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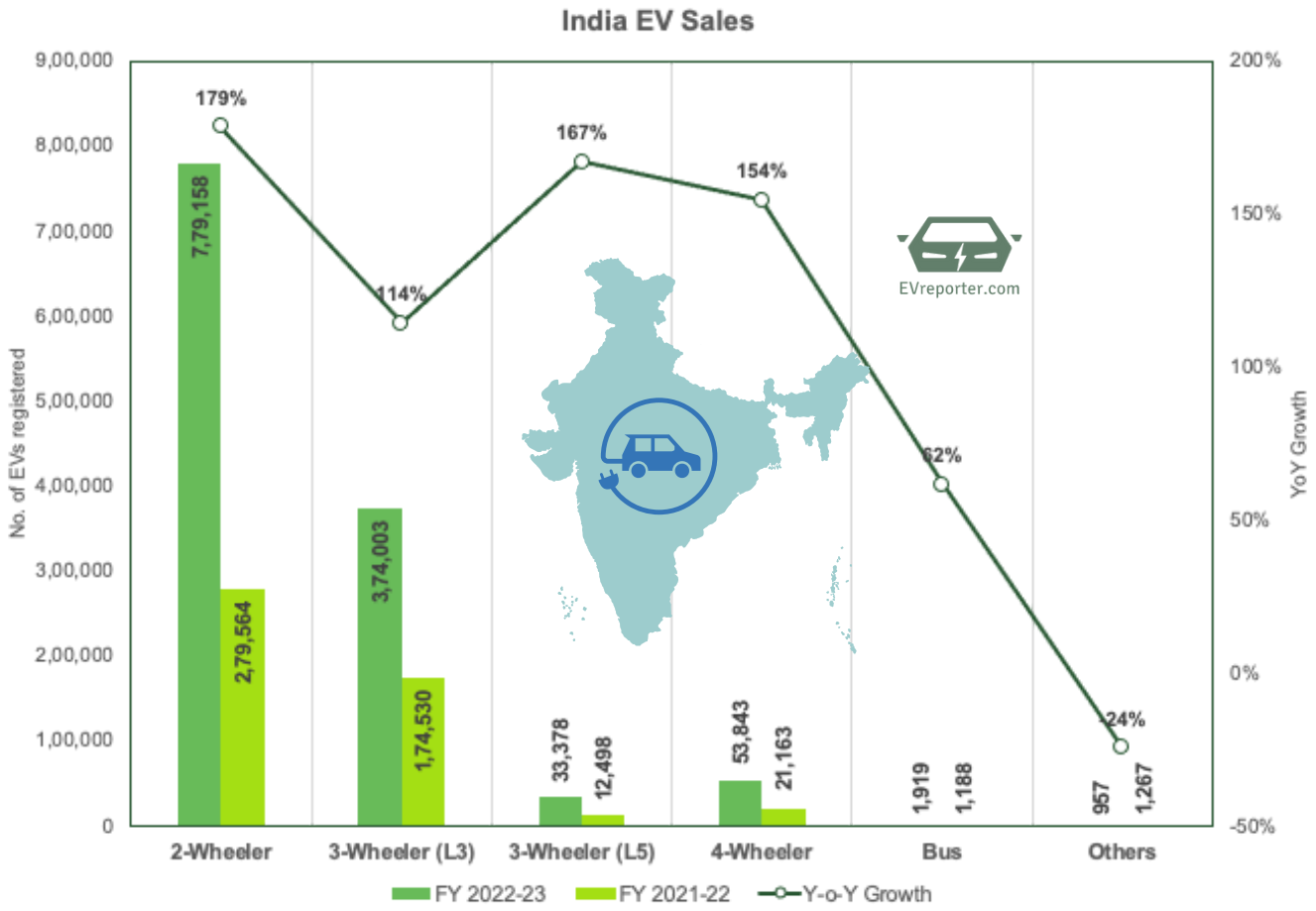
India EV Sales Apr 2022 to March 2023



***Source**: EVreporter Research | Vahan Dashboard Data (FY 2022-23 and FY 2021-22) as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs and Telangana Regional Transport portal (Apr 2021 to Mar 2023). Low speed e2W data not included.*

Observations

- In FY 2022-23, **India registered EV sales for 12,43,258 units,** marking a 154% year-on-year growth over FY 2021-22 EV sales numbers, i.e., 4,90,210 units across all vehicle segments. EV sales for FY 2022-23 show a more than 2.5 times increase from that of units sold in FY 2021-22.

- India's EV industry hits record sales year across all vehicle segments, accounting for **5.59 per cent of overall automobile sales**.

- High-speed **e-2Wheelers, with sales of 7,79,158 units** in FY 2022-23, showed the highest segment share and a Y-O-Y growth rate of 179% over FY 2021-22 sales.

- A total of 4,07,381 electric 3Ws were sold in FY 2022-23, up from 1,87,028 units the year before.

- 53,843 electric four-wheelers were registered in FY 2022-23, marking a Y-o-Y growth of 154%.

For deeper insights into India EV sales trends - segment wise, OEM wise and region wise - register your interest to subscribe to our soon-to-be-launched data portal at an introductory price. Click here to submit interest.

OEM Wise sales data for India (FY 2022-23)

No.	OEMs	FY 2022-23 SALES	FY 2022-23 Market share	FY 2021-22 SALES	FY 2021-22 Market share	Difference	YoY Growth
	Top OEM wise e-2Wheeler sales						
1	OLA ELECTRIC TECHNOLOGIES	1,65,589	21%	17,909	6.0%	1,47,680	825%
2	HERO ELECTRIC VEHICLES	97,812	13%	73,947	26%	23,865	32%
3	OKINAWA AUTOTECH	96,648	12%	47,510	17%	49,138	103%
4	AMPERE VEHICLES	91,604	12%	28,370	10%	63,234	223%
5	TVS MOTOR COMPANY	89,961	12%	10,532	4%	79,429	754%
6	ATHER ENERGY	83,921	11%	22,883	8%	61,038	267%
7	BAJAJ AUTO LTD	30,339	4%	7,841	3%	22,498	287%
8	OKAYA EV PVT LTD	13,510	2%	0	0%	13,510	-
9	REVOLT INTELLICORP	13,822	2%	9,197	3%	4,625	50%
10	PUR ENERGY PVT LTD	13,815	2%	21,023	8%	-7,208	-34%
	Others	82,137	11%	40,352	14%	41,785	104%
	TOTAL	**7,79,158**	**100%**	**2,79,564**	**100%**	**4,99,594**	**179%**
	Top OEM wise e-4Wheeler sales						
1	TATA MOTORS	42,701	79%	17,637	83%	25,064	142%
2	MG MOTOR INDIA	5,591	10%	2,571	12%	3,020	117%
3	BYD INDIA	1,477	3%	72	0%	1,405	1951%
4	HYUNDAI MOTOR INDIA	998	2%	141	1%	857	608%
5	MAHINDRA & MAHINDRA	668	1%	161	1%	507	315%
6	BMW INDIA PVT LTD	469	1%	9	0%	460	5111%
7	KIA MOTORS INDIA	384	1%	0	0%	384	-
8	PCA AUTOMOBILES INDIA	334	1%	0	0%	334	-
	Others	1,221	2%	572	3%	649	113%
	TOTAL	**53,843**	**100%**	**21,163**	**100%**	**32,680**	**154%**
	Top OEM wise e-Bus sales						
1	PMI ELECTRO MOBILITY SOLUTIONS	604	31%	397	33%	207	52%
2	OLECTRA GREENTECH LTD	444	23%	222	19%	222	100%
3	SWITCH MOBILITY AUTOMOTIVE LTD	379	20%	0	0%	379	-
4	JBM AUTO LIMITED	227	12%	247	21%	-20	-8%
5	TATA MOTORS LTD	132	7%	280	24%	-148	-53%
	Others	133	7%	42	4%	91	217%
	TOTAL	**1,919**	**100%**	**1,188**	**100%**	**731**	**62%**

***Source**: EVreporter Research | Vahan Dashboard Data (FY 2022-23 and FY 2021-22) as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs and Telangana Regional Transport portal (Apr 2021 to Mar 2023). Low speed e2W data not included.*

For FY 2022-23, Ola Electric was the top seller in the e-2wheeler category with 1,65,589 units sold, far ahead of the second-ranked Hero Electric which sold 97,812 units. TVS Motors registered an impressive 700% YoY growth in EV sales. 53,843 units of e-4Ws made for **1.49% EV penetration in the 4W sales** in FY 2022-23, up from 0.72% penetration in FY 2021-22. Tata Motors continues to dominate the Indian e-4W space with a 79% market share (42,701 units).

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OEM Wise sales data for India (FY 2022-23)								
No.	OEMs	FY 2022-23 SALES	FY 2022-23 Market share	FY 2021-22 SALES	FY 2021-22 Market share	Difference	YoY Growth
	Top OEM wise e-3Wheeler Passenger and Cargo (L5) sales						
1	MAHINDRA & MAHINDRA	11,914	36%	3,871	31%	8,043	208%
2	PIAGGIO VEHICLES	9,072	27%	3,563	29%	5,509	155%
3	OMEGA SEIKI	3,460	10%	897	7%	2,563	286%
4	E ROYCE MOTORS INDIA	1,163	3%	689	6%	474	69%
5	ATUL AUTO LTD	1,108	3%	396	3%	712	180%
6	ALTIGREEN PROPULSION LABS	1,242	4%	161	1%	1,081	671%
7	DILLI ELECTRIC AUTO	1,028	3%	273	2%	755	277%
8	EULER MOTORS	866	3%	305	2%	561	184%
9	KETO MOTORS	470	1%	569	5%	-99	-17%
10	KINETIC GREEN ENERGY & POWER SOI	155	0%	326	3%	-171	-52%
	Others	2,900	9%	1,448	12%	1,452	100%
	TOTAL	**33,378**	**100%**	**12,498**	**100%**	**20,880**	**167%**
	Top OEM wise e-3Wheeler passenger and Cargo (L3) sales						
1	YC ELECTRIC VEHICLE	29,845	8%	17,041	10%	12,804	75%
2	MAHINDRA & MAHINDRA	24,477	7%	9,638	6%	14,839	154%
3	SAERA ELECTRIC AUTO	22,203	6%	8,825	5%	13,378	152%
4	DILLI ELECTRIC AUTO	15,881	4%	6,525	4%	9,356	143%
5	CHAMPION POLY PLAST	13,946	4%	7,523	4%	6,423	85%
6	MINI METRO EV L.L.P	12,143	3%	4,306	2%	7,837	182%
7	UNIQUE INTERNATIONAL	10,733	3%	5,021	3%	5,712	114%
8	TERRA MOTORS INDIA PVT LTD	8,095	2%	4,065	2%	4,030	99%
9	J. S. AUTO (P) LTD	8,029	2%	3,619	2%	4,410	122%
10	ENERGY ELECTRIC VEHICLES	7,253	2%	3,482	2%	3,771	108%
	Others	2,21,398	59%	1,04,485	60%	1,16,913	112%
	TOTAL	**3,74,003**	**100%**	**1,74,530**	**100%**	**1,99,473**	**114%**

***Source**: EVreporter Research | Vahan Dashboard Data (FY 2022-23 and FY 2021-22) as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs and Telangana Regional Transport portal (Apr 2021 to Mar 2023).*

Observations

- High-speed e-3Wheeler (L5) models sold a total of 33,378 units for the FY 2022-23 and account for 8.41% of all high-speed 3W sold in the country, up from 5.51 % penetration in FY 2021-22.
- **Mahindra, Piaggio and Omega Seiki are the top L5 e-3Wheeler sellers, and together they take up 73% market share.**
- Low-speed e-3Wheeler (L3) models sold a total of 3,74,003 units for the FY 2022-23 and account for 99% of all low-speed 3W sold in the country.
- **YC Electric continues to be the top low-speed e-3W seller in the country.**

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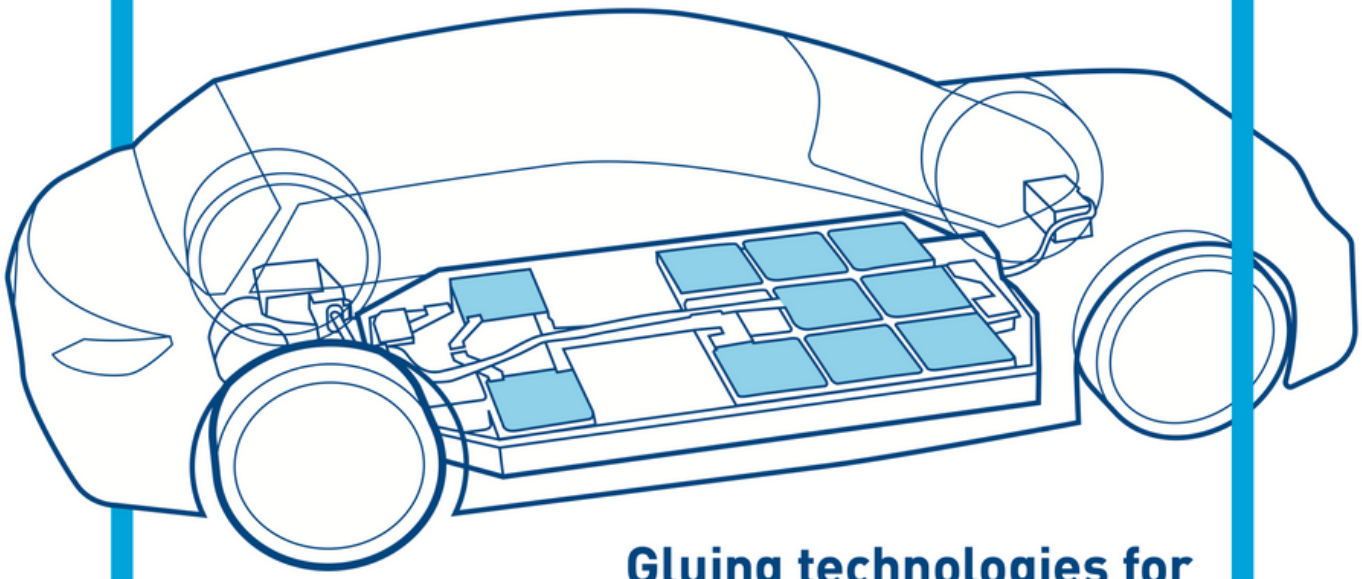

Gluing technologies for battery production

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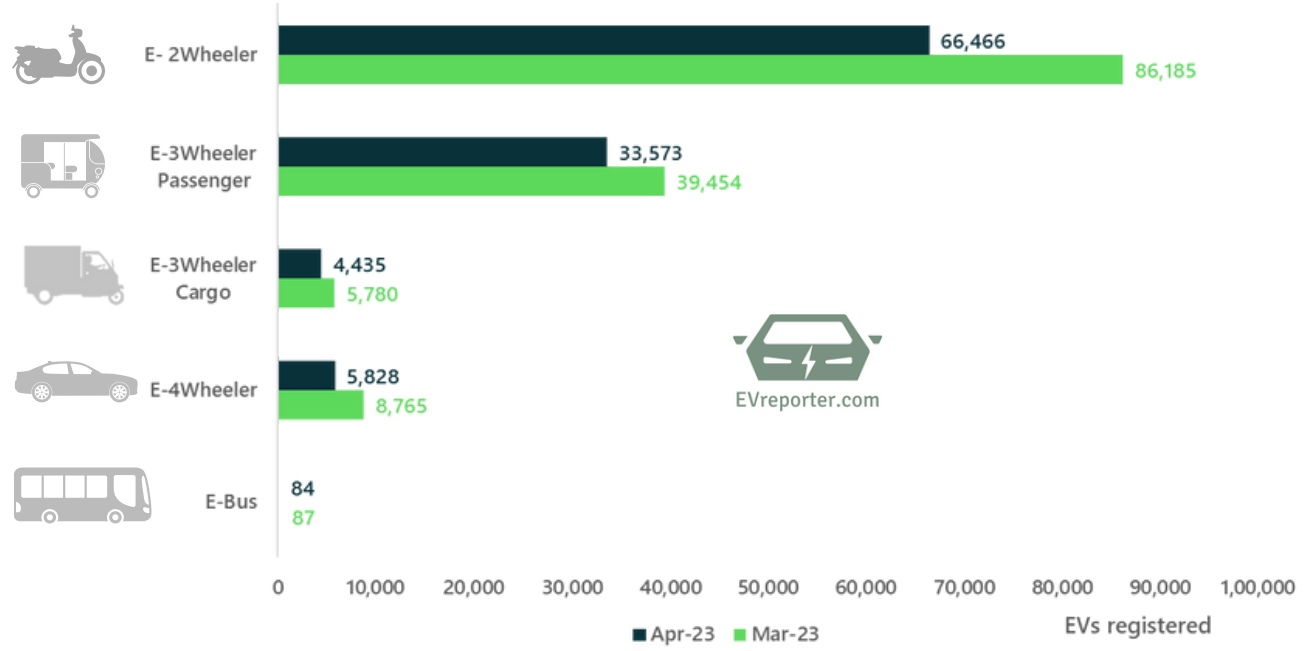
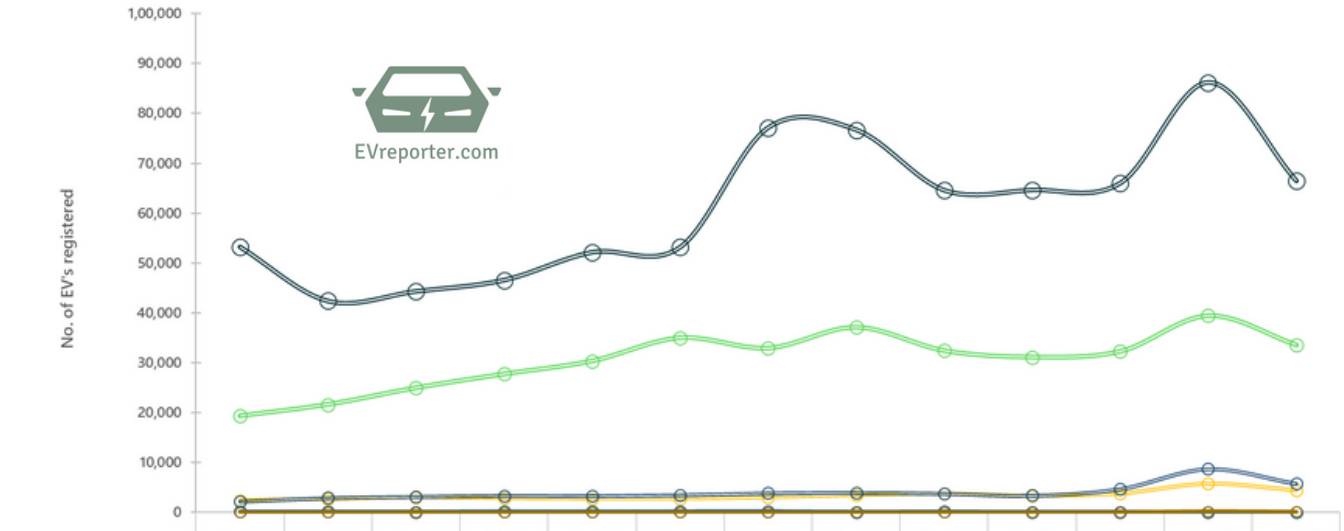
Category wise Electric Vehicle sales, Apr 2023

Total Registered Electric Vehicle Sales - **Apr '23 - 1,10,580** | Mar '23 - 1,40,550



Category wise-Sales Trend from Apr 2022 to Apr 2023

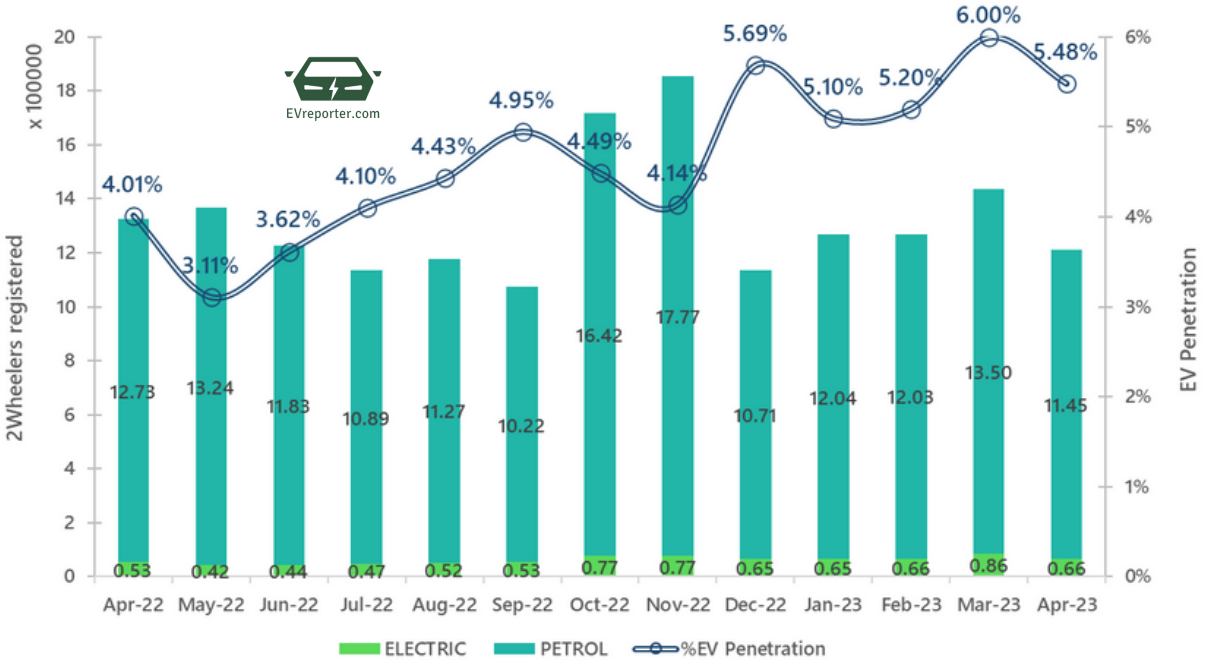
12,14,892 EVs sold in last 12 months from May 2022 to Apr 2023



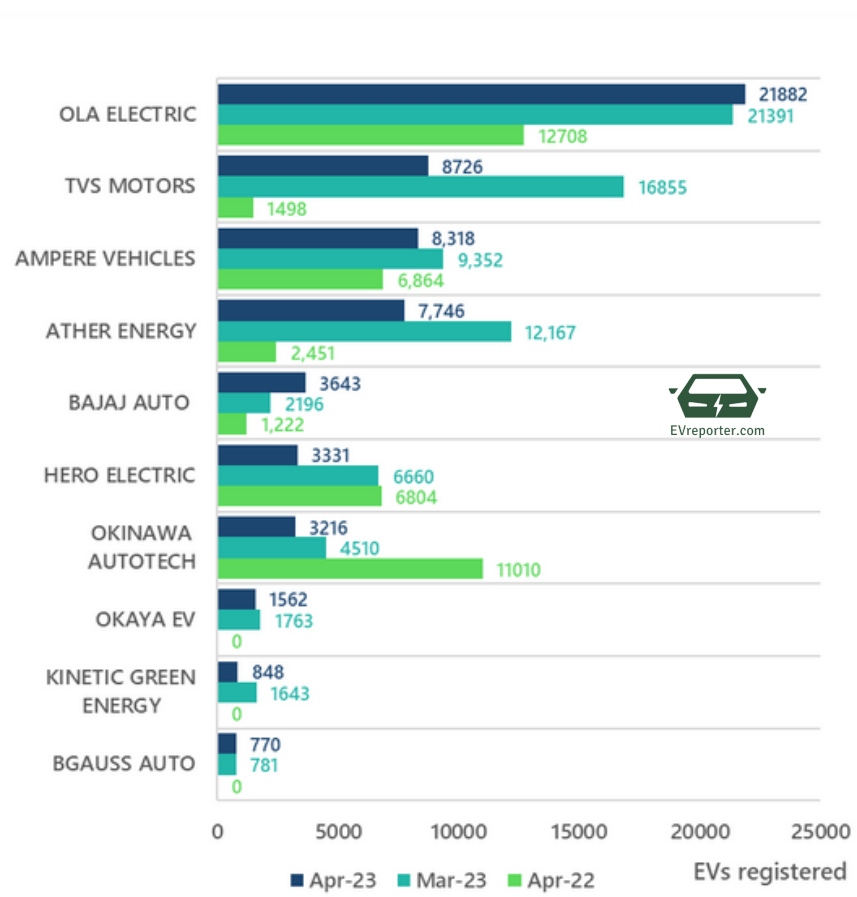
	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23
E- 2Wheeler	53256	42417	44370	46603	52195	53209	77136	76699	64598	64,648	66,030	86,185	66,466
E-3Wheeler Passenger	19340	21641	24988	27757	30370	35041	32957	37138	32442	31,151	32,293	39,454	33,573
E-3Wheeler Cargo	2419	2674	3041	2842	2759	2755	3041	3456	3767	3,326	3,778	5,780	4,435
E-4Wheeler	2249	2959	3210	3406	3356	3,541	3907	3,967	3825	3,429	4,743	8765	5,828
E-Bus	165	165	145	207	227	216	245	117	151	96	98	87	84
Others	63	48	81	52	62	49	44	61	60	63	110	279	194
TOTAL	**77492**	**69904**	**75835**	**80867**	**88969**	**94811**	**117330**	**121438**	**104843**	**102713**	**107052**	**140550**	**110580**

Source: Vahan Dashboard. Data as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs
Low speed 2Ws not included.

Fuel wise 2W Sales Trend, Apr 2022 - Apr 2023



High Speed E-2W Sales Trend by OEM



	% Growth (Y-o-Y)	% Growth (M-o-M)
OLA ELECTRIC	72%	2%
TVS MOTORS	483%	-48%
AMPERE VEHICLES	21%	-11%
ATHER ENERGY	216%	-36%
BAJAJ AUTO	198%	66%
HERO ELECTRIC	-51%	-50%
OKINAWA AUTOTECH	-71%	-29%
OKAYA EV	-	-11%
KINETIC GREEN ENERGY	-	-48%
BGAUSS AUTO	-	-1%

Source: Vahan Dashboard. Data as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs
Low speed 2Ws not included.

Monthly sales of prominent electric 2W OEMs

Source: EVreporter Research, Vahan Dashboard

S.No.	Maker	Apr-23	Mar-23	Difference	% Change	Market Share Apr 23
1	OLA ELECTRIC	21,882	21,391	491	2%	32.9%
2	TVS MOTORS	8,726	16,855	-8,129	-48%	13.1%
3	AMPERE VEHICLES	8,318	9,344	-1,026	-11%	12.5%
4	ATHER ENERGY	7,746	12,167	-4,421	-36%	11.7%
5	BAJAJ AUTO	3,643	2,196	1,447	66%	5.5%
6	HERO ELECTRIC	3,331	6,660	-3,329	-50%	5.0%
7	OKINAWA AUTOTECH	3,216	4,510	-1,294	-29%	4.8%
8	OKAYA EV	1,562	1,763	-201	-11%	2.4%
9	KINETIC GREEN ENERGY	848	1,643	-795	-48%	1.3%
10	BGAUSS AUTO	770	781	-11	-1%	1.2%
11	BATTRE ELECTRIC MOBLITY	651	81	570	704%	1.0%
12	GREAVES ELECTRIC MOBILITY	551	382	169	44%	0.8%
13	REVOLT INTELLICORP	523	1,139	-616	-54%	0.8%
14	PUR ENERGY	503	584	-81	-14%	0.8%
15	CHETAK TECHNOLOGY	370	2,346	-1,976	-84%	0.6%
16	KLB KOMAKI	345	402	-57	-14%	0.5%
17	BEING INDIA ENERGY	339	445	-106	-24%	0.5%
18	TWENTY TWO MOTORS	323	363	-40	-11%	0.5%
19	LECTRIX EV	320	188	132	70%	0.5%
20	WARDWIZARD INNOVATIONS	294	259	35	14%	0.4%
21	JITENDRA NEW EV-TECH	264	350	-86	-25%	0.4%
22	GOREEN E-MOBILITY	247	324	-77	-24%	0.4%
23	IVOOMI INNOVATION	225	192	33	17%	0.3%
24	HERO MOTOCORP	144	298	-154	-52%	0.22%
25	AMO MOBILITY SOLUTIONS	133	258	-125	-48%	0.20%
26	TORK MOTORS	83	88	-5	-6%	0.12%
27	DAO EVTECH	21	37	-16	-43%	0.03%
28	MEW ELECTRICALS	16	35	-19	-54%	0.02%
29	ULTRAVIOLETTE AUTOMOTIVE	9	36	-27	-75%	0.01%
30	ALL OTHER OEMs	1,063	1,068	-5	0%	1.6%
	TOTAL	66,466	86,185	-19,719	-23%	100%

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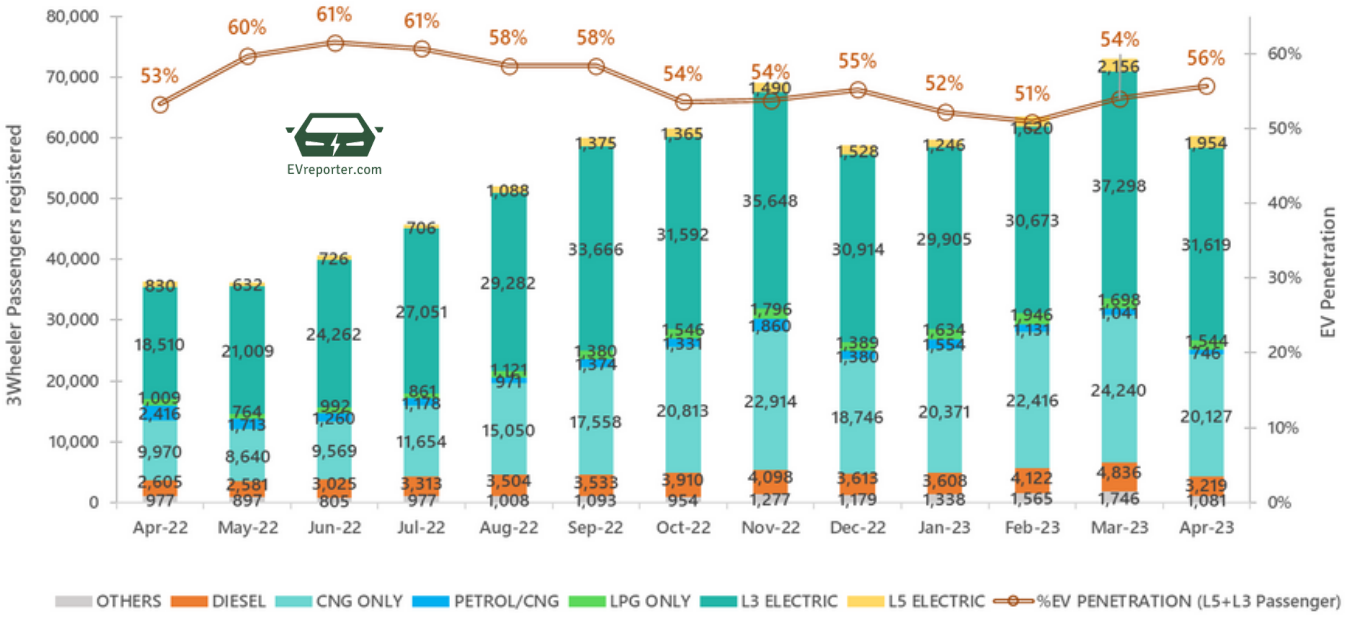
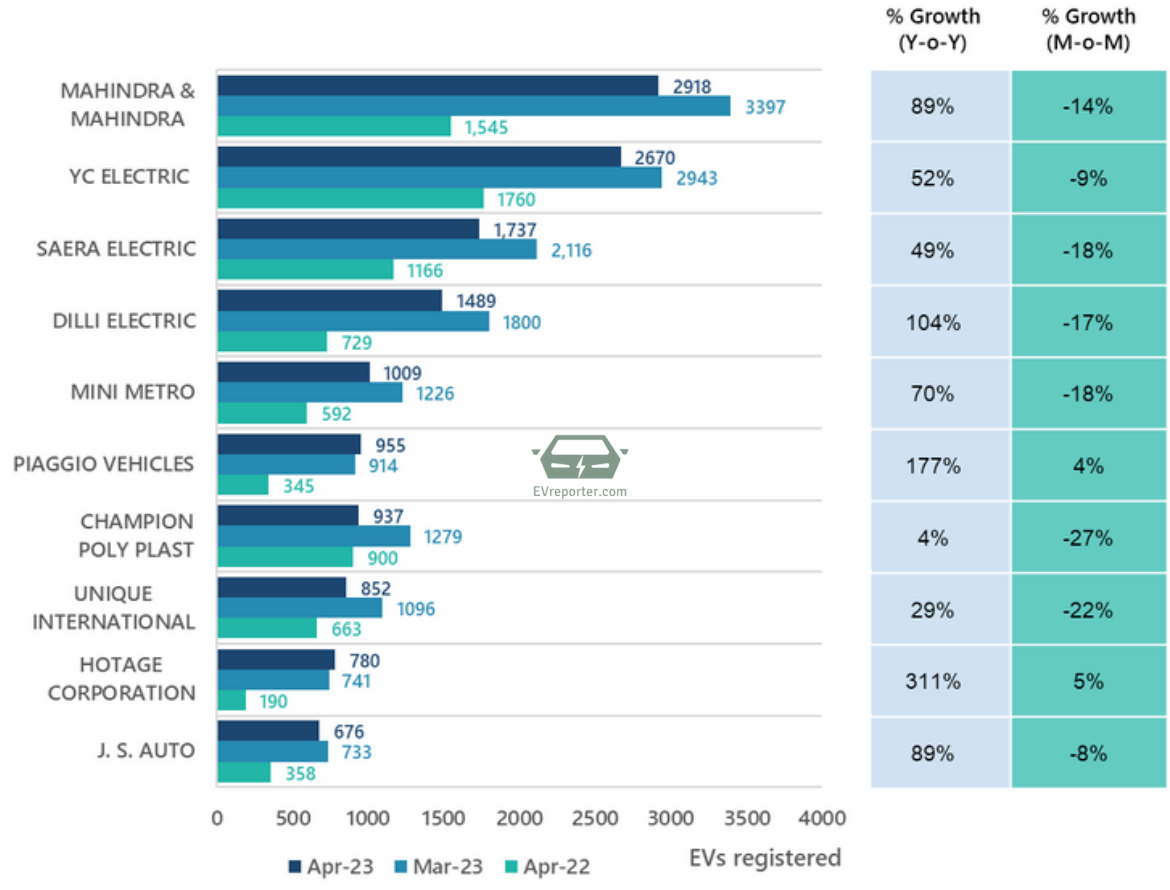
3W Passenger Sales Trend by Fuel Type, Apr 2022 - Apr 2023

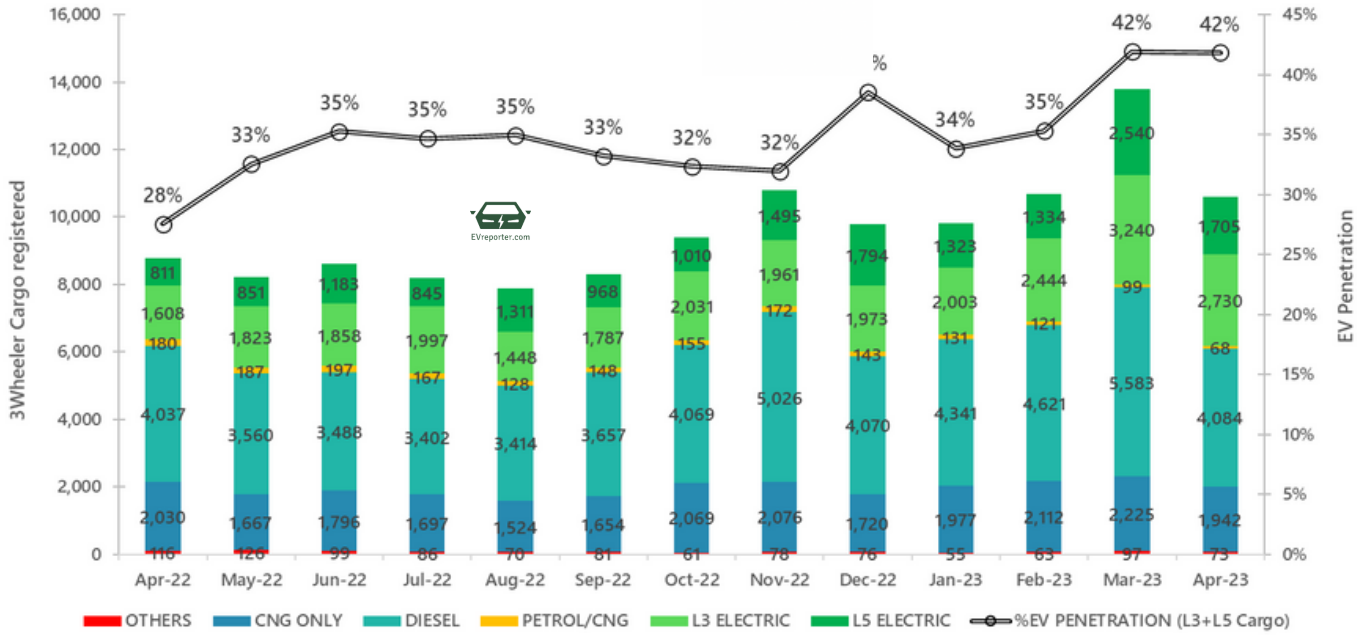


E-3W Passenger Sales Trend by OEM

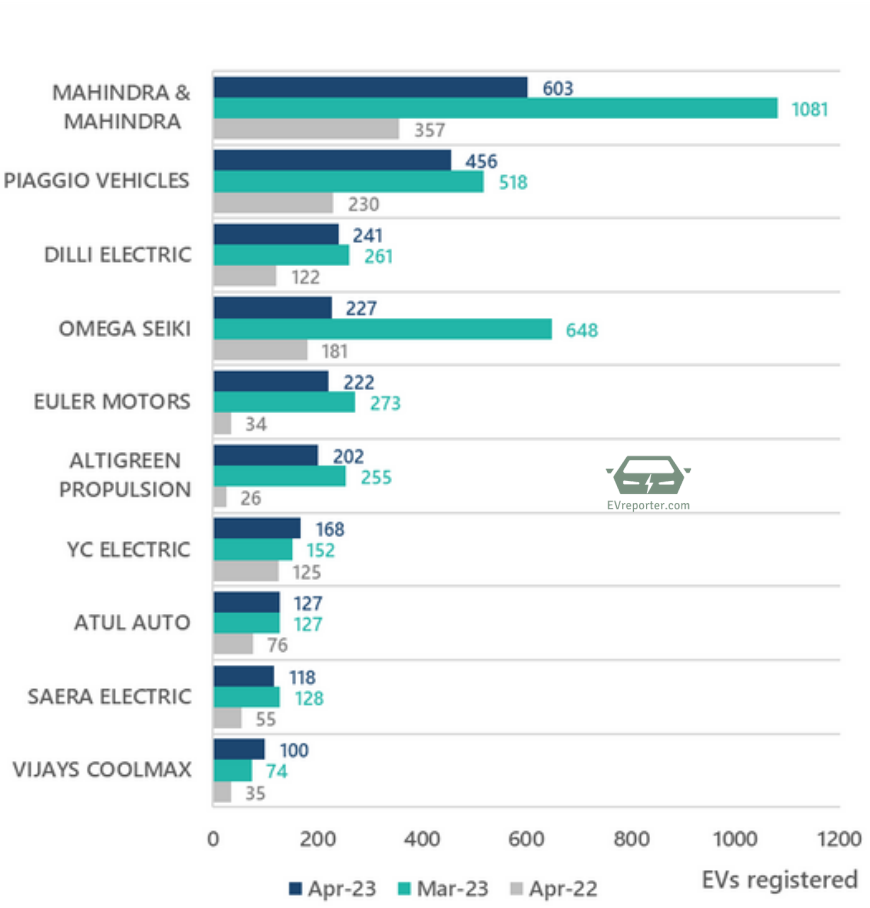


Source: Vahan Dashboard. Data as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs. The aim of these graphs is to represent an overall trend of the new EV registrations in India.

3W Cargo Sales Trend by Fuel Type, Apr 2022 - Apr 2023



E-3W Cargo Sales Trend by OEM



	% Growth (Y-o-Y)	% Growth (M-o-M)
MAHINDRA & MAHINDRA	69%	-44%
PIAGGIO VEHICLES	98%	-12%
DILLI ELECTRIC	98%	-8%
OMEGA SEIKI	25%	-65%
EULER MOTORS	553%	-19%
ALTIGREEN PROPULSION	677%	-21%
YC ELECTRIC	34%	11%
ATUL AUTO	67%	0%
SAERA ELECTRIC	115%	-8%
VIJAYS COOLMAX	186%	35%

Source: Vahan Dashboard. Data as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs. The aim of these graphs is to represent an overall trend of the new EV registrations in India.

OEM wise E- 4Wheeler Sales, Apr 2023

S.No.	Maker	Apr-23	Mar-23	Difference	% Change	Market Share Apr 2023
1	TATA MOTORS	4,388	7,279	-2,891	-40%	75.3%
2	MAHINDRA MOTORS	505	251	254	101%	8.7%
3	MG MOTORS	335	510	-175	-34%	5.7%
4	PCA AUTOMOBILES	229	208	21	10%	3.9%
5	BYD INDIA	154	292	-138	-47%	2.6%
6	BMW	60	55	5	9%	1.0%
7	HYUNDAI	51	47	4	9%	0.9%
8	KIA	34	22	12	55%	0.6%
9	OTHERS	72	101	-29	-29%	1.2%
	TOTAL	5,828	8,765	-2,937	-34%	100.0%

Others include JLR, Porsche, Audi etc.

Source: Vahan Dashboard. Data as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs.

OEM wise Electric Bus Sales, Apr 2023

S.No.	Maker	Apr-23	Mar-23	Difference	% Change	Market Share Apr 23
1	OLECTRA GREENTECH	32	24	8	33%	38%
2	PMI ELECTRO MOBILITY	16	6	10	167%	19%
3	JBM AUTO	13	0	13		15%
4	SWITCH MOBILITY	13	31	-18	-58%	15%
5	MYTRAH MOBILITY	10	12	-2	-17%	12%
6	TATA MOTORS	0	13	-13		0%
7	VE COMMERCIAL	0	1	-1		0%
	TOTAL	84	87	-3	-3%	100%

Source: Vahan Dashboard. Data as per 1350 out of 1436 RTOs across 34 out of 36 state/UTs.

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EV CHARGING CONCLAVE 2023

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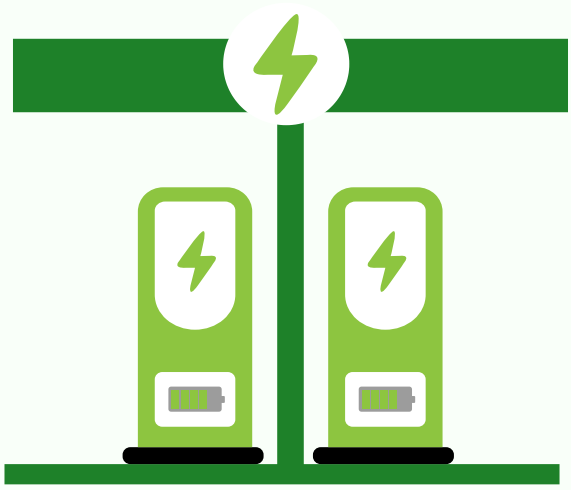
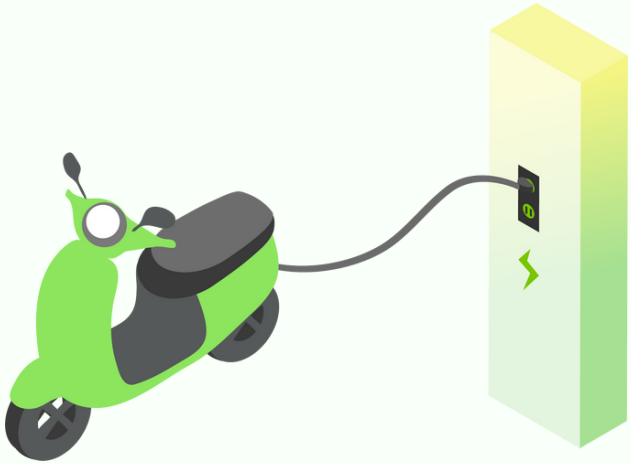
Demystifying India's EV charging space and its unique dynamics





30 May 2023 | 15:00 - 18:00 IST

LIVE WEBINAR

- State of EV charging infrastructure in India
- Charger roaming and interoperability
- Cybersecurity concerns & best practices
- Direction for battery swapping
- Domestic EV charger manufacturing

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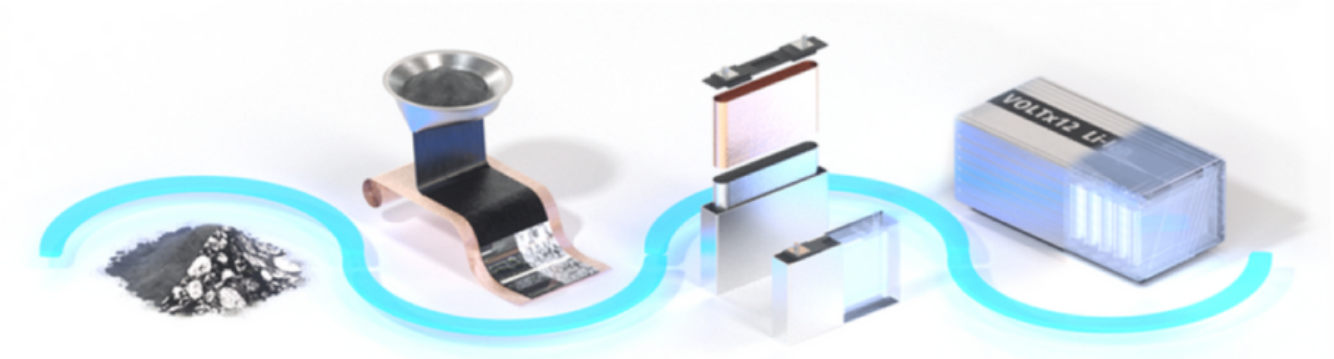
Non-Destructive Quality control of Li-ion Cells using CT scan



- Material Development
- Structural Development

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Cell Prodcution

Module Assembly

Cylindrical Cell

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NDT Characterization of Li-ion cell

- Internal Deformation of Jelly roll
- Overhang Measurement between Anode and Cathode
- Deflected or Bent Electrodes
- Tab and Welding integrity
- Electrode Peeling or Delamination
- Cap and Can welding integrity
- Safety vent mechanism

Observations about Global EV Sales performance in CY 2022

Source: Global EV Outlook 2023 by IEA

Global electric car sales exceeded 10 million in CY 2022

14% of all new cars sold were electric in 2022, up from ~9% in 2021. The number of available electric car models reached 500. Global spending on electric cars exceeded USD 425 billion in 2022. The report forecasts ~ 14 million electric car sales in 2023 globally, accounting for 18% of total car sales in CY2023.

More than half of 26 million electric cars globally on the road in 2022 were in China

Electric cars were sold at much cheaper prices in China than in Europe and the USA. The average price for a small battery-electric vehicle (BEV) in China was below USD 10,000, while in Europe and the USA, it exceeded USD 30,000. The most popular electric cars in China in 2022 were the Wuling Mini BEV and the BYD Dolphin, both models priced below USD 16,000.

In 2022, 35% of exported electric cars came from China

China's share of exported electric cars increased from 25% in 2021 to 35% in 2022, with Europe being its largest trade partner for both electric cars and batteries. Additionally, the percentage of electric cars produced in China and sold in the European market rose from 11% in 2021 to around 16% in 2022.

The commercial vehicle stock is seeing increased electrification

Global electric LCV sales were ~310,000, of which 130,000 were sold in China & 36,000 in Korea. In 2022, 66,000 electric buses and 60,000 medium & heavy-duty trucks were sold globally. Around 220 electric heavy-duty vehicle models entered the market, bringing the total to 800+ models offered by 100+ OEMs.

Global electric two-wheeler sales declined

Global electric two-wheeler sales totalled about 9.2 million in 2022, a drop of nearly 18% from 2021. This drop is almost entirely attributable to the dip in sales of electric mopeds and motorcycles in China, which fell from 10.2 million in 2021 to under 7.7 million in 2022. In terms of absolute volumes, sales grew in most other Asian markets, especially India.

India leads in sales of electric three-wheelers

India leads in electric 3W sales with 4,25,000 units followed by China with 3,50,000 units in 2022. Battery leasing business models and strong FAME II incentives boost Indian electric three-wheeler sales.

EVs are driving demand for batteries and related critical minerals

Automotive Li-ion battery demand increased by about 65% to 550 GWh in 2022, from about 330 GWh in 2021. The share of LFP chemistries reached its highest point ever, driven primarily by China: around 95% of the LFP batteries for electric LDVs and HDVs went into vehicles produced in China.

Battery chemistries are diversifying

New alternatives to conventional lithium-ion are on the rise. Supply chains for (lithium-free) sodium-ion batteries are also being established, with over 100 GWh of manufacturing capacity either currently operating or announced, almost all in China.

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XYRON™ modified polyphenylene ether [mPPE]

Higher class flammability

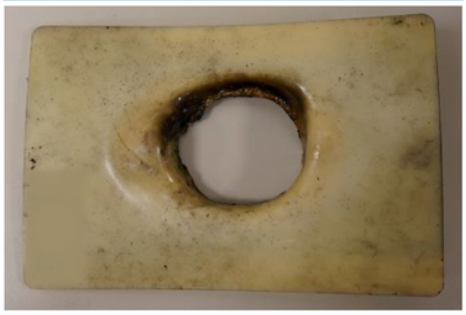
Great hydrolysis resistance

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

Typical PPE/PS (Non-FR)



Burn temp: 760°C
Burn time: 113s (1min 53 secs)
Burn through: Yes
Drip: Yes

Typical PPE/PS (V1)

Burn temp: 760°C
Burn time: 135s (2min 15 secs)
Burn through: Yes
Drip: No

XYRON™ 540Z (V0)

Burn temp: 760°C
Burn time: 514s **(8min 34 secs)**
Burn through: Yes
Drip: No

Testing conditions:
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

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	●	●	●
	1m drop test	Impact strength	●	●	●
	Direct/indirect contact of water	Impact strength (after aging) [1]	●	●	●
	Thermal shock test	Impact strength (after aging) [2]	●	●	●

Testing conditions:
Notched Charpy Impact
1 – Internal Method: -20°C to 85°C/85%RH for 10 cycles.
2 – AIS-156: -40°C to 80°C for 10 cycles.

● Excellent
● Good
● Poor

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SOFTWARE DEFINED VEHICLES AND VEHICLE CONFIGURATION MANAGEMENT

The automotive industry is undergoing a massive transformation, with software taking the driver's seat and reconfiguring the traditional automotive value chains. In this chat with **Shivalik Prasad - VP, Strategic Alliances & Sales at Sibros**, we discuss the increasing role of software in modern-day vehicles and its impact on the automotive ecosystem.

What services does Sibros offer to the automakers?

We are purely an automotive software platform that provides a software abstraction layer on any vehicle's electrical architecture. We deploy firmware on vehicles' Primary ECUs, such as telematics or gateway. We are able to harmonize all of the data flowing in and out of the vehicle. We can log all the CAN and non-CAN traffic existing inside a vehicle, which allows you to diagnose & predict things, see driver behaviour and enhance vehicle safety. You are also able to send remote commands and perform a full vehicle software update for all the ECUs. The solution works across all mobility platforms.

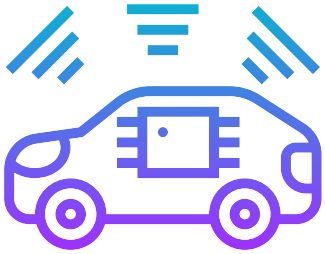
Who are some of the leading automakers deploying your solutions?

Globally, we are working with many OEMs predominantly in the US, UK, Europe, India and Southeast Asia. We are also entering the China and Japan market later this year.

In India, we are working with **Bajaj** for their electric vehicle platform **Chetak**. We are powering them with this harmonization software, configuration and OTA (over-the-air) update software. We also signed up with **Mahindra** recently. In addition, we are working with some German companies and a leading luxury OEM in the UK. We are deeply engaged with one of the big three automakers in Detroit to power their data collection systems. We are also working with many younger companies, such as Sono Motors.

Can you give us some examples of the use cases served by these solutions?

There are varied use cases across vehicle segments. For a two-wheeler, the OEM would like to know how the vehicle is vibrating above the speed of 100 km/h. While driving on a curve, what is the angle from the perpendicular so we know how low can the vehicle go based on the weight of the bike? For an EV, you would like to know how the battery's behaving if the ambient temperature goes above 45 degrees Celsius. From a consumer perspective, I would like to know how many times did I use the brake or my driving pattern on a given day or over a month.



Another use case example can be a fob key for a car. One can get a duplicate fob key made from the aftermarket. But with Sibros, the OEM can work with the supplier to get a new set of security settings for the key and put them on the cloud. The vehicle will sense that, download those new security settings and update the key. Resetting the key settings periodically makes it very difficult to hack or steal the car.

An ICE tractor company might want to change the engine ECU settings based on whether the tractor is working in a high-altitude region or a plain farming base. An EV company would like to see how the batteries are consumed in a cold climate, so they can optimise that. The software becomes a defining factor for different use cases as an OEM, fleet owner, and consumer.

What is a Software Defined Vehicle (SDV)?

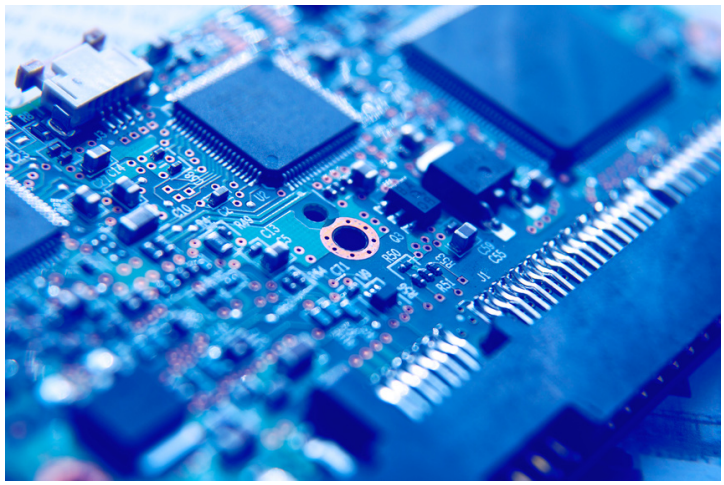
Traditionally, an automobile has been a mechanical product. Then we had a few ECUs (electronic control units) put in and then came along the CAN bus enabling communication across the vehicle. In older vehicles, when you pressed the brake, it was connected directly to the tail light along with the battery connection, and the tail light will turn on. Today, if you press the brake, it goes to a brake ECU that sends a message on the CAN bus. Through the CAN bus, the message is sent to the tail light, and it is turned on. So, it becomes a mechatronics system.

As the number of microcontrollers or chips in the vehicle is increasing, you can potentially manipulate or change the functionality using the software. e.g. if the wipers are on an ECU, you can change the wiper settings through a software update. **The ability to change the functionality of a vehicle using software makes it a software-defined vehicle.**

Most OEMs are putting more and more software components and larger ECUs in their vehicles. There are considerations of modem security settings, communication protocols and who handles which piece of the puzzle. We are going from a purely mechanical vehicle to a very sophisticated electronic or electrical system with a lot of in-built software technologies that will help hyper-personalize the vehicle.

What challenges do the OEMs face due to ECU-dominated vehicles?

The vehicles are becoming software-defined. Even a simple change to one ECU can have a ripple effect on other ECUs in the vehicle. For example, in an electric vehicle, the battery will naturally degrade over time, which means that the battery management system (BMS) settings need to be adjusted periodically. However, changing the BMS settings will also require adjustments to other parts of the vehicle (such as the drivetrain and infotainment for customer consent) to ensure everything remains in sync.



The OEM now has to take ownership of this process. It was first given to the tier-one suppliers of the ECUs, and every ECU was independent inside the vehicle. Now it's all coming together, and the OEMs need to learn to manage the software aspects as well as better coordinate with their tier-one suppliers. One piece of software change on one ECU might cause chaos unless handled properly. The embedded electronics aspect of things is hard because there are many different chip suppliers. Till now, most OEMs never bothered to find out which chipset or operation system version is running inside the infotainment system or any other component supplied by their tier-1 supplier. They are now getting into that level of detail to manage the software and electronics system better.

I think it is a 5-year long journey. The OEMs are in a transition phase, and everyone has their own strategy on how to go about it.

What kind of innovations can be expected in Vehicle Configuration Management going forward?

What does Vehicle Configuration Management mean?

Typically, a vehicle has a base trim, a mid-end trim and a high-end trip. You have a powertrain type, a left-hand drive or a right-hand drive, and then 8-10 colour options. So, broadly the OEM had to manage 30-35 combinations per vehicle platform.

Now with software coming in, the **OEM has to be able to configure every vehicle for a unique customer**. If I am living in a mountainous region, I may not need a long range, but I need better torque. Otherwise, my vehicle will not pull up the slope. So I need a different configuration. Someone might require a different infotainment language setting or a custom wiper setting. I may want my screen to look a certain way and only show the set of apps I want to pay for. **For the same trim, the OEM will need to manage a large number of vehicle configurations.** And as you start going to other countries, each country has its own homologation requirements. The complexity increases manifold, which is hard to manage for any OEM.

Sibros is able to work with the OEMs and help them with configuration management. OTA software updates and data collection are a part of the larger automated configuration management system.

Vehicle personalization and continuous data collection also bring up some concerns about privacy. How do you think that will play out?

This is a concern across the board. However, we can **take a cue from the banking system**. A bank has data on everything - your name, address and your finances, including income, spending patterns and the people you are transacting with. They use your data to upsell and cross-sell their services, but typically, they do not share the data with any third party.

The same thing will happen in the automotive world. OEMs will collect a lot of user data. As long as they keep it to themselves and use it to provide better value-added services to the consumer, it'll be okay. The moment they start trading it, it gets a little tricky. In Europe, the GDPR guidelines address these concerns. Similarly, CCPA guidelines in California take care of this. India does not have a data privacy law at the moment, though one is under discussion.

Honda Motorcycle & Scooter India Unveils EV Roadmap and Future Business Direction

3Es of HMSI EV Roadmap in India

1 FACTORY 'E' – DEDICATED EV MANUFACTURING FACILITY

- Establish a factory for EV production at HMSI's **Narsapura Plant** in Karnataka
- Aim to reach **one million annual EV production by 2030**

2 PLATFORM 'E' – DEDICATED EV PLATFORM

- A platform for **multiple EV types** - fixed, swappable battery, including mid-range EVs
- **Launch 2 EVs in FY 2024** under project Vidyut [Mid-Range EV and swappable battery]
- Swappable battery type to be powered by **Honda Mobile Power Pack e:**

3 WORKSHOP 'E' – EVS OF THE FUTURE WORKSHOP

- Equip the existing dealership network (6,000 touchpoints) with charging spots (HEID Battery Exchangers & charging cables)
- Battery solution for customers at petrol pumps, metro stations and other locations

In March 2023, Honda Motorcycle & Scooter India (HMSI) revealed its future business direction and electric vehicle roadmap in India.

Atsushi Ogata – MD, President & CEO, HMSI said -

"In line with Honda's global direction – to increase Electric Vehicle and Fuel Cell Vehicle unit sales ratio to 100% by 2040, we will continue to improve the efficiency of ICE engines with the ***introduction of Flex fuel engine and follow government direction for alternate fuels while expanding electrification of models and ecosystem.***

On the EV front, we are committed to building India's best EV Business structure. With our EV roadmap now in the execution phase, we are taking substantial steps towards creating exclusive infrastructure for manufacturing a diverse range of electric vehicles. Parallelly, we are also investing in the development of EV technologies, charging infrastructure and after-sales services".

Future Business Direction for FY24

- Complete model line-up transition to OBD2 by first half of FY24
- Expand exports to 58 countries with 20 models and provide power trains for the Global market from HMSI's Gujarat Plant
- New scooter assembly line (6 lac capacity) at Vithalapur Factory (Gujarat)

BEST PRACTICES IN LI-ION CELL QUALITY CONTROL AND PACK MANUFACTURING

Delhi-based **Inverted,** founded in 2017, started supplying EV battery packs in early 2020. Today, it is one of the leading suppliers of Lithium-ion battery packs for light electric vehicles in India and also caters to stationary energy storage applications. In this chat with the co-founder **Raghav Jain**, we discuss the best practices for battery pack manufacturing and ensuring battery performance and safety.

What is the current scale of operations at Inverted for e-mobility applications?

For e-mobility applications, we largely focus on the electric two-wheeler and three-wheeler vehicles. At present, every month, we supply about **10,000 battery packs for e-2Ws, 1000-1500 packs for the e-3W L3 category and ~ 200 for the e-3W L5 category**.

What was the most challenging part about ensuring compliance with the latest AIS -156 amendment 3, phase 2 standard for battery safety?

AIS 156 Amendment 3 is a welcome step, which was desperately needed to build greater reliability and safety in battery packs. There were many such initiatives that we were already working on, so when the notification came, we were well-prepared for most of the requirements.

However, one requirement took us by surprise. **As per the standard, the batteries need to be able to withstand a temperature of 300 degrees celsius - if the thermal runaway happens, the propagation should not spread to the other neighbouring cells**. To fulfil this requirement, we explored multiple thermal management solutions suitable for the Indian context. It took us three months of rigorous testing in our R&D lab to fine-tune and figure out the right solution from a mass production perspective. The solution that we have now implemented is technology agnostic and suitable for any battery chemistry, including NMC and LFP.

What are the best practices for battery pack manufacturing that you follow?

There are four broad facets to be considered while designing a battery pack.

- **Mechanical design** - The mechanical design should ensure the structural strength and stability of the battery pack. The pack should be able to handle the various vibrational impacts it is subjected to. We subject our battery packs to extensive 3G vibrational testing to ensure structural integrity even in the harshest conditions.

- **Thermal management** - The thermal management system of the pack should be able to keep the battery temperature as close to the ambient temperature as possible. The heat dissipation from the centre of the cell needs to be as optimally managed. The design of the thermal solution is highly dependent on the cell chemistry, e.g. when an LFP cell is discharged at high C rates, the temperature increases; however, the delta T is relatively lower than in the case of NMC cells.

Our thermal management solution is designed to ensure that the thermal conductivity of the material we use is managed appropriately and we can dissipate the entire heat. In electric two-wheelers, we use extrusion. Whereas, in L5 battery packs, we use die casting because the cross-section is relatively wider.

- **Electrical aspect** - Our electrical design ensures that the internal resistance, ACIR and DCIR are optimally managed.

- **Electronics aspect** - We ensure that we use the right communication protocol to get the data at the highest frequency and capture all the data parameters of the battery pack. We also work very extensively on the SOC (state of charge) estimation of the pack and rely on data to fine-tune our SOC logic.

Moreover, we do not rush the process of design and exhaustively look at all four aspects before moving to production. We have put in place proper DFMEA and PFMEA systems to take all failure modes into consideration while designing the battery pack.

What is your quality control process for cell procurement?

We follow a rigorous six-month evaluation process before onboarding any cell supplier.

We get a thousand samples from a new potential cell supplier, which are subjected to lifecycle testing. This accelerated testing for about thousand-plus cycles tells us what kind of capacity retention the cells have in ideal conditions. Then we subject the cells to various C rates and different conditions simulating the actual usage scenario. This is done for 50 cycles to see the deviation between the IDC curve and the real conditions. The cells are also subjected to another set of tests, including a crush test, drop test and nail penetration before we approve them for the intended application.

Before deploying for mass production, we subject all the cells to a hundred per cent grading as per capacity, voltage, and IR. So, we can see if there is any deviation from this sample cell, and we refrain from working with that particular cell supplier. Also, we ensure that we work with highly reputed manufacturers, so there's a limited deviation from the specifications.

In the last three years of supplying battery packs, what kind of shift have you noticed in the OEM / industry approach to battery pack selection?

If you look up battery packs sold in 2020, they were extremely rudimentary.

Initially, most people looked at batteries as a standalone product and not in the context of the vehicle. However, now OEMs are way more selective in their approach. The industry has significantly moved forward, and people are talking about vehicle integration testing, lifecycle testing and thermal solutions. OEMs care about details and ask questions, such as which connectors are being used.

This is a significant shift in the approach, and companies are conscious of finding the right battery pack for their applications, which seldom happened before 2020. Now, there is also greater awareness at the consumer end, who are asking tough questions. So automatically, there is greater awareness in the ecosystem overall. Additionally, the latest battery standards by MoRTH are driving the industry towards understanding the battery pack in depth.

Do you also manufacture the BMS in-house?

When we started out, we were using imported off-the-shelf BMS available in the market. However, in the last 18 months, **we have developed our own battery management system on the 18s platform (batteries built on a 48V or a 60V platform)**. For anything which is above the 18s platform, we are dependent on an external vendor for BMS as of today.

However, we are committed to having our own design for the battery management system. We intend to indigenize the BMS across the range of batteries we make and handle the design and component selection ourselves. We are working on a deep SOC/SOH algorithm, and we want to embed the same in the BMS.

Tell us about your focus on building in-house capabilities in battery manufacturing.

We are focused on developing in-house capabilities for everything apart from the cell, whether it is the extrusion, die cast, thermal material, the BMS or the busbars. We have already indigenized most of the battery pack components and aim to indigenise the rest in the next couple of months.

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IS ELECTRIC VEHICLE REPAIR THE NEXT BIG THING?

The electric vehicle (EV) market in India is set to grow significantly in the coming years, with the government's focus on promoting EVs as a key component of its climate change action plan. According to a report by Bloomberg New Energy Finance, about a third of the vehicles sold in India will be electric by 2030. ***However, the infrastructure for repairing and servicing EVs & EV batteries is lacking.***

Venkat Rajaraman, CEO of Cygni Energy*, believes that there is a huge opportunity for the EV repair industry to develop and become the next big thing, especially in the two-wheeler and three-wheeler space.*

Key differences between EVs and ICE vehicles with respect to service requirements

- One of the key differences between EVs and traditional Internal Combustion Engine (ICE) vehicles is the warranty period. **EVs usually come with a longer warranty period compared to ICE vehicles**, primarily due to the fact that EVs have fewer moving parts, which means there are fewer things that can go wrong. For example, the Tata Nexon EV comes with an eight-year warranty for the battery and motor, which is much longer than the standard three-year warranty for ICE vehicles.

- Another key difference between the two kind of vehicles is their **battery servicing requirement**. The traction battery in an EV is a critical component that requires specialized care. The battery pack needs to be regularly inspected and serviced to ensure it is functioning optimally, and any issues need to be addressed immediately.

OEM recommendation for the care of EV battery pack

In general, EV OEMs may recommend an annual or bi-annual inspection of the battery pack, which may include checks for any physical damage, leaks, or abnormal wear, as well as diagnostic testing to ensure the proper functioning of the battery management system and cells. The OEMs may recommend a more frequent inspection if the EV is subjected to extreme conditions, such as high temperatures, frequent fast charging, or heavy use. It is important to follow the manufacturer's recommended maintenance schedule to ensure optimal battery performance and safety.

The need to supplement OEM after-sales support with independent EV repair services

Supplementing EV OEMs' predictive maintenance and after-sales support with independent EV repair services can provide a more comprehensive and accessible range of options for EV owners, contributing to the growth and sustainability of the EV industry.

There are several reasons why the predictive maintenance and after-sales support provided by EV OEMs may need to be supplemented with independent EV repair services, such as:

- The cost-effectiveness of servicing, especially for out-of-warranty parts
- The need for customised solutions
- Service unavailability - **there is a long tail of OEMs, especially in the light EV space**. Most of them don't have a widespread network and flexibility in terms of scheduling repairs.

EV service | Issues to watch out for

EV service is a unique landscape to begin with, even without the repair debate. Fixes will require unique tools and equipment, and there are few technicians specialised in EV repair right now, indicating more time and expense to fix them, at least in the near term. As the EV segment grows, service is growing to be a 'make or break' part of the ownership experience.

However, there are a few issues that need to be watched out for. EV technicians are more like electricians than mechanics and require specialized knowledge and skills - which means there is a need for standardized training and certification programs to ensure that technicians are properly equipped to handle EVs. A vehicle's onboard diagnostics (OBD) is useful to grab info from, but with EVs, the mechanics also need access to more telematics information. **Data sharing via the VCU and cluster panel is tricky as there is no standard today. EV tires also need special attention.** EVs are modestly heavier than the equivalent ICE vehicle. This means that you need tires with a higher weight rating, or they will wear out faster. EV drivers take advantage of the incredible acceleration of their EV for sporty driving and use up rubber faster that way.

EV battery service

In order to maintain the performance of an EV battery, it is important to regularly monitor and repair the battery as needed. However, the lack of infrastructure for EV battery repair services, particularly true for two-wheelers and three-wheelers, is a hindrance to the adoption of EVs in the country.

During the early adoption phases of EVs in India, battery packs were mostly imported, making repairs and replacements difficult and expensive while resulting in longer vehicle downtime and higher costs for consumers. Moreover, imported batteries and BMS make it difficult to source parts and repair services locally. This means that **EV owners often have to rely on unlicensed repair shops or third-party service providers**, which can compromise the safety and performance of their vehicles. Battery servicing requires specialized knowledge and equipment, which most traditional auto repair shops do not have.

To address these challenges, there is a need for a comprehensive network of repair services for EV batteries in India, particularly for two-wheelers and three-wheelers.

- *This network should include authorized repair centres that are equipped with the necessary tools and expertise to repair and replace EV batteries.*
- *In addition, there is a need for **greater collaboration between EV manufacturers and repair service providers.** This could include providing training and certification programs for repair technicians, as well as developing standardized protocols for battery repair and replacement.*

Meeting EV owners' expectations

As a repairer of electric vehicles, product knowledge and understanding exactly how the vehicles are built and being able to talk intelligently about them is key. Customers can see most of the things that a technician is doing - they know where the vehicle is at any given time and how much range it has. A sure-shot way to make an EV customer angry is to leave their vehicle at a low state of charge. Repairers need to think about installing charging infrastructure in their shops to charge any EV.

Electric vehicle owners have a different set of expectations from their service centre as compared to ICE vehicle owners. EV owners are more likely to be digital natives who are more comfortable with technology. They use their mobile device as a key to their vehicle and are not afraid to use the internet to educate themselves on how their vehicle should work.

Emergence of multi-brand service outlets

To address the gaps in the market, several multi-brand service outlets with a focus on EV repair have emerged. These outlets provide specialized services for EVs, including battery servicing and repair, and are equipped with the necessary equipment and expertise to handle EVs. Most of these start-ups are working on an online platform where one can search for a mechanic based on EV brand make/model, select a location, and choose a mechanic. The mechanic can provide the needed services, and the customer can track the status using a mobile app.

The number of EV OEMs in the 2W and 3W categories has seen a spectacular rise in the last few years. According to the Vahan dashboard, there are **100+ OEMs selling electric 2Ws and 300+ OEMs selling electric 3Ws** in the Indian market. Only a handful of these players are focused on establishing a branded service and repair network for after-sales support. Multi-brand service outlets **with due collaboration with OEMs** could be a practical way forward.

Conclusion

The growth of the EV market in India presents a huge opportunity for the EV repair industry, particularly in the 2W and 3W segments. With the increasing popularity of EVs and the longer warranty periods, **specialized multi-brand outlets that offer battery servicing and repair are set to become the go-to places** for EV owners. There is a need for a comprehensive network of authorized repair centres that are equipped with the necessary tools and expertise to repair and replace EV batteries. However, it is important for the industry to address issues such as the lack of standardized training and certification programs for EV technicians and to ensure the safety of EVs so that the growth of the EV repair industry is sustainable in the long run.

About the author

Venkat Rajaraman is the Founder/CEO of Cygni Energy, a leading storage technology company with cutting-edge expertise in EV Batteries (2W & 3W) and Energy Storage Systems (Telecom etc.). Cygni has deployed over 125MWh of storage solutions and powered over 100,000 EVs. Cygni currently has a fully automated battery manufacturing facility at Hyderabad with automated cell sorting, laser welding, cell characterization and End-of-Line (EOL) testing. Cygni's new Greenfield project is currently underway, which supports a capacity of 1200MWh.

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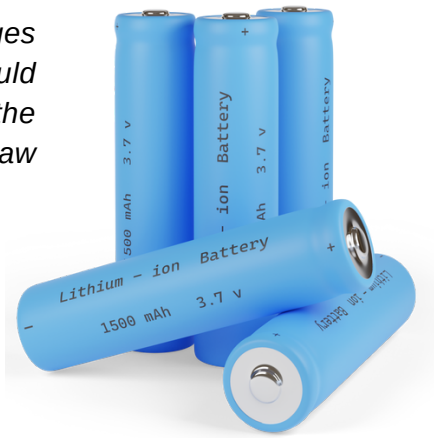
CHALLENGES DURING LITHIUM-ION CELL MANUFACTURING PLANT SETUP - PART 3

POSSIBILITY OF LOCALISATION AND SECURING RAW MATERIALS

Rahul Bollini is writing a series of articles explaining the challenges faced during Lithium-ion cell manufacturing plant setup, which should be relevant to any company entering this field. This article (part 3 of the series) discusses the challenges faced during securing the raw materials for the Lithium-ion cell manufacturing plant setup.



Any company setting up Lithium-ion cell manufacturing will work towards securing the raw materials and look for possible options to localise its supply chain. **Below is the list of the components that go into manufacturing Lithium-ion cells, the challenges in locally sourcing these raw materials in India and the possible supply chain-related issues.**

- **Cathode Active Material -** Lithium Iron Phosphate (LFP) cathode uses raw materials that are easier to source as compared to other cathode materials. LFP cathode is made of a combination of Iron Phosphate (FP) precursor and Lithium Carbonate. The FP precursor is made of a combination of Iron Oxide and Phosphoric Acid. The acquisition of these materials is simpler as compared to Nickel and Cobalt in Sulfate form (battery grade) and converting them into precursor as per NMC or NCA ratio requirement and then adding Lithium Carbonate or Lithium Hydroxide. The focus is on LFP because it simply works out to be cheaper, lasts long, needs lesser thermal management and is safer than the other cell chemistries out there (except LTO).

- **NMP Solvent (solvent for cathode slurry) -** NMP (N-methyl-2-pyrrolidone) solvent is already produced by companies catering to the pharmaceutical industry. Most (>90%) of the NMP is recovered during production through an NMP recovery system (which has heavy power consumption, but it's unavoidable for Cathode Slurry production with present technology). Recovered NMP is reused, so the procurement requirement for future production becomes much lower.

- **PVDF (cathode binder) -** PVDF binder localisation takes time. In fact, even China (with many years of established Lithium-ion cell manufacturing industry) took many years to make a decent PVDF binder but still lacks the kind of performance that one can expect from the binder manufactured by Western countries. A cell manufacturer has to pick whether they want to go with suspension-based or emulsion-based binder material. There are no obvious favourites when it comes to choosing one. There was a shortage of binder in 2022, and the price shot up multiple times. **As long as PVDF binder is used for cathode slurry making, NMP solvent is the only way to make slurry because PVDF has a hard time dissolving in water.**

- **Conductive Carbon Additive (for Cathode and Anode) -** There are top companies in the West that stand out when it comes to conductive carbon. A few companies have been focussing on conductive carbon additives for lead-acid batteries. Although the properties vary, localising this in any country shouldn't take very long.

- **Anode Active Material -** Graphite (Natural and Synthetic) is about achieving the purity, particle size and certain other critical parameters right. The plant setup cost is also not very high and can be localised comparatively easily. However, when it comes to Silicon-Graphite (Si-Gr)/Silicon-Carbon (Si-C) anode, things become complex because it is a quickly evolving technology. An increase in the silicon content will result in a significant increase in the specific capacity of the anode material. LFP cell manufacturers are very much working with only Graphite, but NMC 811 and NCA work with SiGr/SiC and have to be more careful about their procurement. **Petroleum coke, which is used to make synthetic Graphite, is among the cheapest in India,** giving India an edge to become a market leader in this space.

- **Solvent for Anode Slurry (Deionized Water) -** Water is processed in a deionized water filter to make it suitable for use in Anode Slurry. It can be produced in the cell manufacturing plant.

- **Anode Binder [Carboxymethyl Cellulose (CMC) and Styrene Butadiene Rubber (SBR)] -** These materials are already locally manufactured, but they need some more work to match the battery grade specification.

- **Separator -** It is the only plastic-based material in the list of major components of a Lithium-ion cell. Choosing a separator from available options can be complex. The most basic type is **Dry process-based PP (polypropylene) separator**, which is the easiest to localize. It also happens to be the least expensive and is commonly used in LFP cells. However, things get complicated when cell manufacturers want to differentiate themselves and decide to step up to other separator options. The alternatives include dry process-based PP separator with ceramic coating (one or two sides), wet process-based PE (polyethylene) without any coating or with ceramic coating (one side or two sides) along with or without PVDF coating. **Dry PP separator with ceramic coating** can be the next easiest type of separator to localize. However, the production of wet separators may require significant capital expenditures that are only justifiable when catering to a large number of high-capacity cell manufacturing facilities.

- **Electrolyte Salt in EC (Ethylene Carbonate) and other Carbonate-based organic solvents along with additive(s)** - To localize electrolyte production, the initial step involves importing the necessary salt and formulating the electrolyte locally. This is a preferred method and doesn't involve much complexity. The second step of localization would be to manufacture the electrolyte salt domestically, which would require importing Lithium Hydroxide Salt. Organic solvents for electrolyte making are available locally, and localization of electrolyte additives, such as Vinylene Carbonate (VC), Fluoroethylene carbonate (FEC) etc., would be another great step. Due to the risks involved in transporting the complete electrolyte solution, it is highly advised to start with the first basic step immediately.

- **Cathode Current Collector (Aluminium Foil) -** Any local aluminium foil manufacturer who can make foils as low as 10-micron thickness with a high level of consistency would be suitable to work with.

- **Anode Current Collector (Electrodeposited Copper Foil) -** The plant setup for anode current collector can be very expensive because of the electrodeposition method of manufacturing copper foil. Such a high CAPEX plant is only justified when the plant caters to a large number of big-capacity cell manufacturing plants. Until then, it has to be imported. Furthermore, it is anticipated that there will be a copper shortage in the near future due to its rapidly increasing demand in multiple industries. Hence, it is imperative to secure this essential raw material.

- **Cathode Tab (Aluminium) -** Cathode tab comes in rolls and can be made available locally. Shapes and dimensions vary for each form factor (cylindrical, pouch and prismatic).

- **Anode Tab (Nickel Coated Copper) -** Anode tab can also be procured locally. Shapes and dimensions of the tab vary for each form factor (cylindrical, pouch and prismatic). It's crucial for the Nickel coating to be consistent to prevent any performance issues. Any coating that comes off during charging or discharging can cause problems.

- **Nickel-Coated Stainless Steel/Aluminium Cylindrical Can Assembly Kit for Cylindrical Cell -** Until recently, cylindrical cells have typically been housed in nickel-coated stainless steel cans. However, there is now a growing demand for aluminium cans to be used for cylindrical cells. There is a difference in their tabs, and according to the preference of welding, the type of metal for cylindrical can is selected. For example, an aluminium can not be grooved like a nickel-coated stainless steel can, so its cap is different. Moreover, it comes with laser welding-friendly tabs on both ends. But aluminium cans tend to experience dents. On the other hand, nickel-coated stainless steel cans are friendly for spot welding (a method favoured by many in the industry due to ease of operation).

- **Aluminium Prismatic Can Assembly Kit for Prismatic Cell -** Prismatic cans are made of aluminium with high strength to withstand any bulging that tends to happen with ageing. But the bulging does show up eventually. The cap of the prismatic can has a flat type tab, which is generally made for laser welding purposes. But with special orders, it is also made to be threaded. Localisation for this needs careful validation before mass deployment.

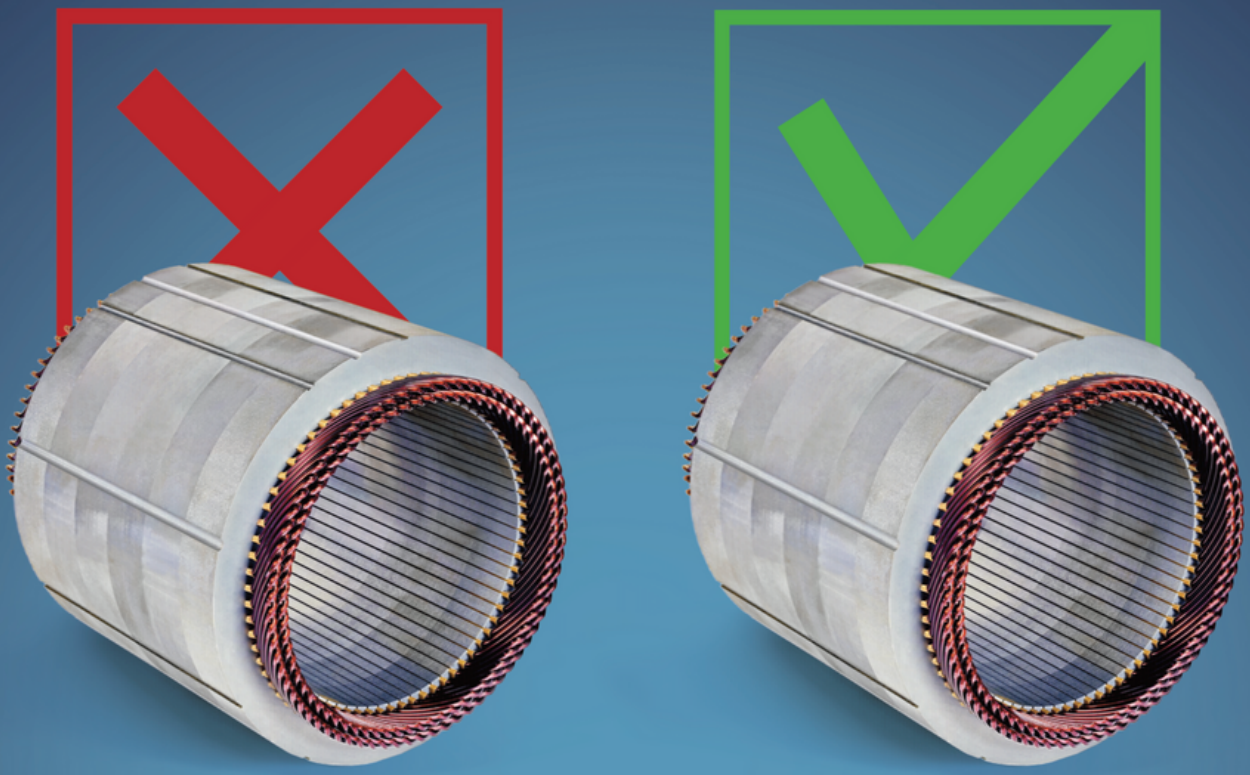
- **Aluminium Laminated Film for Pouch Cell-** Easiest of the three casings to manufacture, it has a multilayer of materials combined together. It is made in sheets and sold in square meters. It is customised according to the requirement.

Note - All metal-based products *(Cathode Current Collector, Cathode Tab, Anode Tab, Assembly Kit for Cylindrical Cell, Prismatic Cell and Aluminium Laminated Film for Pouch Cell)* ***can be localised*** *comparatively easily. The only exception is Anode Current Collector (Electrodeposited Copper Foil) due to commercial viability and very high CAPEX.*

Upcoming parts of this series:

- Part – 4 (Plant Setup Planning)
- Part – 5 (Process Optimisation and Skilled Man Power)
- Part – 6 (Expansion and Diversification of Portfolio)
- Part – 7 (Evolving to Newer Technologies)
- Part – 8 (Backward Integration)

Rahul Bollini *is an R&D expert in Lithium-ion cells with 8 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. Rahul can be reached at +91-7204957389 and bollinienergy@gmail.com.*



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THE ROLE OF ALUMINIUM IN THE ELECTRIC VEHICLE (EV) INDUSTRY

Aluminium is incredibly important to the development of sustainable and energy-efficient transportation solutions. From EV batteries to body construction, this versatile metal plays a critical role in the development of EVs, thanks to its lightweight, high-strength, and low-cost properties.

Sayan Dey from **Bhoruka Fabcons,** a downstream aluminium company that manufactures EV battery casings, highlights some of the prominent applications of aluminium in the EV ecosystem.

The Global EV Outlook 2023 by IEA forecasts **~ 14 million electric car sales this year**, accounting for 18% of total car sales in CY2023. The demand for EVs is growing worldwide across vehicle segments, and aluminium is becoming increasingly important in the production of these vehicles.

As per CRU, **the combined requirement of aluminium extrusion and sheet metal for EVs worldwide will be almost 10M tonnes by 2030 and extrusion demand will be around 2M tonnes.**

Aluminium is a cost-effective and environmentally friendly material, making it an ideal choice for EV manufacturers. Unlike traditional internal combustion engine vehicles, which rely on heavy steel frames, **EVs require lightweight materials** to maximize efficiency and range. Aluminium meets these requirements by providing strength and durability while minimizing weight. One of the most significant advantages of using aluminium in EVs is that it is a highly **recyclable** material. In fact, up to 90% of aluminium can be recycled, making it one of the most sustainable materials in the automotive industry. This recyclability feature allows automakers to reduce their carbon footprint and help to conserve natural resources.

Some prominent applications of aluminium in the EV ecosystem are as below:

Battery pack enclosures

One of the most significant ways aluminium is used in EVs is in battery pack enclosures. Aluminium is lightweight, durable, and has excellent thermal conductivity, making it an ideal material for battery casings. It is crucial to ensure that the batteries are well-protected at all times. Regulations such as AIS-156 Amendment 3 demand the utmost safety of these battery packs. According to BNEF, **aluminium demand for batteries (including battery enclosures) will reach about 1.9 million tonnes/year by 2030**. For the 4W segment, the battery assembly makes up 25% of the vehicle weight. For instance, a 60kWh to 100kWh battery unit can weigh from 350kg to 600kg. Therefore, lightweighting becomes a major driver for choosing Aluminium.

Most **swappable batteries use aluminium extrusion** technique to manufacture the battery casings. Other techniques would be **sheet metal processing, pressure die casting and gravity die casting**. In addition, aluminium is also used in battery conductors, crash structures, housing trays, cooling systems and terminals. Furthermore, the use of aluminium in battery technology is also essential for reducing the overall weight of the vehicle and making it more range efficient.

Body construction

Another crucial area where aluminium is used in the electric vehicle industry is body construction. EVs need to be lightweight to reduce energy consumption. **Aluminium is nearly as strong as steel but significantly lighter**, making it an ideal material for constructing EV bodies. In addition to weight reduction, aluminium is also highly **durable** and **resistant to corrosion**, making it an ideal material for use in harsh environments.

The use of aluminium in EV body construction is driving innovation in the industry, with manufacturers designing vehicles that are both lightweight and strong. **According to BNEF, the average aluminium extrusion content will increase from the current ~65kg/BEV to ~80kg/BEV by 2030.** BEV stands for Battery Electric Vehicle.

Charging infrastructure

For the success of EV adoption, having a robust charging structure is critical. BAAS (battery as a service) companies, charge point operators and vehicle manufacturers are investing in building charging and swapping stations. It is reported that around 20 lakh charging stations are required to cater to 5 crore electric vehicles by 2030. **According to AluMag, around 45% of charging station producers use aluminium for housing.** The use of aluminium will further accelerate with changing price sensitivity in the market, especially the Indian market.

Leading aluminium companies around the world, such as **Hydro**, use **aluminium extrusion housing solutions for charging stations**. The extrusion-based design is not only strong and durable but also cost-effective as it integrates components such as heat sinks, screw ports and other profiles, thereby eliminating post-process activities such as milling and welding.

Conclusion

India has a net zero target of 2070, while some countries have this target set to as early as 2045. Aluminium application in EVs can be a significant contributor to this journey. Aluminium is a highly recyclable material, with **over 75% of all aluminium ever produced still in use today**. Furthermore, the lightweight and durable nature of aluminium means that EVs made with this material require fewer resources to manufacture, resulting in a lower carbon footprint. As the demand for sustainable and environmentally friendly EVs continues to grow, the use of aluminium in their production will only become more critical.

In conclusion, aluminium is an essential material in the EV market, playing a vital role in battery technology, body construction, infrastructure and driving sustainability. As the demand for sustainable and efficient EVs continues to increase, the use of aluminium in their production will only become more critical.

We must also note that the opportunities for extrusion in the EV space are immense. But **limitations exist within Indian extruders in terms of die development and press sizes**. **China's prices are nearly 8% lower than India, with added benefits of export subsidy by China.** For these reasons, localization of products becomes a challenge for companies. It is important for Indian extruders to invest in technology, form consortiums, and develop collaborations with research institutes to improve on technology and cater to the burgeoning market.

BFPL has expertise in aluminium battery casings and caters to prominent EV battery manufacturers in India. They can be reached at marketing@bhorukafabcons.com

Power Finance Corporation, a Maharatna company and the leading NBFC in the Indian power sector, has sanctioned a loan of ₹633 crores to Gensol Engineering Ltd to purchase 5,000 passenger EVs and 1000 cargo EVs. The passenger EVs will be leased to Blusmart Mobility to expand its fleet of ride-hailing cabs. The first tranche of the loan has been disbursed, and the first lot of EV cabs has hit the roads of Delhi.

BluSmart Mobility has also raised an equity round of $37 million and venture debt of $5 million. Company founders and leadership team contributed nearly 50% of the capital raised. Entrackr reported that the start-up aims to increase its fleet size to 10,000 in FY24 from the current strength of 3,500.

EV Financing platform Ohm Mobility has raised INR 3 crore in pre-seed funding led by Antler India. The latest round also saw participation from Blume Founders Fund and angels such as Sagar Gubbi (Ecoforge), Anshuman Bapna (Terra.do), Mathew Chako (Spice Route Legal), and Karishma Menon. Ohm is also backed by Catalyst Fund - a FinTech and Climate Finance accelerator and angel investors like Kunal Shah.

Ohm's tech platform went live in April 2023 and has since facilitated over 5Cr ($625k) of financing, said a company statement. Currently, Ohm's client portfolio includes Race Energy (battery tech), Eveez (EV Fleet), Hala Mobility (E-MaaS platform), etc.

Kazam has raised $3.6 million in a round led by Avaana Capital Climate Fund. Other investors include Third Derivative and existing investors Inflection Point Ventures and We Founder Circle. Kazam offers a white-labelled suite of software designed to handle the end-to-end energy flow from the grid to the vehicle and its consumption.

According to a company statement, the platform manages 150,000 kWh of electricity per month, with 10% of contribution by its clients in the USA, Europe and Asia-Pacific. Kazam's immediate plan is to integrate 60,000 charging and swapping stations with its operating system in the next 15 months. The start-up has 7,000+ charging points under management and partnerships with two USA CPOs, managing 3,000 vehicles.

Chennai-based EV start-up Raptee has raised INR 3.27 crore as a grant from ARAI. Raptee is one of those ten start-ups from the MSME sector that have received the grant. The company plans to use the newly generated funds to develop the high-voltage motor controllers needed for its motorcycles and design its motorcycle models.

EV components startup NYSHA MOBILITY TECH raised USD 3.5M in a seed funding round, which consisted of **equity and debt**. Touchstone Ventures, Panthera Peak Capital, and a few family offices and angel investors participated in the round.

The company has opened its first manufacturing facility in Nelamangala, Karnataka. Nysha has more than 40 clients, including SUN Mobility, Ola Electric, Pranav Vikas and Virya Mobility 5.0, and targets to onboard over 100 customers in 2023.

Mufin Green Finance, a listed NBFC with 100% EV Portfolio, announces investment in an EV servicing startup EV Clinic. As per the release, "EV Clinic promises to be a one-stop solution for all service requirements of e-cycles, e-2wheelers and e-3wheelers. In addition, EV Clinic has entered into collaboration with various domestic EV OEMs to be their exclusive service partner across India."

Log9 Materials launched a **commercial Li-ion cell manufacturing facility at its campus in Jakkur, Bengaluru,** with an initial capacity of **50 MWh**. This facility will cater to **LTO** and **LFP** cell manufacturing and support the production of large form factor cylindrical cells ranging from 22 Series to 66 Series. In addition, Log9 Materials also launched its indigenously developed Battery Management System named Charvik.

Ola Electric, Hero MotoCorp, Ather Energy and TVS Motors to reimburse the cost of chargers to eligible customers - The Ministry of Heavy Industry found that these OEMs were selling portable chargers separately instead of including them in the price of the EV. According to a report by Hindu BusinessLine, **Ather will reimburse ₹140 crores to its 95,000 customers; TVS Motor ₹15.61 crore to 87,000 customers; Hero MotoCorp ₹2.23 crore to 1,100 of its Vida consumers and Ola Electric to reimburse ₹130 crores to one lakh consumers.**

ODISHA has increased the amount of demand incentive on electric 2W, 3W and 4Ws. The max amount of state subsidy on e-2Ws has been increased from INR 5,000 to INR 20,000 [at the rate of INR 5,000 per kWh]. For electric 3W, a flat subsidy of INR 30,000 per vehicle is being offered. For e-4Ws, the max subsidy has been increased from INR 1,00,000 to INR 1,50,000 [at the rate of INR 10,000 per kWh].

Odisha Renewable Energy Development Agency **(OREDA) has issued RFP for EV Fleet as a Service (EVFaaS) for a quantum of 300 EVs.** The selected EV fleet service provider should provide the electric car for a monthly travel distance of 2,000 km/vehicle for small hatchback and sedan models and 2,500 km/vehicle for SUV models.

Punjab Government has exempted the Motor Vehicle Tax on EVs registered in the state during the period of three years from the issuance of the Punjab Electric Vehicle Policy 2022.

Mahindra Last Mile Mobility held the ground-breaking ceremony for its new EV manufacturing unit at its plant in **Zaheerabad,** Telangana, following the ₹1000 Crore investment announcement in the state by M&M in February 2023. The company also aims to build an assembly line for battery packs and manufacture electronic and drivetrain components for electric 3Ws and 4Ws.

AutoNxt Automation plans to start commercial production of its **battery-operated tractors** in Uttar Pradesh's **Hapur** district in May 2023. The startup has already raised the seed round of INR 6 crore that went into developing the production-ready tractors. It has also raised a part of pre-series A round of $2 million, which was utilised to set up the phase zero facility.

Gogoro has launched its battery-swapping platform and Smartscooters in Delhi NCR, unveiling **four battery-swapping stations in Gurgaon and two in Delhi**. Focused on the last-mile delivery use case, this launch is part of Gogoro and Zypp Electric's pilot program.

Israel-based EVR Motors is **setting up EVR India to support their customers in** India and global markets. The new EVR India facility is being set up in **Manesar.** The factory is soon expected to be ready to provide the company's coils for the motors its customers will manufacture for electric vehicle applications.

Source: Opher Doron on LinkedIn

LOHUM

Battery reuse and recycling solutions provider **LOHUM** has partnered with **ACKO for EV battery insurance.** ACKO will continue to provide performance warranty insurance for EV batteries to multiple OEMs and offer redressal in case of performance-related issues. Lohum will work towards collecting, repurposing, and recycling used batteries that will come back as a result of liability from the product, thereby producing raw materials for new batteries.

Morris Garages India unveiled the **MG Comet EV**. The MG Comet EV is a compact electric vehicle aimed at city driving. Equipped with an IP67 rated **17.3 kWh** battery pack, the Comet can travel up to **230 kilometres** on a single charge. It does not support fast charging; and can be charged from 0-100% using an AC charger (3.3 kW) in around 7 hours.

The MG Comet EV is priced starting at INR 7.98 lakhs, while the top variant comes at INR 9.98 lakhs (ex-showroom, India). Bookings start on 15 May.

Tata Motors achieved the **10,000 delivery mark for its Tiago EV in less than four months.** This announcement comes shortly after the Tiago.ev became the 'Fastest Booked EV in India', receiving 10,000 bookings in 24 hours and 20,000 bookings by Dec 2022.

Tata Motors also launched NEXON EV in a Dark avatar. The new Nexon EV MAX DARK will be available in two trims: XZ+ LUX (INR 19.04 lakhs, ex-showroom) and XZ+ LUX with a 7.2 kW AC fast charger (INR 19.54 lakhs, ex-showroom).

Euler Motors launched an advanced version of **HiLoad EV 2023** with a 12.96 kWh battery pack, 170 km kilometre ARAI certified range (Real Range 100-120 km), and 688 kg of payload capacity. It offers a load body of 170 cubic feet in addition to an existing 120 cubic feet variant. The vehicle is being manufactured at a facility in Palwal, Haryana. Euler aims to deploy over 6,000 units in FY 24.

In another update, the **company parted with nearly 10% of its workforce**. "*We are restructuring our Company to better deliver to customers as well as to investor expectations of greater efficiency in the context of changing global circumstances*", said a statement.

Lohia Auto has launched the limited edition of its Narain electric 3-wheeler, targetting last-mile connectivity. The EV offers a range of 100 km per charge with a max speed of 25 kmph. **Manufactured at the company's Kashipur facility** in Uttrakhand, the e3W features a 1.2kWh BLDC motor and a load-carrying capacity of a driver plus four passengers. The company is offering two years warranty on the product.

Premium Electric Motorcycle OEM **Ultraviolette announced the opening of its first experience centre,** 'The Ultraviolette Hangar' in Bengaluru, spanning over 10,000 sq. ft.

Yulu has launched its e-2W **Wynn for personal ownership with a swappable battery and mobility subscription packages.** This model is built by **Bajaj** on the same platform that is being used for their shared mobility vehicles (Miracle and Dex). Launched at an introductory price of INR 55,555, Wynn will be priced at INR 59,999 after the introductory period. Deliveries are expected to commence in mid-May.

Simple Energy announced that it will launch its electric 2-wheeler - the Simple ONE, on 23rd May 2023 in Bangalore.

On May 5, CEO Suhas Rajkumar shared a picture of the first scooter rollout from its **Shoolagiri facility in Tamil Nadu.**

Delhi-based Elesco has launched two models: of electric 2W - Elesco V1 and V2. On a single charge, the scooters have a range of 80 to 100 km. Both variants contain a 2.3 kWh battery and a 72V hub motor. The Elesco V1 has a top speed of 60-70 kmph, whereas the V2 has a top speed of 75-85 kmph. The e-scooters have ex-showroom prices starting at INR 69,999.

Hyderabad-based RACEnergy has teamed up with Hala Mobility, a multi-modal ride-sharing platform, to launch a fleet of 2,000 electric 2Ws with battery-swapping technology. The electric scooters will be integrated with RACEnergy's battery-swapping tech, which will be utilised for delivery services across India. The first phase of the rollout will begin in July 2023.

Zypp Electric has partnered with Zomato to deploy 1 lakh e-scooters for last-mile deliveries. This association is part of a larger plan of Zomato to go completely electric by 2030 as part of its commitment to "The Climate Group's EV100" initiative. Zypp Electric recently secured USD 25M in Series B funding and aims to do more than one crore deliveries for Zomato via EVs by 2024.

Electric L5 OEM Altigreen Propulsion Labs has partnered with Sundaram Finance (an NBFC) to make it easy for Altigreen's retail customers to access vehicle finance.

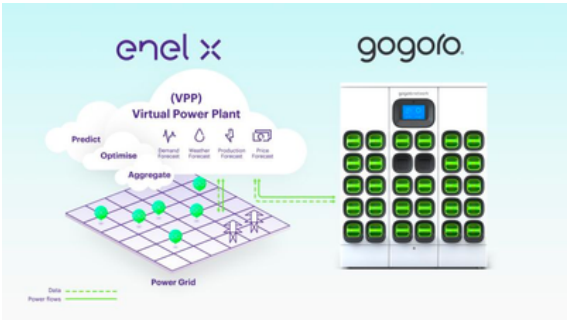
Matter has partnered with **OTO** (a digital financing platform for two-wheelers) to provide consumers with vehicle financing options for its upcoming e-motorbike, the AERA. The start-up will also make the e-motorcycle available on **Flipkart** to enable an easy pre-booking and buying experience.

BPCL announced the launch of 30 kW EV charging stations on six highways in Western India. Four highway sections surround the city of Pune, covering the stretches to Aurangabad, Solapur, Nashik and Kolhapur. The other two stretches lie between Mumbai and Nashik and Nashik and Shirdi. The company had previously announced plans to build a charging network of 22,000 chargers by 2026.

Sona BLW Precision Forgings inaugurated its second-largest manufacturing plant in Chakan, Pune. The new plant manufactures **driveline products for EV and non-EV applications and serves customers in India and globally**. The plant has a production capacity of nearly 11.8 million gears, expected to reach 20.1 million differential gears by the end of FY25. The total investment required for this plant is estimated at INR 231 crores.

In FY22-23, the company's BEV revenue share stood at 26%. Of its **order book of INR 215 bn, 77% comes from EV programs.**

EV fleet operator MoEVing has joined Shell Fleet Solutions' Accelerate to Zero (A2Z) programme. The A2Z programme aims to help the fleet industry meet their decarbonisation goals.



In Taiwan, **Gogoro is deploying battery-swapping stations for Enel X's Virtual Power Plant (VPP) participation**. The integration enables dynamic pausing of swapping network energy usage from the grid and allows the swapping network to send energy to the grid as needed. Under this effort, 2500 GoStations will be deployed across 1000 locations across Taiwan. The companies have already deployed nearly 1300 stations and plan to activate the remaining stations by mid-2023.

Vietnamese EV OEM VinFast receives fresh funding pledges worth US $2.5 Billion. Pham Nhat Vuong, Vingroup's Chairman, and Vingroup intend to contribute 1 billion and 500 million USD, respectively, through non-refundable grants, and Vingroup may loan up to a further 1 billion USD to VinFast with a maximum tenor of five years.

US-based battery tech company 24M has been awarded a $3.8 million contract from the United States Advanced Battery Consortium. The two-year project, which includes a 50 per cent cost share, will focus on the development of a low-cost, fast-charging EV battery technology. Using its SemiSolid manufacturing and product design platform, 24M will create lithium-metal cells for electric mobility applications with a targeted cost of less than $75/kWh and the ability to charge to 80% in 15 minutes or less.

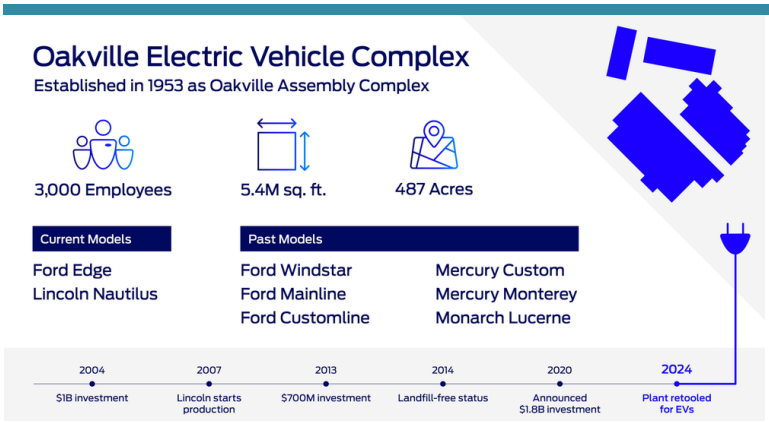
General Motors and Samsung SDI announced an investment of $3 billion to build a new battery cell plant in the USA with 30 GWh capacity. The operations will start in 2026. The new JV will produce nickel-rich prismatic and cylindrical cells. It will be the fourth battery plant in the USA for GM. The total capacity could reach 160 GWh at full production.

Starting April 18, 2023, **only 10 EVs (including 2 plug-in hybrids) qualify for the full $7,500 Tax Credit in the USA**. The reduction is attributed to the implementation of revised guidelines under the US Inflation Reduction Act (IRA), which was signed into law in August 2022 to incentivise the domestic production of EVs and batteries.

Hyundai Motor Company aims to become one of the world's top 3 EV manufacturers by 2030 through the combined sales of Hyundai Motor, Kia and Genesis electric models.

- The Group aims to expand the annual EV production in Korea to 1.51 million units and global volume to 3.64 million units by 2030.
- They plan to invest KRW 24 trillion in the domestic EV industry through Hyundai Motor, Kia and Hyundai MOBIS by 2030.
- In 2030, Hyundai Motor Group will have 31 EV models, including models from Hyundai Motor, Kia, and the luxury brand Genesis.
- Kia will launch EV9, its first three-row seat electric flagship SUV, this year, and Hyundai Motor plans to launch the IONIQ 7 in 2024.

Rivian has announced its plan to switch its entire lineup to lithium iron phosphate (LFP) batteries. The company has optimized its manufacturing processes and introduced LFP batteries and Enduro drive units in its EDV 500 and 700 vans. It plans to offer LFP versions of its R1S and R1T models soon.



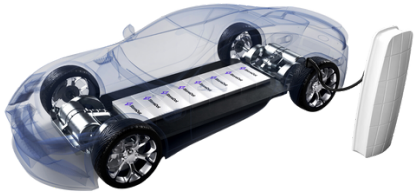
Ford Motor Company is investing C$1.8 billion in its Oakville Assembly Complex to transform it into a high-volume hub of **electric vehicle manufacturing in Canada**. The campus, to be renamed Oakville Electric Vehicle Complex, will begin to retool and modernize in the second quarter of 2024 to prepare for the production of next-generation EVs.

This marks the first time a full-line automaker has announced plans to produce passenger EVs in Canada for the North American market.

Jaguar Land Rover will invest £15bn over 5 years into an electric-first future.

- All-electric Range Rover available to order later this year
- Halewood in Merseyside, UK, will become JLR's first all-electric car plant
- The first of three reimagined Jaguars will be a 4-door GT, with a range of up to 700 km prices starting from £100,000
- New Jaguar Architecture, named JEA, will launch in 2025
- JLR will retain the flexible MLA architecture on which Range Rover and Range Rover Sport are built, offering ICE, HYBRID and BEV options for the global market
- Engine Manufacturing Centre in Wolverhampton to be renamed Electric Propulsion Manufacturing Centre, confirming future building electric components

CATL's first Sodium-ion battery will power Chery EV models. Sodium-ion batteries will break through resource bottlenecks and is a cost-effective choice, CATL said without giving further details.



Fast-charging battery tech company Storedot will manufacture its XFC batteries on three continents - the US, Europe, and Asia. StoreDot plans to produce these batteries in existing and future local gigafactories rather than building its own facilities in the mid-term. Production is on track to commence later next year. The company said it will continue to develop its cells in its labs in the US and Israel and remain on target for mass production readiness of '100in5' cells by 2024, delivering at least 100 miles of range for each five minutes of charging.

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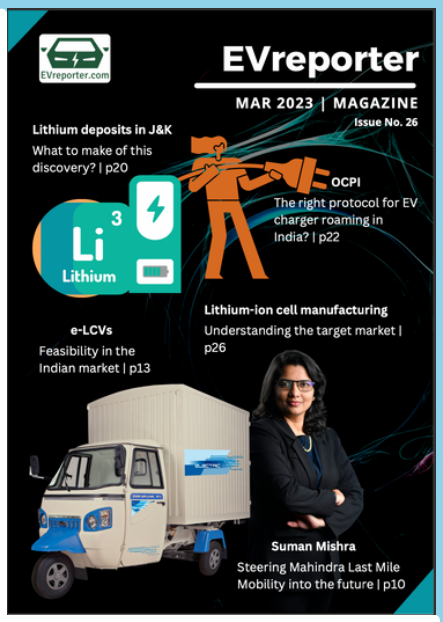

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