energy Storage Systems (ESS)** in areas where the local grid is incapable of supplying enough power. The ESS would charge from the grid when the chargers are not in use and discharge to provide complementary power to charge the EVs.



BYD demonstrated its Megawatt Flash Charger. In 5 minutes, Han L EV went from 5% to 63.16% SoC and the estimated range went from 35.05 km to 442.75 km.

It is expected that Han L EV can fully charge from 0 to 100% in 20 minutes. It is a well-known fact that fast charging a battery shortens its life, and hence, these EVs are expected to have a robust cooling system to manage the heat generated during ultra-fast charging.

Han L EV uses an 83.212 kWh battery pack, and Tang L EV uses a 100.531 kWh battery pack; both use **BYD's second-generation LFP blade cells.**

BYD's second-generation LFP blade cells have been awaited for long, with an expectation of higher energy density, faster charging, lower cost and longer lifespan. Han L EV and Tang L EV seem to be the first set of vehicles deployed with them. These cells are expected to be launched in two variants, one with high energy density and slower charging speed and another with low energy density and faster charging speed.

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Maharashtra has approved its **Electric Vehicle Policy 2025, effective until 2030** and allocated **₹1,993 crore** to implement the policy. Financial incentives:

- 10% discount for passenger mobility vehicles, i.e. electric 2Ws, 3W, 4Ws, state transport scheme buses (M3, M4), and special urban transport scheme buses.
- 15% discount for goods vehicles such as electric 3Ws, 4Ws (transport - M1), LCVs, goods carriers (N2, N3), and e-tractors and single-axis cutting machines for agricultural purposes.
- 100% exemption of toll fees for e-4Ws on major highways and 50% discount on toll for e-4Ws on other state and national highways under the jurisdiction of the Public Works Department.
- Exemption from motor vehicle tax, RC or renewal fees for all EVs.

***Sachidanand Upadhyay**, MD, **Lord's Mark Industries**, remarked, "A key highlight of the policy is the plan to install EV charging stations every 25-kilometre along state and national highways, a move aimed at eliminating range anxiety and encouraging broader adoption. Additionally, the provision of 100% loan facilities will help overcome financial barriers. The enhanced capital investment is expected to significantly scale up production capabilities, reinforcing Maharashtra's role in driving sustainable and future-ready mobility solutions."*

***Ketan Kulkarni** - Managing Director and CEO - **Gati Express** and Supply Chain Limited, said, "Maharashtra's EV Policy 2025 is a forward-thinking blueprint that makes the transition to electric mobility both economically viable and operationally practical for logistics and transport businesses. By addressing core challenges like upfront cost, infrastructure readiness, and fleet viability, the policy creates real momentum for companies to electrify their fleets at scale."*

The Gujarat government has cut the motor vehicle tax on electric vehicles from 6% to 1%, effectively providing a 5% rebate. The scheme, which is active on the VAHAN 4.0 portal and will run until March 31 next year, aims to encourage EV adoption, safeguard the environment, and support tourism.

Delhi has introduced the **Delhi Electric Vehicle Interconnector (DEVi)** initiative to ply **electric buses between metro stations and key bus terminals.** In its first phase, 400 DEVi compact buses have been introduced across East Delhi and West Delhi, covering Ghazipur, Vinod Nagar East, and Nangloi.

Each DEVi bus will have 23 seats, with 6 seats reserved exclusively for women, and the capacity to accommodate 13 standing passengers. The fare structure will range between ₹10 and ₹25, while women passengers can travel free of cost.

Switch Mobility delivers 100 customised IeV3 vehicles for Waste Management to Indore Municipal Corporation. These specially designed **electric garbage tippers** will replace conventional diesel vehicles. The vehicles are equipped to handle the transportation of both wet and dry waste.

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Mahindra & Mahindra is set to acquire **a 58.96% stake in SML Isuzu Ltd. (SML) for INR 555 crore** to strengthen its position in the trucks and buses segment.

M&M would acquire the entire stake of 43.96% held by Sumitomo Corporation, promoter of SML, and separately also acquire 15% stake held by Isuzu Motors Ltd. M&M would also launch a mandatory open offer for acquisition of up to 26% stake from eligible public shareholders of SML in accordance with the SEBI Takeover Regulations.

Mumbai-based **REMSONS acquires a 51.01% stake in electric 3W OEM Astro Motors for INR 14.22 crores.**

Astro Motors has a plant in Chakan (Pune) and develops e-3Ws with gear technology. It plans to launch its passenger EVs in up to six months. Their cargo 3W, Astro Navya, has a 10.2 kWh battery, a payload capacity of 747 kg and a range of 131 km.

Hindalco delivers **10,000 Aluminium Battery Enclosures to Mahindra from its facility in Chakan (Pune).** The enclosures are meant for BE 6 and XEV 9e electric SUVs.

Hindalco also unveiled its EV component manufacturing facility in Chakan, built with a capital investment of ₹500 crores. It can produce 80,000 enclosures annually at present.

Cygni Energy inaugurates **BESS (Battery Energy Storage System) Gigafactory.** Located in E-Mobility Valley, at the Electronics Manufacturing Cluster in **Maheshwaram,** Hyderabad, the facility has been set up with an investment of over ₹100 crores, initially with an **initial capacity to produce 4.8 GWh** of battery packs for EVs and energy storage systems.

In March 2025, **CBAK Energy Technology**—through its wholly owned subsidiary Nanjing CBAK New Energy Technology Co., Ltd.—**received purchase orders from Ather Energy** for its Model 32140 cylindrical lithium-ion cells. These cells, designed for electric two-wheelers, three-wheelers, and light electric vehicles, will now be integrated into Ather's electric scooters.

Mindra Group has inaugurated a new 70,000 sq. ft. manufacturing facility in **Ahmedabad,** Gujarat, **dedicated to solar inverters and EV chargers.** With an annual production capacity of 1.20 GW, the facility reflects the company's transition from a 200 sq. ft. setup to a large-scale operation.

JBM Electric Vehicles has formed a strategic partnership with **Hitachi ZeroCarbon** to incorporate the ZeroCarbon BatteryManager into its electric bus operations. The collaboration aims to evaluate the performance and durability of electric public transport in high-demand urban settings.

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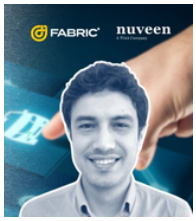

Nuveen, a TIAA company, **invests USD 13.5 million in Fabric IoT – the parent company of Intellicar.** Founded in 2022, Fabric IoT delivers data solutions for the EV and automotive industry through Intellicar, which currently serves 300,000+ EVs. **MG Motors' BaaS** is an example of their technology enabling OEMs and financiers to launch new pricing models to enable EV adoption

IPEC India has secured an investment of **USD 3 million** from **Gruhas.** The Bangalore-based company manufactures a range of EV chargers. IPEC India was started in 2017 as a JV between Meher Group, Deki Electronics Ltd and Sungho Electronics. Having delivered over 10 lakh EV charging products to the top EV OEMs in India, the firm is now gearing up to expand its manufacturing capacities to 50,000 monthly units, IPEC said in a statement.

GreenLine Mobility Solutions, an Essar venture that operates LNG and electric heavy commercial trucks, announces **a $275M equity investment,** including a $20M investment from Nikhil Kamath.

The funding will enable the deployment of over 10,000 LNG and EV trucks and establish a network of 100 LNG refuelling stations and EV charging stations. GreenLine said it aims to transition India's heavy-duty vehicle fleet to LNG and EV trucks by offering logistics services at cost parity with diesel trucks.

Napino Auto & Electronics inaugurated the **manufacturing line** to start the production of **EVR Motors's patented electric traction motors in Halol, Gujarat.** Napino and Israel-based EVR Motors had entered a licensing agreement in April 2022 to develop and manufacture EVR's Trapezoidal Stator - Radial Flux Permanent Magnet motors for India's e-2W market.

Uno Minda Board has approved a Detailed Project Report for a ₹423-crore investment in a **four-wheeler EV initiative.** The project will produce high-voltage EV components—such as combined charging units, e-axles, inverters, and motors.

Uno Minda will invest ₹114 crores for a 70% equity stake in the JV Company's equity capital over the next 3 years. Innovance Automotive (through its Hong Kong subsidiary) will invest in remaining 30% equity shares of the JV Company.

Endurance Technologies is setting up a new manufacturing facility for **lithium-ion battery packs** with a capex outlay of **INR 47.3 crores** at Taluka Maval, District **Pune,** Maharashtra**.** The facility will have a production capacity of nearly 35,000 packs per month. The product launch is anticipated for Jan 2026. The proposed capacity will be added in phases starting Q4 FY25-26.

Mercury EV Tech Limited, via its subsidiary **Powermetz Energy Private Limited,** will commission a **3.2 GW lithium-ion battery pack** manufacturing facility in **Vadodara**. Pilot production is scheduled to start from mid-May 2025.

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Greaves Cotton partners with **Chara Technologies for synchronous reluctance motors and controllers.** These motors and controllers will be exclusively manufactured by Greaves and assembled at a facility in Shendra, **Aurangabad**. Chara's motors use rare-earth-free magnets and have both automotive and non-automotive applications, including L5 three-wheelers, golf carts, and four-wheelers.


Numeros Motors partners with **IIT Bhubaneswar to** research **rare-earth-free motor technologies** for electric vehicles.

KPIT and **Mercedes-Benz Research and Development India (MBRDI) collaborate** to accelerate the development of **Software-Defined Vehicles (SDVs).** By prioritizing software development, Mercedes-Benz AG aims to deliver continuous improvements to customers through regular updates, ensuring vehicles remain technologically current throughout their lifecycle.

Mahindra Last Mile Mobility partners with **RiseWise Capital** to offer flexible financing solutions for both retail and B2B customers.

Battery swapping solution provider **Indofast Energy** and e-mobility solution provider **EVeez aim to deploy 20,000 e-bikes in the next 2 years across key Tier I and Tier II cities,** including Chennai, Mumbai, Pune, Jaipur, and Lucknow. This partnership allows EVeez to significantly accelerate expansion into Tier II cities, where they are witnessing tremendous growth in quick commerce and delivery services.

Omega Seiki Mobility (OSM) places an order worth **₹50 crore** for **Ergon Labs' Integrated Power Converter** (IPC) solution to power its upcoming e-3Ws. Bengaluru-based Ergon Labs is an emerging player in light EV powertrain technologies. The IPC combines the on-board charger and motor controller into a single unit. OSM chairman Mr Uday Narang has also made an investment in the start-up.

Tivolt Electric (Montra Electric SCV) will supply **100 Eviator E350L electric goods carriers** to **Magenta Mobility.** The MoU was signed by SAJU NAIR, CEO of TIVOLT Electric Private Limited, and Maxson Lewis, MD and CEO of Magenta Mobility. With this partnership, Montra Electric and Magenta Mobility will aim to accelerate EV adoption in the SCV segment.

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Ampere Electric Vehicles introduces **Reo 80, a low-speed** e-2W at ₹59,900 with a range of 80 km.

Ultraviolette Automotive is set to launch its electric motorcycle F77 MACH 2 RECON in the **United Kingdom and Benelux (Belgium, the Netherlands, and Luxembourg) region**, with MotoMondo as importer and distribution partner. A company statement said the F77 MACH 2 RECON will be introduced in Europe with an on-road price starting at £8,499.

Zen Mobility launches an integrated fleet operations solution for last-mile logistics. The company also introduced the **Zen Micro Pod ULTRA**, an electric 3W with an LMFP battery pack capable of over 5,000 charge cycles. It comes with a 5-year warranty on the vehicle and the battery. The vehicle is available with leasing plans starting INR 7500 per month.

Exicom unveiled the **Tritium® TRI-FLEX EV charging platform.** The platform, featuring distributed architecture, enables easy scalability from 4 to 64 charging points, empowering EV charge point operators to expand their capacity and revenue without overhauling existing infrastructure.

ChargeZone announced that it has expanded its EV charging network to over **13,500 charging points.** This company has forged **OCPI-based roaming** partnerships with other EV infrastructure players, including Statiq, Bolt Earth, Kazam, Pulse Energy, chargeMOD, ElectreeFi, evnnovator, and others. These partnerships enable users to access chargers across all participating platforms through the CHARGE ZONE app.

EzUrja, in partnership with **Andrew Yule & Company Ltd (Govt of India Undertaking),** plans to develop a MicroGrid integrated EV charging hub at Togami, Thakurpukur, Kolkata, spread over an area of 2 acres and featuring 300 EV chargers. The microgrid will combine Solar, Wind, and BESS for efficient EV charging to supplement the grid supply. EZUrja is also collaborating with electric fleet operator Snap-E Cabs.

Let's driEV and **Moto Business Service India Pvt. Ltd. (Subsidiary of Yamaha Motor Co., Ltd.)** partner to deploy **100 TVS iQube scooters in Bangalore.** The partnership enables a monthly subscription model for 2W ownership, backed by MBSI's expertise in two-wheeler leasing.This collaboration follows their earlier venture in Bhubaneswar.

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EKA Mobility, in consortium with **Chartered Speed,** has been awarded the Letter of Award for deploying **675 electric buses** across **Rajasthan** under the PM e-Bus Sewa Scheme. The order includes 565 nine-meter (9m) and 110 twelve-meter (12m) electric buses. This deployment will span Jaipur, Kota, Udaipur, Ajmer, Alwar, Bikaner, Bhilwara, and Jodhpur.

Refex Green Mobility is phasing out its airport EV taxi services in Bangalore. The company will keep running and scaling its service for institutional customers for employee transportation, corporate rentals, enterprise airport transfers, and fleet partnerships with other leading ride-hailing platforms. Launched in March 2023, Refex's Green Mobility has nearly 1300 electric 4Ws in its fleet, with a presence in Bengaluru, Chennai, Hyderabad, and Mumbai.

EV-as-a-service platform **Zypp Electric recorded a revenue of ~₹455 crore (pre-audited) in FY'25,** i.e. nearly 50% revenue growth from ₹302 crore in FY'24. Quick commerce accounted for 47% of the deliveries made on the platform in FY'25, up from 30% in FY'24.

BPCL and **Mahindra Electric Automobile Limited** have entered into a partnership to improve access to electric vehicle charging infrastructure. BPCL's network of fast chargers will be integrated into Mahindra's Me4U mobile application, allowing Mahindra EV users to locate and use these charging stations more easily.

Gujarat CM Bhupendra Patel inaugurated **Matter Motor Works' electric motorcycle manufacturing plant at Changodar near Ahmedabad.** Matter will roll out its electric motorcycle, the Aera, in eight additional Indian cities after its Bengaluru debut.

Omega Seiki Mobility said it will deploy **2500** specially designed Pink Auto Rickshaws with women drivers across India, in collaboration with **Naari Shakti (Women Welfare Charitable Trust)** as a part of its CSR.

The OSM's e-3W will be offered at a lower price of ₹2,59,999 (on-road, Delhi) and a 1% interest rate. The first fleet of Pink Auto Rickshaws will be deployed in Delhi NCR.

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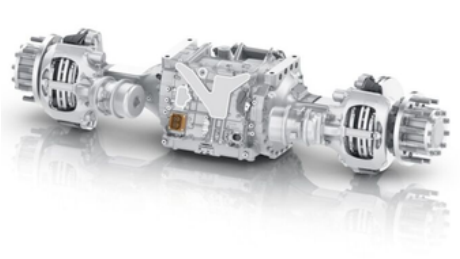

ZF Group will supply several thousand units of its **AxTrax 2 electric axle to a commercial vehicle OEM in India.** The axle will power intercity **electric buses** and introduce ZF's electric axles to the Indian market.

The AxTrax 2 incorporates high-tech components from ZF's new e-mobility kit. It is designed to replace the engine, transmission and conventional axle to electrify a commercial vehicle and delivers 210 kW continuous power.

Saudi Arabia's Aramco, one of the world's largest integrated energy and chemicals companies, **and China's BYD,** a leading EV and battery manufacturer, **are set to collaborate on new energy vehicle (NEV) technologies.**

Aramco is exploring several ways to potentially optimize transport efficiency, from innovative lower-carbon fuels to advanced powertrain concepts.

Volektra has raised new funding to advance its **Virtual Magnet motor—an alternative motor design that avoids the use of rare earth magnets.** The funding round was led by Chakra Growth Capital, with additional backing from investors involved in deep tech, manufacturing, and energy sectors. The company plans to use the funds to expand into automotive, micromobility, industrial, and defense applications.

California-based Electric powertrain startup **Conifer has secured $20 million** in seed funding to advance its software-based, **magnet-agnostic motor technology.** Investors in the round include True Ventures, MFV Partners, MaC Ventures, Voyager, Z21 Ventures, Silicon Valley Bank, and Higher Life Venture. The funding will be used to launch Conifer's first product—a geared in-wheel powertrain—intended for use in vehicles, lawn equipment, and tractors, with plans to extend into stationary applications like HVAC systems and industrial pumps.

At its first Super Tech Day, **CATL introduced four new EV battery products:** the Freevoy Dual-Power Battery, the Naxtra Passenger EV Battery, the second-generation Shenxing Superfast Charging Battery, and the Naxtra 24V Heavy-Duty Truck Integrated Start-Stop Battery. These launches mark the start of what the company calls the "Multi-Power Era."

STMicroelectronics has introduced Stellar with xMemory, a **new memory technology integrated into its Stellar series of automotive microcontrollers.** Designed to support software-defined vehicles and electrification platforms, the technology aims to streamline development processes for emerging vehicle architectures. Production is expected to begin later in 2025, starting with the Stellar P6 microcontrollers, which are focused on electric drivetrain applications.

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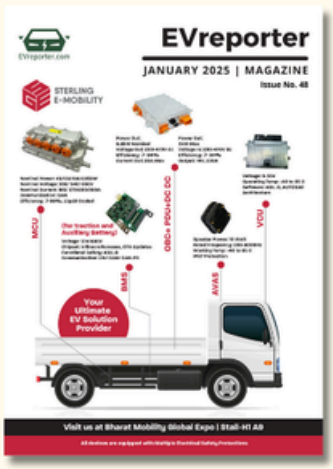

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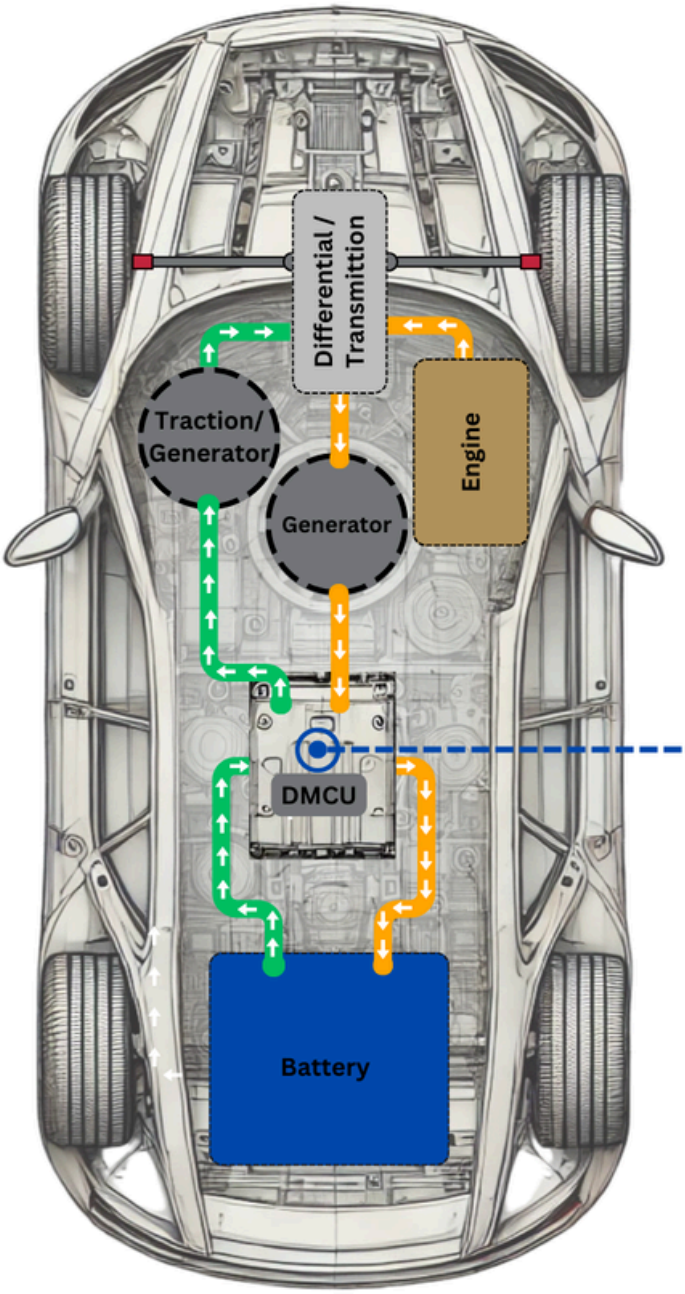
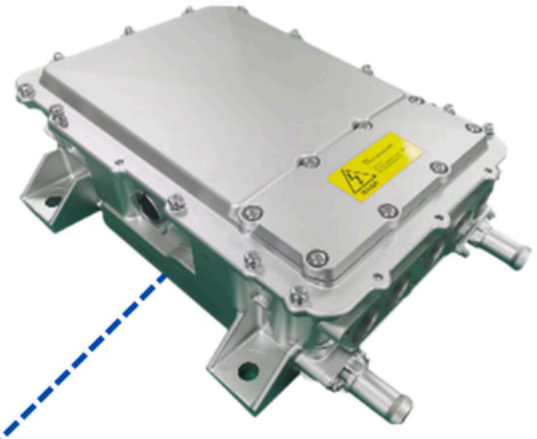
STERLING E-MOBILITY



GCU
(Generator Control Unit)

DMCU
(Dual Motor Control Unit)



Parameters	GCU	DMCU
Nominal Voltage	220-500Vdc	250-460Vdc
Rated power	60-150kW	60 and 75kW
Communication	CAN	CAN
Thermal Mgmt.	Liquid Cooled	Liquid Cooled
IP Rating	IP67	IP68

Products for Hybrid Vehicles

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