ELECTRIFY30

THE FUTURE OF MOBILITY

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Foreword

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The transition to electric mobility solutions is no longer futuristic but a reality. As the world confronts the challenges of a global climate crisis, the need for sustainable transportation solutions has never been more pressing. In this context, India's role in shaping the future of mobility is pivotal.

This comprehensive report explores the dynamic landscape of electric mobility adoption in India, a nation that stands as the world's third-largest greenhouse gas (GHG) emitter. India is on the road to an electrifying transformation, and this report delves into the implications and opportunities that this change presents to various stakeholders.

With a keen focus on clean energy and mobility, this report navigates through the intricate web of the electric vehicle (EV) and the associated clean ecosystem. It underscores how the Indian government's vision of promoting electric mobility through policies and initiatives is steering the nation toward a sustainable future. Yet, the landscape is diverse and multifaceted, where electric mobility encompasses not only EVs but also the ecosystem solutions and services that support them, which, albeit less talked about, are paramount for the success of the overall industry.

The findings in this report unearth the EV landscape in India, revealing that while certain segments like 2W passenger vehicles (PVs) and 3W commercial vehicles (CVs) have achieved substantial EV penetration, there is still considerable room for growth in other segments. The implications extend not only to the mobility products but also to the broader ecosystem, which includes EV components, ecosystem solutions, and services.

Despite some of the slowdown in EV adoption that the western markets are witnessing early in 2024, Praxis Global Alliance strongly believes in the domestic opportunity and the transition curve. Some of the factors that are driving global slowdown are geopolitics, shifts in global trade, and the high cost of local manufacturing. A lot of these issues do not impact India, and we thereby have a more favorable atmosphere for EV adoption.

This report provides an elaborate analysis of EV automotive segments and the associated auto components, examining their current sourcing status and localization prospects. It outlines the significant initiatives key industry players are undertaking to establish localized supply chains, thereby reducing import dependence and ensuring complete control over the supply chain, while also passing on the cost benefits to the consumers.

Additionally, the report provides a deep understanding of the various facets of the EV ecosystem, including battery charging and swapping, retail and dealerships, fleet operations across logistics and transportation segments, asset management, EV financing and leasing, the evolving technology ecosystem, regulatory dynamics, and consumer preferences. It highlights the nascent yet rapidly growing demand for charging infrastructure, innovative ownership models, and the emergence of multiple players in the clean technology ecosystem.

The report also explains the critical role of government incentives in promoting EV adoption and the global context of leading EV markets. Understanding the implications and opportunities in these domains is pivotal as India accelerates its shift toward cleaner and more sustainable logistics and transportation solutions.

The report highlights the significance of the electric mobility value chain, where innovations in battery technologies and alternative fuels are paving the way for the future. Additionally, it uncovers emerging themes that hold promising business opportunities for industry players, from startups to established giants.

As India, much like the rest of the world, undergoes a profound transformation, all stakeholders must comprehend the implications and act decisively. This report aims to provide a clear roadmap for all the stakeholders involved, including original equipment manufacturers (OEMs), battery charging and swapping players, EV financing companies, fleet operators, and the entire industry.

Glossary of terms

Acronym	Description
2W	Two-Wheeler
3W	Three-Wheeler
4W	Four-Wheeler
ACC	Advanced Cell Chemistry
ASP	Average Selling Price
B	Billion
BaaS	Battery as a Service
BLDC	Brushless Direct Current Motor
BMS	Battery Management Software
BOM	Bill of Materials
BEV	Battery Electric Vehicle
CAFE	Corporate Average Fuel Efficiency
CAD	Computer-Aided Designing
CAGR	Compound Annual Growth Rate
CDM	Clean Development Mechanism
CMS	Charger Management Software
CO_2	Carbon dioxide
CPO	Charging Point Operator
CY	Calendar Year
DC	Direct Current
E2W	Electric Two-Wheeler
E3W	Electric Three-Wheeler
E4W	Electric Four-Wheeler
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
E-Bus	Electric Bus
EV	Electric Vehicle
EVCS	Electric Vehicle Charging Station
EVSE	Electric Vehicles Supply Equipment
FAME	Faster Adoption and Manufacturing of (hybrid and) Electric Vehicles
FCEV	Fuel Cell Electric Vehicles
FMS	Fleet Management Software
FY	Fiscal Year

Glossary of terms

Acronym	Description
GHG	Greenhouse Gas
GoI	Government of India
GWh	Gigawatt hours
H1	First half of the year
HDV	Heavy-Duty Vehicle
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
ICE	Internal Combustion Engine
INR	Indian National Rupee
K	Thousand
kWh	Kilowatt-hour
LDV	Light Duty Vehicle
LSP	Logistics Service Provider
LV	Low Voltage
M	Million
MBO	Multi-Brand Outlets
MDV	Medium Duty Vehicle
MMTPA	Million Metric Tons Per Annum
MoU	Memorandum of Understanding
OEM	Original Equipment Manufacturer
OES	Original Equipment Supplier
NASA	National Aeronautics and Space Administration
NEV	New Energy Vehicle
PCBA	Printed Circuit Board Assembly
PDU	Power Distribution Unit
PE	Private Equity
PHEV	Plug-In Hybrid Electric Vehicle
PLI	Production-Linked Incentive Scheme
PMSM	Permanent Magnet Synchronous Motor
PM	Particulate Matter
PV	Passenger Vehicles

Glossary of terms

Acronym	Description
PWM	Pulse Width Modulation
RTE	Round Trip Efficiency
SGST	State Goods and Service Tax
SoC	State of Charge
SoH	State of Health
SRM	Synchronous Reluctance Motor
TCO	Total Cost of Ownership
ToD	Time of Day
VAT	Value Added Tax
VC	Venture Capital
VCS	Voluntary Carbon Standards
VCU	Vehicle Control Unit
WBG	Wide Bandgap Semiconductors
ZEV	Zero Emission Vehicle

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GLOBAL CLIMATE CRISIS AND NEED FOR CLEAN MOBILITY

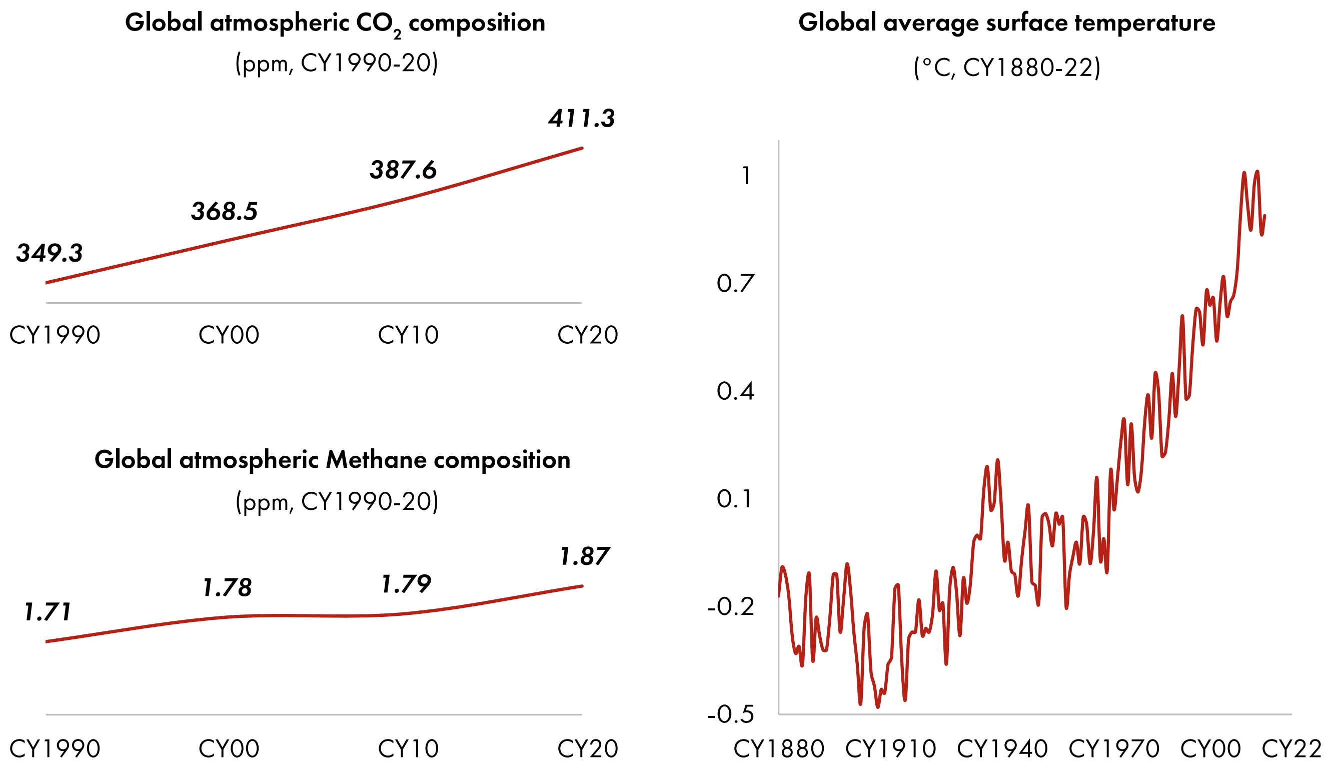
1.1 Global climate crisis

Global warming has significantly impacted Earth's ecosystem and society, leaving a lasting impact that poses greater challenges for future generations. In the last 50 years alone, over 11K catastrophic natural events have been recorded, highlighting the severity of the climate crisis. These events have resulted in substantial loss of life and upheaval in communities worldwide. Furthermore, the threat of extinction looms over more than 10K species because of these environmental changes.

The concentration of CO_2 has escalated extremely rapidly over the past 170 years, a rate far exceeding the natural progression that would have taken approximately 20K years to achieve. The atmospheric CO_2 composition has shown a steady incline, rising from 349.3 parts per million (ppm) in 1990 to 411.3 ppm in 2020, and further reaching 418.2 ppm by 2023.

Exhibit 1.1.1

Global atmospheric composition of CO_2 and methane (LHS) and global average surface temperature (RHS)



Due to global warming, the sea level has risen at a rate twice as fast in the last two decades compared to the last century. In the past decade, over 23M people were displaced annually due to weather-related events. If climate change continues unabated, it is estimated that by the end of this century, it could potentially lead to ~3.4M deaths annually. Climate change is spawning a humanitarian crisis and calls for urgent intervention.

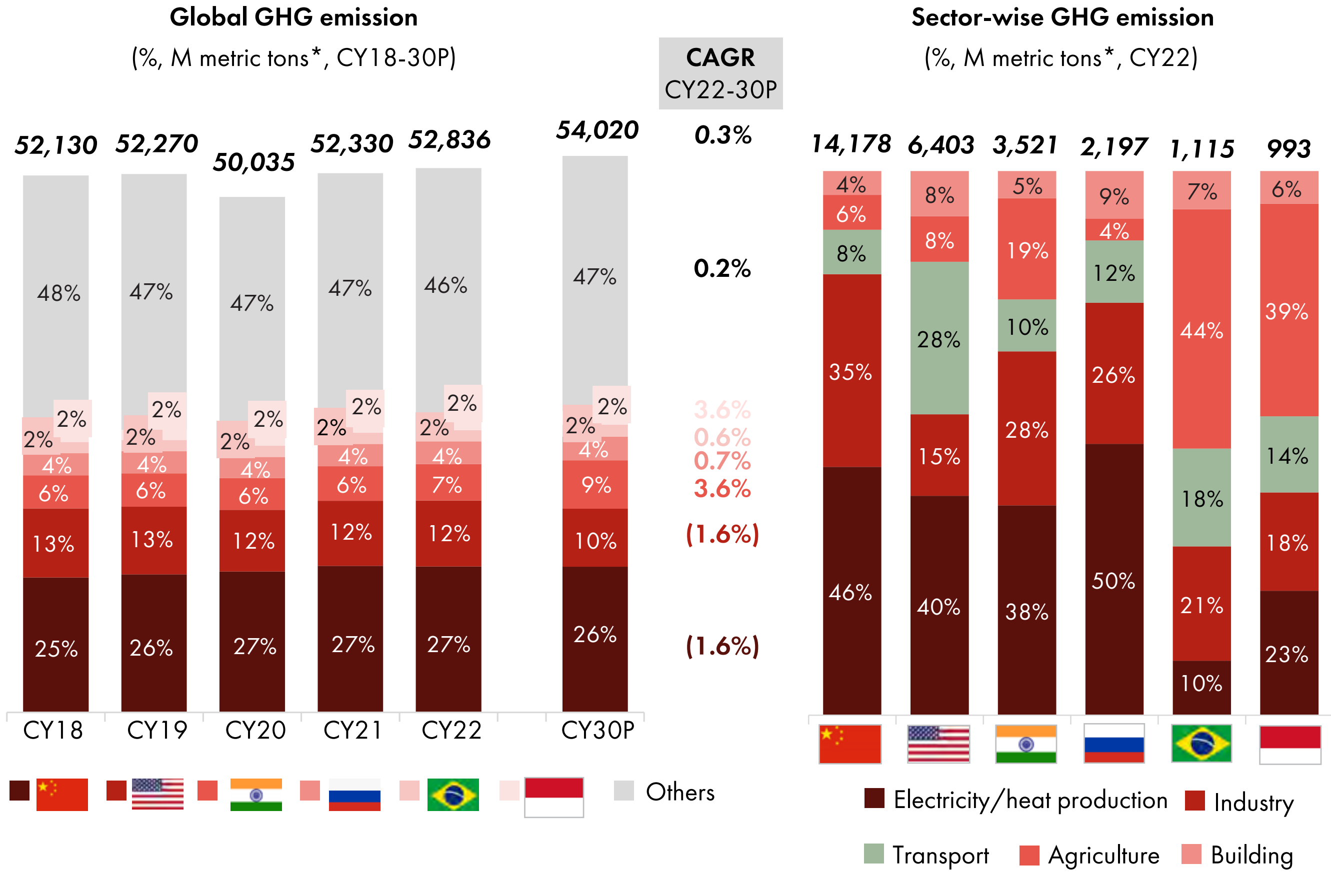
1.2 Challenges faced by India

Global GHG emissions reached 53B metric tons in CY22. Among the major emitters, China, the USA, India, Russia, Brazil, and Indonesia collectively account for over half of the world's GHG emissions.

GHG emissions vary across sectors among the top emitters, with electricity/heat production, industries, transport, and agriculture emerging as major contributors. In countries such as China, the USA, India, and Russia, electricity/heat production accounts for 40-50% of emissions, while agriculture contributes 40-45% in Brazil and Indonesia. Transport emissions range from 10-15% in countries like China, India, Russia, and Indonesia, while in the USA it accounts for approximately 30% and 18% in Brazil.

Exhibit 1.2.1

Global GHG emission (LHS) and sector-wise GHG emissions (RHS)



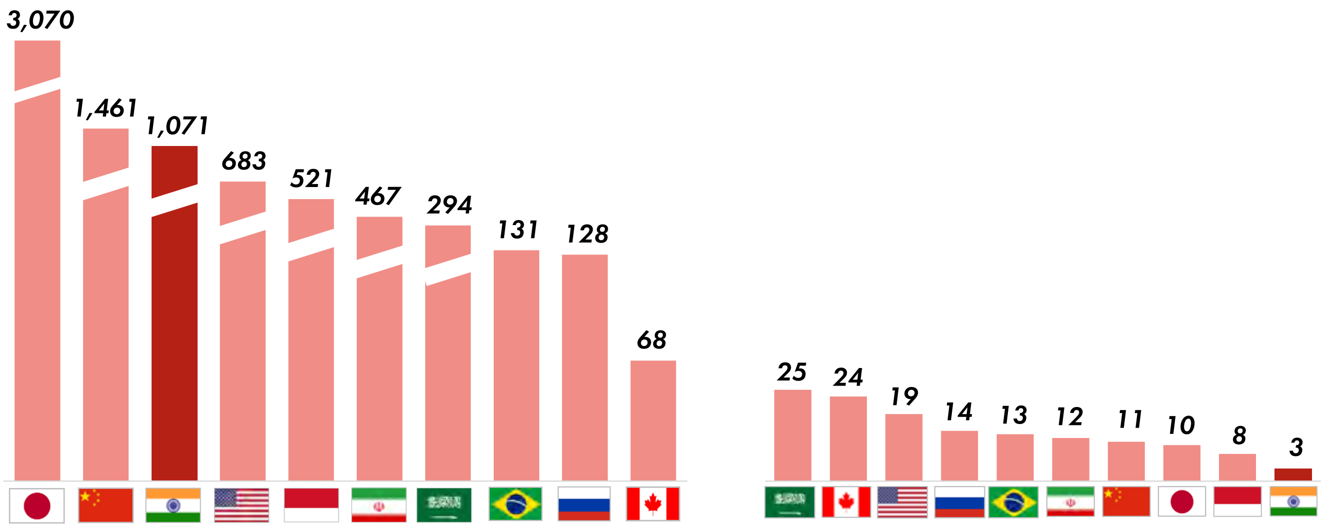
Note(s): *Carbon dioxide equivalent value
Source(s): World Bank, Climatewatchdata.org

In CY22, India accounted for 7% of the total GHG emissions, clocking 3.5B metric tons of CO_2 emissions. In terms of intensity of emissions, India ranked third with 1,071 metric tons of GHG emissions per km², behind only Japan and China. A lot of statistics show emissions per capita, however, the ability of a nation to absorb emissions and recycle depends on its geographical assets. Per capita GHG emissions in CO_2 equivalent stood at 3 metric tons, significantly lower compared to the top 10 global GHG emitters, given low per capita GDP and income, and hence consumption. We are less polluting at an individual level, but the world's third-largest emitter from a total/intensity of emissions standpoint.

Exhibit 1.2.2

Per-km² GHG emissions in CO_2 equivalent (LHS) and per-capita GHG emissions in CO_2 equivalent (RHS)

Per-km² GHG emissions in CO_2 equivalents (metric tons*, CY22) | **Per-capita GHG emissions in CO_2 equivalents** (metric tons*, CY22)



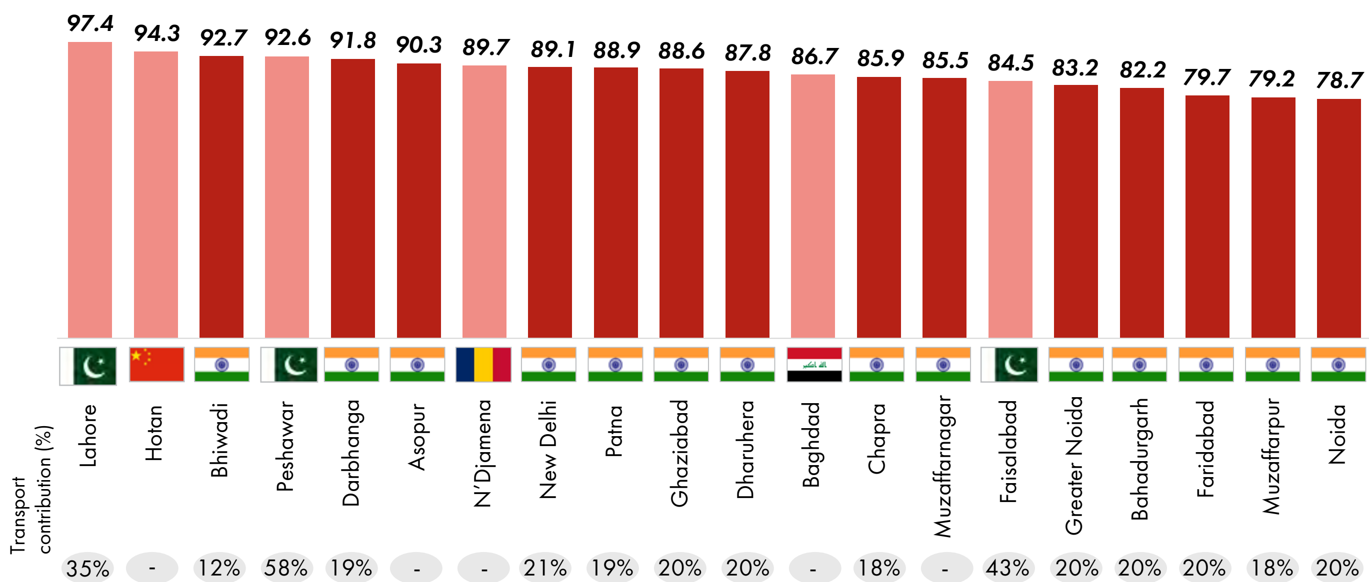
Note(s): *Carbon dioxide equivalent value
Source(s): World Research Institute, Ourworldindata.org

This is reflected in the fact that India confronts a significant challenge regarding air quality, with 14 Indian cities ranking among the top 20 most polluted globally. Among these cities, New Delhi, the capital, stands as the eighth most polluted city worldwide. Transport contributes an average of 20% to the pollution levels in all these cities, highlighting the importance of the need for alternative solutions to reduce GHG emissions.

Exhibit 1.2.3

City-wise annual average PM2.5 concentration across the globe

City-wise annual average PM2.5 concentration across the globe
(ug/m³, CY22)



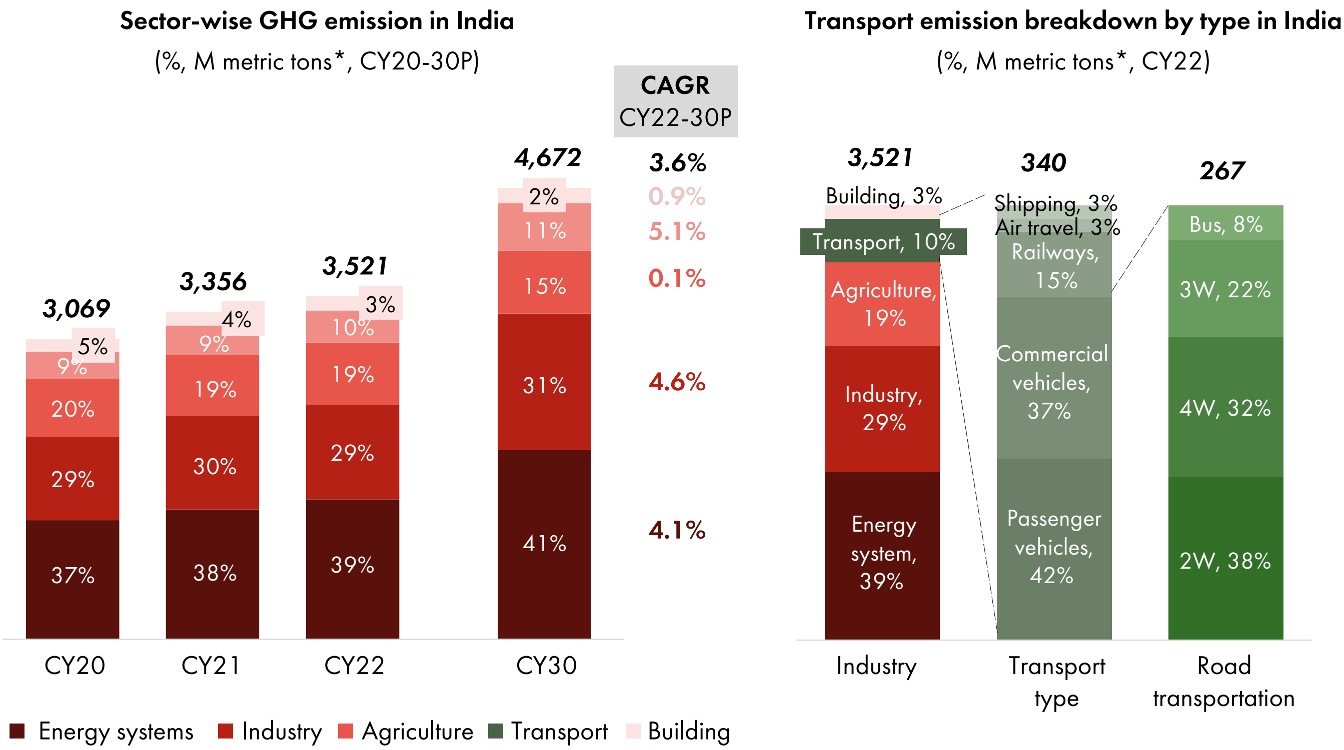
Source(s): TERI

1.3 India's transportation pollution

India is experiencing an upward trajectory in annual GHG emissions, with a projected CAGR of 3.6% for the period of CY20-30. Primarily, the energy sector drives India's GHG emissions and is expected to contribute a significant 41%, amounting to ~2B metric tons by 2030.

Exhibit 1.3.1

Sector-wise GHG in India from CY20 to CY30 (LHS) and transport emission breakdown by type in India (RHS)



Note(s): *Carbon dioxide equivalent value, passenger vehicles includes cars, motorcycles, buses and other 2/3W, freight includes: lorries and trucks

The transport sector is anticipated to exhibit the highest CAGR for GHG emissions, projected to grow at a rate of 5.1% for the same period, reaching 510M metric tons by CY30. In CY22, the transport sector emitted 340M metric tons of GHG emissions, with road transport constituting 80% of this total. Within road transport, emissions from 2W and 4W vehicles accounted for 70% of the total emissions. This is why electric mobility is one of the, if not the most critical, levers for driving this environmental change.

1.4 Need for EV transition in India

The transition to clean EVs in India is imperative for several reasons.

First, the global temperature has risen by ~1.5° C, with increased global atmospheric levels of CO_2 and methane by 18% and 9%, respectively, in the last 30 years.

Second, India is the third largest GHG emitter in the world after China and the USA.

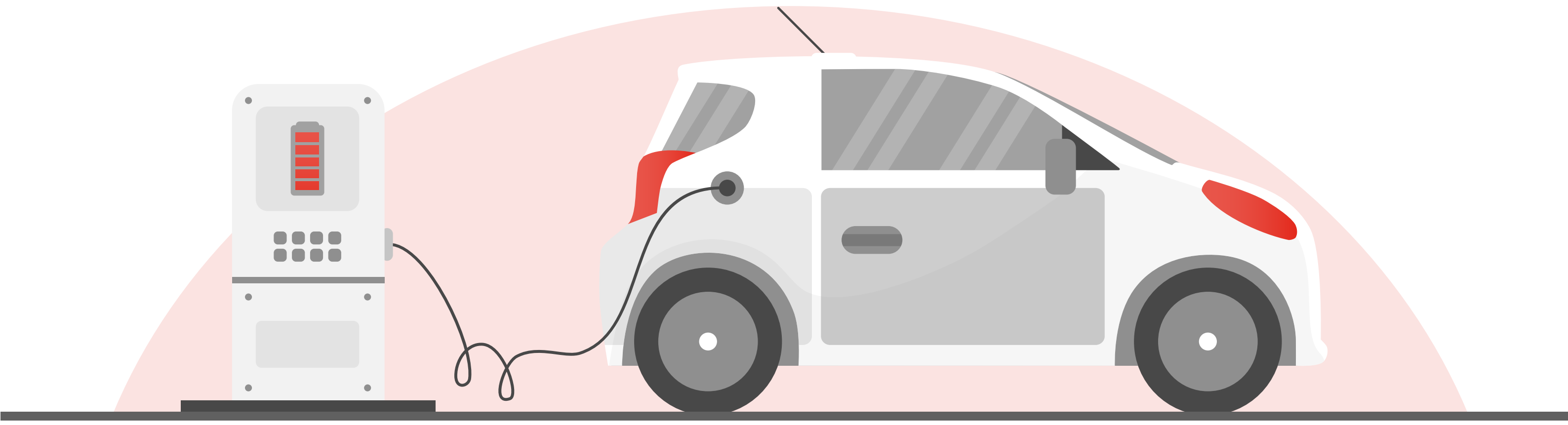
Third, the transport sector was accountable for 1.7M deaths due to air pollution in FY20. Furthermore, transportation contributes to ~29% of PM2.5 pollution and 24% of PM10 pollution, rendering it the second-largest source of both PM2.5 and PM10 pollution.

Fourth, in CY23, 85% of India's crude oil requirements were met through imports, leading to a significant trade deficit, and substantially impacting economic progress. Transitioning the transport sector away from fossil fuels is essential for ensuring energy security, particularly considering that automobiles currently account for approximately 55% of crude oil imports.

Fifth, to fulfill its global sustainability commitments under the Paris climate agreement, India has pledged to reduce its GHG emissions by 33-35% by 2030 from its 2005 levels, expand non-fossil fuel power capacity by 50%, and establish an additional carbon sink capable of absorbing 2.5-3B metric tons of CO_2.

Exhibit 1.4.1

Need for EV transformation in India



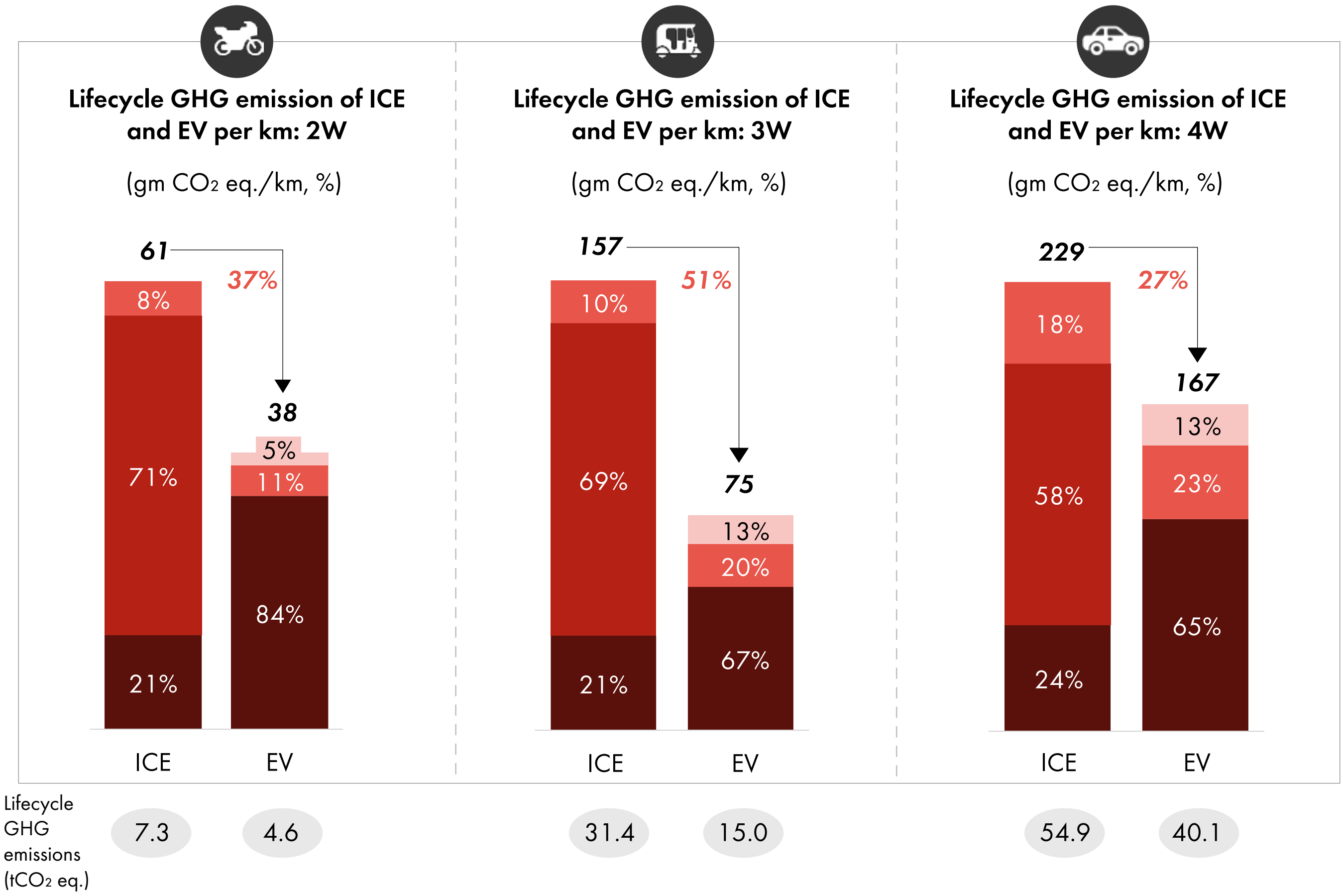
Global warming	Increased GHG emission	Effect of transport sector	Import burden of crude oil	Paris agreement goals
~1.5°C Rise in surface temperature	**~3.5K MMTPA** CO_2 eq released in CY22	**2nd largest** Source of PM2.5 and PM10 pollution	**~55%** Automobile share of crude imports	**Target - 2030** Reach decarbonization targets
Due to unwarranted human activities	**Need of a cleaner environment**	**Increased air pollution**	**Increased energy security**	**Towards a cleaner future**
• The global atmospheric level of **CO_2** and **Methane** has grown by **18%** and **9%** in the last 30 years • Global temperature has risen by ~1.5° C leading to climate disruptions, catastrophes and loss of human life	• India is the third largest GHG emitter in the world • **14 cities out of the top 20** polluted cities are in India	• India's transport sector contributes **~24% of PM10 pollution and ~29% of PM2.5 pollution** in summers • More than 1.7M air pollution-related deaths were recorded in FY20	• **~85% of crude requirements** is fulfilled by imports • **Automobiles take ~55% of crude consumption** from imports	• Reduction of **Greenhouse emissions by 33-35% till 2030** • Increase **50% of the power capacity contribution to non-fossil fuels** • Creation of an **additional carbon sink of 2.5-3B tons of CO_2**

Note(s): MMTPA - Million metric tons per annum, PM - Particulate matter
Source(s): IQ Air

While claiming that EVs are truly driving GHG emissions reduction, it is important to look at the facts at the first principles. One must look at the entire carbon footprint of internal combustion engine (ICE) vehicles vs EV across the lifecycle, from production, usage (of both, the vehicle, and the fuel) as well as recycling. The adoption of EVs can play a pivotal role in achieving the above goals, as EVs emit 25-50% fewer GHGs compared to ICE vehicles across all segments on a lifecycle basis. Even if a nation drives electricity production through fossil fuels, independent power producers (IPPs) and large-scale energy generation units are much more efficient than smaller engines at a vehicle level. With lower emissions during production and zero direct combustion release during usage, EVs are crucial for mitigating the environmental damage already done.

Exhibit 1.4.2

Lifetime GHG emission of EVs vs ICE vehicles



- Well to tank — *Emissions released during production, processing, and delivery of fuel to the vehicle's tank*
- Tank to wheel — *All GHG emissions from combusting the fuel to power the vehicle*
- Vehicle production — *Emissions during vehicle production phase*
- Battery production — *Emissions during battery production*

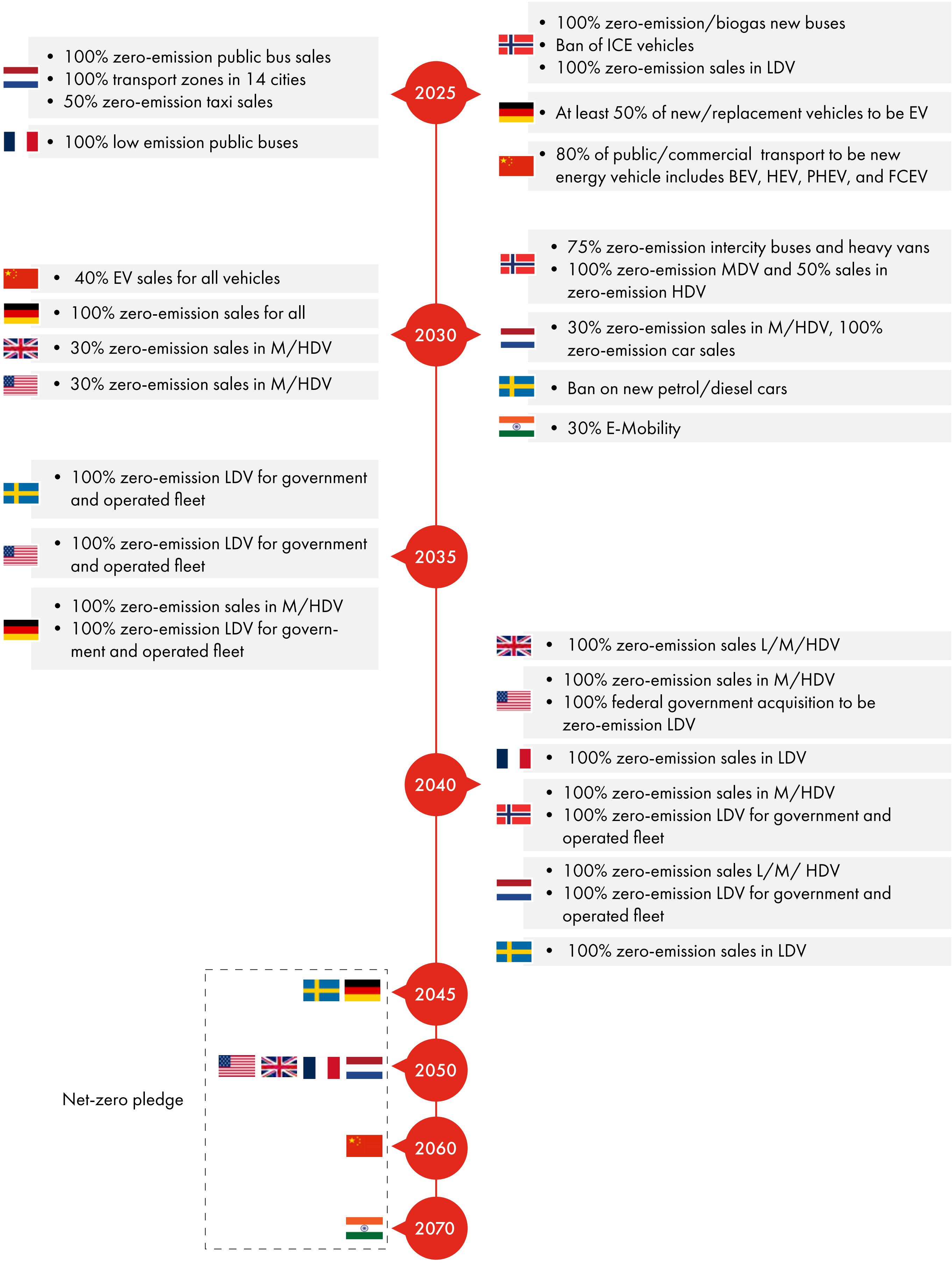
Note(s.) Average life considered for 2W, 3W and 4W are 120K km, 200K km and 240K km respectively

1.5 EV transition globally

Amidst the global push for cleaner energy and sustainability, several nations globally have committed to clean targets. India aims to reach net-zero emissions by 2070, while developed nations like Australia, the USA, and the Netherlands are pledging to achieve net-zero emissions by 2050.

Exhibit 1.5.1

Global climate change mitigation targets from 2025-70

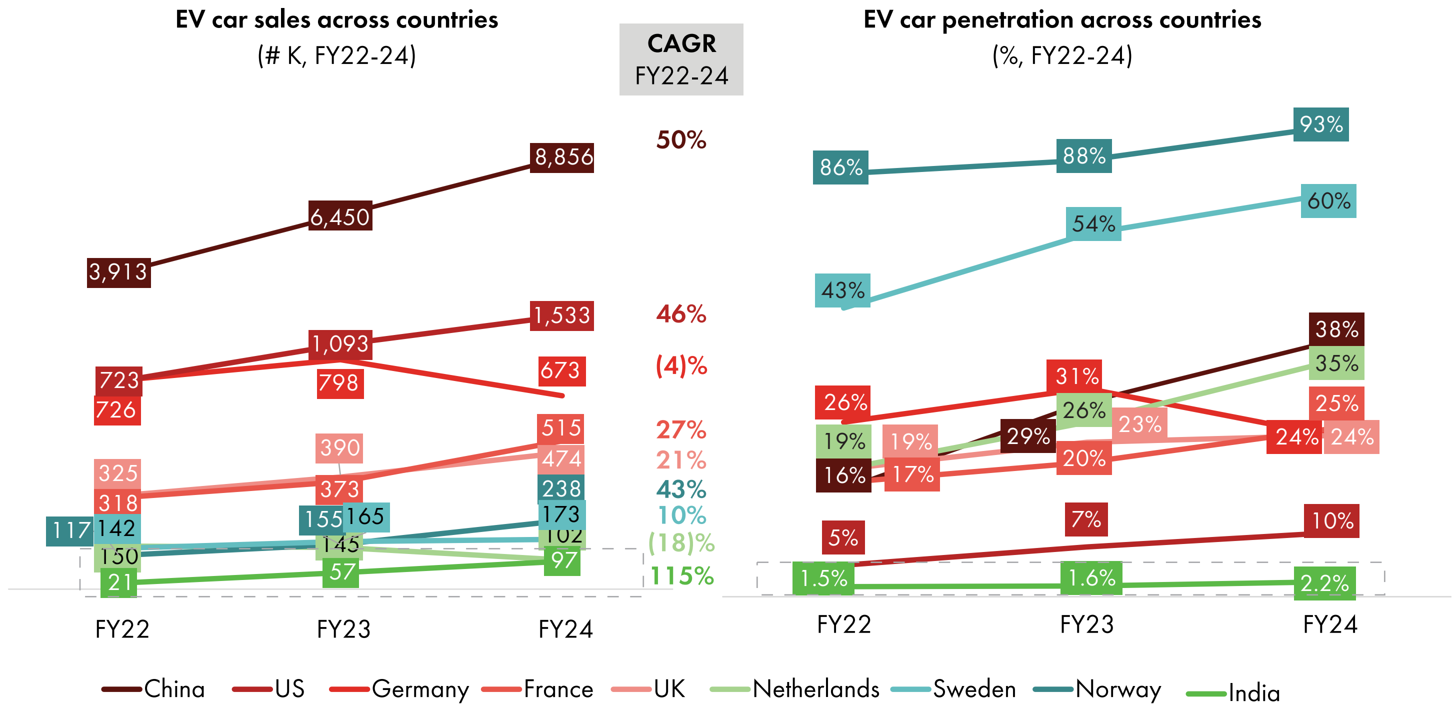


Note(s): L/M/HDV: Light/Medium/Heavy duty vehicle
Source(s): IEA

One target for each country has been to reduce their transportation emissions emanating from ICE vehicles and have focused on transitioning their fleet to EVs. China leads in EV adoption across the globe, with electric car sales more than doubling from ~4M in FY22 to ~9M in FY24, driven by supportive policies and infrastructure. Meanwhile, Norway has the highest global EV penetration at 93% in FY24, attributed to significant incentives and robust charging infrastructure.

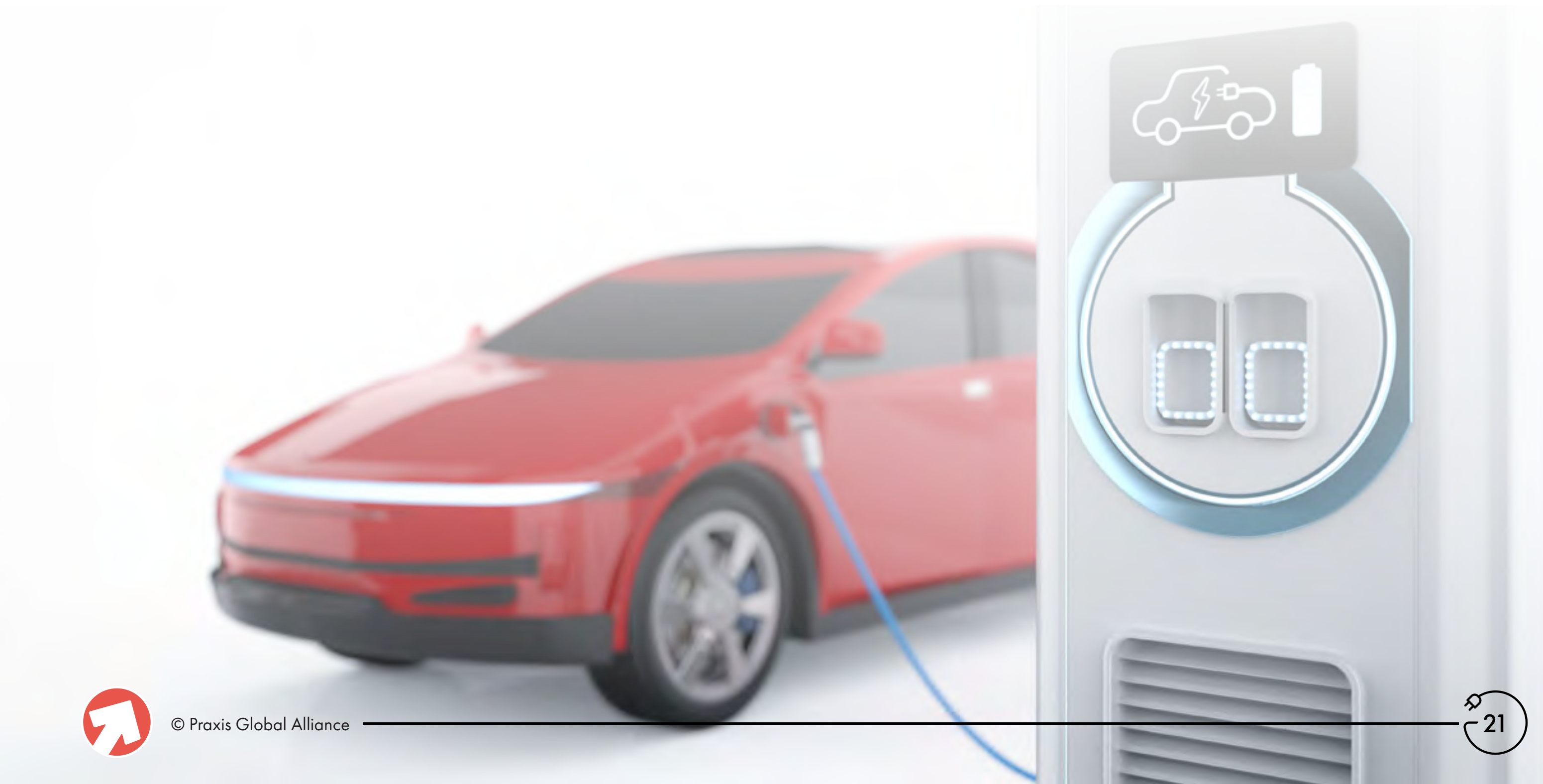
Exhibit 1.5.2

Global EV car sales (LHS) and global EV car penetration (RHS)



Note(s): E2W, E3W, E-Buses and E-Trucks are not included
Source(s): IEA

With ambitious sustainability targets and a major push on EVs globally, India's 4W EV penetration stands at only ~2%, showcasing the significant headroom for adoption and highlighting the need for urgent policy interventions and infrastructure development to accelerate EV adoption.



02

ELECTRIC MOBILITY ECOSYSTEM AND OPPORTUNITY IN INDIA

2.1 Timeline of EV promotion in India

The Government of India (GoI) has implemented a range of policies aimed at facilitating the widespread adoption of EVs. Some key aspects of these policies include providing incentives, subsidies, and regulatory support that promote the development, manufacturing, and adoption of EVs and the associated charging infrastructure necessary for the overall development.

Exhibit 2.1.1

Timeline of policy initiatives taken by the Government of India from 2013-23

2013

- GoI launched **NEMMP (National electric mobility mission)** intending to reduce dependence on crude oil for transportation by promoting EVs in India

2014

- Creation of a **standing committee** on energy storage by MNRE
- Amendment to the **Motor Vehicle Act (2014)** for E-Rickshaws to be registered and licences to be mandated for drivers

2015

- **FAME I** in operation between April 1, 2015, and March 31, 2019. Cabinet approved an outlay of INR 0.3 billion for charging infrastructure

2016

- **Technology platform for electric mobility (TPEM)** set up to support R&D consortia projects

2017

- **National Board for Electric Mobility (NBEM)** is constituted after its approval
- Launch of Karnataka and Telangana draft EV state policy

2018

- **National E-Mobility Program 2020** launched to promote the E-Mobility ecosystem with focus on creating charging infrastructure
- **EV@30** policy framework so that by 2030 more than 30% of vehicles will be electric

2019

- **FAME II** commenced from April 1, 2019. Cabinet approved an outlay of INR 10 billion for charging infrastructure
- **GST** on EVs reduced from **18% to 5%**
- **Phased manufacturing plan (PMP)** for EVs

2020

- **National Mission on Transformative Mobility and Battery Storage** for setting up infrastructure for one E-Charging kiosk at around 69K petrol stations across India

2021

- Launch of PLI scheme to **bring down ACC battery prices**
- Revision of PMP for EV parts under FAME II

2022

- **Amendments to Charging Infra Guidelines** to provide affordable charging tariffs and enable charging at residences and offices
- Announcement of phase-wise installation of **EV public charging infrastructure**

2023

- Allocation of **INR 5,172 Cr. to FAME II** subsidy outlay which is 85% of the total budget allocated for the Ministry of Heavy Industries
- GoI exempts **EVs from permits and advised the states to waive road tax**

Note(s): FAME - Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
Source(s): Niti Aayog, CEC, Ministry of Power, BEE, JMK Research Report, Department of Heavy Industries Website

The GoI has implemented several key initiatives to promote the adoption of EVs. One notable program is the Faster Adoption and Manufacturing of (hybrid and) EVs (FAME) in India initiative, launched on April 1, 2015, to support EV adoption and develop charging infrastructure. The scheme was extended in 2019, increasing subsidies for EVs and reducing the GST rate on EVs from 18% to 5% to enhance affordability. Additionally, under the Make in India initiative, the Production Linked Incentive (PLI) scheme was launched in June 2021 by the Department of Heavy Industry to boost the manufacturing of advanced chemistry cell battery storage.

In April 2022, the Ministry of Road Transport and Highways issued a draft notification for the Battery Swapping Policy for EVs, aiming to promote battery-swapping method(s) for powering EVs. The government has proactively supported in development of the EV ecosystem in India, and continued support is crucial to meet the 30% electrification target by 2030.

2.2 Current EV ecosystem in India

The EV ecosystem in India is characterized by the involvement of multiple stakeholders, including both private enterprises and government institutions. Their collaborative efforts are instrumental in fostering the continual growth of the ecosystem.

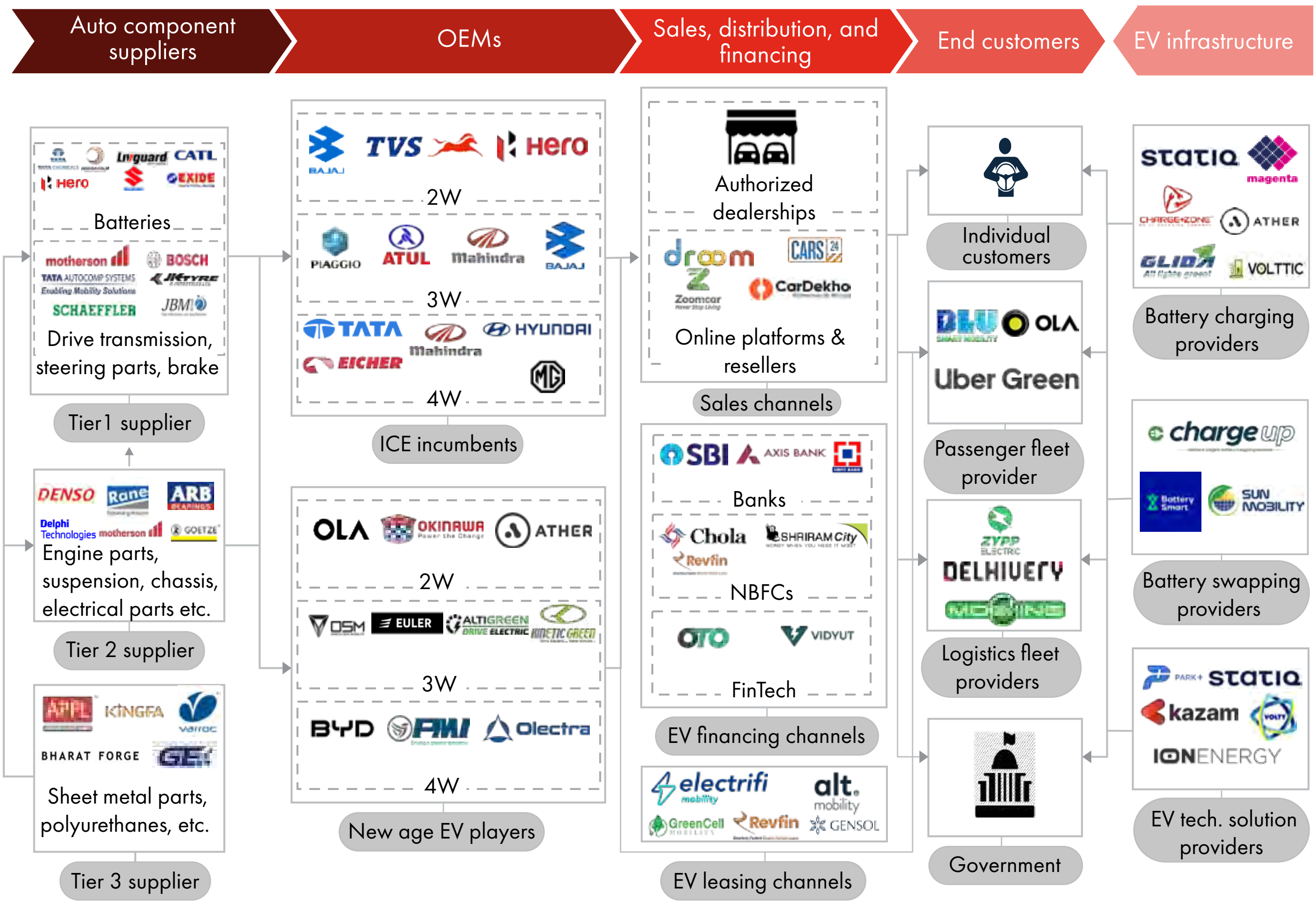
Auto component suppliers play a crucial role in localizing EV-specific components, such as batteries and electric motors. In terms of OEMs new-age EV players, particularly in the E2W category, such as Ather and Ola Electric, alongside established incumbents, both domestic and international. Companies like Tata Motors, BYD, Mahindra Electric, MG, TVS, and Bajaj have introduced their EV products to the market, offering a diverse range of E2Ws, E4Ws, and commercial vehicles.

In parallel, the adoption is also supported by the charging infrastructure developing companies that are involved in the establishment of charging stations across various cities. Financial institutions have overcome their initial reluctance to provide EV financing and now offer specialized loans and innovative products (battery as a subscription) for EV purchases.

The government bodies supporting ecosystem development include the Ministry of Heavy Industries and Public Enterprises, the Department of Science and Technology, and the National Institution for Transforming India (NITI Aayog). The sustained collective effort of everyone involved will determine the success of EV electric mobility solutions in India going forward.

Exhibit 2.2.1

EV ecosystem in India



Note(s): Tier 1 suppliers supply directly to OEMs. Tier 2 suppliers supply to Tier 1 suppliers, although these firms could be selling directly to OEMs, Tier 3 suppliers supply raw, or close-to-raw material to OEMs, Tier 1 and Tier 2 companies

2.3 Mobility and electric mobility ecosystem in India

Mobility is not an industry, it is not a market, it is an overall ecosystem with a massive opportunity.

Mobility in India is a large and multidimensional ecosystem. The effect of adopting and transforming to electric mobility is not limited to vehicle manufacturers but has wide-ranging ripple effects on the entire ecosystem. Hence, it is critical to consider the overall ecosystem created by electric mobility, not just the OEMs. The entire ecosystem comprises various segments falling under the categories of products and services. The product categories include components sold to OEMs, aftersales market (including batteries), passenger vehicles, commercial vehicles, and charging products/equipment. The services segment includes transportation, logistics services, financing, leasing, insurance, EV charging, battery swapping, and auto aftersales services.

Exhibit 2.3.1

Classification of mobility ecosystem segments

	Products			Services		
	Commercial vehicle	**Passenger vehicle**	**Components and after market**	**Logistics**	**Transportation**	**Ecosystem solutions**
Overall mobility	• 3W (passenger and cargo) • LCV (capacity < 7.5 tons) • MCV (capacity between 7.5-12 tons) • HCV (capacity >12 tons) • Bus • Retail and dealerships	• 2W (scooters and bikes) • 4W (passenger cars, utility vehicles, vans) • Retail & dealerships	• Overall auto components and after market for ICE and EV vehicles	• Goods and cargo rail • Road (2W, 3W cargo, LCV, MCV, HCV) • Air way • Water way	• 2W taxi • 3W taxi (intra and inter city) • Cab services (intra and inter city) • Bus transport (intra and inter city) • Passenger rail • Air	• PV financing, leasing and insurance • CV financing, leasing and insurance • Auto aftersales service
Clean mobility	• E3W • E-LCV • E-M&HCV • E-Bus • Retail and dealerships	• E2W (scooters and bikes) • E4W (passenger cars, utility vehicles) • Retail and dealerships	• EV components and after market - Battery - Electric motor - Power electronics - Body and chassis - Others • EV charging components/ equipments	• E-Rail • E-Road (using E2W, E3W cargo, E4W LCV)	• E2W taxi • E3W taxi • E-Cab • E-Bus • E-Rail and metro	• E-PV financing, leasing and insurance • E-CV financing, leasing and insurance • EV charging and battery swapping • Software (BMS, CMS, FMS, TMS) • EV aftersales service

2.3.1 Products

The products segment in the mobility ecosystem comprises commercial vehicles, passenger vehicles, components sold to OEMs, aftersales market, and charging equipment for EVs.

Commercial vehicles include passenger buses and cargo vehicles, which are further classified into distinct categories: 3W passenger and cargo vehicles, light commercial vehicles (LCVs), and medium & heavy commercial vehicles (M&HCVs).

The passenger vehicles segment includes 2W and 4W for both traditional ICE and EVs.

Components and after-market segments include auto components, catering to both ICE and EVs sold directly to OEMs and in aftermarkets for service requirements. This includes critical EV components such as batteries, motors, and other relevant elements integral to the vehicle.

Charging components and equipment segments include all the products and industrial-grade equipment used to set up charging stations.

2.3.2 Services

The services ecosystem comprises logistics services, transportation services, and ecosystem solutions, including financing, insurance, leasing, software, battery charging, swapping stations, and aftersales service.

Logistics includes the transportation of goods through various modalities, including road, rail, air, and water. Within this framework, electric mobility services are presently offered by railways, which handle logistics. However, there is a rapid adoption of electric mobility occurring, particularly in the 4Ws (especially in LCVs).

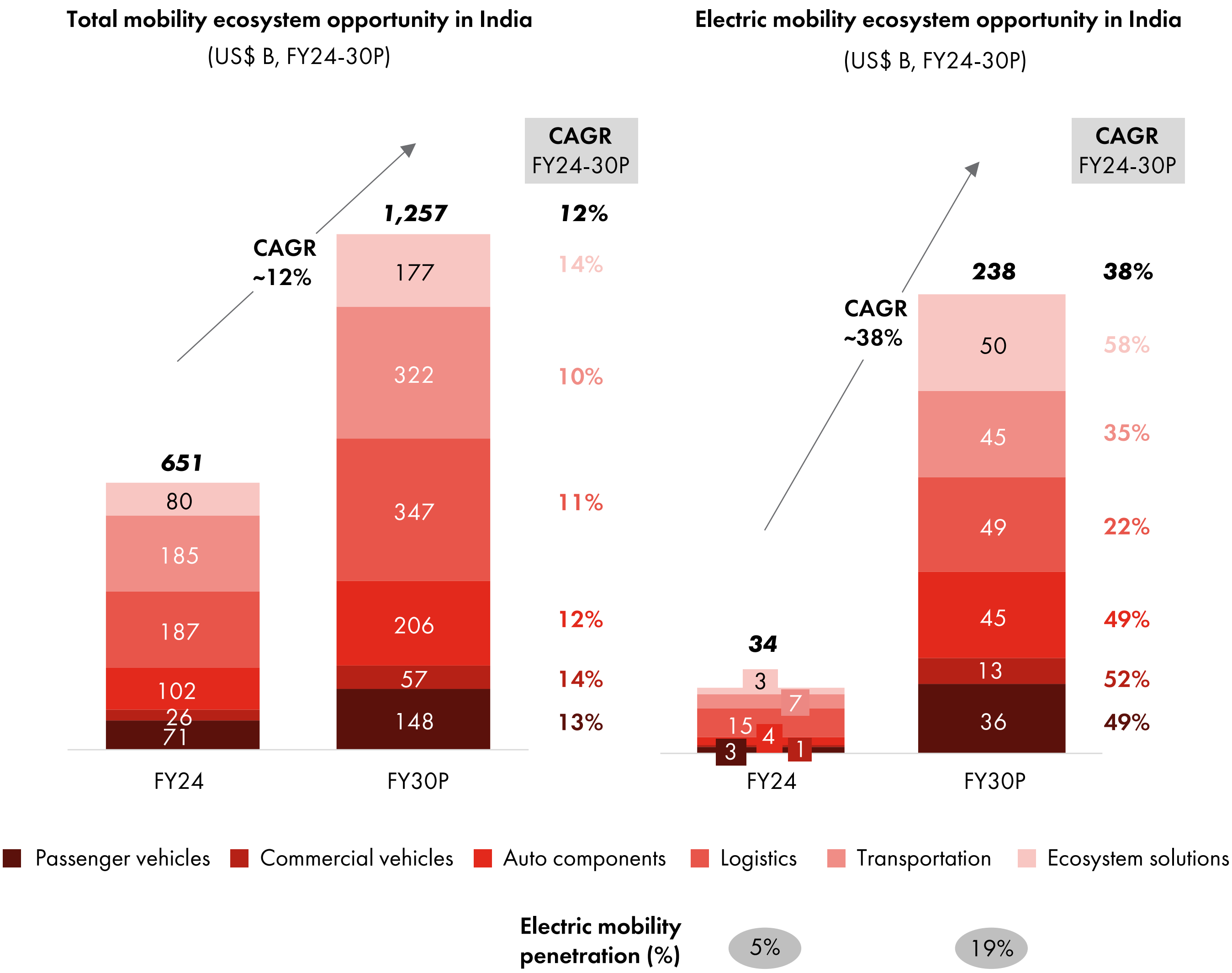
Transportation, in a broader sense, includes diverse modes of passenger commute through 2W, 3W, and 4W cabs, inter and intra-city buses, and railway commutes. Promoting the adoption of electric mobility solutions in transportation, particularly for 2W, 3W, and 4W, can be facilitated by highlighting their economic advantages. Meanwhile, transitioning buses and railways to EVs can be driven by governmental initiatives aimed at promoting adoption in these sectors.

Ecosystem solutions include an array of services such as financing, leasing, insurance, software, EV battery charging and swapping, and auto aftersales services, which enable the adoption of clean vehicles and their sustenance.

2.4 Mobility and electric mobility ecosystem by value

Exhibit 2.4.1

Mobility and electric mobility ecosystem opportunity in India



Note(s): Auto components in electric mobility market includes EV charging equipment market

The Indian mobility ecosystem, comprising passenger and CVs, auto components, logistics and transportation services, and other ecosystem solutions, was valued at US$ 651B in FY24 and is projected to grow annually at 12% to reach ~US$ 1,257B by FY30. Passenger and commercial vehicles are expected to grow at a projected CAGR of 13% and 14% from FY24-30, respectively. Within the overall mobility ecosystem, current electric mobility penetration stands at 5%, with an overall opportunity valued at US$ 34B. The penetration is expected to significantly grow ~4x and increase to ~20% by FY30, owing to the increased adoption of electric PVs and CVs. Overall, the electric mobility ecosystem is expected to become a US$ 238B opportunity by FY30, growing at a CAGR of 38%.

Exhibit 2.4.2

Overview of mobility and electric mobility opportunity in India

Unit - US$ B

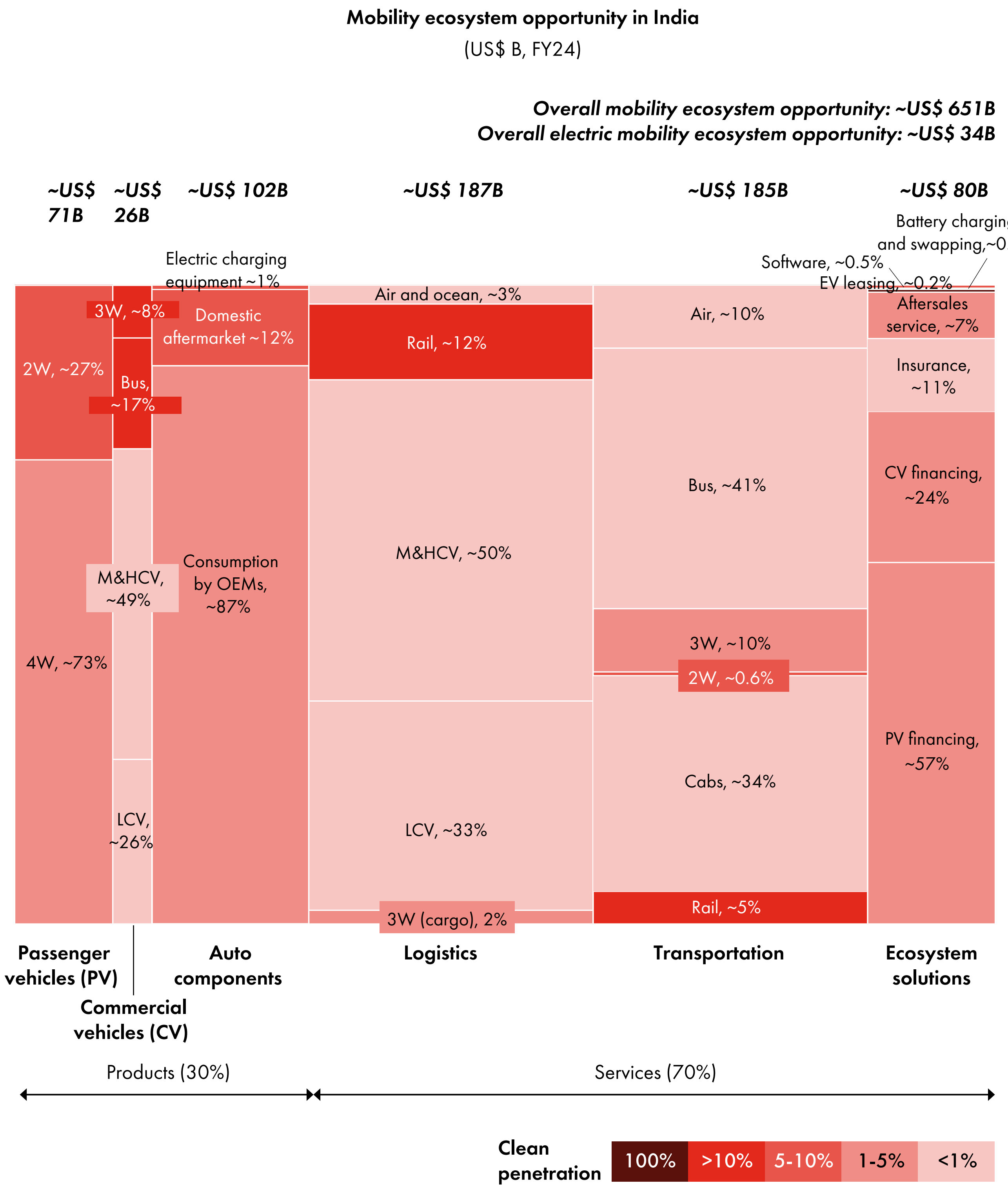
		Overall mobility		Electric mobility		Electric mobility penetration (%)	
		FY24	FY30P	FY24	FY30P	FY24	FY30P
PV	2W	19	45	1	18	8%	40%
PV	4W	52	103	2	18	3%	18%
PV	**Total**	**71**	**148**	**3**	**36**	**5%**	**24%**
CV	3W passenger	2	2	0.3	1	17%	67%
CV	3W cargo	~0.4	~0.7	~0.1	~0.6	31%	77%
CV	LCV	7	15	~0.03	4	<1%	28%
CV	M&HCV	13	26	~0.1	1	1%	4%
CV	Bus	4	13	~0.6	6	13%	47%
CV	**Total**	**26**	**57**	**1**	**13**	**4%**	**24%**
Auto components	OEMs domestic consumption	89	177	3	36	4%	25%
Auto components	Aftersales market	12	25	~0.5	4	4%	18%
Auto components	Charging equipment	~0.7	5	~0.7	5	100%	100%
Auto components	**Total**	**102**	**206**	**4**	**45**	**4%**	**22%**
Total product market (A)		**199**	**411**	**8**	**94**	**4%**	**23%**
Logistics	3W cargo	4	8	~0.3	4	7%	51%
Logistics	LCV	61	118	~0.04	7	<1%	6%
Logistics	M&HCV	94	170	~0.02	1.5	<1%	~1%
Logistics	Rail	22	44	15	37	66%	85%
Logistics	Air and ocean	6	8	-	-	-	-
Logistics	**Total**	**187**	**347**	**15**	**49**	**8%**	**14%**
Transportation	Cabs	62	120	~0.2	12	<1%	10%
Transportation	2W	1	3	~0.1	1	8%	40%
Transportation	3W passenger	18	29	~0.5	10	3%	36%
Transportation	Bus	75	121	~0.3	9	<1%	8%
Transportation	Rail	9	14	6	12	66%	85%
Transportation	Air	18	36	-	-	-	-
Transportation	**Total**	**185**	**322**	**7**	**45**	**4%**	**14%**
Ecosystem solutions	Financing[1]	64	132	2	31	3%	24%
Ecosystem solutions	Battery charging and swapping	~0.3	10	~0.3	10	100%	100%
Ecosystem solutions	EV Leasing	~0.2	5	~0.2	5	100%	100%
Ecosystem solutions	Software solutions	~0.4	2	~0.4	2	100%	100%
Ecosystem solutions	Insurance	9	18	~0.1	2	1%	12%
Ecosystem solutions	Aftersales services	6	11	~0.1	1	2%	7%
Ecosystem solutions	**Total**	**80**	**177**	**3**	**50**	**4%**	**28%**
Total service market (B)		**452**	**846**	**26**	**144**	**6%**	**17%**
Total market (A+B)		**651**	**1,257**	**34**	**238**	**5%**	**19%**

Note(s): [1]Financing market size is considered as the total loan value disbursed

In FY24, the mobility ecosystem was US$ 651B, where services contributed ~70% to the overall opportunity with the logistics and transportation sectors each contributing ~41% to the overall service opportunity. Within the product opportunity, the PV opportunity was valued at US$ 71B, with the 4W vehicle segment contributing 73% to the total PV opportunity.

Exhibit 2.4.3

Mobility and electric mobility ecosystem opportunity in India



Note(s):[1]E-Rickshaws are not included in the 3W CV market; [2]Auto components market includes the sales to OEMs & aftermarket excluding exports; [3]EV financing includes loan disbursal amount for new vehicles in the given year; [4]Vehicle prices are taken as ex-showroom prices

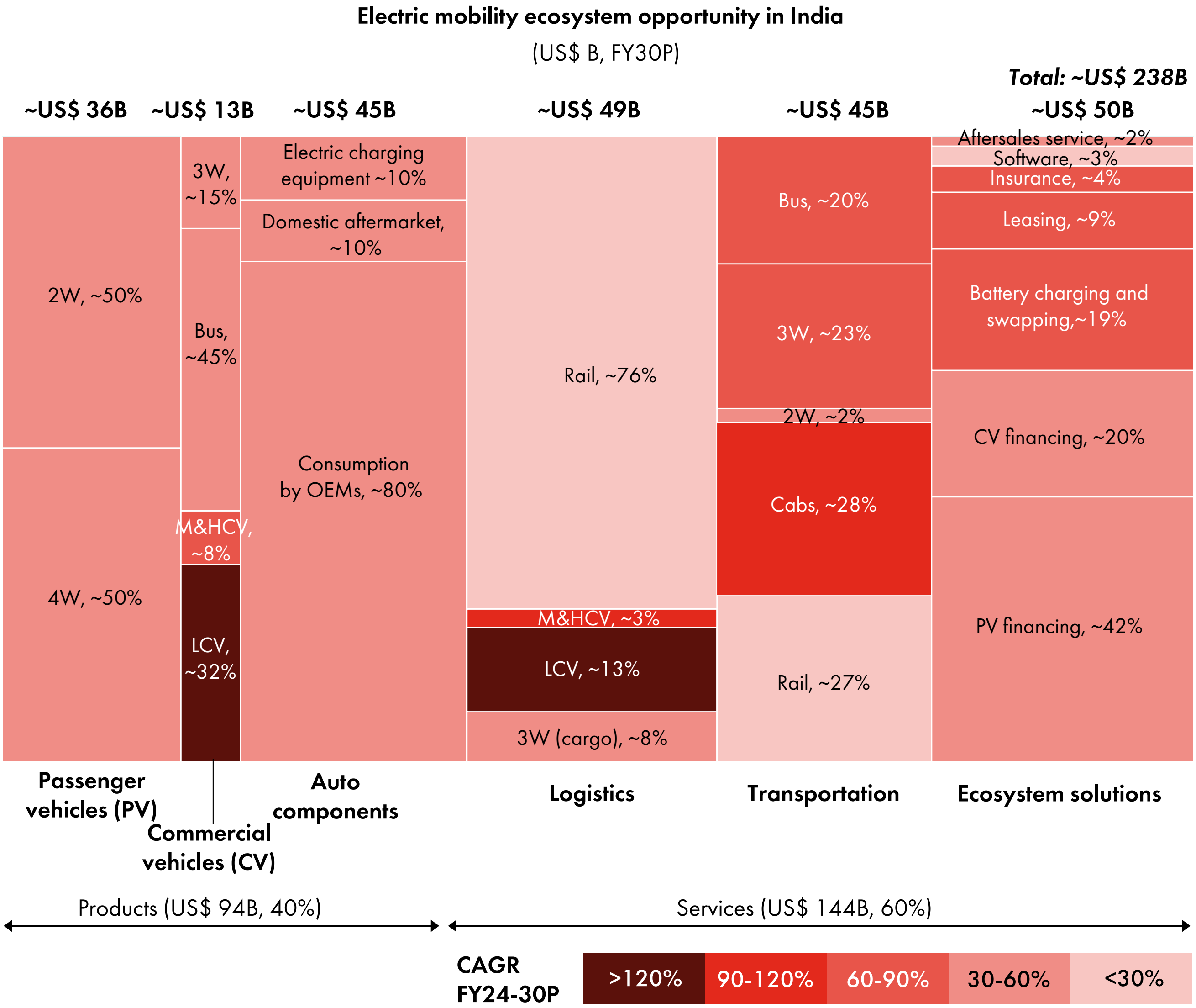
Electric mobility penetration in the total mobility opportunity stood at ~5% in FY24, amounting to US$ 34B. Only a few segments like E3W and E-Bus in EV products, rail logistics and transportation in services, etc., have penetration above 10%, driven by government initiatives such as the electrification of state bus fleets and India's rail network, which currently stands at 66%. Lower electric mobility penetration among other segments underscores both the opportunity and the challenges faced by the mobility industry for widespread EV adoption.

For the products (vehicles and components) segment, the overall opportunity amounted to ~US$ 200B in FY24. PVs constituted ~36% of the overall product opportunity, while the CVs opportunity added another US$ 26B. The electric mobility products opportunity in India in FY24 was valued at US$ 8B, representing about 4% of the overall product mobility opportunity.

In the 2W mobility category, E2W penetration stood at 8% in FY24, while E4W electric mobility penetration stood at 3%. Within the CV mobility segment, 3Ws for both passenger and cargo applications witnessed significant electrification, with penetration reaching 17% and 31% respectively in FY24. Additionally, E-Bus penetration reached approximately 13%. The adoption has been led by government support, improving ecosystem infrastructure, and increased awareness about the savings that EVs provide over their ICE counterparts. (All penetration figures mentioned are value penetrations, based on the market value of EV and associated products).

Exhibit 2.4.4

Electric mobility ecosystem opportunity in India (FY30)



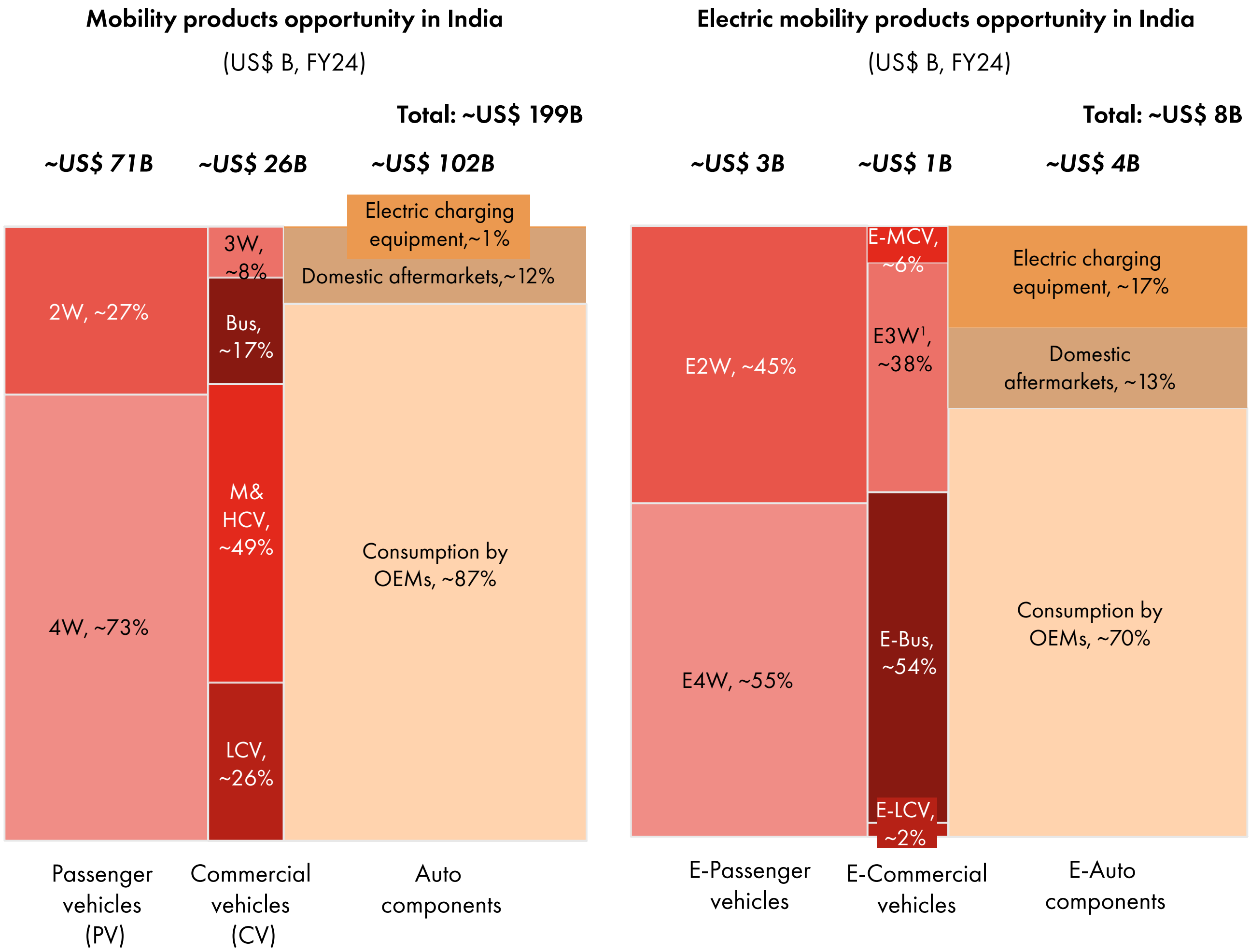
Note(s): [1]E-Rickshaws are not included in the 3W CV market; [2]Auto components market includes the sales to OEMs & aftermarket excluding exports; [3]EV financing includes loan disbursal amount for new vehicles in the given year; [4]Vehicle prices are taken as ex-showroom prices

Electric mobility opportunity in the total mobility opportunity is projected to reach US$ 238B by FY30. This opportunity would include ~US$ 94B opportunity from products segment in FY30. PVs are projected to be 15% of the overall electric mobility opportunity, while the CVs opportunity will add another US$ 13B of opportunity. While the electric mobility services opportunity in India is projected to reach ~US$ 144B by FY30 with transportation, logistics, and ecosystem solutions contributing equally.

In FY24, India's mobility product opportunity was ~US$ 200B, with the electric mobility product opportunity accounting for ~US$ 8B.

Exhibit 2.4.5

Mobility and electric mobility products opportunity in India (FY24)



Note(s): E-Rickshaws are not included in the 3W CV market

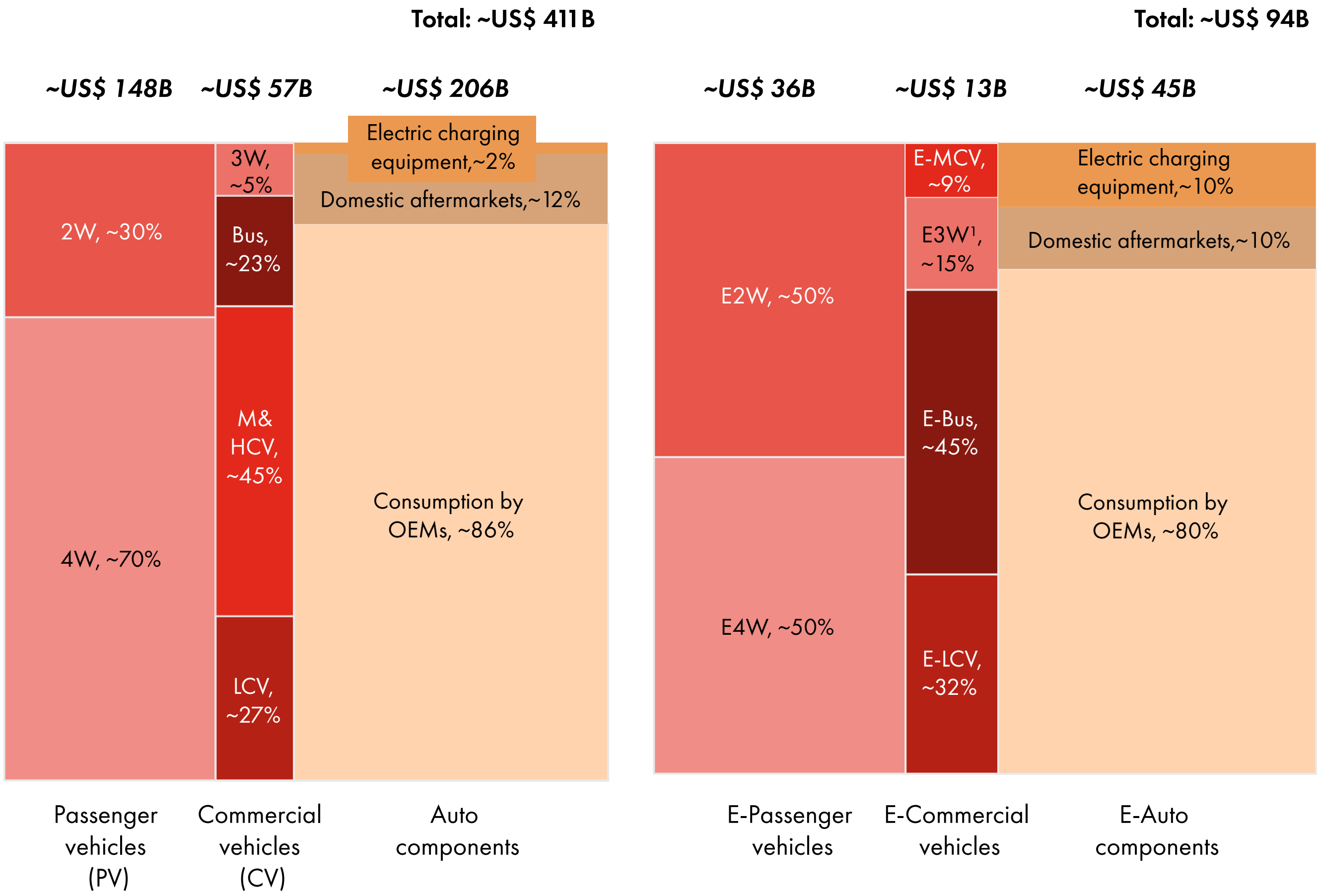
E-Mobility product opportunity is projected to hit ~US$ 94B, with overall penetration rising significantly to ~23% by FY30. E-Mobility penetration in PVs is set to reach 24%, with E2W penetration hitting 40% by FY30. In the CV segment, E3W penetration is projected to reach 70%. E-Bus and E-LCV penetration by value are expected to see significant increases, reaching 47% and 28% respectively, due to continuous government support and decreasing price differentials between them and their ICE counterparts. The E-M&HCV segment within CVs will see muted growth due to their high upfront cost exacerbated by high battery power requirements. With the increasing penetration of EVs, electric auto components are also expected to experience significant growth, rising from a 4% share in FY24 to a 22% share of the total auto components market by FY30. It is imperative to note that there is a growing vehicle export opportunity in India, which is also creating rapid growth for component manufacturers beyond the domestic vehicle sales opportunity. Notably, this is only a domestic opportunity, and exports of both vehicles and auto components directly to foreign markets will only be an upside to this opportunity.

Exhibit 2.4.6

Mobility and electric mobility products opportunity in India (FY30)

Mobility products opportunity in India (US$ B, FY30P)

Electric mobility products opportunity in India (US$ B, FY30P)



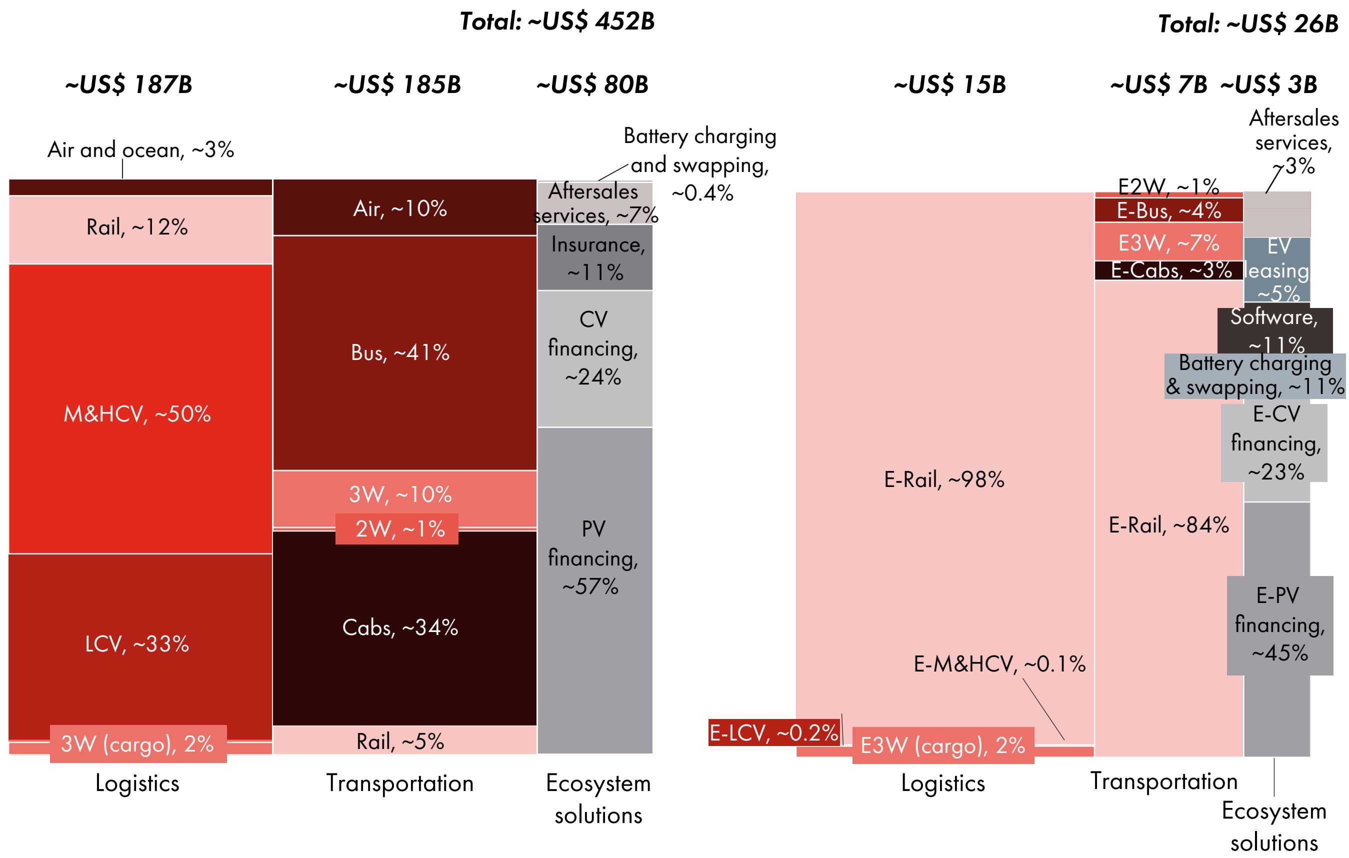
Note(s): [1]E-Rickshaws are not included in the 3W CV market

Mobility services opportunity in India is worth ~US$ 450B in FY24 with more than 80% of the opportunity lying in transportation and logistics services. At present, ~6% of the overall mobility services opportunity is catered by clean service providers, with E-Rail (both logistics and transportation) contributing more than 80% of the overall electric mobility service opportunity.

Exhibit 2.4.7

Mobility and electric mobility service opportunity in India (FY24)

Mobility services opportunity in India (US$ B, FY24) | **Electric mobility services opportunity in India** (US$ B, FY24)



Note(s): E-Rickshaws are not included in the 3W CV market; EV financing includes loan disbursal amount for new vehicles in the given year

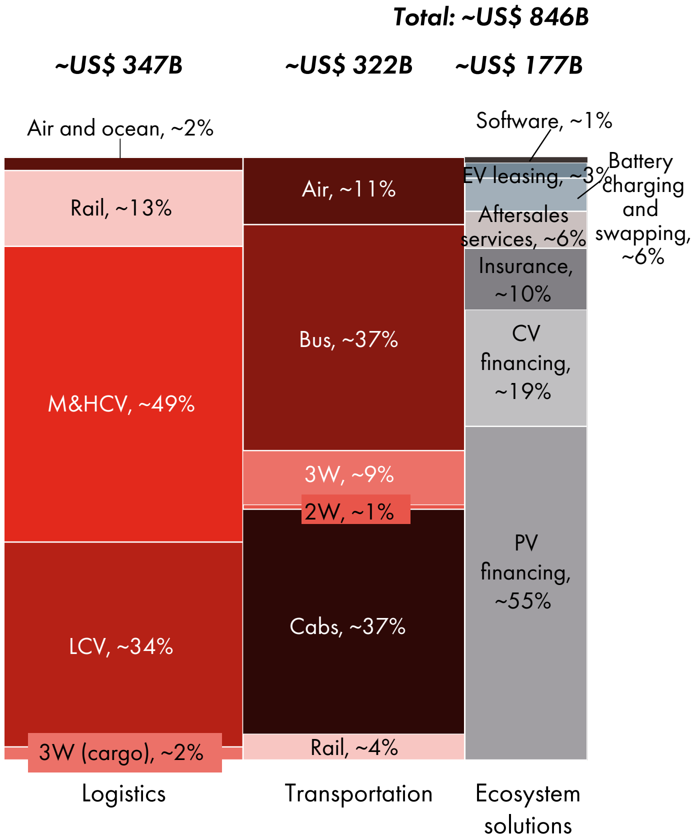
The mobility service opportunity is expected to grow to US$ 850B by FY30 growing at a CAGR of ~11% with the ecosystem solutions segment growing the fastest at 14% annually. Within the ecosystem solution segment battery charging and swapping is expected to grow at a rate of ~75% CAGR annually. Penetration of electric mobility services in overall mobility services is expected to increase to 17% by FY30 from 6% in FY24 with the overall electric mobility service opportunity amounting to ~US$ 144B. Clean logistics and transportation opportunity is expected to diversify from rail with the adoption of EVs in other means (such as LCV, cabs, 3W, bus, etc.) of transportation and logistics.

Exhibit 2.4.8

Mobility and electric mobility service opportunity in India (FY30)

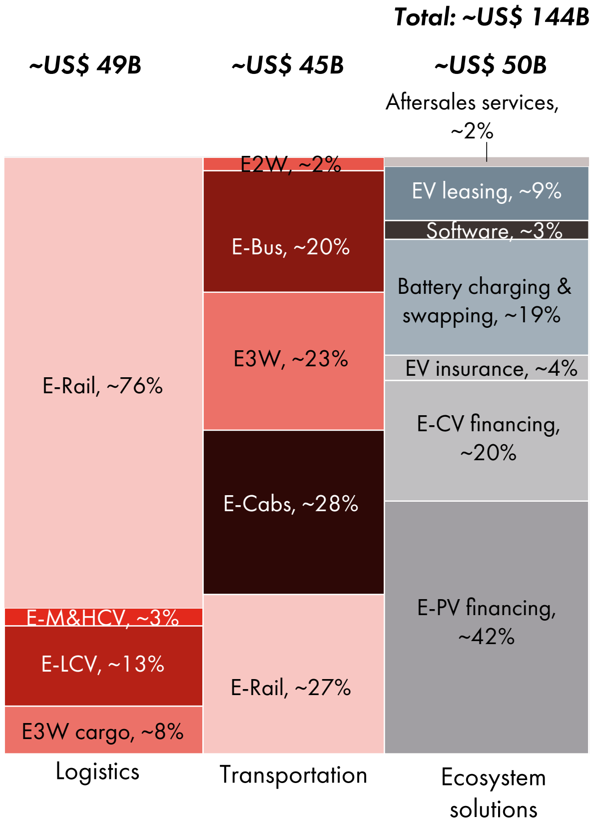
Mobility services opportunity in India

(US$ B, FY30P)



Electric mobility services opportunity in India

(US$ B, FY30P)

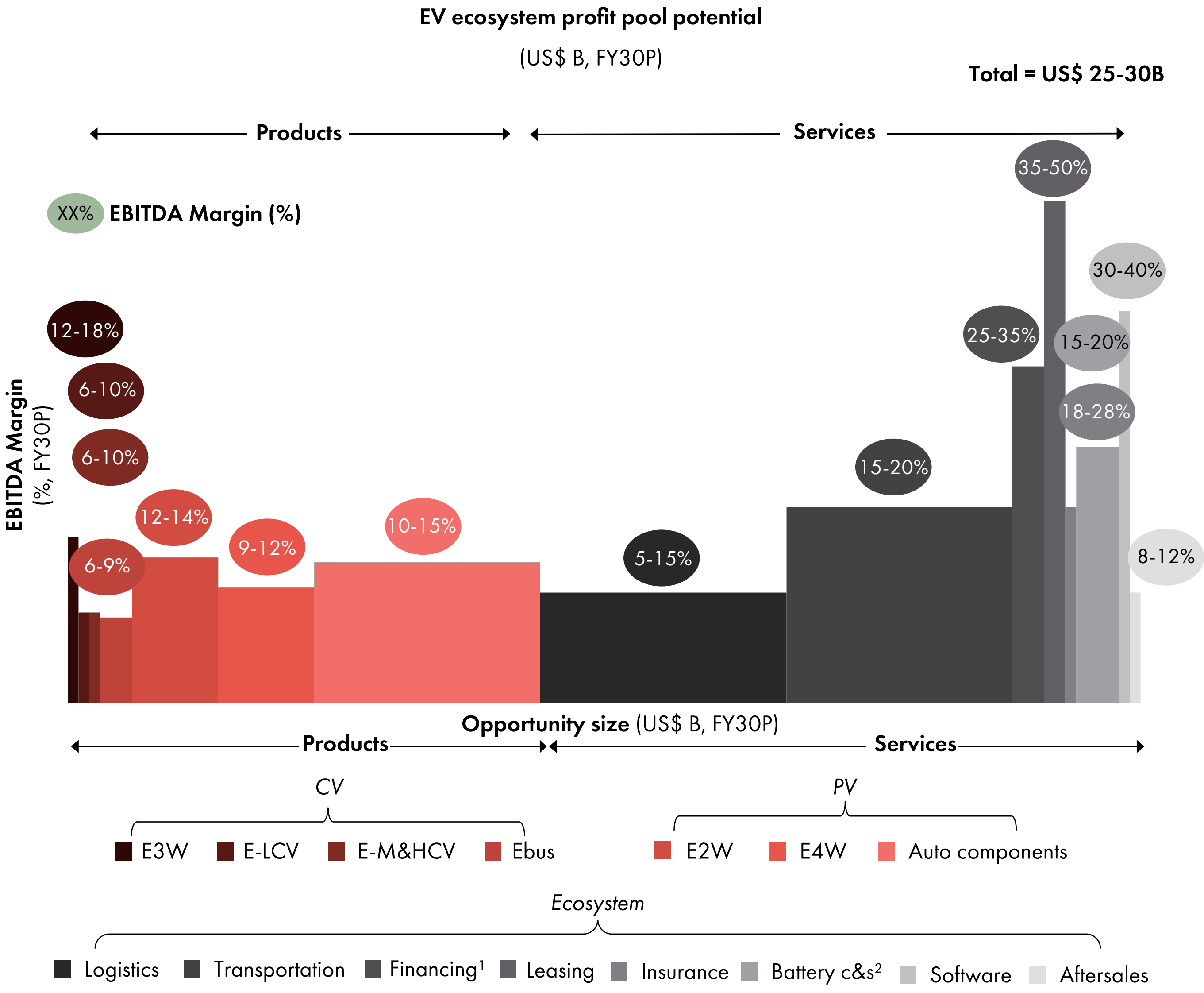


Note(s): E-Rickshaws are not included in the 3W CV market; EV financing includes loan disbursal amount for new vehicles in the given year

Achieving the projected level of penetration of clean solutions across products and services is forecasted to yield a profit pool of US$ 25-30B by FY30 for the ecosystem players. Within the profit pool available for products, E4W players will constitute the largest share, followed by E-Bus and E2Ws. The profit available to stakeholders across the ecosystem is expected to differ from the current mobility solutions industry, as multiple new EV-specific products and services would emerge in the industry. Within mobility services, transportation services are projected to contribute the largest share to the profit pool, closely followed by E-Logistics.

Exhibit 2.4.9

EV value chain profit pool (FY30)



	E3W	E-LCV	E-M&HCV	Ebus	E2W	E4W	Auto components	Logistics	Transportation	Financing	Leasing	Insurance	Battery c&s	Software	Aftersales
Opportunity size (US$ B, FY30)	2.0	4.2	1.2	6.1	18.0	18.2	44.7	49.1	44.8	5.0	4.6	2.1	9.7	1.6	0.8
Profit pool (US$ B, FY30)	0.3	0.3	0.1	0.4	2.2	1.8	5.3	4.6	7.4	1.4	1.9	0.4	2.1	0.5	0.1

Note(s): EBITDA margins on basis of current ICE margins; profit pool of CV and PV is at OEM level, [2]c&s: charging and swapping, [1]EV financing EBIDTA is considered on the interest component of the loan value

2.5 Challenges hindering EV adoption among commercial and passenger vehicles

While the growth outlook for Electric mobility opportunities appears promising, major roadblocks are encountered by key stakeholders, including customers, manufacturers, service providers, and government institutions.

For customers, subsidies help reduce upfront costs for E2Ws, but high initial expenses, range anxiety, and charging infrastructure issues remain significant concerns for other vehicle types. Limited options from OEMs and inadequate EV financing options also contribute to customer apprehension.

For OEMs, dependence on imports for critical EV components makes them vulnerable to supply disruptions, squeezing margins and increasing final product costs. Ecosystem service providers face hurdles such as the lack of charger standardization and high initial capital expenditure requirements. Regulatory support and mitigating measures are needed to achieve electrification targets by FY30.

Exhibit 2.5.1

Challenges hindering EV adoption among CVs and PVs

	Key challenges	Description	Passenger vehicles			Commercial vehicles				
			E2W scooter	E2W motorcycle	4W cars	E3W passenger	E3W cargo	E-LCV	E-M&HCV	E-Bus
Customers	High upfront cost	High upfront cost of EVs due to expensive battery prices	◔	◔	◕	◔	◔	◑	●	●
Customers	Lack of charging infrastructure	Low ratio of EVs to charging stations in India	◑	◑	◕	◕	◕	◕	◕	◕
Customers	Range anxiety	Fear of running out of battery charge due to limited charging options	◕	◕	◑	◕	◕	◕	◕	◑
Customers	Limited product range	Lack of choice for customers, especially in CV segment	◔	◑	◕	◔	◔	◕	●	◕
Customers	Safety related issues	Frequent EV safety incidents like battery fires	◕	◕	◕	◑	◑	◑	◑	◑
Customers	EV financing	High perceived risks for lenders due to uncertainty regarding esale value	○	◔	◑	◕	◕	●	●	●
Vehicle manufacturers	Supply chain scalability	Import dependence on critical EV components like chips and lithium batteries creates vulnerability to supply chain disruptions	◔	◔	◕	◑	◑	◕	◕	◕
Vehicle manufacturers	Reliance on regulatory support	Manufacturers rely heavily on the subsidies to support sales and avoid impact on their margins	◕	◕	◑	◑	◑	◑	◑	◑
Service providers	Inadequate government support	Lack of incentives and subsidies by government for EV charging station, battery swap center etc.	◔	◔	◑	◑	◑	◔	◑	◔
Service providers	High investments	Setting up EV infrastructure require high Capex investments	◕	◕	◕	◕	◕	◕	◕	◕
Service providers	Lack of standardization	Variance in battery types installed in vehicle limit service applicability	◔	◔	◑	◑	◑	◑	◑	◔
Overall feasibility			◕	◑	◑	◑	◕	◔	◔	◔

03

ELECTRIC MOBILITY PRODUCTS

3.1 Commercial vehicles

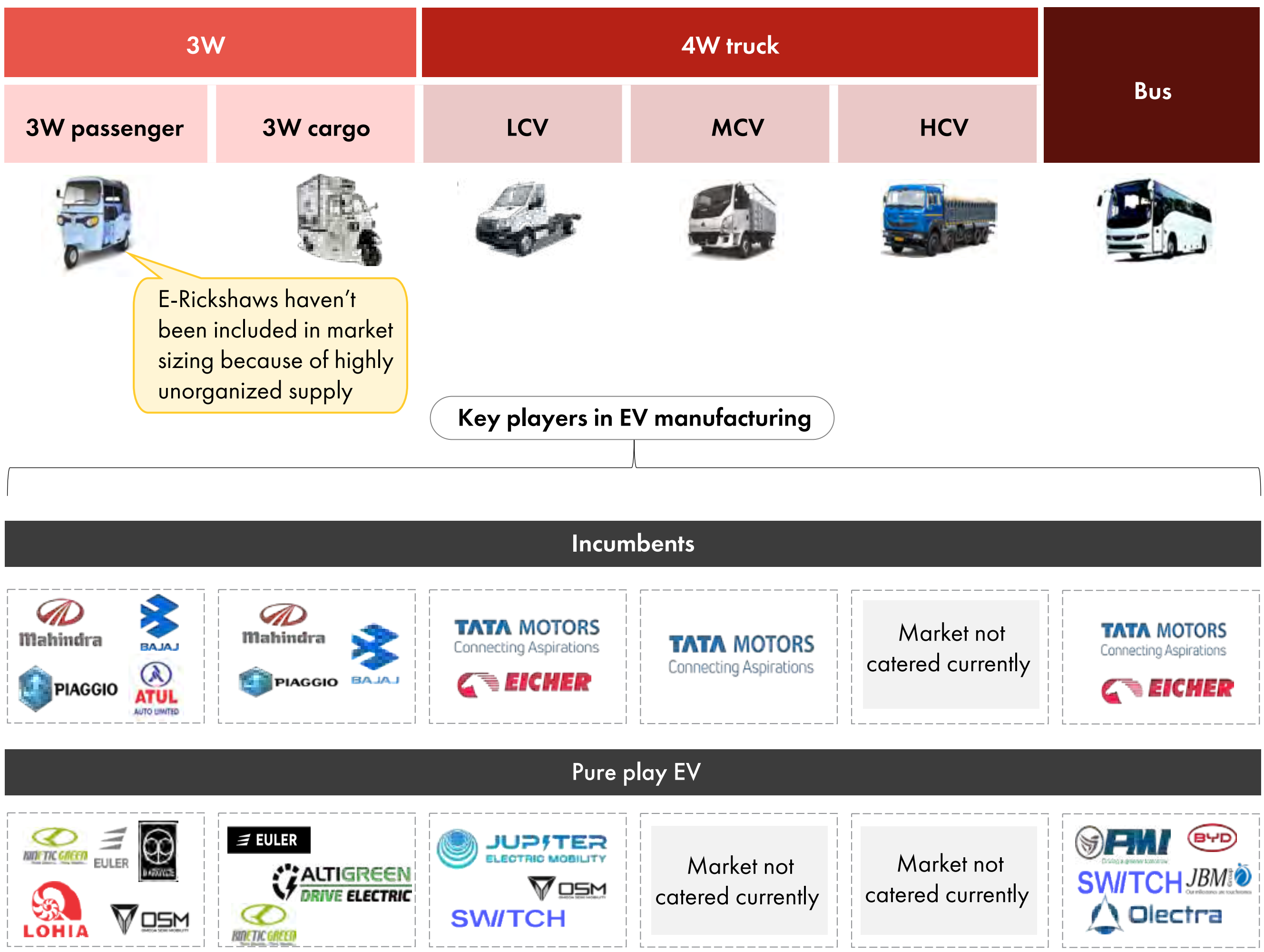
3.1.1 Introduction

Commercial vehicles are segmented into four main categories: three-wheelers (3W) used for both passengers and cargo, light commercial vehicles (LCVs) medium and heavy commercial vehicles (M&HCVs), primarily utilized in the logistics industry, and buses, used for passenger transport.

The 3W segment has seen the emergence of numerous pure-play EV players and incumbents launching their EV variants, leading to significant EV penetration in this segment. The M&HCV segment has been the least penetrated segment in CVs, with very few EV models launched thus far. E-Buses, whose adoption has been primarily driven by government fleet electrification initiatives, have also seen the emergence of new-age EV players launching their products alongside incumbents.

Exhibit 3.1.1

EV commercial vehicle landscape in India



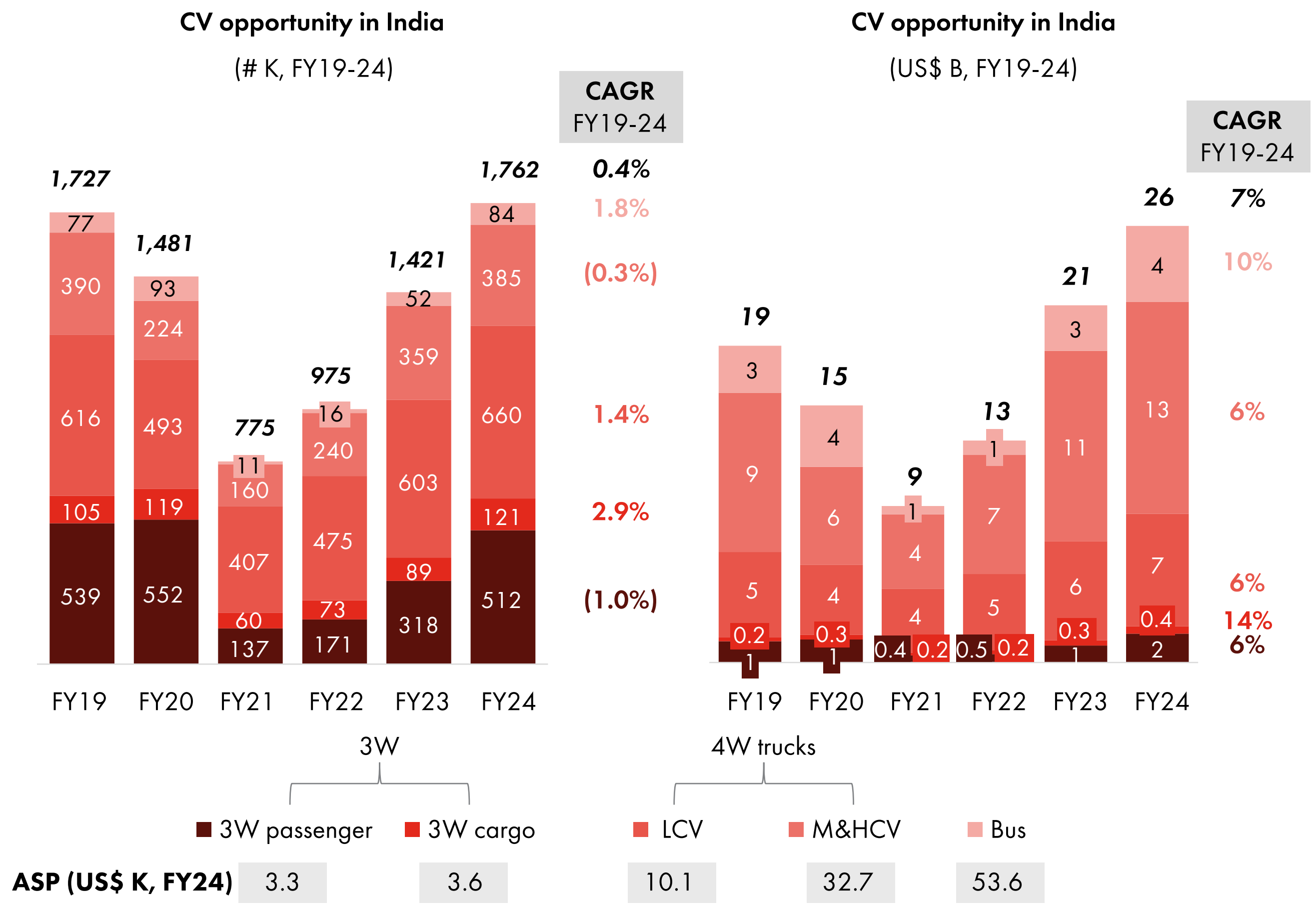
3.1.2 Overall CV opportunity in India

In FY24, CVs recorded sales of 1.8M units, rebounding and surpassing pre-COVID sales levels of around 1.5M units sold in FY20, with the LCVs segment registering the highest sales.

The opportunity has grown from US$ 19B in FY19 to US$ 26B in FY24, registering an annual growth rate of 7%. In FY24, 4W truck sales accounted for 74% of the overall CV sales value.

Exhibit 3.1.2

CV opportunity in India in volume (LHS) and value (RHS)



Note(s): E-Rickshaws are not included in the 3W CV market
Source(s): Vahan dashboard

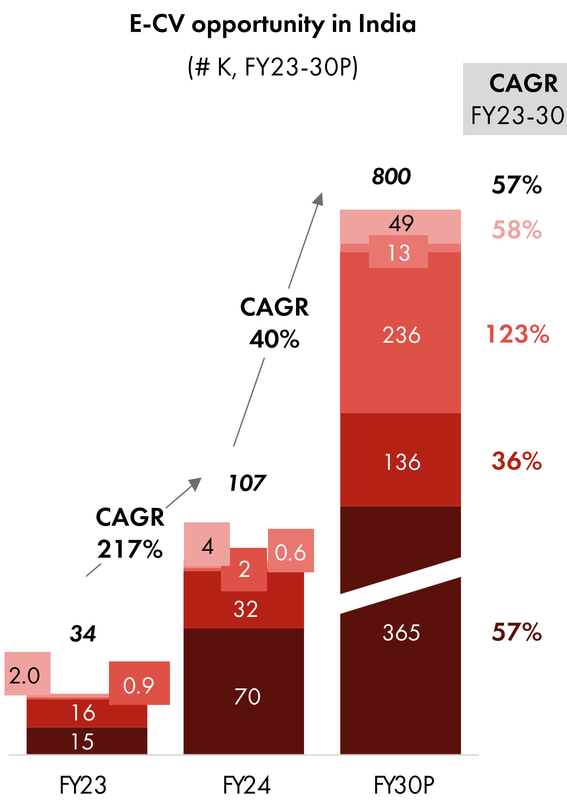
3.1.3 Overall E-CV opportunity in India

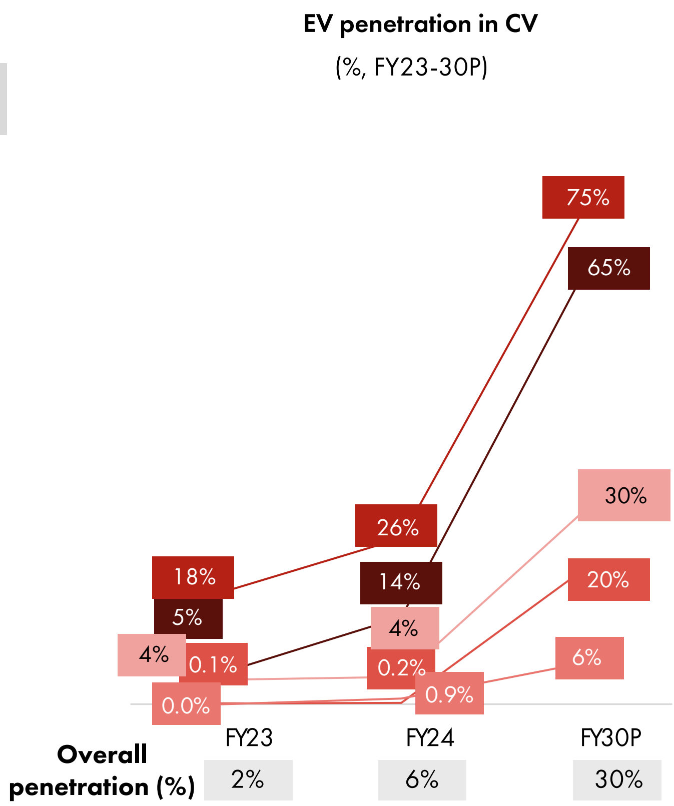
In FY24, E-CV sales soared to 107K units, nearly tripling the units sold in FY23. Annual sales volume is projected to surpass 800K units by FY30, growing annually at a rate of 40% from FY24-30. Within this, the E3W segment is projected to experience a 5x growth in sales volume, increasing from ~100K units sold in FY24 to ~500K units sold annually by FY30. Additionally, E-LCVs are anticipated to account for 30% of total E-CVs sold in FY30. Sales penetration for E3W passenger and cargo vehicles are expected to be ~70% and 80% respectively, 21% for E-LCVs, and 30% for E-Bus by FY30, while it is projected to be lowest for E-M&HCV at ~5%.

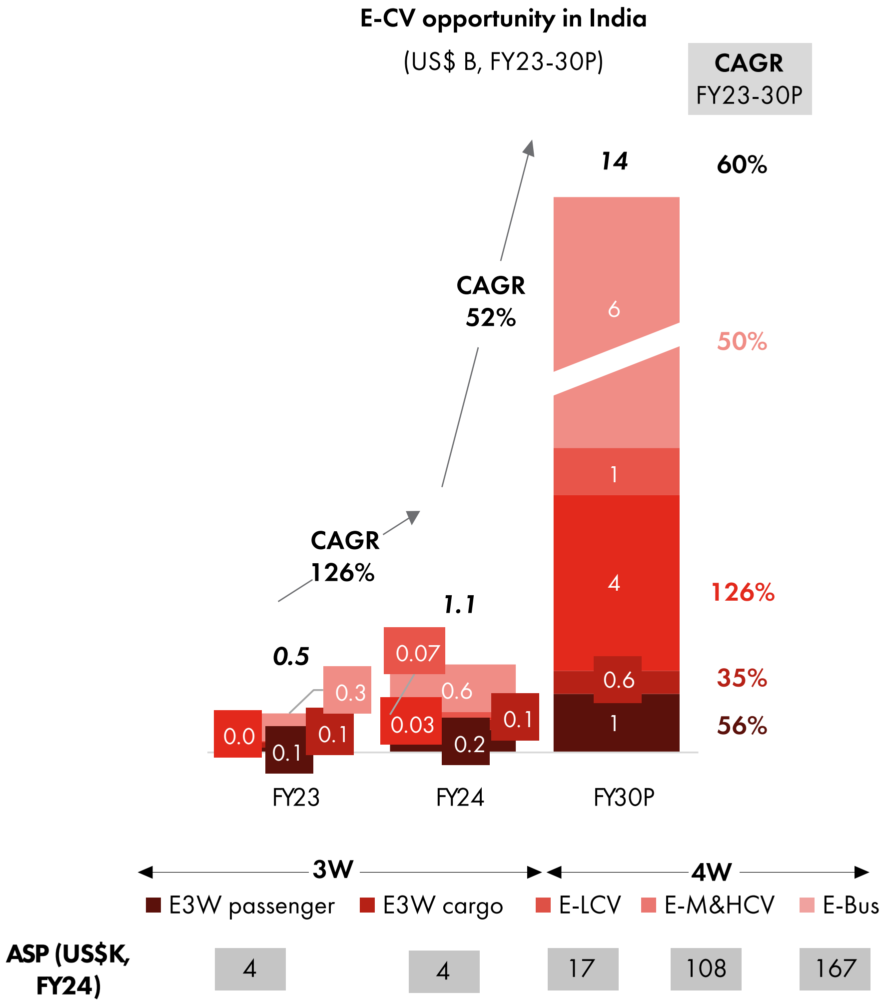
Clean CV opportunity stood at US$ 1.1B in FY24, having grown from US$ 0.5B in FY23 at a YoY increase of over 126%, primarily driven by E3W sales. The opportunity is further expected to be ~US$ 14B by FY30, growing at ~52% annually from FY24-30. Prices for EVs are likely to continue declining as adoption increases at scale and battery technology improves. The E3W prices are expected to align with ICE 3W prices by FY30, while the price differential for E-LCVs will reduce to 45% from the current 65%. The price differentials for M&HCV and bus will decrease but remain relatively high by FY30, due to the high cost of batteries for meeting the energy requirement of these vehicles.

Exhibit 3.1.3

E-CV opportunity by volume, value, and penetration in India







3.1.4 Commercial EV landscape

E-CVs are classified into E3W, E-LCV , E-M&HCV, and E-Buses based on their carrying capacity and purpose. In the E3W segment, vehicles are categorized into two primary categories based on their purpose of use: cargo and passenger. The E3W opportunity is relatively well-represented, with multiple OEMs, including both incumbents and new-age EV players such as Mahindra, Bajaj, Atul, Piaggio, Kinetic Green, and OSM. Collectively, these companies offer 30-40 different variants at various price points, providing consumers with a wide array of options.

E-LCVs are classified based on cargo capacity, with segments including those less than 3.5 tons and those between 3.5-7.5 tons. The E-LCV opportunity is still in its nascent stage and evolving, with only 10-15 models currently available in this segment. Tata Motors is the key incumbent, while OSM and Switch are pure-play EV companies in this segment. The E-M&HCV segment remains underserved, with almost no OEMs currently present. E-Buses are classified based on seating capacity, including 10-30-seater, 30-50-seater, and more than 50-seater categories. Tata Motors is the key incumbent in the E-Bus segment, with several pure-play EV companies such as Switch, Olectra, Lancer, BYD, and JBM also present. E-Buses with more than 50 seating capacity remain underserved, with fewer OEM players and a smaller number of models offered.

Exhibit 3.1.4

Commercial EV landscape

	Variant	Sales volume (# K, FY24)	Use case	# of models[2]	Major players: Incumbents	Major players: Pure play EV	Prevalence in the market
E3W[1]	Cargo	101.2	Last-mile delivery, cargo transportation in congested areas, e-commerce and courier	20	Mahindra electric, Atul, Piaggio, Bajaj	Kinetic Green, OSM, Euler, Lohia	◕
E3W[1]	Passenger		Short-distance commuting, taxi services	13	Mahindra electric, Bajaj, Piaggio	Kinetic Green, Altigreen, OSM	◕
E-LCV	Cargo (less than 3.5 tons)	1.5	Urban deliveries (small cargos), trades and services (e.g., plumber and electrician)	6	Tata Motors	OSM	◑
E-LCV	Cargo (3.5-7.5 tons)		Construction and industrial use	4	Tata Motors	OSM, Switch, Jupiter	◔
E-M&HCV	Cargo (more than 7.5 tons)	0.6	Transporting heavy machinery, materials, and equipment	-	Market not well catered currently		○
E-Bus	10 to 30-seater	3.6	Local transportation and shuttle services	3	Tata Motors	JBM, Switch, Olectra	◑
E-Bus	30 to 50-seater		Shorter intercity routes (e.g., school buses)	9	Tata Motors	PMI, Switch, Olectra, BYD	◕
E-Bus	More than 50-seater		Mass transit and intercity transportation	3	NA	Lancer, Switch	◔

Low ○ ◔ ◑ ◕ ● High

Note(s): [1]E3W cargo and E3W passenger does not include E-Rickshaw; [2]Includes only the # of models offered by major players as of 9th May'24

3.1.5 E3W players' expansion plans

The E3W segment in India is expected to boom with established players like Mahindra, Piaggio, and Bajaj investing to expand their E3W offerings for cargo and passengers. Mahindra is investing US$ 120M in Telangana, Piaggio is expanding its EV lineup and investing in manufacturing, and Bajaj is setting up E3W plants with a US$ 55M investment. Additionally, newer companies like Omega Seiki Mobility, Euler, and Alti Green Drive Electric are also making waves. Omega Seiki is considering a significant investment in manufacturing, Euler is expanding sales outlets and raising funds, while Alti Green Drive Electric is innovating with fast-charging models and seeking funding for expansion.

Exhibit 3.1.5

Expansion plans of E3W players

	Incumbents			Pure play EV			
	Mahindra	PIAGGIO	BAJAJ	KINETIC GREEN	OSM	EULER	ALTIGREEN DRIVE ELECTRIC
Current EV products	**Cargo:** Treo Zor, ZorGrand, E-Alfa Cargo **Passenger:** Treo, Treo Yaari, E-Alfa 	**Cargo:** Ape E-Xtra & Xtra FX Max **Passenger:** Ape E-City & E-city Max 	**Cargo:** RE E-Tec **Passenger:** Maxima Cargo 	**Cargo:** Jumbo Ranger, Shakti **Passenger:** DX 	**Cargo:** Rage+ **Passenger:** Stream and Stream city 	**Cargo:** HiLoad 	**Cargo:** NeEV Tez, high and low deck 
Product expansions	• **Launched new variants** of existing cargo and passenger versions **at reduced prices** • Partnership with fleet owners for the deploy-ment of EVs	• Increased domestic EV footprint by providing **24K+** vehicles across **key fleet operators** (Sun Mobility, MoEVng, Magenta, etc.) • Launched new variants of existing cargo and passenger versions	• **Official roll-out** of E3W vehicles began in **Apr-May '23** with further expansions announced • **~100 units sold in Jun'23** with sales footprint **expected to increase** over the **festival season**	• Aims for **0.1M** EV sales in FY25 and INR 1K Cr. turnover	• **Expanded into the Passenger** E3W segment with the launch of the new **'Stream' line of vehicles**	• **Expanded geographically** by establishing **sales outlets in S. India** (Karnataka and Telangana)	• Launched their **fast-charging variant** neEV Tez in **collaboration with charging infra** player **exponent**
Investments	• **~US$ 120M** expansion of manufacturing plants in Telangana specifically for E3Ws	-	• **~US$ 55M** earmarked for establishing **E3W manufacturing plants** in Aurangabad	• Set to raise **US$ 100M-150M** for the EV business expansion	• In talks to invest **~US$ 200M** to establish **manufacturing plants in India**	• Raised **US$ 60M** in venture funding to **grow retail footprint**	• Looking to raise **US$ 80-85M** to expand **manufacturing capacities** and develop **newer models**

3.1.6 E-LCV players' expansion plans

In E-LCV segment, although there are relatively few players, the recently introduced vehicles have generated significant pre-bookings, indicating a strong demand in the market. Since the indication of demand, the incumbents are making significant investments in expanding the existing manufacturing capabilities. TATA Motors plans to invest US$ 245M annually, with focus on E-LCV vehicles, while Switch (Ashok Leyland) plans to invest US$ 150M to increase its electric footprint. In addition to established incumbents, pure-play EV companies are making significant investments to ground their presence in the commercial vehicle opportunity. For instance, Jupiter Mobility plans to invest US$ 25M for an end-to-end production setup, and Omega Seiki Mobility aims to raise US$ 200M by CY25.

Exhibit 3.1.6

Expansion plans of E-LCV players

	← Incumbents		→	← Pure play EV	→
	TATA MOTORS	EICHER	SWITCH	JUPITER ELECTRIC MOBILITY	OSM
Current EV products	• **LCV:** Tata Ace EV 	• **LCV:** Pro 2049 EV 	• **LCV:** IeV 3, IeV 4 	• **LCV:** JEM Tezz, EV Star CC 	• **LCV:** M1KA 
Product expansions	• **Signed** a strategic **MoU** with leading e-commerce companies and LSPs for **delivering 39K units** of Tata Ace EV • **Completed pilots** for 6 months **with courier partners and e-commerce companies** for complete package including support center and charging infrastructure	• **Collaborates with Amazon** to deploy electric trucks for middle and last-mile deliveries	• **Secured ~13K orders** from e-commerce players for the **IeV range** • Plan to **set up 70 outlets** to deliver **service and ensure maintenance** of vehicles	• LCV range **planned for commercial release in Q3 FY24** • Plan to focus only on 4W CVs	• Plan to invest **US$ 100M** to build manufacturing facilities in India
Investments	• **Plan to invest ~US$ 245M annually on CV segment, with special focus on** the expansion of the E-CVs	• Announced a CAPEX of **US$ 122M** for FY2023-24, towards EV manufacturing facility and product development	• **Ashok Leyland will invest ~US$ 150M** by FY24 aimed at increasing electric footprint	• **Plan to invest ~US$ 25M** for to undertake end-to-end **production in India** and establish service verticals in key markets	• **Plan to raise US$ 200M** by CY25 to fund its ongoing business • **Signed MoU with Punjab National Bank to augment EV financing** for dealer network as well as end customers

Note(s): Switch mobility is the EV arm of Ashok Leyland

3.1.7 E-Bus players' expansion plans

E-Bus manufacturers are actively pursuing strategies to expand their product range and strengthen their domestic manufacturing capabilities. This strategic shift is in direct response to the increasing demand from state governments for the electrification of their inter and intra-state transportation fleets, as well as the entry of new private players dedicated to providing inter-state E-Bus transportation services. E-Bus players such as Switch and JBM are investing US$ 146M and US$ 60M, respectively, for E-Bus manufacturing.

Exhibit 3.1.7

Expansion plans of E-Bus players

	TATA MOTORS	EICHER	PMI	Olectra	SWITCH	JBM
Current EVs	**Vehicle/product range:** Starbus EV Ultra 9/9m, Urban 9/12m, Tata 4/12m 	**Vehicle/product range:** Skyline pro E 9M/12M 	**Vehicle/product range:** Urban (12M), Regio (9M), Lito (7M), School (9M) 	**Vehicles/product range:** CX2, X2, iX, V2 	**Vehicles/product range:** Switch Eiv 12, Eiv 7, Eiv 22, MetroDecker, e1, Solo, Metrocity 	**Vehicles/product range:** Eco-life, Luxury, E-Skoolife, E-Bizlife, E-Skylife 
Product expansions	• Recently has supplied 400 state-of-the-art EV buses to DTC • It achieved inaugural CMVR approval for Hydrogen FCEV buses	• Plans to integrate 10K EVs into the delivery fleet in India by 2025	• **Recently** won the bid to supply ~2K vehicles to the Delhi government (by CY25)	• Show-cased/unveiled **Hydrogen FCEV** buses in **partnership with Reliance** • Received orders (letter of intent) to supply **5K+ E-Buses to the government of Maharashtra**	• Expect to launch **~5 products,** incl. **2 E-Buses** (for Indian and European markets)	• **Showcased 3 new variants** of E-Buses in **Apr'23** focusing on the luxury segment
Investments	• Ongoing talks with global investors to raise at least **US$ 500-600M** more for its fast-growing EVs business, just over a year after it received **US$ 1B** from TPG's Rise Climate Fund and ADQ	• GreenCell Mobility has signed a deal with VE Commercial Vehicles (VECV), a joint venture between Volvo Group and Eicher Motors Limited, to get 1K E-Buses from Eicher for its inter-city business, NueGo	• **Invested ~US$ 5-6M** to establish E-Bus depots for transportation bodies in Maharashtra, Kerala, Goa, etc. • Currently seeking a capital Infusion of **~US$ 48M** to help expand R&D, manufacturing and their fleet operations	• Looking to raise **~US$ 90–100M for E-Bus manufacturing plants** in Hyderabad	• Infusing **~US$ 146M** earmarked (from internal reserves) for **domestic E-Bus manufacturing plants** in India	• Earmarked **~US$ 60M** to enhance E-Bus manufacturing capacities and development

Note(s): Includes # of models offered by major players as of 29th May'24

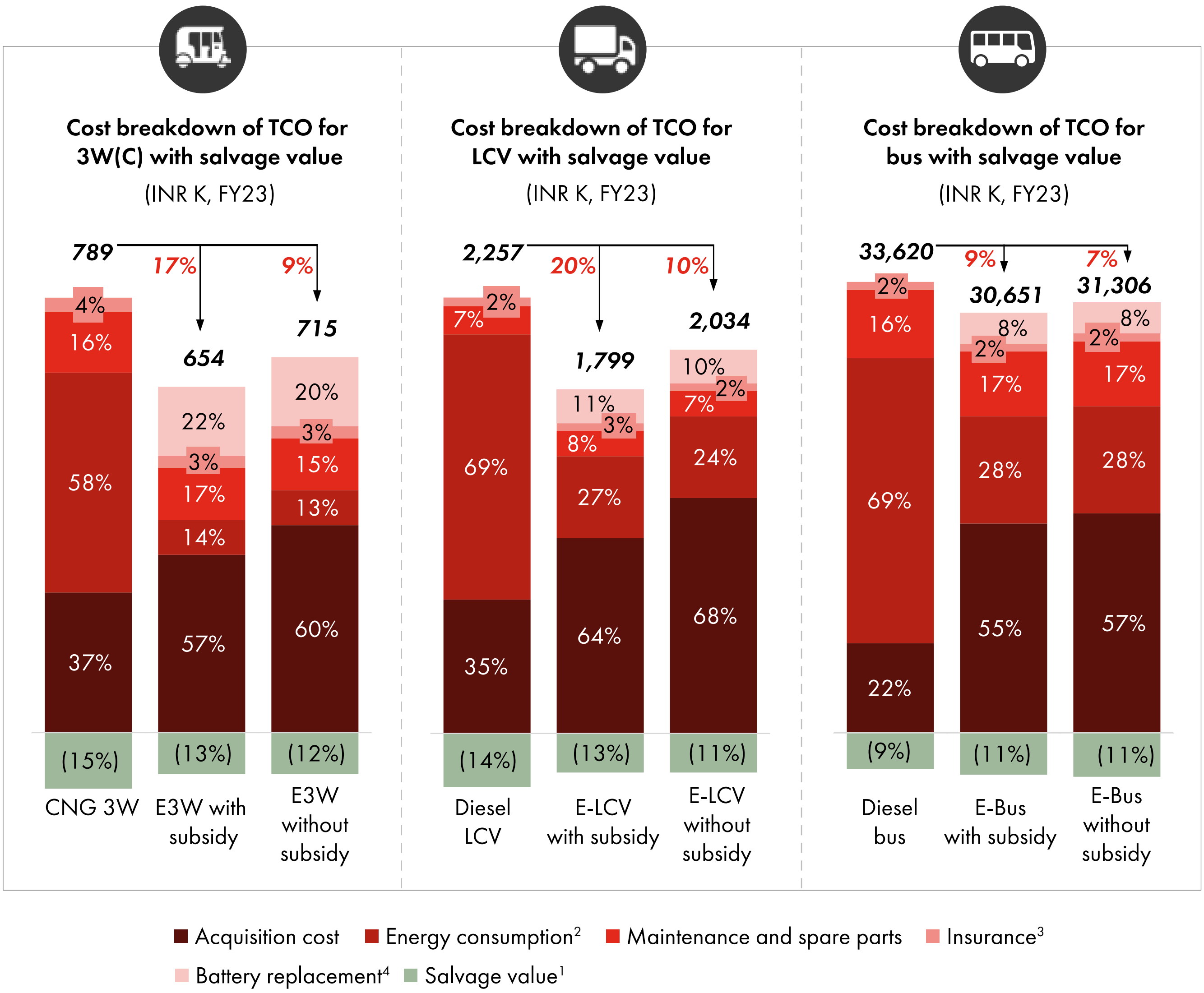
3.1.8 Total Cost of Ownership (TCO)

While E3W and E4W have high initial investments, overall ownership costs throughout the lifecycle of vehicle are more economical than those of traditional ICE vehicles. These vehicles offer lower energy consumption and lower insurance costs.

For E3Ws sold with subsidies, there is a reduction of 15-20% in TCO compared to ICE 3Ws, while without subsidies, the reduction is 8-10%. Similarly, for E-LCVs, TCO decreases by 15-20% with subsidies and 8-10% without subsidies. For E-Buses, TCO declines by 8-10% with subsidies and 6-8% without subsidies, although this reduction is slightly lower than in other segments. In the M&HCV segment, the TCO benefit is yet to be reflected.

Exhibit 3.1.8

TCO breakdown for electric and ICE CVs



Note(s): [1]Salvage value for ICE = 40%, for EV = 20% of acquisition cost; [2]Cost of fuel is taken as the average of all states in India and cost of electricity is average across Delhi, Maharashtra, Gujarat, and Karnataka; [3]Insurance cost is the average value taken from policybazaar; [4]Battery life and warranty considered is 5 years
Source(s): State ERC, WRI India, IEA

Despite the initial higher investment in EVs, the TCO is notably lower due to these long-term savings. Even though EVs incur costs related to battery replacement, these expenses are spread over time and are offset by competitive or even superior salvage values. Ultimately, this cost-effective approach positions EVs as financially advantageous in commercial applications such as LCVs and buses. Moreover, a lot of these TCO benefits do not include the potential increase in crude oil prices and global instability, which could further exacerbate the cost and energy intensity of ICE vehicles.

3.1.9 Opportunities and challenges for E-CV adoption

Government incentives, lower cost of ownership, the increasing trend in adopting E-CVs for last-mile delivery, and the growing electrification initiatives by both State and Central Governments serve as key drivers for E-CV adoption.

Although, challenges such as the high upfront costs, anxiety across the range, limited availability of public charging infrastructure, constrained range of financing options, shortage of diverse EV models, and lack of awareness among fleet operators/drivers about the favorable TCO present significant hurdles to widespread E-CV adoption.

3.2 Passenger vehicle

3.2.1 Introduction

PVs are further categorized into 2Ws (motorcycles and scooters) and 4Ws (sedans, SUVs, hatchbacks, etc.) used for personal use by individuals or businesses.

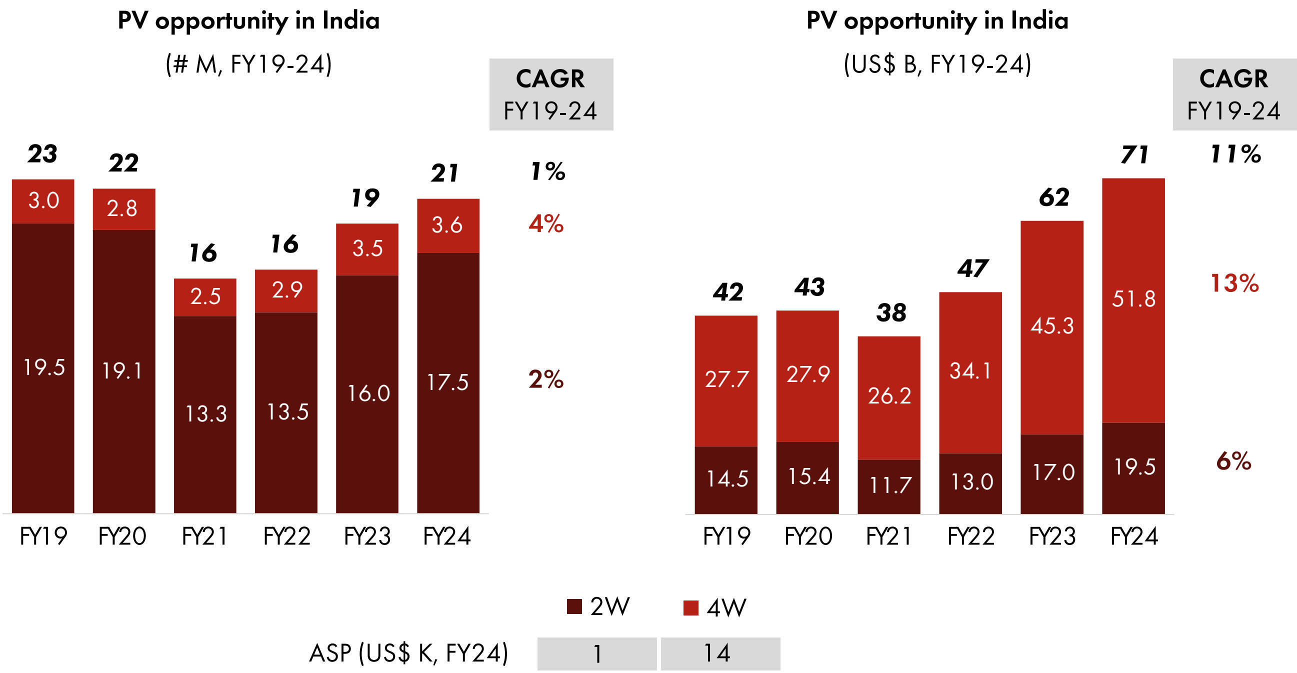
3.2.2 Overall PV opportunity in India

In FY19, India recorded ~23M PV sales, with 2W contributing more than 85% to overall sales volume. However, the pandemic led to a decline, with total PV sales dropping to ~16M in FY21 and slightly recovering to ~16.5M in FY22. Despite these setbacks, the market rebounded and recorded ~19M units sold in FY23 and further increased to ~21M units sold in FY24. While the 2W market has not rebounded to the pre-COVID level, the 4W has witnessed increased adoption with FY24 recording ~30% higher sales than FY20.

Although 2W dominates the sales volume, 4W has the larger share of the overall market by value. In FY23 Indian PV opportunity was valued at US$ 62B and grew by 15% to reach US$ 71B in FY24, significantly surpassing the FY20 value of US$ 43B, driven by continued growth of the 4W segment within the PV industry in India and introduction of higher-end variants, improved safety standards and shift to BS VI norms within the 4W segment. Despite the overall muted volume growth since FY20, the opportunity has grown rapidly in value owing to 4W growth and an increase in ASPs.

Exhibit 3.2.1

PV opportunity in India by volume (LHS) and value (RHS)



3.2.3 E-PV opportunity in India

In FY23, overall EV penetration in the PV segment reached 4%, increasing to 5% in FY24. FY24 saw E-PV sales pass the 1M units mark, growing by 1.3X from FY23. By FY30, overall EV penetration in PV volume is forecasted to reach 36%, resulting in 13M annual E-PV sales. Increased adoption will primarily be driven by E2W, with EV penetration reaching 40%, and an estimated sales of 12.6M units annually, alongside 0.9M E4W sales in FY30 at close to 16% penetration.

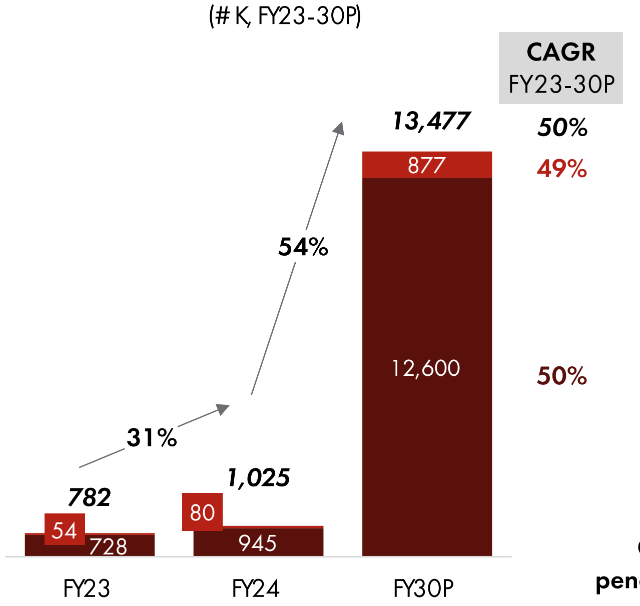
The E-PV opportunity is currently valued at US$ 3B (FY24), with the opportunity split in a 45:55 ratio between E2W and E4W. The opportunity is projected to grow at a CAGR of 49% from FY24-30 to reach US$ 36B by FY30. The prices for EVs are likely to continue declining as adoption grows and battery prices decline. E2W prices are estimated to come in line with ICE 2W prices by FY30, while the price differential for E4W will come down to 15% from the current price differential of 75% between the equivalent ICE and EV models.

Exhibit 3.2.2

E-PV opportunity by volume, value, and penetration in India

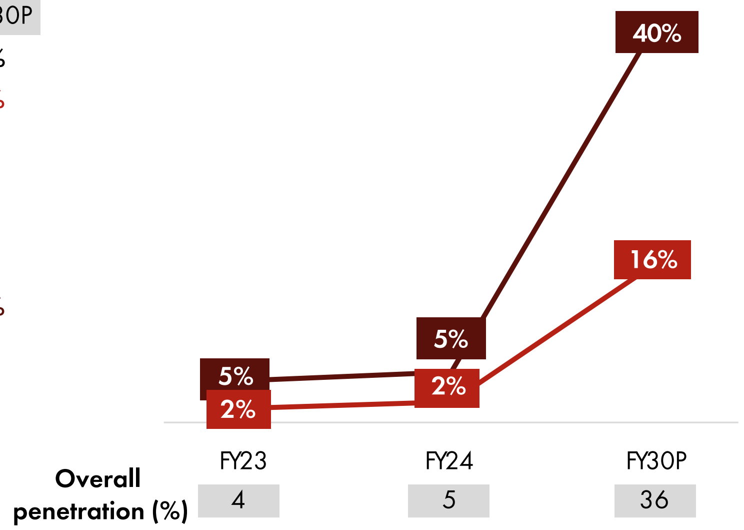
E-PVs opportunity in India

(# K, FY23-30P)



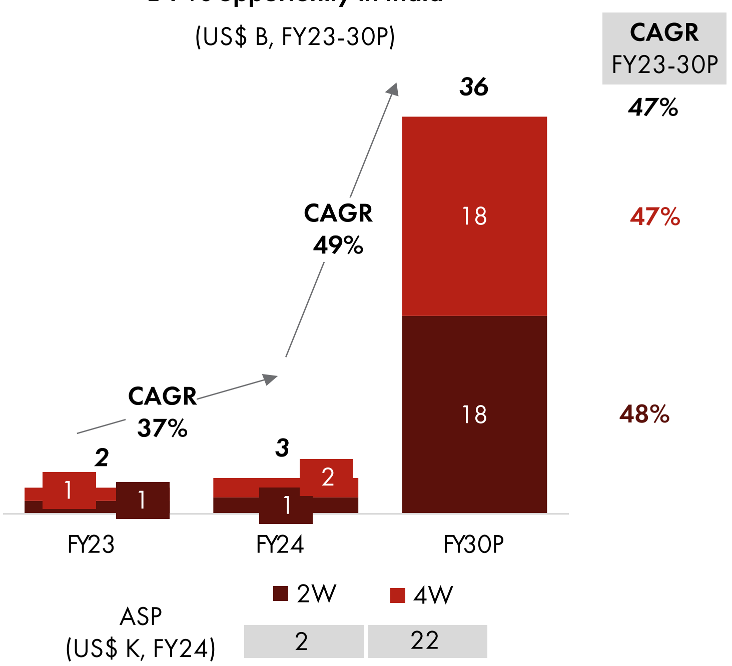
E-PVs penetration in India

(%, FY23-30P)



E-PVs opportunity in India

(US$ B, FY23-30P)



3.2.4 Passenger EV landscape

E2W category is divided into three major sub-categories: low-speed scooters with a top speed below 25 kmph, high-speed scooters with a top speed exceeding 25 kmph, and E-Bikes.

The E4W category can be further classified as hatchbacks (typically accommodating 4-5 passengers), sedans (generally seating 4-5 passengers), and utility vehicles (often designed to seat 5-7 passengers).

Adoption levels among these EV categories vary, depending on their specific use cases and the variety of models offered by OEMs, apart from their price relative to their ICE counterparts.

In the E-PV market, the level of product variant coverage varies across the 2W and 4W segments. In the high-speed scooter category, the opportunity is relatively well-represented, with multiple OEMs, including both incumbents and new-age EV players like TVS, OLA Electric, Ather, Hero Electric, and Pure EV. These companies collectively offer ~50-60 different variants at multiple price points, providing consumers with a wide array of options.

On the other hand, the low-speed scooter segment is relatively underserved, with only 10-15 models available from Hero Electric, Pure EV, Yulu, and Okinawa. For motorbikes, the market is still in its nascent stage and rapidly evolving, with 5-10 models currently offered by Revolt, Pure EV, and Komaki.

Exhibit 3.2.3

E-PV landscape in India

	Variant	Sales volume (# K, FY24)	Use case	# of models[1]	Major players: Incumbents	Major players: Pure play EV	Prevalence in the market
E2W	Low speed scooter[2]	945	Short commute	12	Hero Electric	Yulu, Pure, Okinawa	◔
	High speed scooter[3]		Extended commute (within city)	54	Hero Electric, TVS, Vida, Bajaj	OLA Electric, Pure, Ather, Okinawa	◕
	Bikes		Versatile commuting	7	NA	Pure, Komaki, Ultraviolette, Revolt	◑
E4W	Hatchback	80	Daily commuting	2	Tata Motors		◔
	Sedan		Long distance travel	15	Tata Motors, Mercedes-Benz, Audi, Porsche, BMW, Mahindra Electric	BYD	◑
	Utility vehicle		Carry significant amount of luggage and equipment	18	Tata Motors, Volvo, BMW, Porsche, MG, Hyundai, Mercedes-Benz, Mahindra Electric, Kia, Audi, Land Rover	BYD	◕

Low ○ ◔ ◑ ◕ ● High

Note(s): [1]Includes only # of models offered by major players as of 9th May'24, [2]Top speed of <25 kmph; [3]Top speed of >25 kmph; *Two or lesser products available in the market

The E4W category, with a sales volume of ~80K in FY24, varies across vehicle variants. The utility vehicle segment is the most well-served, with OEMs such as Tata Motors, BMW, Audi, Jaguar, Land Rover, Mercedes, Hyundai, and Mahindra offering around 18 different models to customers. Sedans are the next best-represented 4W segment with 15 models in the market. However, the hatchback category is notably underserved. This indicates that while certain segments have made headway into the EV market, providing consumers with diverse choices, there are still some product segments catering to specific sets of customers that have not attracted the attention of EV OEMs.

3.2.5 E2W players' expansion plans

The EV landscape for passenger 2Ws is witnessing significant innovation and expansion efforts from established ICE incumbents and emerging pure-play EV companies. Established OEMs like Vida, Bajaj, and TVS are strategically shifting their focus towards EVs by increasing EV sales targets, expanding EV distribution networks to new cities, introducing new models, and making substantial capital investments to improve production infrastructure. Conversely, pure-play EV players such as Ola and Okinawa are actively diversifying their product portfolios, unveiling new electric scooter and motorcycle models, while expanding their sales outlets and manufacturing capacities.

Exhibit 3.2.4

Expansion plans of E2W players

	Incumbents				New entrants		
	HERO ELECTRIC	VIDA	BAJAJ	TVS	OLA	OKINAWA	ATHER
Current EVs	• **Scooters:** Electric photon, Atria LX, Flash LX, Optima 	• Vida V1 Pro (80 km/h top speed), Vida V1 Plus (80 km/h top speed) 	• **Scooters:** Chetak Premium (73 km/h top speed), Chetak Urbane (73 km/h top speed) 	• **Scooters:** iQube (82 km/h top speed) 	• **Scooters:** OLA S1 Air (90 km/h top speed), OLA S1 (90 km/h top speed), OLA S1 Pro (120 km/h top speed) 	• **Scooters:** OKHI-90 (74 km/h top speed), i-Praise+ (56 km/h top speed), Praisepro, Dual 100 (60 km/h top speed) + 5 E-Scooters 	• **Scooters:** 450X, 450S, 450 Apex, Rizta 
Expansion plans/ new EV launch	• Aims to roll out over **1M vehicles** annually in the next two to three years from its manufacturing units in India	• Expansion of the E2W portfolio to **four models** in **FY25, including one B2B** product for the last-mile connectivity business	• Expansion of **monthly sales of Chetak scooters from 6K units to 10K units** • Creation of a separate **dealer network for EVs** and an increase in the number of stores to 600 by the mid of FY25 (current is 200)	• Launch new versions of **iQube** E-Scooter, E3W in **FY25** • Introduce a range of products within the **5** to **25** kilowatt range in 2024	• **Mass market E-Scooter S1 Air launched in 2023** • **Premium and mass market E-Motorcycles** to be launched in 2024	• Launch of **OKHI-90** E-Scooter with an **updated battery** • Launch of E-Scooter **Cruiser** and **Oki 100**	• Launch of the family E-Scooter- **Ather Diesel** by mid - 2024
Capex / investment towards EVs	• Aims to invest up to **US$ 180M** for developing premium bikes and EVs in India	• Plans to spend **US$ 120-180M** every year in capex focused on **building leadership in EV** • Plans to **upgrade 30-40%** of primary dealers to **retail EVs and premium products**	• **US$ 100M capex investment** planned for EV business in FY25 (majority towards E3W and Chetak E-Scooter)	• Investment in **Singapore based EV startup ION mobility in FY22** end to expand global presence	• Roadmap to build **world's largest EV hub in India for an investment of US$ 900M** • Establishment to be present in Tamil Nadu and span an area of 2K acres	• Plans to invest **US$ 100-120M over the next three years** to expand sales to 1M units per annum by 2025-2026 • Plans to commission third manufacturing facility having a total installed capacity of 1M units	• Has secured an investment of **US$ 110M** from Hero MotoCorp and Singapore's GIC • Plans to **launch IPO** by FY25 end, earlier than initially planned

Note(s): Includes models offered by major players as of 22nd May'24

3.2.6 E4W players' expansion plans

Major players in India's passenger 4W market are actively planning to expand their presence in the EV sector. Tata Motors is set to launch 10 different EVs, investing US$ 1.8B in the next 4-5 years and aiming to raise an additional US$ 1B in funding to finance its EV growth story. Leading OEM Maruti Suzuki plans to enter the EV race and introduce its first EV by the end of FY25, followed by six more variants by 2030, having allocated around ~US$ 0.4B in setting up EV manufacturing facilities. Mahindra Electric has set an ambitious target of achieving 20% of their utility vehicle sales through EVs by 2027, launching five new EV models and making significant investments in manufacturing. Hyundai and MG Motors, who have successfully launched EV models in India, are further focusing on EVs to expand their sales footprint.

Exhibit 3.2.5

Expansion plans of E4W players

	TATA	MARUTI SUZUKI	Mahindra electric	HYUNDAI	MG	CITROËN	BYD
Current EVs	Nexon EV (SUV)  Punch EV (SUV)  Tigor EV (sedan)  Tiago EV (hatchback) 	–	XUV 400 (SUV)  Reva (hatchback) 	Kona Electric (SUV)  Ioniq 5 (SUV) 	ZS EV (SUV)  Comet EV (hatchback) 	EC3 (hatchback) 	Atto 3 (SUV)  Seal (sedan)  E6 (MPV) 
Expansion plans / new EVs launch	• **Launch of 10 EVs** in different vehicle segments, body styles and affordability levels announced on world EV day 2022 • Sale of **Harrier EV and Sierra EV to start in 2024 and 2025** respectively	• Plans to launch their **first all-EV by FY25** • Roadmap for launching **six new EVs across segments by 2030**	• Wants **20% of all utility vehicles sold to be EVs by 2027** • Plans to launch **5 EVs in the sub-4m and 4m SUV categories by 2027** • Aims to sell 200K EVs by 2027	• Roadmap to launch **five new EV cars by 2028** • Begin sales of **electric Creta SUV in India by 2025**	• Five-year roadmap to achieve **65-75% sales in India from electric cars by 2028** • Plans to launch new models (mostly EV cars) in the next five years	• Roadmap to launch **EC3 Aircross SUV,** in continuation with its earlier launch of EC3 hatchback	• The hatchback, Seagull to be launched soon
Capex / investment towards EVs	• Investment of **US$ 1.8B towards EV in the next 4-5 years** • Plans to **raise US$ 1B from sovereign wealth funds and PE investors**	• Suzuki to **invest US$ 370M for a new plant to produce EVs** and **US$ 880M to manufacture electric batteries in 2026**	• M&M has raised **US$ 230M in a proposed EV subsidiary from BII** • **EV manufacturing plant in Pune** at an investment of **US$ 1.2B** and in **Telangana for US$ 120M**	• **US$ 2.4B investment over next ten years** to expand EV lineup • **Set up 100 EV charging stations along key highways** over next five years	• **US$ 600M+** investment plan includes EV facility expansion. • Plans to **strengthen EV localization** and set up a **battery assembly unit at Gujarat plant**	• Invested over **US$ 240M** in setting up factories in Tiruvallur and Hosur in Tamil Nadu and R&D centers in Chennai and Pune	• Proposed a **US $1B investment** in India to establish manufacturing facilities for EVs and batteries

Note(s): Includes models offered by major players as of 21st May'24

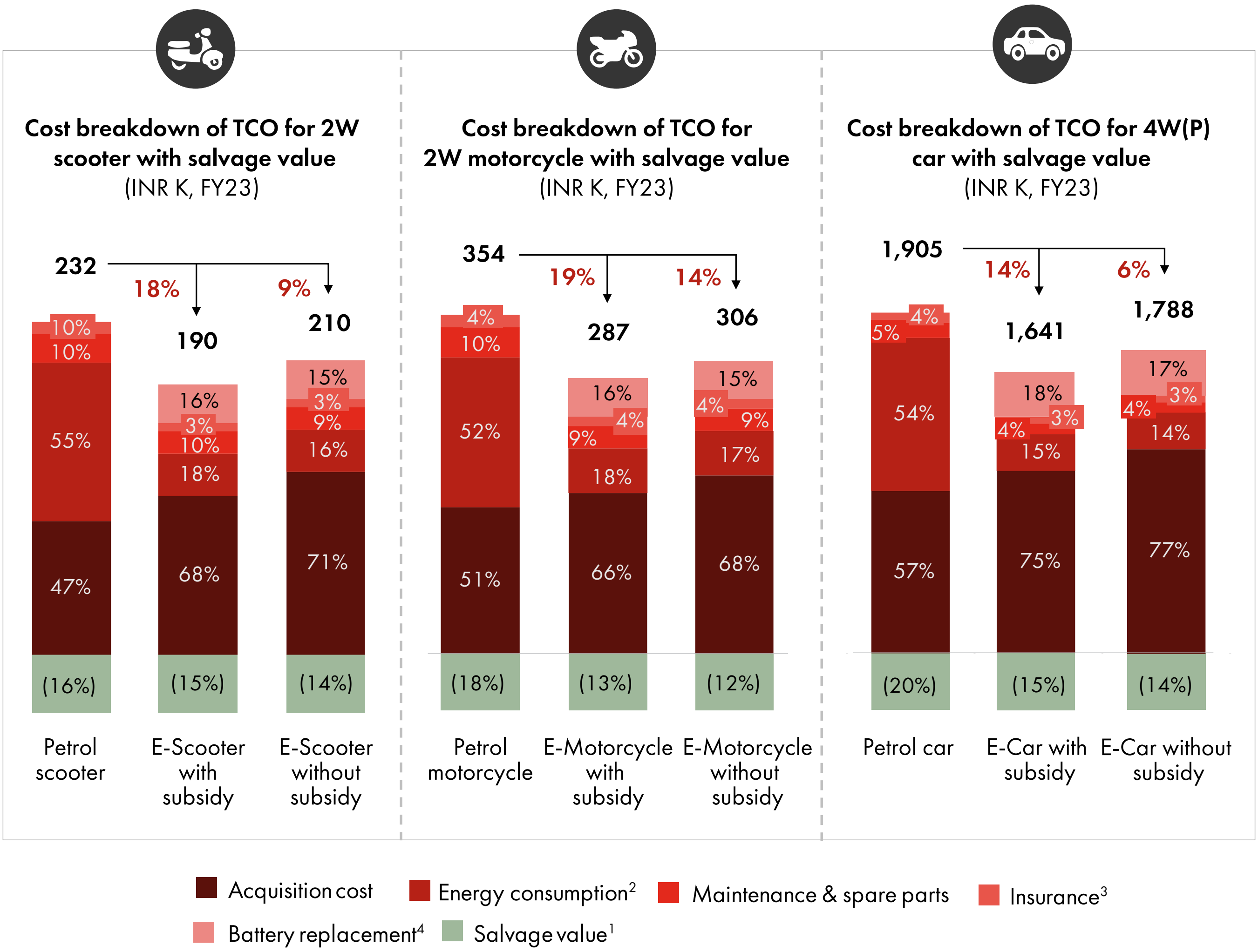
3.2.7 Total Cost of Ownership (TCO)

Despite the high initial investment, PVs like electric bikes and cars offer more economical ownership costs over their lifecycle compared to traditional counterparts. The substantial fuel consumption savings of E2Ws and E4Ws effectively balance out their higher upfront capital costs when compared to ICE vehicles.

For E2W scooters sold with subsidies, there is a reduction of ~20% in total ownership cost over ICE 2W, compared to an 8-10% reduction in total ownership cost when sold without subsidies. Similarly, for electric cars, total ownership costs decline by 15% with subsidies, and even without subsidies, there's a 5-8% reduction in ownership costs.

Exhibit 3.2.6

TCO breakdown for electric and ICE PVs



Note(s): [1]Salvage value for ICE = 40%, for EV = 20% of acquisition cost; [2]Cost of fuel is taken as average of all states in India and cost of electricity is average across Delhi, Maharashtra, Gujarat and Karnataka; [3]Insurance cost is the average value taken from policybazaar; [4]Battery life and warranty considered is 5 years; average daily distance considered is 75 km for E3Ws and 120 km for E4Ws; TCO as of Sep'23 FAME II subsidy (31st Mar'24) for per kWh battery and maximum up to 40% of the cost of vehicle, INR 15K for 2W, INR 10K for 4W, INR 20K for E-Bus and INR 10K for 3Ws
Source(s): State ERC, WRI India , IEA, Press articles

3.2.8 Opportunities and challenges in E-PV adoption in India

While the Indian EV growth story has seen the emergence of new players and incumbents entering the EV segment, challenges remain for widescale adoption because of significant upfront cost, limited options availability compared to ICE, range anxiety, lack of power for rough terrains, and shortage of developed charging infrastructure. Additionally, issues like high financing rates and safety concerns, exemplified by incidents like battery fires, underscore the need for sustained safety measures. Addressing these concerns will be pivotal in shaping the adoption landscape of E-PVs in India.

3.3 EV components

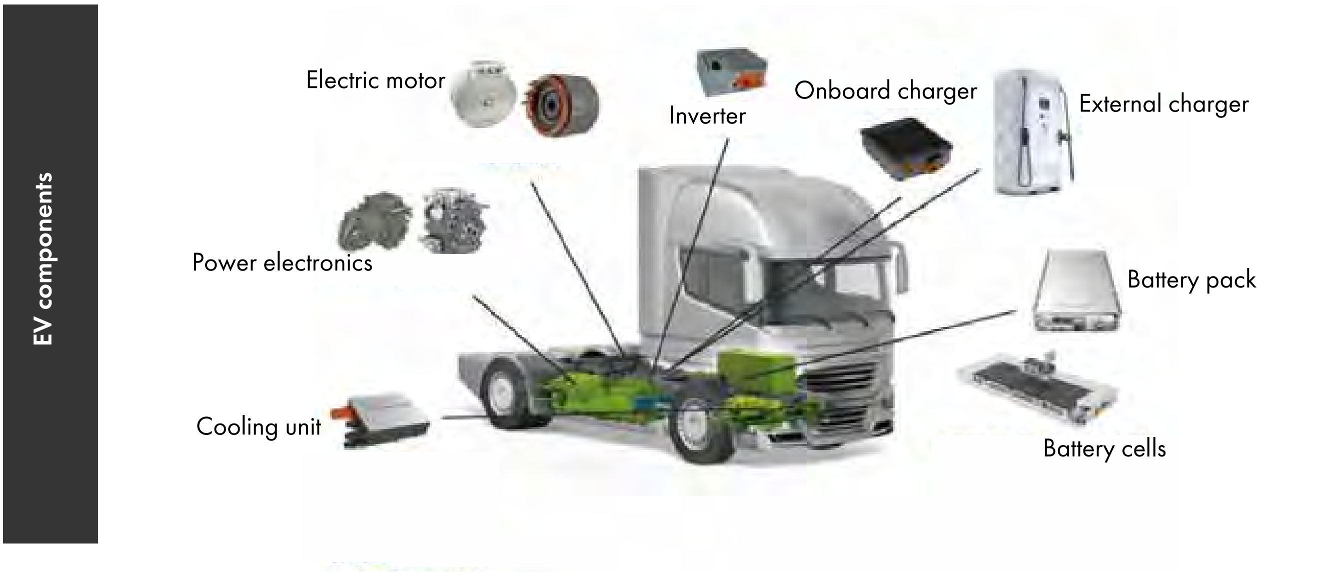
Auto components have been a shining star of the Indian manufacturing industry with strong export potential. However, with the advent of EV disruption, this industry is facing multiple challenges and transformations at a fast pace. Traditional component manufacturers are having to catch up with fast-paced product growth in the EV segment from OEMs. The value chains are evolving, requiring nuanced business models to serve the EV products, as the assembly lines also change. Moreover, there is a complete transformation in the tech of cars, with the advent of digital, smart cars, and electronically featured vehicles. EVs and ICE vehicles differ significantly in key components and cost breakdown. EVs have replaced the traditional ICE engines and transmission systems with batteries and electric motors. Batteries are major cost heads and constitute 30-45% of EV costs, followed by chassis and body contributing 15-25% of vehicle costs. This will lead to a major transformation of the auto components sector in India. The players embracing this change will thrive in the new wave while the ones who will brace for it will likely perish under this transformation. Moreover, the aim to reduce the import dependence of EVs will also give an impetus to domestic manufacturing and self-reliance.

3.3.1 How EV components are different

EVs consist of several key components, including the battery pack, battery management system (BMS), electric motor, chassis and body, power electronics, other miscellaneous components, and charging equipment.

Exhibit 3.3.1

EV vs. ICE components



The battery pack typically constitutes 35-45% of the total vehicle cost and includes components such as battery cells, connectors, wiring, hosing, brackets, clamps, and safety vents. While some Indian players have begun local battery assembly and customization, they still rely heavily on imports, particularly from China. Semiconductors, a crucial component, are entirely import-dependent.

The BMS, responsible for monitoring and optimizing battery performance and safety, accounts for 5-10% of the total cost and includes PCBA, software integration, fault detection and diagnostics, user interface, sensors, and housing.

The electric motor contributes approximately 5-15% to the overall EV cost and includes components like the rotor, stator, feedback system, support assembly, end plates, housing, and bearings.

The chassis and body, serving as the structural frame for the EV, account for about 15-25% of the cost and include components such as suspension, steering system, and sheet metal parts, with OEMs utilizing existing supply chains for sourcing.

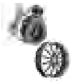
Power electronics, responsible for various functions like inverter operation and regenerative braking, account for 10-20% of the vehicle cost and include components like the DC-DC converter, power distribution unit, onboard charger, thermal system, and communication interface, with a majority being imported from China due to a lack of technical expertise by existing OEMs.

The remaining 10-15% of the cost is attributed to components common to EVs and ICE vehicles, such as tires, HVAC systems, wiper systems, rear axle systems, brakes, and castings, leveraging existing supply chains.

Charging equipment, classified into DC chargers and AC chargers, varies in terms of import dependence. While 120 kW DC chargers and AC chargers are imported as completely built units, 50-60 kW DC chargers are assembled in India, with a significant portion of components being imported.

Exhibit 3.3.2

List of all EV components

Components	Battery pack	BMS	Electric motor	Chassis and body	Power electronics	Others	Charging equipment
							
Description	• Powers the electric motor of the vehicle. Acts as an electric storage system	• Responsible for monitoring, managing, and optimizing the performance and safety of the high-voltage battery pack	• Propels the vehicle by converting electrical energy from the battery into mechanical energy to drive the wheels	• The structural frame of the EV body where all other components are assembled	• Includes major electronic components like inverter operation, regenerative braking, voltage/ current control, etc.	• Other important components like tyres, axel, transmission, and HVAC	• **2 main types** of chargers: **AC** (Level 1 and level 2 chargers) and **DC** (level 3 chargers) • Major components include: connectors, charging cable, control board, and rectifiers
% Cost share	• 35-45%	• 5-10%	• 5-15%	• 15-25%	• 10-20%	• 10-15%	-
Sourcing and manufacturing status	• Supply is **dominated (>70%) by imports from China.** Some Indian players have started assembling and customizing battery packs. Semiconductor is the main component which is entirely import-dependent			• OEMs have existing supply chains which can be leveraged	• Supply is dominated (>70%) by imports from China. Incumbent OEMs currently lack the technical knowledge	• Components are the same as ICEs and have existing supply chain	• Larger DC chargers (120kW+) and AC chargers are imported as **completely built units,** 50-60 kW DC chargers are assembled locally, with **60-70% components imported** • Startups that assemble locally are currently importing **30-40% components** for AC chargers
Keyplayers – Global	OKAYA, Coslight	EMURON	MAHLE, ABB, Valeo	-	ABB	-	ABB, DELTA
Keyplayers – Domestic	Indi Energy, ION ENERGY, LOG9	Sun Mobility, ION ENERGY, GRINNTECH	Altigreen, BATTRIXX, GRINNTECH		DELTA, TATA ELXSI, SEDEMAC	elecnovo, UNO MINDA	TATA AutoComp Systems, ATHER, exicom

Note(s): *Illustrative list, HVAC - Heating, ventilation and air conditioning, OEM - Original equipment manufacturers

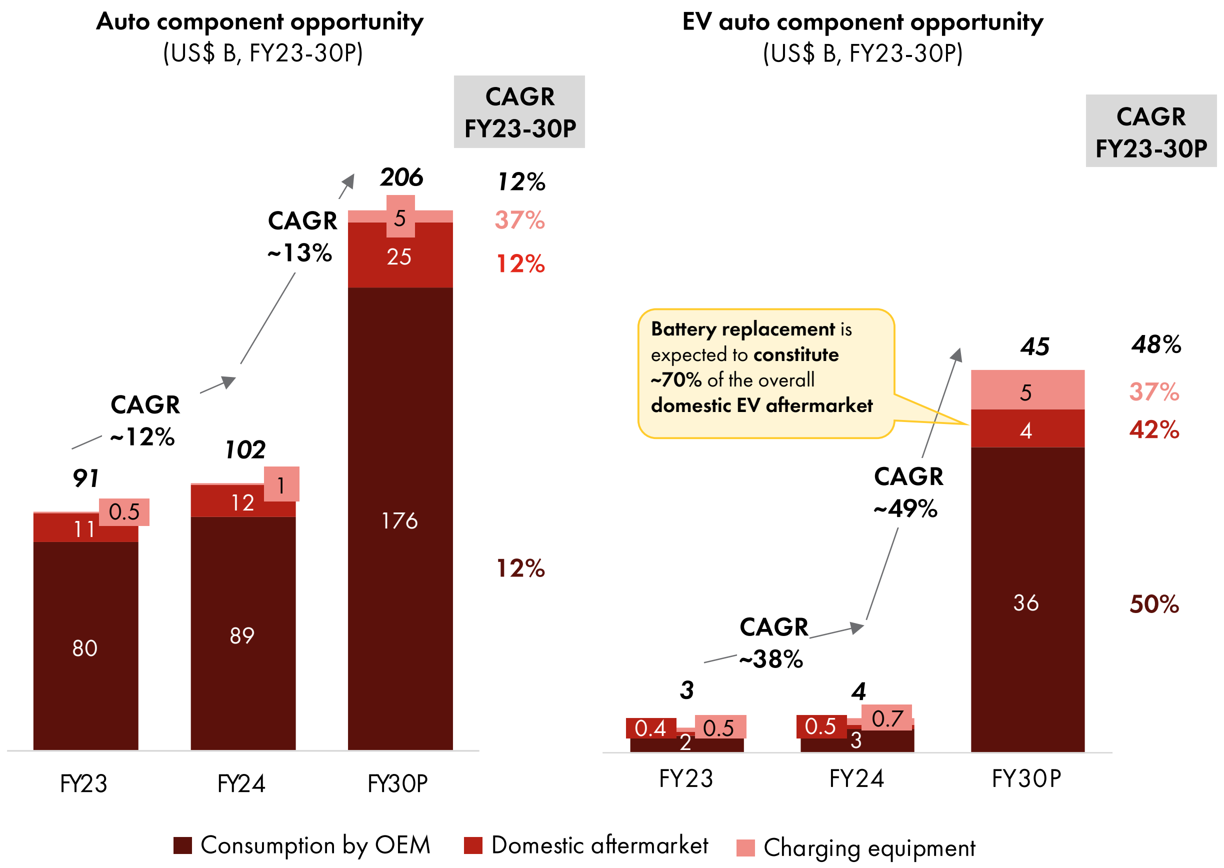
3.3.2 EV components opportunity

The auto component demand from OEMs and aftermarket reached US$ 102B in FY24, showing a 12% YoY increase, while the EV auto components opportunity amounted to US$ 4B in FY24, registering a significant 38% increase from FY23.

The overall auto component opportunity is projected to surge to US$ 206B by FY30, growing at a CAGR of approximately 12% from FY23-30. Within this market, EV auto components are expected to contribute over 22%. The charging equipment will constitute 10% of the overall EV auto component opportunity. Charging equipment sales are forecasted to reach US$ 4B by FY30. As the number of EVs increases and existing EVs reach the end of their battery shelf life (typically 5-6 years for personal use), the aftermarket for battery replacement is expected to grow even more rapidly. This growth will be driven by the necessity for EV owners to replace their batteries in the aftermarket. Currently, the market is not seeing much replacement demand as most of the vehicles are new and covered under the manufacturer's warranty.

Exhibit 3.3.3

Auto component and EV auto component opportunity size



Source(s): ACMA, CRISIL

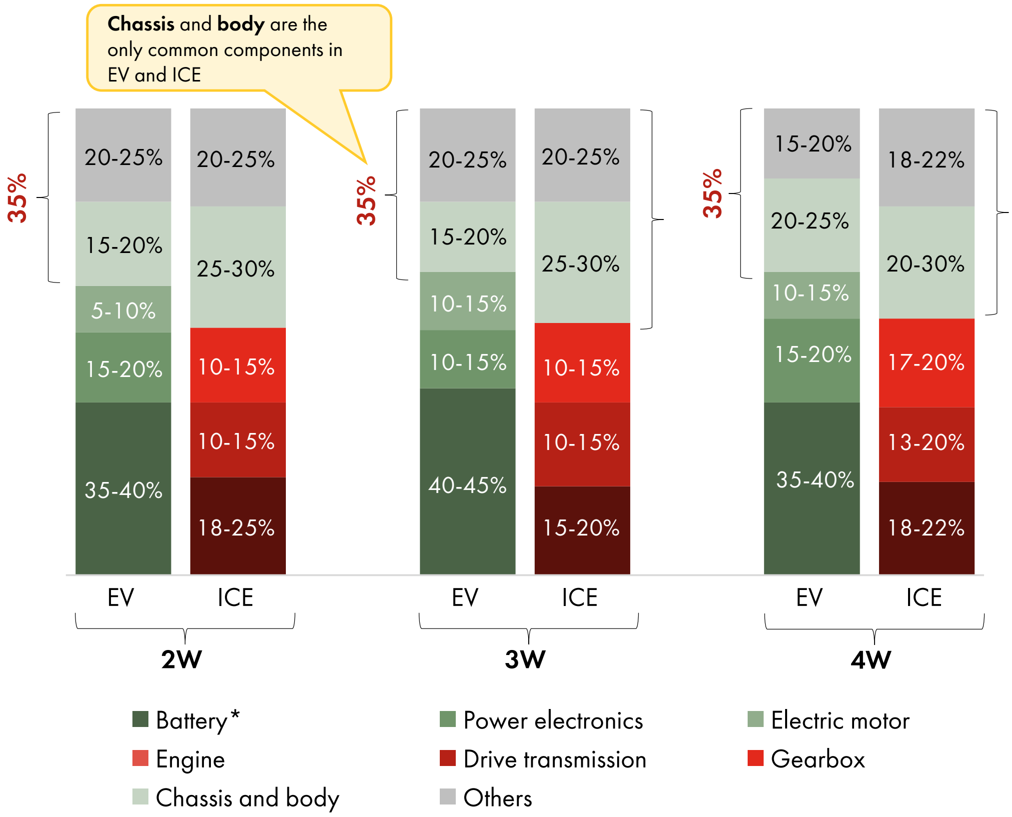
3.3.3 ICE vs. EV BOM

EVs have a battery pack, charger, inverter, electric motors, and cooling units as unique components compared to ICE vehicles, requiring significant component transformation, with only ~35% cost overlap between an EV and an ICE vehicle, and the rest of the cost is associated to the unique components used in EVs. The following exhibit describes the cost breakdown across segments for EV vs. ICE.

Exhibit 3.3.4

EV and ICE component cost breakdown across vehicle segments

EV and ICE component cost breakdown across segments



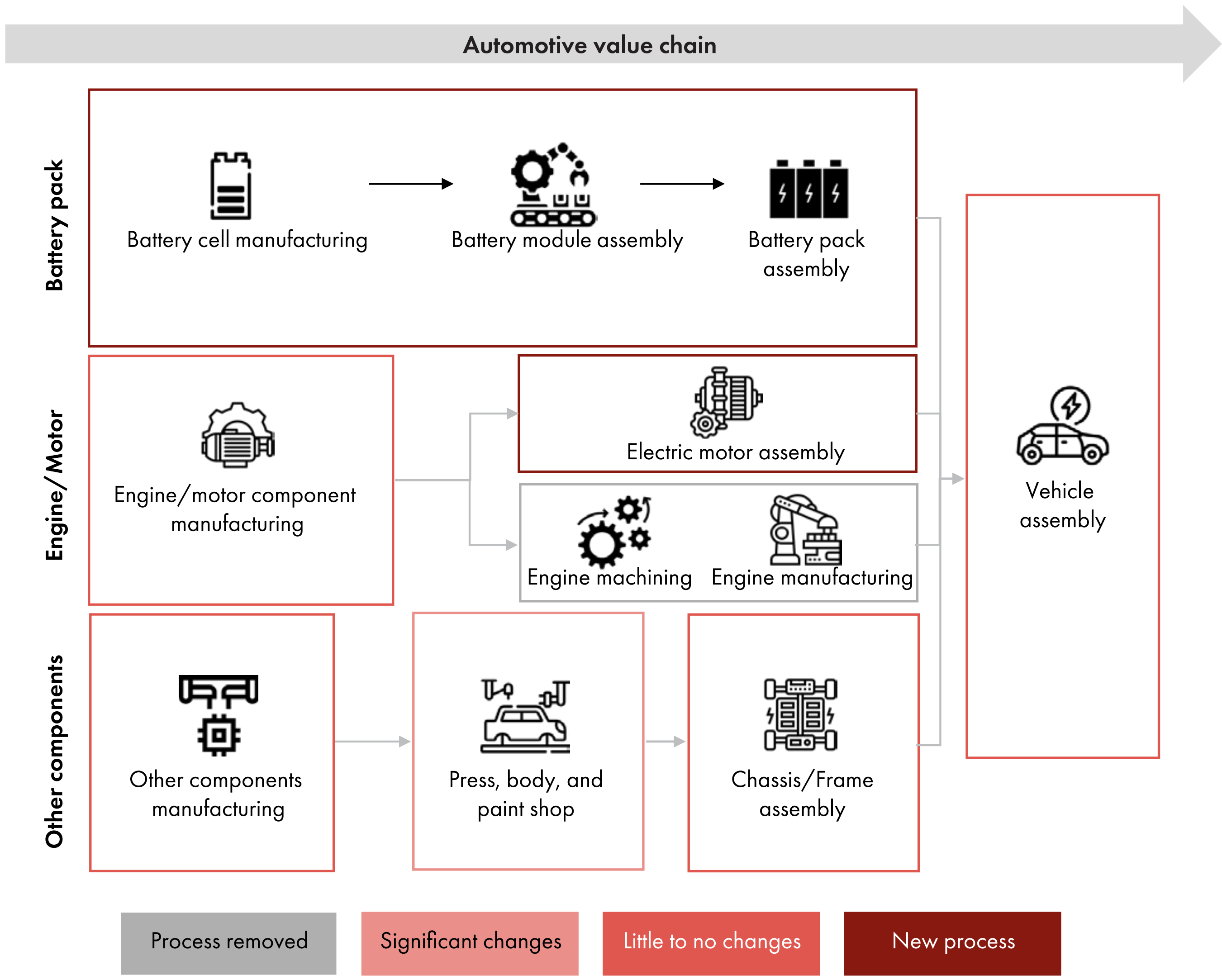
Note(s): *BMS is included in the battery cost for EVs

3.3.4 Transition in automotive value chain

The shift from ICE to EV will significantly alter the automotive manufacturing value chain with the introduction of new and unique components in the EV manufacturing supply chain. Assembly of components such as fuel tank, piping, gearbox, etc., and manufacturing of engine will be phased out, making way for the introduction of new assembly components like motor, battery pack, cooling tubes, and inverters.

Exhibit 3.3.5

Transition in automotive value chain due to introduction of EVs



Change in automotive components

New components	Components removed
Motor	Exhaust system and propeller shaft
Battery pack and control module	Fuel tank and piping
High-voltage cables and charging units	Gear box and engine
Cooling tubes	Fuel and oil
Converter/Inverter	Alternator and starter

3.3.5 Localization of EV components

At present OEMs are highly dependent on imports for sourcing key components such as semiconductors, BMS, motors, battery cells, etc., which makes them vulnerable to supply chain disruption and price fluctuations and it becomes important for them to mitigate these risks by localization of their component sourcing to the extent possible. In this regard, BMS, and power electronics present significant potential for localization, whereas battery cells and electric motors have limited potential, but this could dramatically change with geo-political relationships, de-China policy, and government/foreign investment coming into these areas, which is hard to predict.

Chassis and body: High localization levels due to their lack of reliance on specialized raw materials or technology, and the presence of existing local production facilities.

Battery cells: Due to the low availability of lithium and the capital-intensive nature of battery R&D, the current local production is low but with the recent discovery of Lithium deposits in the country, there is optimism for localization. Currently, the major sourcing regions for battery components are China, South Korea, and Japan. To promote battery manufacturing several steps have been taken both by private players and the government. For instance, Amara Raja's plans to invest ~US$ 1.1B for phased manufacturing of Li-ion batteries, Tata Group's plans to establish a Li-ion cell factory with an investment of US$ 1.6B and JSW Group has signed an agreement with Odisha Government to set up 50 GWh battery manufacturing facilities with an investment of US$ 5.8B in the state.

Exhibit 3.3.6

EV components localization potential

Sub-component	Current locali-zation	Localization challenges	Major sourcing geographies	Supply risk	Locali-zation potential	Localization by 2026		Localization initiatives
						Optimistic	Pessimistic	
Battery cell	Very low	Unavailability of lithium, coupled with capital-intensive nature of battery R&D	China South Korea Japan	◑	◑	60%	10%	• **Amara Raja** plans to invest ~US$ 1.1B for phased manufacturing of Li-ion batteries • **Tata Group** plans to build a Li-ion cell factory, based on ~US$ 1.6B investment • **Hyundai and Kia** partner with **Exide Energy** for local production of Lithium-Iron-Phosphate (LFP) batteries
Chassis and body	High	These parts do not require special raw materials or technology and are already produced locally	NA	◔	●	100%	90%	• Body manufacturers are **investing intensively to targe reduction of vehicle mass,** hence improving efficiency
Electric motor	Very low	Lack of availability to rare earth magnets	• China • Japan	◑	◑	80%	40%	• **Wardwizard Innovations** to invest ~US$ 24M to develop EV motor assembly unit in Gujarat
Power electronics	Very low	Power electronics like controllers and power IC are technology-intensive; capital investment necessary	China	◑	◕	95%	50%	• BorgWarner opened new **EV-focused propulsion engineering centre** in Bengaluru in Jan'23
Others	Medium	Indian manufacturers are strongly positioned in this category which includes BMS, HVAC, control units, etc.	• China • Japan	○	◕	90%	60%	• Valeo India is expanding factories in **Pune and Sanand** for manufacturing of powertrains, BMS lighting, thermal systems, etc.

Very low ○ ◔ ◑ ◕ ● Very high

Exhibit 3.3.7

Investments and initiatives by players to localize the supply chain

Japanese firm acquired 180 acre land in Haryana to set up Li-ion polymer battery plant

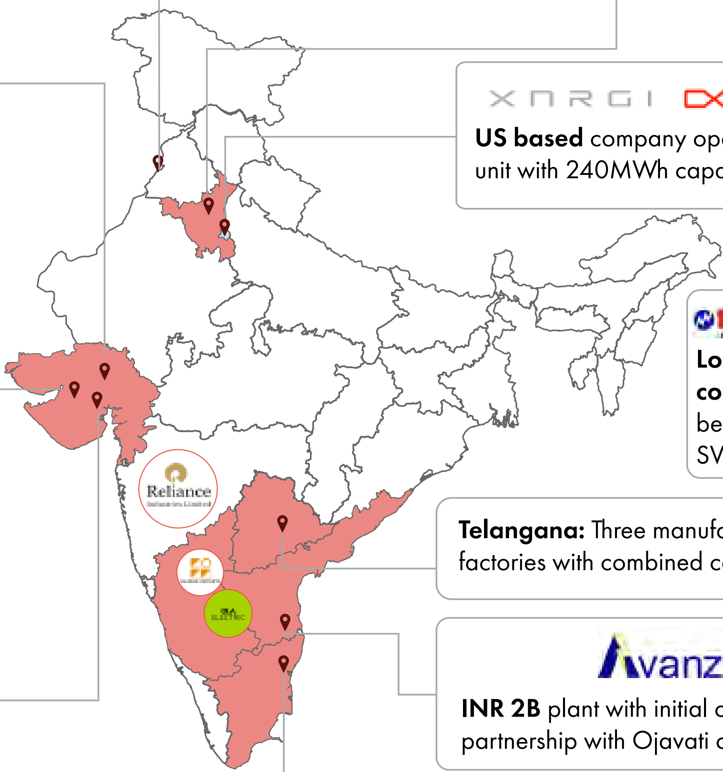
LOHUM

India's largest **3GWh** Li-ion battery factory to be set up by Lohum

INR 12B invested in first phase, **INR 37B** invested in Jan 2020

XNRGI

US based company opened unit with 240MWh capacity



Long-term technical collaboration between Exide and SVOLT Energy Tech

75:25 JV between Exide and Leclanche

Telangana: Three manufacturers to set up factories with combined capacity of 10GWh

TATA CHEMICALS LIMITED

INR 40B invested in plant with initial capacity of 10GWh to expand to 50GWh

INR 2B plant with initial capacity 1GWh in partnership with Ojavati of Singapore

Lucas TVS to **build Giga plant** to make Li-ion cells in tie-up with US co

Note(s): Hyundai was also awarded the PLI incentive, but it backed out of the scheme in 2022; it is expected that the open place will now be taken by Panasonic, which plans to set up a battery manufacturing plant in India under the ACC PLI scheme
Source(s): Media reports, Press articles

3.3.5 Localization of EV components

Electric motors: Due to the unavailability of rare earth magnets, electric motors or their components are import-dependent and are sourced from China and Japan.

Power electronics: Due to the technology-intensive manufacturing process and substantial initial capital investments, the Indian EV industry is dependent on China for sourcing power electronics components. Localization efforts have been initiated in this segment, like BorgWarner's inauguration of an EV-focused propulsion engineering center in Bengaluru.

Other components: BMS, HVAC, and control units, and other components have a moderate level of localization in India. Despite the strong positioning of Indian manufacturers in this category, some elements are still sourced from China and Japan. Initiatives like Valeo India's expansion of factories in Pune and Sanand are geared toward manufacturing powertrains, BMS, lighting, and thermal systems, to strengthen the localization efforts.

Despite increased investments, there is significant reliance on imported battery cells, highlighting the need for additional efforts required for the localization of the EV supply chain.

3.3.6 EV auto components: Battery

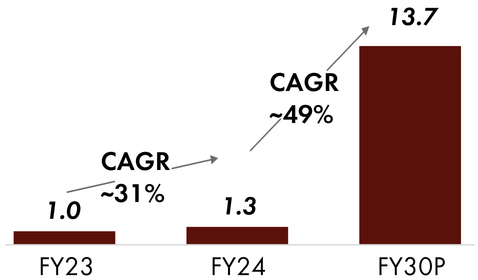
The EV battery opportunity is forecasted to grow from US$ 1.3B in FY24 to a projected size of ~US$ 14B by FY30, exhibiting a CAGR of 49% from FY24-30. Additionally, annual battery manufacturing capacity for automotive use is rising within the country, projected to increase from 5 GWh in FY23 to 104 GWh by FY30.

Several new manufacturers, both domestic and global, are entering the market, which is expected to diminish the dependence on imports for Li-ion batteries from China and Japan.

Exhibit 3.3.8

EV battery opportunity size (LHS) and battery manufacturing landscape (RHS)

EV battery opportunity in India
(US$ B, FY23-30P)



Annual additions of Li-ion battery for automotive use (GWh): ~5 (FY23); ~104 (FY30P)

Currently, Li-ion cells are mainly **imported** from **China, Taiwan, Japan, and Korea** to be **assembled** in India. The government has taken certain measures to promote the production of batteries in India:

- RFP to develop greenfield giga-advance **cell manufacturing** under **PLI**
- **FAME II** benefits, increased **import duties** on Li-ion batteries

Battery manufacturing landscape

Battery technology/manufacturing

- Global players: Okaya, Tanaka Chemical Corporation, CATL, Coslight, Samsung SDI, Narada, BASF, LG Chem, Toshiba
- Local players: Indi Energy, E-Veda, Avanze, HBL, emo, Log9, Cygni, TDSG, Godi, Grinntech, Exicom, Amara Raja, Nash Energy, Trontek, Lohum, Exide, Ion Energy

Upcoming manufacturers

- Global players: Panasonic, ATL, Li-S Energy
- Local players: Tata Chemicals Limited, Lucas TVS, 50Hertz, Munoth, HEG

Note(s): Illustrative list market size includes value of imports
Source(s): ACMA, IEEFA, PIB India, News articles

Battery cell components

Battery cell components include the anode made of graphite, which supplies electrons and the cathode made of lithium metal oxides, responsible for accepting electrons. An electrolyte medium is present for ion transport between the anode and cathode. A separator physically isolates the cathode and anode, preventing internal short circuits. The current collector directs electrons from the electrodes to external devices. The packaging and housing are made from aluminum or steel, to ensure safety and protect the battery from physical damage. These components collectively form the EV battery.

Exhibit 3.3.9

Battery cell components

Battery cell

Components	Anode	Cathode	Electrolyte	Separators	Current collector	Packaging and housing
Description	• Electrode that **supplies electron** • Typically made of carbon-based materials (graphite)	• Electrode that **accepts an electron** • Typically made of lithium metal oxides ($LiCoO_2$, $LiMn_2O_4$, $LiFePO_4$)	• Medium that **provides ion transport mechanism** between the cathode and anode of the cell	• A thin porous membrane that **physically separates the cathode and anode**	• Bridges the electrons from active materials (electrodes) towards external devices	• Casing made of aluminum or steel to ensure safety and prevent physical damage
Properties	• Ease of fabrication • Stability at elevated temperature • Efficient conductor • High coulomb efficiency	• High energy density • Efficient conductor • Fast ion diffusion – ensure fast charge and discharge • Stability at elevated temperature	• Electrochemical stability • Thermal stability • Efficient ion coordination • High conductivity	• Allow movement of ions while preventing short circuit • High mechanical and thermal strength	• High electrical conductivity • Helps in providing high power density • High mechanical and thermal strength	• Mechanical stability • Low permeation • Electrical insulations • Chemical stability
% Cost share	11-15%	21-42%	5-7%	4-6%	16-22%	23-29%
Key global players*	JFE Chemical Corporation, Kureha, sgl carbon, Showa Denko	posco, Targray, umicore, Sumitomo	UBE, Mitsubishi Chemical Group, Targray, redflow	Semcorp, Asahi Kasei, SK ie technology, Toray, sinoma	umicore, MTI, Mitsubishi Chemical Group	amcor, DNP, Hefab, Mitsubishi Chemical Group

Note(s): *Illustrative list
Source(s): ACMA, IEEFA, PIB India

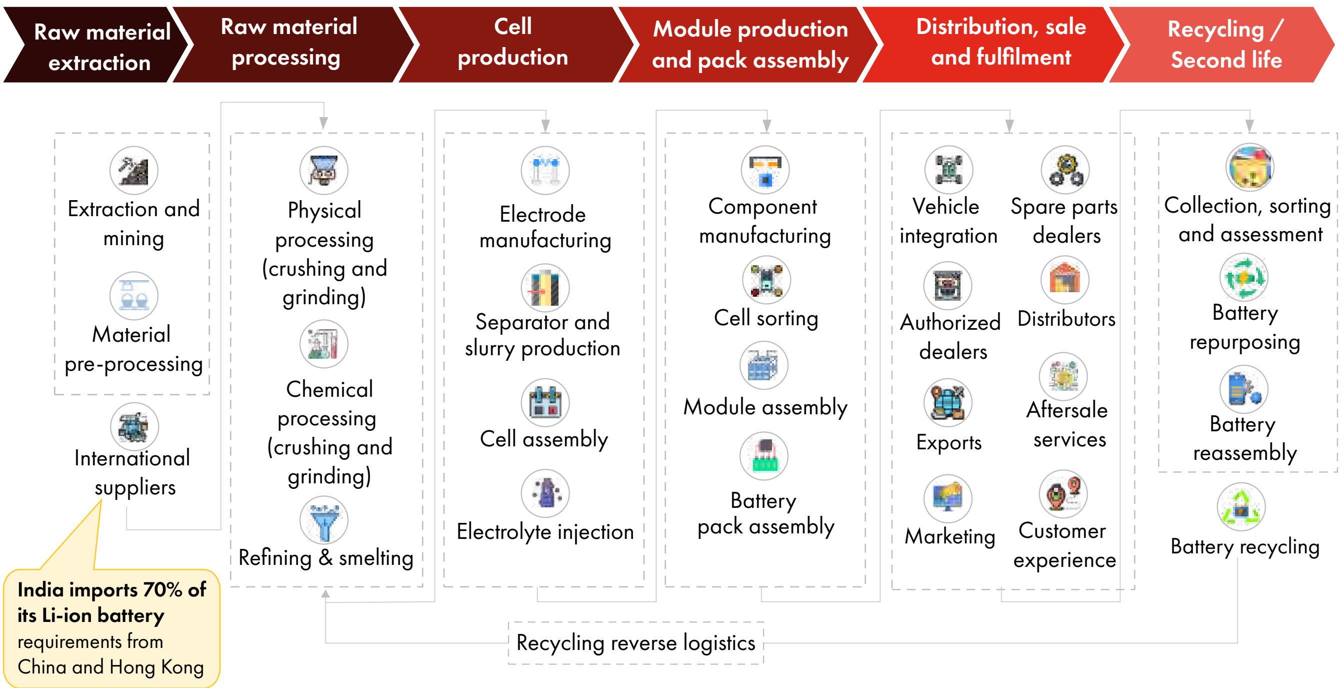
Battery cell supply chain

Manufacturing of batteries is a global supply chain of large-scale players. It constitutes a global network of interconnected processes ranging from raw material extraction to the recycling of batteries. India has an opportunity to play across multiple parts of this value chain owing to the global de-China aspirations and the strong local demand for EVs. However, players will need to carefully examine the potential and profit pool across each of these parts of the chain and match their current strengths to determine areas of play. Moreover, the profit pool is shifting as the sector matures.

The process starts with raw material mining, where lithium, cobalt, and nickel are extracted. Following this, physical and chemical processing refines these raw materials into usable compounds required for cell production. These are then shaped into electrodes, separators, electrolytes, and other parts. The cell assembly is then taken for module production to achieve the battery pack assembly. The battery pack assembly is then sold to multiple end users. Once the battery pack's life is finished, it can be recycled to extract

Exhibit 3.3.10

EV battery supply chain, key opportunities, and key players



Key opport-unities					
Discovery of **INR 34T worth of lithium reserves** unearthed in J&K	**India requires 35K tons $NiSO_4$, 11K tons $MnSO_4$, and $CoSO_4$** to meet the 200GWh Li-ion battery demand by 2030	**Advanced chemistry cell (ACC) battery market demand in India is expected to grow** from 20GWh in 2022 to around 220GWh by 2030	**NITI Aayog plan aims to establish three to ten giga-factories** with capacities ranging from 5 GWh to 20 GWh	**India's 2030 EV target** translates into total sales of more than 100M EVs and around an annual **145-158 GWh of battery demand by 2030**	**Batteries recycled through pyrometallurgy achieve 99% efficiency** in recovering valuable materials

Key Players

	Raw material extraction	Raw material processing	Cell production / Module production / Distribution	Recycling
Global	Vale, SQM, Albemarle	Vale, SK innovation, Ganfeng Lithium	Tanaka Chemical Corporation, BASF, Toshiba, Panasonic, LG Chem, Samsung SDI, Narada, CATL	Exigo, BATX, ACE Green Recycling
Local	KABIL	Vedanta, Sterlite Copper	Exicom, Luminous, Exide, Grinntech, Cygni, Okaya, Waaree, Future	Attero, Gravita, Ziptrax

Source(s): Research Gate, CII report, IISD report, ADL report, News articles

Battery technologies

There are four popular types of battery technology currently prevalent:

- **Lead-acid batteries:** A mature-stage technology providing high current output, recyclability, and affordability, via reaction between lead dioxide and sponge lead. Despite being a mature technology, it exhibits a lower energy density.

- **Lithium-ion batteries:** Provides high energy density, lightweight design, and fast charging capabilities with low self-discharge rates. Their commercial feasibility and superior performance make them widely adopted.

- **Sodium-ion batteries:** An emerging technology, that generates power via the flow of sodium ions but exhibits lower energy density and operates at higher temperatures.

- **Flow batteries:** Characterized by storing liquid electrolytes in separate tanks, offer a long cycle life, low environmental impact, and wide temperature tolerance. Although a nascent technology, they do not suffer from capacity degradation.

While China and the USA manufacture all technologies, especially growth and futuristic technologies, India is one of the biggest manufacturers of lead-acid batteries, however, has a limited presence in the future of EV batteries. This represents a strong opportunity for players to invest and build facilities.

Exhibit 3.3.11

Type of battery technologies

Type of batteries

	1 Lead-acid battery	2 Lithium-ion battery	3 Sodium-ion battery	4 Flow battery
Process	Uses a chemical reaction between **lead dioxide and sponge lead** to generate power	Working mechanism involves **flow of lithium ions** between cathode and anode	Generates electrical power through the flow of **sodium ions**	Power generated through electrochemical reactions in **liquid electrolytes** stored in separate tanks
Key manufacturing locations	China, India, USA, Germany, South Korea	China, Hungary, USA, Poland, South Korea	China, USA	China, Australia, USA, Germany, South Korea
Key global players	HAWKER, CLARIOS	TOSHIBA, Panasonic, CATL, SAMSUNG SDI	faradion, FIAMM, NGK INSULATORS, SHARP	Sumitomo Corporation, INVINITY, PRIMUS POWER, cellcube
Key local players	EXIDE, LUMINOUS, AMARA RAJA	SERVOTEC, WAAREE	**Market not catered currently**	**Market not catered currently**
Properties	• High current output • Recyclability • Low cost • Low energy density	• High energy density • Lightweight • Fast charging • Low self-discharge rate	• Low energy density • Eco-friendly • Resource availability • Operate at higher temp	• Long cycle life • Low environmental impact • No capacity degradation • Wide temp. tolerance
Product lifecycle stage	Mature technology	Growing technology	Nascent technology	Nascent technology

3.4 Retail and dealerships

Automotive retail and dealerships are facing transformative change. With ever-increasingly informed passengers, a rising number of models, the need for longer and more engaged test drives, and penetration of finance/warranties, the role of dealerships is increasing and playing a pivotal role in sales. Moreover, India has traditionally been a single-brand retail format with a fragmented base of individual dealers for most OEMs. With the advent of digital and D2C models, dealerships could get challenged and need to tweak their business model, in tandem with OEMs.

Multiple new OEMs are entering the market and each has to set up their own dealership and service network. Dealerships must also navigate through the complex regulatory requirements in selling and servicing vehicles, to serve customers well. The advent of EVs only creates another dimension of complexity. Within EVs, there are incumbents and pure-play EV players. The dealership network is a natural strength and a significant competitive advantage of incumbents to tap the wave of EV substitution, however, new-age EV players are giving tough competition to the large existing OEMs. It is also critical to create an economical model that is viable for EV sales for dealers because a majority of the existing dealers drive their margins from service and not sales, while in EVs, spending on servicing is lower than traditional ICE.

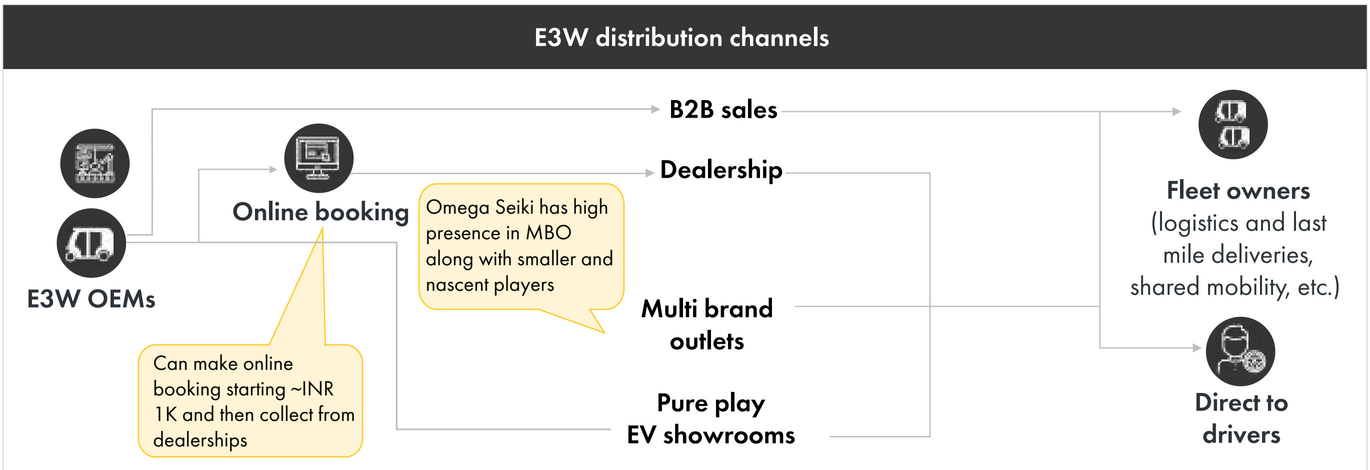
Furthermore, selling EVs requires specialized sales personnel training, battery knowledge and standards/offers, integration of subsidies, and a whole lot of other complications. Existing OEMs also face the risk of cannibalization of their ICE models from EVs, thereby stagnating sales. EVs are also seeing, for the first time, D2C sales of vehicles as well as multi-brand outlets. This could represent a major challenge and disruption to the existing distribution-led sales model for OEMs. Finally, for pure-play EV players, it is critical to determine the proposition for dealers as they miss the ICE portfolio, thereby reducing the topline of their dealers and margin potential compared to incumbent dealers.

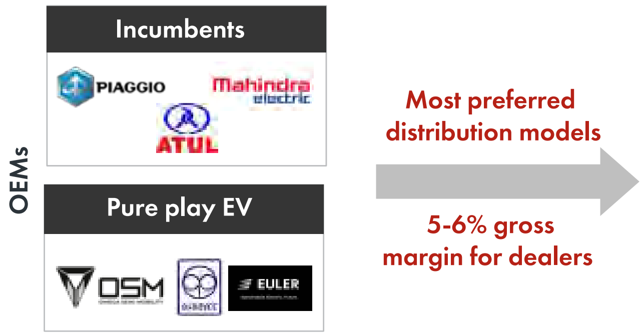
3.4.1 E3W distribution channels

In E3W distribution, incumbents like Atul, Piaggio, and Mahindra Electric prefer exclusive dealerships. On the flip side, pure-play EV makers like Omega Seiki, Kinetic Green, and E-Royce have a more varied strategy. They focus on multi-brand outlets (MBOs) and online channels along with exclusive dealerships to reach more customers and compete with incumbents on a well-established distribution network. While the incumbent brands don't use online platforms or pure EV showrooms, pure-play EV brands actively use these methods. B2B sales are also a major target for both incumbents as well as pure-play EV brands.

Exhibit 3.4.1

E3W distribution models





Distribution models	Incumbents	Pure play EV
Exclusive dealerships	✓	✓
Multi brand outlets	✓ (low)	✓
Pure EV showrooms	×	✓
B2B sales	✓	✓

✓ High preference ✓ Low preference × No presence

Note(s): MBO – Multi Brand Outlets

3.4.2 E2W distribution channels

In E2W distribution, established brands like Bajaj, Hero Electric, TVS, and newer pure-play EV brands use exclusive dealerships, online and multi-brand outlets (MBOs) for their distribution network.

Exhibit 3.4.2

E2W distribution models

Distribution models for E2W players

OEMs

Incumbents: Bajaj, Hero Electric, TVS

Pure play EV: Ampere, Okinawa, Ola, Pure, Ather, Revolt

Several MBOs are emerging and organizing the market (E1, b live)

Most preferred distribution models

7-10% gross margin for dealers

Distribution models	Incumbents	Pure play EV
Exclusive dealerships	✓ (High preference)	✓ (High preference)
Multi brand outlets	✓ (Low preference)	✓ (Low preference)
Pure EV showrooms	× (No presence)	✓ (High preference)
B2B sales	✓ (High preference)	✓ (High preference)
Online channel	✓ (High preference)	✓ (High preference)

✓ High preference ✓ Low preference × No presence

3.4.3 E4W distribution channels

In the E4W industry, Tata Motors, Mahindra, MG, and Hyundai have exclusive dealership structures. Tata Motors recently launched pure-play EV showrooms, signaling a shift towards EV-focused retail spaces while also exploring online bookings as an alternate sales channel.

Exhibit 3.4.3

E4W distribution model

Distribution models for E4W players

Tata motors has launched pure play EV showrooms

OEMs

Incumbents: Tata Motors, Mahindra, MG, Hyundai

Most preferred distribution models

3-6% gross margin for dealers

Currently, only BYD exists as pure play EV, however Tesla and other players are likely to enter soon

Distribution models	Incumbents	Pure play EV
Exclusive dealerships	✓ (High preference)	✓ (High preference)
Multi brand outlets	× (No presence)	× (No presence)
Pure EV showrooms	✓ (Low preference)	✓ (High preference)
B2B sales	✓ (High preference)	✓ (High preference)
Online channel	✓ (Low preference)	× (No presence)

✓ High preference ✓ Low preference × No presence

Note(s): MBO - Multi Brand Outlets

04

ELECTRIC MOBILITY SERVICES

4.1 Battery charging and swapping

4.1.1 Need for charging infrastructure

One of the new sectors that the EV transition is creating is the charging ecosystem. In the way that ICE vehicles created fuel stations, charging stations are going to be the next big "oil distribution" equivalent industry. However, there are a couple of fundamental differences in this sector as compared to fuel stations –

1. There is the feasibility to charge vehicles at home
2. Charging types and standards are very different, but this is getting streamlined
3. The amount of time it takes to charge is much higher than refueling
4. OEMs are also participating in this sector themselves e.g., Tesla in the USA

OEMs are also investing aggressively to increase the range of vehicles, which could reduce the need for numerous charging stations while making home charging a more viable option. Further, there is the option of battery swapping that can be used by mostly fleet operators. It will be interesting to see how this sector evolves with these dynamics, with the government also playing a role here.

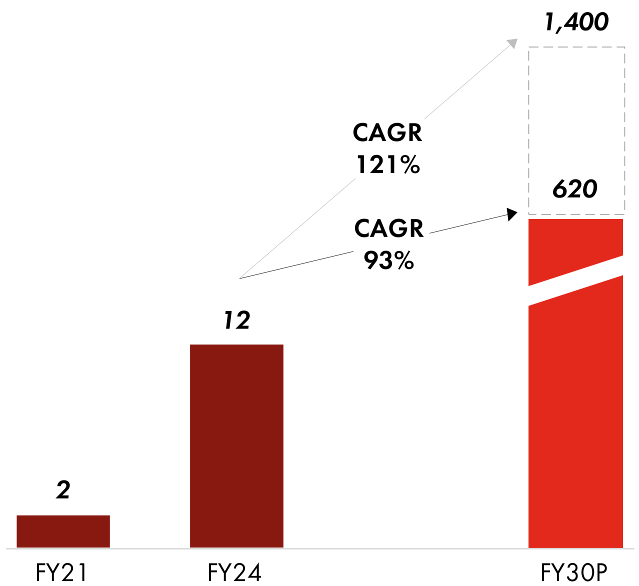
Establishing a robust and accessible charging network is imperative for the widespread adoption of EVs. This infrastructure serves as a critical enabler, addressing concerns such as range anxiety and facilitating the seamless integration of EVs into everyday life. These stations play a pivotal role in supporting drivers, ensuring convenient and efficient charging to propel the success of the transition to EVs.

Despite the growing significance of EVs globally, India currently lags in the number of operational charging stations. In FY24, India had approximately 12K charging stations, significantly fewer than other leading nations. With this number of charging stations, the ratio of EVs to charging stations stands at 9:1. To maintain this ratio, India would need around 0.6M charging stations by FY30. However, to achieve an optimal ratio of 4 EVs per charging station, ~1.4M charging stations would need to be installed by FY30.

Exhibit 4.1.1

Charging stations in India from FY21 to FY30

Public charging stations in India
(# K, FY21-30P)



Scenario 1	→	Charging stations required by FY30 if the current ratio is of **9 [1]EVs per 1 charging station**
Scenario 2	→	Charging stations required by FY30 if the current ratio of **4 [1]EVs per 1 charging station**

Note(s): [1]- Total EVs on road, Does not include home charging stations

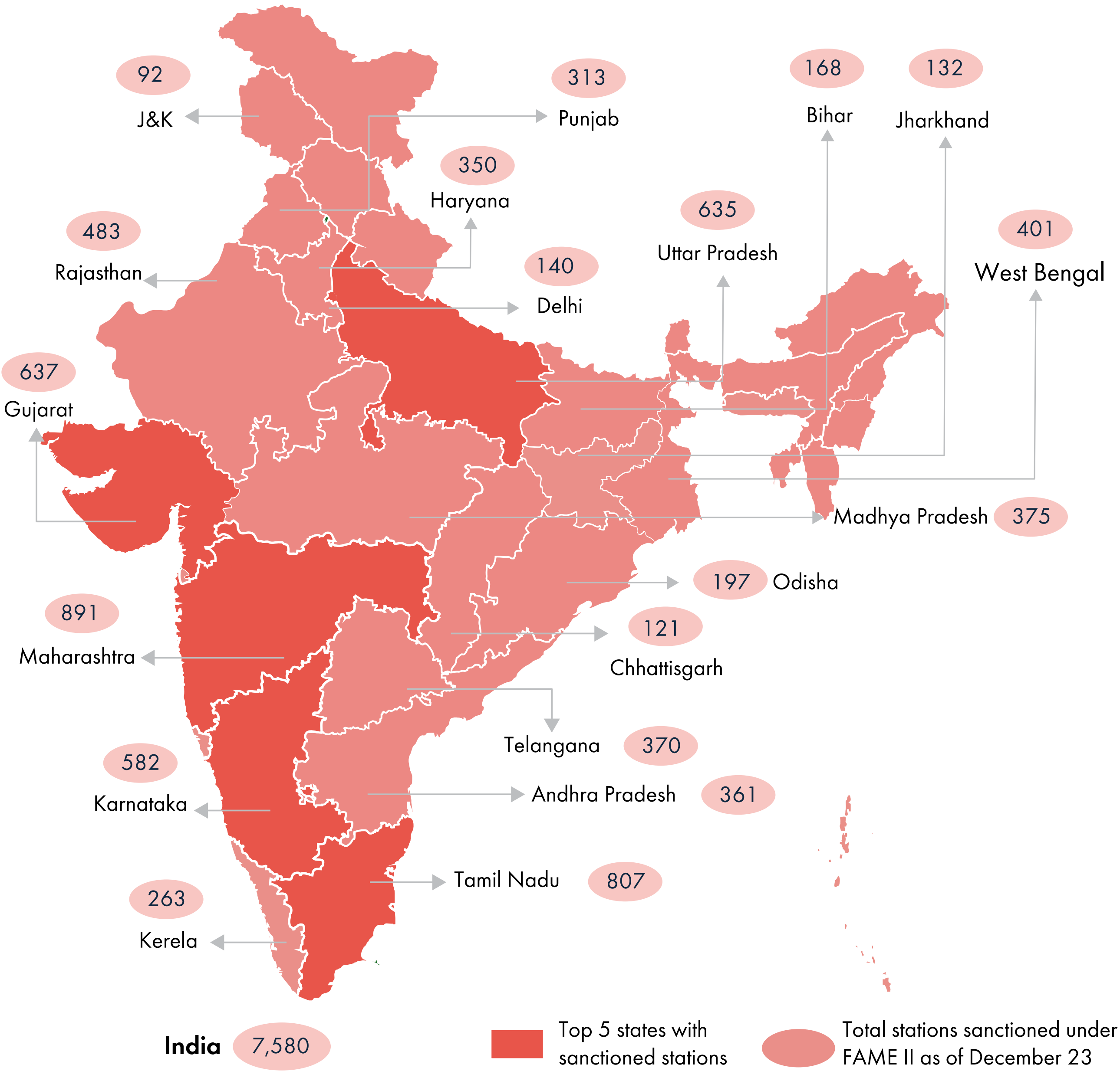
4.1.2 Current state of charging infrastructure in India

At present, India has an EVs to charging station ratio of 9:1 and to reach the globally acceptable standard ratio of 4:1, the government has taken multiple initiatives, including significant allocations in FAME II (over US$ 120M) and the reduction of GST rates on EV chargers.

Exhibit 4.1.2

Indian charging infrastructure

Goals		• **Streamlining the approval process** for public charging infrastructure • **Rationalizing demand charges** by aligning them with actual utilization • **Integrating charging networks** into town planning for both new and existing urban areas • **Establishing a Special Purpose Vehicle** for deploying charging infrastructure in tier 2, tier 3, and rural regions • **Incentivizing domestic manufacturing** of components for EV charging stations • The government aims to improve the **ratio of EVs to charging stations** from current **9:1 to 4:1** ratio which is considered ideal globally
Growth drivers	**Strong government push**	**A solarization scheme targeting 1 Cr. households was** announced that can bolster the private EV charging ecosystem within homes. As, it aims to generate **more than 300 units of free electricity** per household every month
	Industry initiatives	• **Large-scale fleet operators, e-commerce & rental players** to become strategic drivers of the market • Increase in-community charging stations, **tie ups of OEMs with petrol pumps** to increase reach
Inhibitors	**End user challenges**	• **Range and time anxiety** remains a primary concern • **Land shortage** for public charging infrastructure and unpredictable electricity demand add to the problems • **High hardware equipment cost** acts as a major challenge



Note(s): Only states with more than 50 sanctioned charging stations are considered for representation on the map; highways with more than 100 EVCS are mentioned in the table: EVCS - EV charging station; FAME - Faster Adoption and Manufacturing of Hybrid and EVs

Further, the Ministry of Heavy Industries has sanctioned a total of 7,580 EV stations spread in all states and 6 UTs under the FAME India scheme Phase II as of December 2023. Industry players, especially large-scale fleet operators and e-commerce entities are actively contributing to the expansion through collaborations and community charging stations.

Despite this progress, challenges persist. Land prices/shortages for charging infrastructure and the unpredictable electricity demand complicate the establishment of charging stations. Additionally, the high cost of hardware equipment poses a significant barrier to widespread adoption.

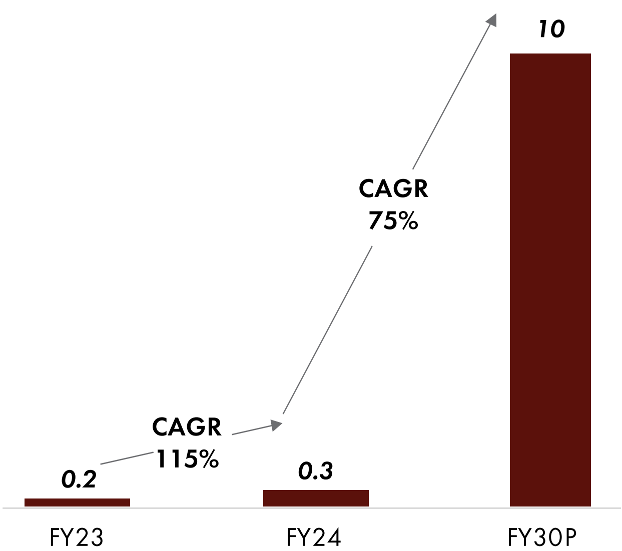
4.1.3 Battery charging and swapping opportunity

There are two primary methods currently in use for charging an EV - battery charging and battery swapping. The charging and swapping opportunity is expected to become a ~US$ 10B opportunity by FY30, growing at a CAGR of 75% from FY24 to FY30. This growth is primarily attributed to the increasing adoption of EVs, government initiatives, and the emergence of fast-charging technology.

Exhibit 4.1.3

Battery charging and swapping opportunity size and growth drivers

Battery charging and swapping opportunity
(US$ B, FY23-30P)



Growing EV penetration	Expected to grow with **higher EV penetration** for E2Ws and E3Ws, likely to cross 40% by 2030
Government initiatives	Indian government promotes electrification with **policies, incentives, tax subsidies** for **charging infrastructure** establishment
Emergence of fast-charging technology	Charging station operators are adopting fast-charging tech, like **Ather Grid,** enabling EVs to **charge in just 60 minutes**
Growing hyperlocal B2B delivery space	Battery swapping demand rises with **increasing e-commerce**, employing 2Ws for efficient last-mile fulfillment

4.1.4 Battery charging

The preferred mode for replenishing the energy required to run EVs varies across vehicle segments. For vehicles that have lighter battery weights, detachable batteries (enabling convenient handling), and smaller range which necessitates frequent and a time-efficient way for replenishing energy, battery swapping becomes predominant. This segment of vehicles includes E3Ws (both passenger and commercial) as well as E2Ws, however for E2Ws home charging also prevails due to its sheer convenience of overnight charging.

Whereas for vehicles that have higher range and moderate to high route predictability (which enables strategic planning of charging infrastructure) and have constraints in battery handling due to increased battery size and weight, battery charging is preferred, these segments include passenger and commercial E4Ws, as well as both inter-city and intra-city busses. Moreover, in premium categories of these segments where detachable batteries are absent, battery charging is left as the sole alternative.

4.1.4.1 Modes of EV charging

There are two primary modes for charging an EV - home charging and public/private charging. Home charging, utilizing standard household, provides a convenient and overnight solution for EV owners while public/private charging stations, equipped with fast and rapid chargers, cater to on-the-go needs.

Home charging:

Home charging utilizes standard household outlets (220V in India) and provides a convenient overnight solution to EV owners. Typically offering a charging speed of 1.4-1.9 kW, it is suitable for overnight charging when the vehicle is not in use for an extended period. This method is well-suited for daily commuting needs, ensuring that the EV is consistently charged and ready for regular use. Home charging is particularly effective for EV owners with access to private parking spaces, providing a hassle-free and cost-effective solution. Commonly employed standard charging protocols include Type 2 (AC) for home charging.

Public and private charging:

Public and private charging stations are equipped with fast chargers (2.5-19 kW) and rapid chargers (50 kW and above) to cater to on-the-go charging needs. Fast chargers offer a quicker charging experience, making them suitable for short breaks during travel or at locations with higher footfall. Rapid chargers provide an even faster charging experience, suitable for highway stops or situations where rapid replenishment is crucial. Common charging standards include Combined Charging System (CCS) and Charge for moving (CHAdeMO), ensuring compatibility with various EV models.

Exhibit 4.1.4

EV charging comparison for home vs. public/private charging

Parameters	At home	Public charging/Private charging	
Type	• Home charging	• Fast chargers	• Rapid chargers
Charging speed	• 11-20hrs • (1.4-1.9 kW)	• 3-8hrs • (2.5-19 kW)	• 0.5-1hrs • (> 50 KW)
Locations	• Home with parking	• Commercial areas and residential areas	• Highways, Public charging stations, EV owner outlet
Voltage	• 120V (AC)	• 208-240V (AC)	• 208-600V (DC)
Use cases	• Low-cost and slow. Best for overnight charging	• Convenient charging office space retail areas	• Users away from home who need fast charging
Indian standards	• No specific standards	• Bharat EV charger AC001 and DC 001 • CHAdeMO, CCS2 and Bharat Chargers as connectors	

4.1.4.2 Unit economics: Fast and slow battery charging stations

Fast battery charging station: Fast chargers, also known as DC chargers, are high-capacity charging stations with power outputs ranging from 25 to 350 kW. These chargers are strategically located along highways and major routes, providing rapid charging for EVs. Designed to cater to vehicles frequently covering long distances or in need of quick top-ups, fast chargers are commonly utilized by buses, trucks, and commercial cars.

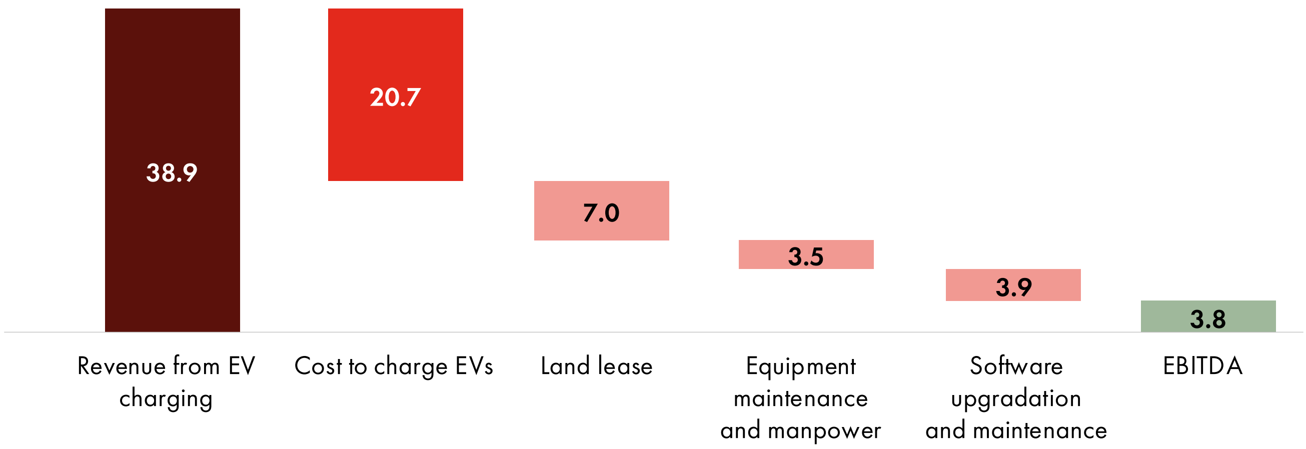
From a unit economics perspective, a fast-charging station operator with a single CCS 30 kW fast charger operating at a utilization level of 12% can generate a monthly revenue of ~INR 40K with an estimated EBITDA margin of around 10%.

Exhibit 4.1.5

Unit economics of fast charging station

Monthly unit economics: Fast charging station (CCS 30 kW single gun)

(INR K, Jan 2024)



	Revenue from EV charging	Cost to charge EVs	Land lease	Equipment maintenance and manpower	Software upgradation and maintenance	EBITDA
% of revenue	100%	53%	18%	9%	10%	10%
INR per charge	450	240	81	41	45	43
INR K per year	467	249	84	42	47	45

Revenue | Variable cost | Fixed cost | EBITDA

Note(s): Analysis as of Jan'24; number of days in a month is considered to be 30; per unit cost of electricity is taken as INR 6.35 plus taxes in Haryana

Slow battery charging station:

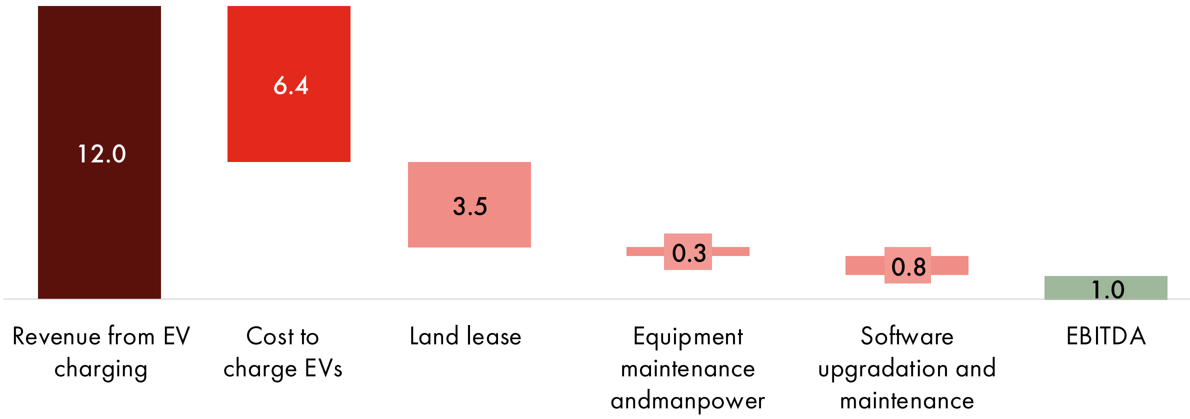
Slow chargers, also referred to as AC chargers, have the distinctive characteristic of longer charging durations, typically ranging from 6 to 8 hours. Operating at lower capacities, between 3.3 and 22 kW, they are strategically placed in residential areas, workplaces, and malls. These chargers are especially suitable for vehicles with residential charging setups or those with longer parking durations. Commonly utilized by 2W, 3W, and personal cars, slow chargers provide a convenient charging solution in everyday environments. One notable advantage of slow chargers is their positive impact on long-term battery health and longevity, as claimed by a lot of EV OEMs.

Exhibit 4.1.6

Unit economics of slow charging station

Monthly unit economics: Slow charging station (AC type-2 7.4 kW single gun)

(INR K, Jan 2024)



% of revenue	100%	53%	29%	3%	7%	8%
INR per charge	450	240	131	13	30	36
INR K per year	144	77	42	4	10	12

Revenue | Variable cost | Fixed cost | EBITDA

Note(s): Analysis as of Jan'24; number of days in a month is considered to be 30; per unit cost of electricity is taken as INR 6.35 plus taxes in Haryana

From a unit economics perspective, a battery charging station operator with a single AC type-2 7.4 kW slow charger operating at a 15% utilization level can generate monthly revenue of ~INR 12K with an estimated EBITDA margin of around 8%. While slow chargers may have a longer charging duration, their economic viability is underscored by their contribution to extended battery life.

While the economics of fast and slow charging stations look a bit unattractive, it is imperative to note that these stations are currently very minimally utilized. With increased density and utilization of charging stations, this will improve significantly.

4.1.4.3 Battery charging models

The charging infrastructure landscape in India comprises three predominant models: government-driven, consumer-driven, and the service provider model, each playing a crucial role in the development of a robust charging network.

Government-driven:
This model operates on government-owned lands, leveraging financial subsidies and concessional land provisions. The government supports charging point operators (CPOs) to reduce the initial cost of implementation. The objective is to strategically establish charging stations, ensuring widespread accessibility, and encouraging CPOs to contribute to the national EV infrastructure.

Consumer-driven:
In the consumer-driven model, charging locations are distributed across various areas such as malls, offices, homes, and fleet owner premises. Consumers have control over charging sessions through software services accessible via mobile apps. Additionally, Time of Day (ToD) tariff advantages incentivize users to charge during off-peak hours, promoting optimal utilization of the charging infrastructure.

Service provider:
This model involves charging locations on CPO-owned or private lands, allowing for flexibility in establishing stations in high-demand areas. A key feature is revenue sharing with the landowner, creating a mutually beneficial arrangement.

Exhibit 4.1.7

EV charging models

	Implementation models	Charging location	Description
Government driven model	CPO — Government/CPO owned charging equipment →	Government-owned lands	• **Public charging infra provision is led by government agencies.** Charging services can be self-managed or outsourced to a CPO • Government offers **financial subsidies, concession in land provisions and energy supply to incentivize CPOs to reduce capital costs of implementation**
Consumer driven model	CPO — Purchase of charging equipment for end user and fleet owners → Partnerships: malls, offices or fleet owners	Malls, offices, and retail Home Fleet owner	• Employed for **private (malls, retail shops, etc.) and semi-public charging facilities.** Partner with a CPO for overall mgmt. of the EVSE supply and procurement is through direct purchase • **Software services** are available through a mobile app **to control charging sessions taking ToD tariff advantage**
Service provider model	CPO — CPO-owned charging equipment →	CPO-owned/private land	• CPOs drive EV charging provision for public & semi-public charging. EVSE equipment is owned by CPO and charging service is under CPOs brand name • CPOs aim to establish **charging stations in high-demand areas** and often enter **revenue sharing contracts with land-owners**

Note(s): CPO - Charging Point Operator, EVSE - EV Service Equipment, ToD - xTime of Day
Source(s): Niti Aayog

4.1.4.4 Headwinds and tailwinds

The journey to establish a robust EV charging infrastructure in India is characterized by numerous challenges and opportunities. Overcoming hurdles such as grid constraints, logistical complexities, and regulatory intricacies has been a gradual process, slowing down the deployment of charging stations. Additionally, managing various charging standards among EV models adds complexity, necessitating adaptable solutions.

Despite these obstacles, favorable conditions contribute to the growth of EV charging infrastructure in India. The increasing adoption of EVs acts as a powerful catalyst, driving the demand for an expanded network of charging facilities. Government initiatives, exemplified by FAME policies and Ministry of Heavy Industries (MHI) incentives, have played a pivotal role in supporting the charging infrastructure.

The emergence of fast-changing technologies, demonstrated by solutions like Ather Grid's 60-minute charging, offers potential solutions for extended charging durations. Industry-driven initiatives, such as collaborations with fleet operators and the proliferation of community charging stations, further strengthen the availability of charging points in public spaces.

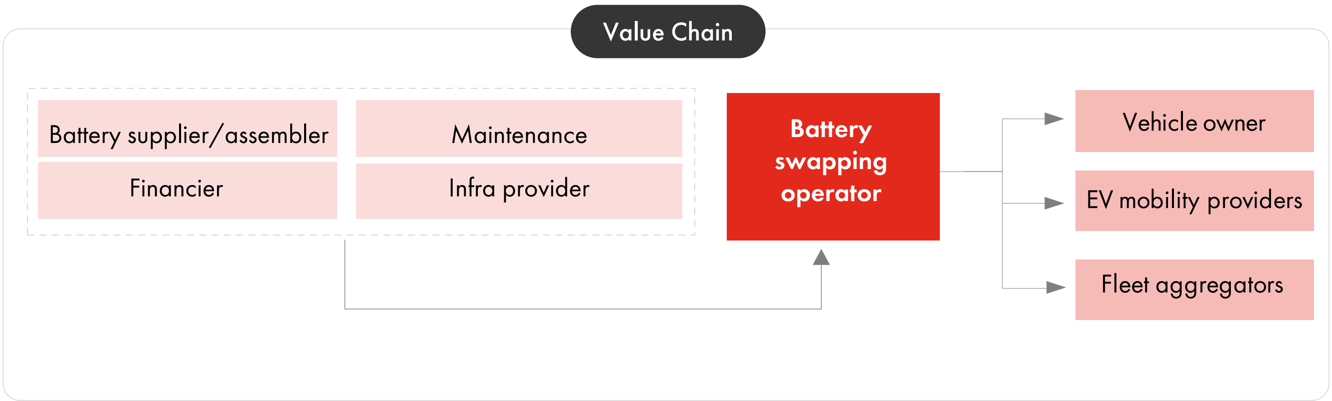
4.1.5 Battery swapping

Battery swapping emerges as an alternative to EV charging in the EV landscape, involving the swift exchange of discharged batteries for fully charged ones. This model finds favor, particularly among B2B users, 2W, and 3W owners, driven by the higher daily usage. The convenience of swapping in minutes, compared to the hours needed for traditional charging, is a significant advantage. This approach becomes especially effective for users who cannot afford the vehicle to be out of operation for extended charging periods, maximizing income generation. Therefore, 2W and 3W commercial vehicles use battery swapping as their preferred mode of refueling their EVs.

In the battery swapping value chain, key stakeholders include battery suppliers/assemblers, maintenance providers, financiers, and infrastructure providers collaborating with battery swapping operators, ultimately serving vehicle owners, EV mobility providers, and fleet aggregators.

Exhibit 4.1.8

Battery swapping value chain



Key players

4.1.5.1 Headwinds and tailwinds

The battery-swapping landscape faces its share of challenges. High capital requirements pose a hurdle, demanding significant investment to procure a substantial number of batteries for breakeven. The non-standardization of EV batteries across brands complicates matters, necessitating investments in various battery types and hindering scalability. Operational challenges, including finding skilled operators, ensuring battery security, securing access to a reliable power supply, and addressing insurance uncertainties, further contribute to the headwinds.

On the flip side, tailwinds are evident in the anticipated growth of EV penetration, especially for 2Ws and 3Ws, and are expected to exceed 40% by 2030. The rise of hyperlocal B2B delivery services, driven by the surge in e-commerce and last-mile deliveries using 2Ws, enhances the need for battery swapping. Encouragingly, both new entrants and established players are investing in battery swapping infrastructure, signifying a promising trajectory for this evolving landscape. Charging and swapping are two different approaches to re-energizing EVs for usage, with both having different applicability to different use cases. Moreover, in the operator's space, there is an asset-light model as well as an asset-heavy model, both with their share of pros and cons.

Exhibit 4.1.9

Vehicle suitability for charging vs. swapping

Segments	Daily running mileage	Range	Weight of battery	Charging infra requirement	Route predictability	Remarks
Description	• Higher run would necessitate frequent charging increasing preference for swapping	• Determines frequency of charging required • In case of high range, charging can be done overnight	• Determines ease of swapping • Requirement of robots/ additional capex in case of higher weight	• Space required for parking while charging impacts convenience	• Predictable routes helps plan for charging & reduces attractive-ness of swapping	-
Passenger						
2W passenger	Moderate	Low (60-150 km /charge)	Low	Low (limited space and standard charge points)	Moderate	Lower range and battery weight and limited route predictability makes swapping attractive
3W passenger	Moderate	Low (80-150 km /charge)	Low	Moderate	Low	Low range per charge, low weight of battery and route low route predictability play in favour of swapping potential
4W passeger car	Low	High	Moderate	Moderate	Low	Low mileage, high range and lower charging infrastructure requirement make charging attractive
Commercial						
2W	High	Low (60–150 km /charge)	Low	Low (limited space and standard charge	Low	High running mileage, low range and weight of battery makes swapping attractive
3W	High	Low (80–150 km /charge)	Low	Moderate	Moderate	High daily running mileage, low range per charge and low weight of battery play in favour of swapping potential
4W cargo (mini, pickup)	High	Moderate (~150 km/ charge)	Moderate	Moderate	Moderate	High mileage however high weight of bat-tery requires additional capex investment from swapping players, thereby making the segment neutral to both charging and swapping
4W cargo (LCV, MCV/HCV)	High	Moderate (~150 km /charge)	High	High	Moderate	Higher mileage and weight of batteries make 4W cargo more convenient for charging
4W utility vehicle	Low	High (150–300 km /charge)	Moderate	Moderate	Low	Low swapping potential due to low mileage, high range and lower charging infrastructure requirement
Intra-city-Bus	High	Moderate (80-180 km /charge)	High	High	High	Heavy weight, capex involvement in swapping and high route predictability make segment attractive for battery charging
Inter-city Bus	High	High (250–300 km /charge)	High	High	High	Heavy weight, capex involvement in swapping and high route predictability make segment attractive for battery charging

Low — High

Battery charging | Battery swapping | Battery charging/swapping

4.1.6 Upcoming services: Battery as a Service (BaaS) and battery leasing

Battery as a Service (BaaS) and battery leasing are innovative approaches aimed at mitigating the high upfront costs of EVs by 30-40% and addressing concerns related to battery degradation. The cost of ownership and maintenance is effectively spread over the vehicle's lifetime.

BaaS is a concept where a third-party provider offers BaaS. In this model, consumers swap their discharged battery for a recharged one at swapping stations. Users do not own the battery, but rather pay for it via pay-per-use or subscription models. The provider assumes responsibility for maintenance and upgrades. BaaS promotes sustainability through efficient recycling and reuse practices. However, challenges include the need for widespread standardization of EV batteries and charging infrastructure for BaaS to thrive. Users face a trade-off, as they lack ownership, leading to limited control over maintenance and replacement timing, with potential long-term cost implications for paying for battery usage over time. Moreover, we have seen in multiple categories that where a user/consumer does not own the asset, it has been misused and the asset has depreciated very fast.

Battery leasing involves leasing from an automaker, leasing company, or another entity for a set duration, with payments based on annual mileage. Lessee (usually EV users) own the battery after the completion of the lease, making regular payments like traditional vehicle leasing. They control battery use and maintenance, with options to purchase or return the battery at the end of the lease period. Fixed payments ensure cost predictability over the lease term. However, leasing has its own set of challenges such as uncertain resale value influenced by factors like technological advancements, and potential additional costs or restrictions at the end of the lease.

4.2 EV logistics

The logistics opportunity in India, covering road, rail, air, and waterways, is valued at US$ 187B in FY24 and is projected to reach US$ 347B by FY30, growing at a CAGR of 11%. This sector is a shining star of the Indian economic growth story. With India's transition to a global manufacturing hub, strong local consumption demand, and significant government investment in the improvement of transport infrastructure, this sector will continue seeing fast growth. Road logistics constitute over 86% of India's overall logistics opportunity, with most vehicles being ICE driven currently.

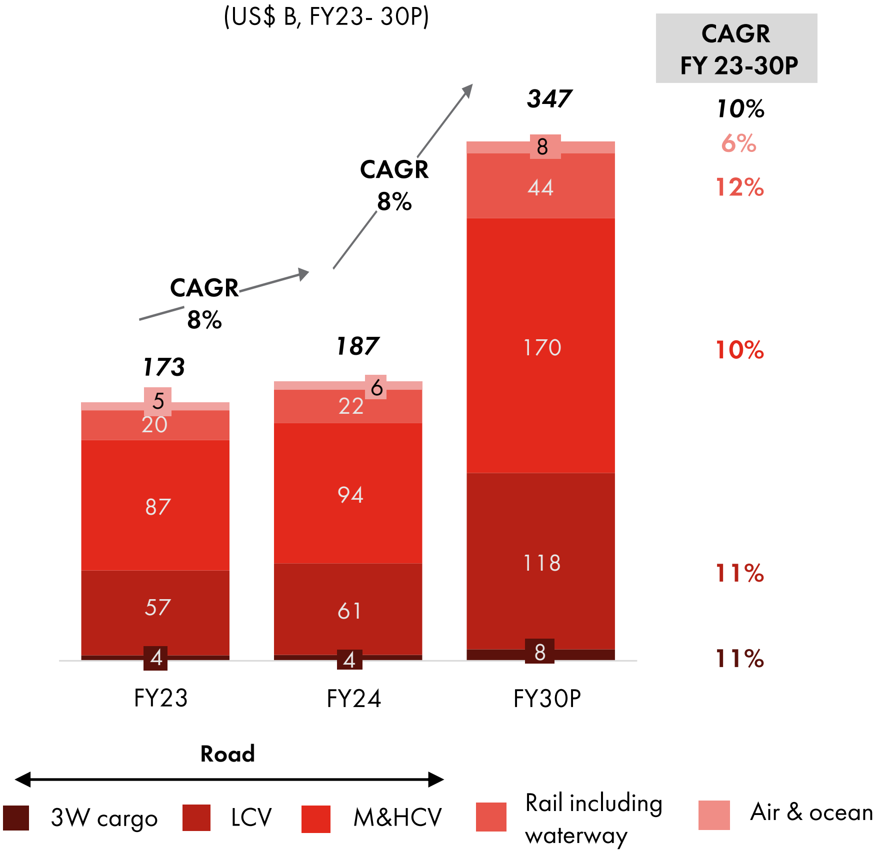
The penetration of EVs in the logistics market currently stands at roughly 8%, amounting to US$ 15B in FY24 by value, with E-Rail accounting for more than 95% of this opportunity. The total EV penetration in logistics is expected to reach 14% by FY30, with US$ 49B worth of logistics handled by EVs from the overall US$ 347B logistics opportunity in FY30. In the EV logistics market, there will be increasing adoption of EVs in the 3W and LCV categories. In the road logistics opportunity, the share of EV road logistics is expected to reach 4% by FY30, compared to the current level which stands below 1%. This will lead to an overall opportunity of US$ 10B+ in the EV road logistics sector.

Exhibit 4.2.1

Overall logistics opportunity and EV logistics opportunity value

Overall logistics opportunity in India

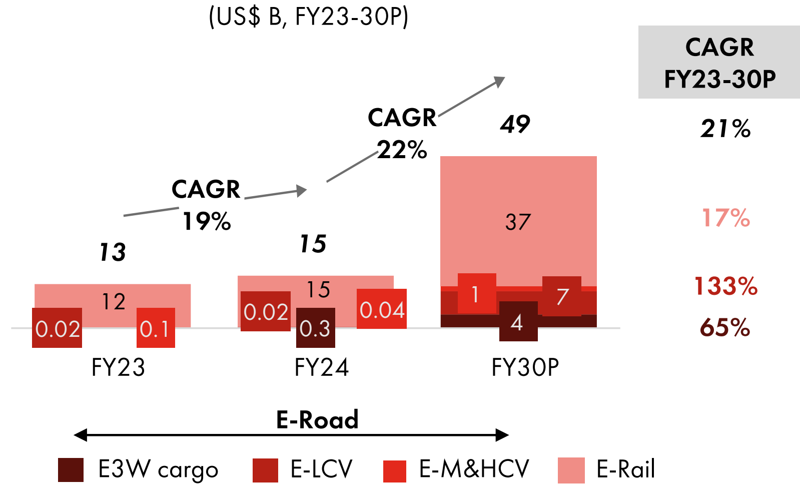
(US$ B, FY23- 30P)



	3W cargo	LCV	M&HCV	Rail including waterway	Air & ocean
Market share (%, FY23)	2%	33%	51%	11%	3%
Market share (%, FY30P)	2%	34%	49%	13%	2%

EV logistics opportunity in India

(US$ B, FY23-30P)



	E3W cargo	E-LCV	E-M&HCV	E-Rail
EV penetration (%, FY23)	3%	-	-	63%
EV penetration (%, FY30P)	51%	6%	1%	85%

4.2.1 E-Logistics landscape

E-Logistics landscape can be categorized based on the type of vehicle used during transportation: E3W, E-LCV, E-M&HCV and E-Rail. The E3W cargo vehicles, good at navigating different areas, are great for last-mile logistics, delivering smaller shipments and parcels directly to end consumers and have witnessed high electrification relative to other road transport vehicles.

Exhibit 4.2.2

E-Logistics landscape in India

	Mode	Use case	Major players		Prevalence in the market
			Incumbents	Pure play EV	
E-Road logistics	E3W cargo	Well-suited for last-mile logistics delivering smaller shipments and parcels directly to end consumers	Gati, FM Logistic, Delhivery, Blue Dart, DHL, Ecom Express, Porter, Cogos	Magenta, Zevo, LoadExx, Evify, MoEVing	◑
E-Road logistics	E-LCV	Last mile and inter-city logistics providing flexibility in transporting larger loads over longer distances	Gati, Safexpress, Delhivery, Rivigo, FedEx	Magenta, Zyngo, Zevo, MoEVing, Edel, LoadExx	◔
E-Road logistics	E-M&HCV	Regional distribution, linking distribution centers and warehouses to retail outlets or businesses	Market not catered currently		○
	E-Rail	Bulk freight transportation for shipments like commodities, agri products and raw materials	Indian Railways	-	◕

Low ○ ◔ ◑ ◕ ● High

4.2.2 Expansion plans of logistics fleet operators

Logistics fleet operators in India, specifically operating in E3W and E-LCV segments are embracing a transformative shift towards EVs as part of their expansion plans, aiming to enhance sustainability. Incumbents such as Delhivery, Ecom Express, FM logistics and Rivigo have already integrated EVs in their fleets and announced future ambitious electrification plans, with Ecom Express targeting the conversion of 50% of its vehicle fleet to electric by 2025, and Rivigo aiming for 40% EVs by 2026 with a fleet size of 3-4K EVs.

This shift towards EVs is not exclusive to incumbent logistics players, as pure-play EV companies like MoEVing are securing significant investments, with plans to onboard 1M EVs by 2030 and expand into 10 new cities by 2024.

While the 3W and LCV segment is witnessing the EV transition, M&HCV fleet operators who has a larger share in the overall road logistics market are still facing challenges like, limited availability of EV models and significantly high upfront costs associated with the E-M&HCVs.

Exhibit 4.2.3

EV expansion plans of logistics companies

	Incumbents				Pure play EV	
	Ecom Express	RIVIGO	FM Logistic	DELHIVERY	magenta	MoEVing
Current EV products	• E3W 	• E-LCV 	• E3W 	• E-LCV 	• E3W cargo and E-LCV 	• E3W cargo and E4W 
Geographical presence	• 2.4K cities	• Present all over India	• 35+ cities	• Present all over India	• Bengaluru, Mysuru, Delhi NCR, Mumbai and Hyderabad	• Present in 14 cities
Industries catered	• Retail and e-commerce	• FMCG, e-commerce, fashion and lifestyle	• FMCG, retail, pharma, e-commerce, retail & telecom	• FMCG, e-commerce, retail, manufacturing, lifestyle	• Food, courier, e-commerce, FMCG	• E-commerce, e-grocery, FMCG, logistics and D2C
Current EV fleet	• 420 EV fleet	• 1.3K EV fleet (currently 20% last mile is EV)	• 30 EVs deployed so far	• 1.8K CNG and EV fleet deployed	• Existing fleet of more than 1.2K cargo E3Ws	• 2K EVs and 30 charging hubs deployed
Expansion plans	• Ecom express plans to convert **50% of its vehicle fleet to electric by 2025**	• **40% electric by 2026,** plan to have 3-4K EV's • Aims to become **carbon neutral by 2040**	• FM logistics plans to deploy **50%** of its **turnover from EV's by 2026** • Plans to become **carbon neutral by 2030** • Strategies to expand from 3PL to 4PL	• Actively **collaborating with OEMs to increase adoption of EV's** in mid and last mile operations	• Plans to expand its fleet to 12K E3Ws and E4Ws across the country by 2024 • Currently in 7 cities, plans to **expand to 8 more cities**	• Aims to **onboard 1M EV by 2030,** have 50% of India's charging stati-ons on its app • MoEVing has plans to expand its footprint, and **enter 10 new cities by 2024**
Capex/ investment towards EVs	-	• Once the company crosses threshold of 2K EV's it plans to **explore partner model**	• FM logistics **plans to invest US$ 20M** more in the upcoming year to have energy efficient devices at warehouse	-	• Raised **US$ 22M** from Morgan Stanley India Infrastructure and BP Ventures to expand EV ecosystem	• Raised **US$ 5M** to develop MoEVing's online platform and expand its footprint in India

4.3.3 Opportunities and challenges in adoption of EV fleet for logistics in India

Logistics firms in India are actively considering the transition to EVs and several promising factors are fueling this exploration. The decreasing cost of EV batteries is a significant driver, making these vehicles more affordable. Government incentives, including subsidies and tax breaks, further reduce the upfront costs of these vehicles. EVs are also more economical from an operational point of view with lower charging costs compared to fuel costs associated with ICE vehicles and present significant savings over their lifecycle. Additionally, integrating advanced fleet management tools is proving instrumental in enhancing operational efficiency, optimizing routes, and ultimately reducing last-mile delivery costs.

However, the shift to EVs doesn't come about without its challenges. Limited battery range and a shortage of charging infrastructure raise concerns about the practicality of widespread adoption. High costs involved in setting the charging infrastructure for inter-city logistics further hinders the adoption of EVs in LCV and M&HCV segment. The substantial upfront investment required for EVs, despite promising long-term savings, poses a financial hurdle for logistics firms. The development of reliable EV aftersales service centers adds an additional layer of complexity.

4.3 EV transportation

We are the world's largest country by population, and transportation is one of the key macro sectors in India. India's overall passenger transportation opportunity is valued at US$ 185B in FY24, with inter and intra-city bus commute holding the highest share at 40%, followed by inter and intra-city cabs holding a share of 34% in FY24. The transportation opportunity is expected to grow at a CAGR of 10% to reach US$ 322B by FY30, with 2W commute growing the fastest at 15%, followed by air travel (12%) and passenger cabs (11%).

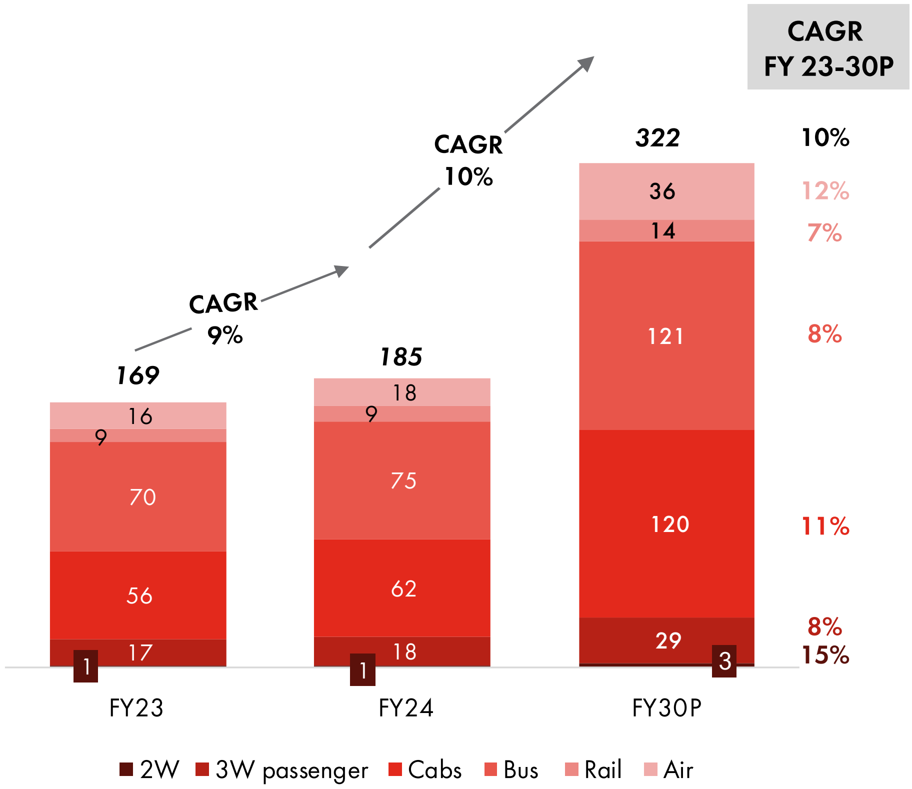
EV penetration in the overall transport opportunity is 4% at present, amounting to a total opportunity of ~US$ 7B, with E-Rail transportation having the highest share of 84%. EV penetration in transportation is expected to increase to 14% by FY30 to become a US$ 45B opportunity. E4W cabs opportunity is expected to grow the fastest to become a US$ 12B opportunity by FY30 as fleet/individual operators operating on aggregator platforms are transitioning to EVs rapidly due to better unit economics offered by EVs. The EV bus transportation opportunity is expected to grow significantly, becoming ~8% of the overall bus transportation opportunity as state bus transport electrifies their fleets. This penetration is expected to increase rapidly post FY30 as the share of the E-Buses installed base increases rapidly and ICE buses start to phase out.

Exhibit 4.3.1

Transportation opportunity overall and EV

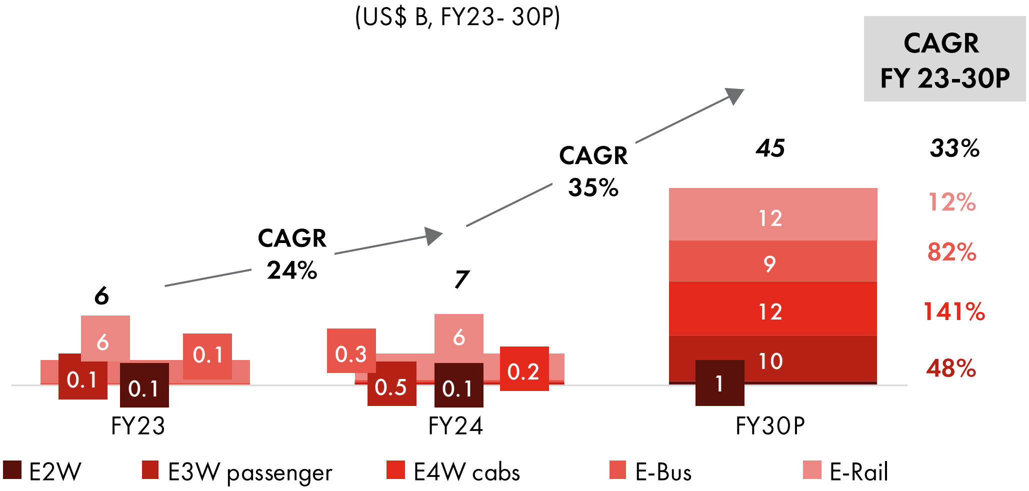
Overall transportation opportunity

(US$ B, FY23-30P)



EV transportation opportunity

(US$ B, FY23- 30P)



	E2W	E3W passenger	E4W cabs	E-Bus	E-Rail
EV penetration (%, FY23)	7%	1%	-	-	63%
EV penetration (%, FY30P)	40%	36%	10%	8%	85%

4.3.1 E-Transportation landscape

Aggregators like Uber, Ola, Rapido and pure electric mobility players like BluSmart are leading transition of India's 4W and 3W cabs transportation market to shift to EVs. State Government led transition of their bus fleet to EVs and have been joined by existing and new private bus operators and aggregators in using E-Buses for intercity bus commute.

Exhibit 4.3.2

E-Transportation landscape

Mode	Use case	Major players: Incumbents	Major players: EVs	Prevalence in the market
E-Cabs	Encompasses urban commuting, airport transfers, tourist transportation, corporate shuttles, and last-mile connectivity	Uber, OLA, MERU	BLU Smart Mobility, eVera, eee-Taxi, Cab-e, Uber Green, Snap-E	◔
E3W	Well suited for short distance commuting and intra city transportation, catering to last-mile connectivity needs for passengers	rapido, Auto Raja, JUGNOO	eVAHAK, SMART E	◔
E-Bus	Providing eco-friendly mass transit solutions, inter and intra city transportation	zingbus, Shuttl	EveyTrans, NUEGO, PURPLE	◔
E-Rail	Mass transportation for passengers with seamless connectivity, reducing air and noise pollution	DMRC, Mumbai Metro		◕

Low ○ ◔ ◑ ◕ ● High

4.3.2 Transportation players' expansion plans

The EV transportation landscape is witnessing substantial expansion efforts by key players, encompassing both established incumbents and emerging pure-play EV transportation companies. In this regard, Uber has planned to increase the number of green fleets operating on its app to 25K in the next 3-4 years under its "Uber Green" brand. Similarly, pure-play EV players such as BluSmart and NueGo will be increasing their fleet size, introducing new electric car and bus models to their fleet respectively.

Exhibit 4.3.3

EV transportation players' expansion plans

	Incumbents			EV	
	Uber	rapido		BLU SMART MOBILITY	
Current fleet	Cabs, 3W, bikes 	Majorly 3W, bikes 	Trains 	Cabs 	Buses 
Geographical presence	Present all over India, over 125 cities	Marks its presence in over 100 cities in India	Operates all over India	Delhi, Noida, Ghaziabad, Gurgaon, Jaipur and Mumbai across India	Expanded its presence in 12+ cities in India including south and north India
Expansion plans	The company plans to deploy around 25K electric cars in the next three years	It forays into cab services segment; plans to roll out in 35 cities by 2024	Plan to put 3K new trains on tracks in the next 3-4 years	It is looking to scale its fleet size to around 8K EVs across Delhi-NCR and Bengaluru by 2024	Signed MoU to deploy 1K E-Buses
Capex/ investment towards EVs	US$ 800M funding to help driverstransition to electricvehicles by 2025	It has raised a tota funding of US$ 324M over 10 rounds and has witnessed threefold revenue increase in FY23	It has outlined a plan to invest INR 100K Cr. in procuring new trains in the upcoming years to address the growing demand in the passenger travel sector	It raised US$ 24M or around INR 200 Cr. in fresh capital from some of its existing investors	It is to invest INR1.5K Cr. to double EV buses supply in India

4.3.3 Headwinds and tailwinds

The Indian transportation market faces several significant headwinds in its transition to EVs. One major hurdle is the limited charging infrastructure available for a large number of cabs/buses operating. Additionally, the time required for charging can lead to downtime for fleet operations, impacting their productivity and efficiency. Furthermore, securing financing for EVs has been challenging, especially for individual or smaller players. Finally, the high initial investment compared to traditional vehicles remains a barrier, even though long-term operational costs might be lower.

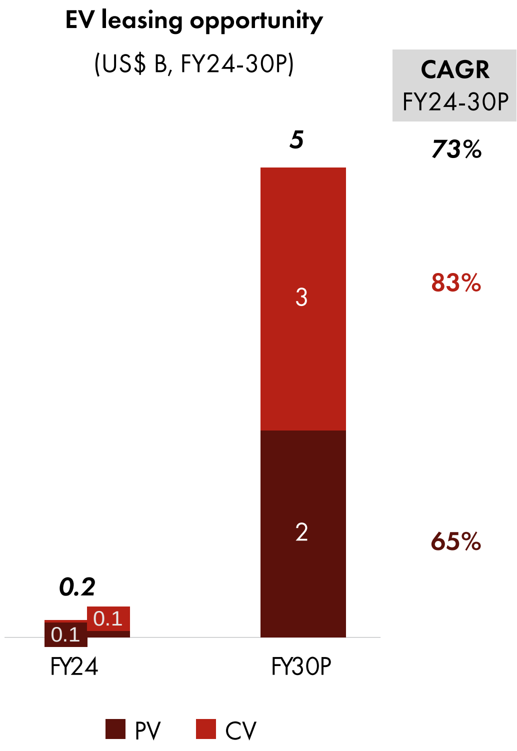
Despite these challenges, there are also significant tailwinds propelling the transportation market toward electrification. The government's strong push through financial incentives, subsidies, and tax benefits is significantly reducing the upfront cost of EVs, making them more attractive for both individual consumers and fleet operators. Additionally, the expected decrease in battery prices from current highs to around US$ 80-90/kWh by 2030 will further improve affordability in the long run. Finally, collaboration between fleet operators and OEMs can lead to the development of EVs tailored to specific fleet needs, enhancing efficiency and productivity, and making them even more appealing for adoption.

4.4 EV leasing

EV leasing opportunity in India at a nascent stage, valued at ~US$ 170M and expected to become a US$ 4-5B opportunity by FY30 growing at a CAGR of ~73%. The majority of contribution to the overall leasing opportunity will come from CVs.

Exhibit 4.4.1

EV leasing opportunity



Stakeholders involved in the EV leasing model:

- **EV manufacturer/OEM:** EV OEMs engage in selling or leasing EVs to fleet owners or leasing companies. They provide the necessary vehicles, ensuring a seamless transition to electric mobility for fleet operators.
- **Fleet owner/leasing company:** Fleet owners or leasing companies act as intermediaries between EV OEMs and EV fleet operators. They acquire EVs from OEMs and lease them out to EV fleet operators, streamlining the process for businesses looking to adopt electric mobility.
- **EV fleet operator/mobility provider:** EV fleet operators or mobility providers are the end-users of leased EVs. They lease EVs from fleet owners or leasing companies to offer services such as logistics, ride-hailing, or corporate commuting.
- **Customers for logistics (e-commerce, FMCG, etc.) and passenger fleet (B2B customers/enterprise, B2C customer/-passengers):** Businesses in the logistics sector, including e-commerce and FMCG, leverage leased EVs for efficient and sustainable transportation of goods. Corporate entities and individual customers benefit from the availability of leased EVs for their transportation needs.

4.4.1 Headwinds and tailwinds in the EV leasing model

Talking about headwinds, the high leasing rates pose a significant hurdle, primarily driven by the substantial initial cost of EVs. This makes it challenging for leasing companies to provide competitive rates. Additionally, the uncertainty surrounding the resale value of EVs is another challenge with insufficient historical information, technological advancements, and market shifts creating ambiguity for lessees regarding the long-term value of their leased vehicles.

Despite its challenges, the EV leasing sector is gaining momentum, as leasing companies can bring down upfront costs by signing exclusive EV procurement agreements with OEMs, and additional government incentives, including anticipated tax breaks, enhance the feasibility of competitive leasing rates. Further, the ability of a leasing company to offer charging, service, and maintenance at a single place for leased EV reduces the operational cost for both the drivers and the leasing company. Also, with the increased focus on sustainability, a rise in corporate fleet offerings presents a valuable opportunity for EV leasing companies, as businesses seek to adopt EVs to reduce their carbon emissions.

4.5 EV financing

The EV financing disbursed loan value was US$ 2B in FY24, and with increasing penetration, the disbursed loan value for EVs is expected to reach US$ 31B by FY30. For E2Ws, financing penetration stood at approximately 40% and LTV at 70% in FY24. Both financing and LTV are expected to reach around 55% and 80%, respectively, by FY30, almost equaling ICE 2W finance penetration and LTV levels by then. For the E4W segment, finance penetration is projected to reach 80% by FY30, up from 70% in FY24. Simultaneously, finance penetration for the E-CV segment is expected to reach 95% by FY30.

Exhibit 4.5.1

EV financing opportunity and landscape

Banks

SBI, HDFC Bank, Union Bank of India, Yes Bank, ICICI Bank, Axis Bank, pnb

NBFCs

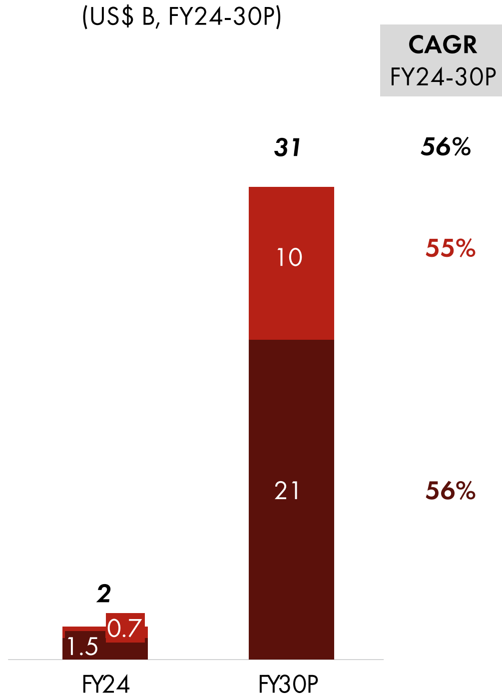
Tata Capital, Shriram Finance, Manappuram Finance Limited, Mahindra Finance, Mufin, Chola, Revfin, Vedika Credit Capital Ltd, ev.fin by Greaves, HeroFinCorp, Ascend Capital, ecofy, Poonawalla Fincorp, Three Wheels United

FinTech

LoanTap, OTO, Vidyut, rupyy

EV financing disbursed loan value

(US$ B, FY24-30P)



	FY24	FY30P
Total financing disbursed loan value (US$ B)	64	132
EV penetration (%)	3%	24%

Note(s): PV includes both E2W and E4W

4.5.1 Vehicle financing: EV vs. ICE

Financing parameters, interest rates and loan tenures vary significantly for EVs compared to ICE vehicles across different segments. For instance, banks charge ~0.5% lower interest rates for high-speed E2Ws compared to ICE counterparts. On the contrary, the difference in interest rates in case of commercial EVs may be 1-7% higher compared to ICE, highlighting the challenges faced in financing of EVs. Similarly, the interest rates for other segments is generally higher when compared to ICE counterparts.

Exhibit 4.5.2

EV financing across vehicle categories

	Vehicle segment	EV/ ICE	Interest rates		Loan tenure (months)	LTV
			Banks	NBFCs		
Passenger vehicles	2W	High speed EV	Typically, similar interest rates; 0.3-0.7% lower than ICE	2–4% higher rates vs ICE; lower rates for EVs priced between **~INR 140-160K**	18–24	65–75%
		Low speed EV			24–36	75–80%
		ICE			46–48	Up to 95%
	4W	EV	Typically, similar interest rates; 20-25 bps lower rates available under green loans	*Banks dominate this space*	36–120	80–90%
		ICE			36–84	80–90%
Commercial vehicles	3W passenger	EV	*NBFCs dominate this space*	1–7% higher vs. ICE	24–42	70–90%
		ICE			24–60	85–100%
	3W cargo	EV	2–3% higher vs. ICE	1–8% higher vs ICE	24–42	70–90%
		ICE			24–60	85–100%
	4W LCV	EV	0.5–3% higher vs. ICE	*Banks dominate this space*	36–60	60–70%
		ICE			48–60	80–90%

Low ■ ■ ■ High

Source(s): NITI Aayog report

4.5.2 EV financing challenges

EV customers face multiple challenges related to financing like shorter loan duration, higher interest rates charged by banks or NBFCs compared to ICE counterparts, lower LTV for EV compared to ICE, and recurring cost related to battery replacement. While the challenges remain the same across PVs and CVs, the degree of these challenges varies.

From financiers' perspective unestablished resale market, uncertainty regarding battery value or degradation are the major challenges which they face. To mitigate such challenges financiers, use different strategies like low LTVs, high interest rates and shorter loan tenures.

As the adoption of EVs grows, and financing institutions gather more information regarding behavior of EVs, they are likely to let go of these mitigating measures and offer loans on similar terms as ICE vehicles.

Exhibit 4.5.3

Challenges in EV financing

	Key challenges	Description	Passenger vehicles 2W	Passenger vehicles 4W	Commercial vehicles 3W passenger	Commercial vehicles 3W cargo	Commercial vehicles 4W
Customer pain points	Higher financing burden	• 10-30% lower LTV for EV vs. ICE depending on vehicle category • Tenure 6-18 months shorter compared to ICE • Interest rate 1-7% higher for EV vs. ICE depending on vehicle category	●	○	●	○	●
Customer pain points	Recurring capex with low financing options	• For E3Ws, battery replacement after 4-5 years acts as additional capex burden for the buyer with limited availability of financing options			●	●	
Financiers' challenges	Unestab-lished resale market	• Due to no established resale market, underwriting becomes difficult for financiers	●	●	●	●	●
Financiers' challenges	Unknown battery life/ value	• Due to uncertainty regarding EV battery life and end-of-life value, lenders commonly synchronize loan durations with battery warranties to minimize financial risk	●	●	●	●	●
Financiers' challenges	No assurance of product quality	• Diverse range of EV manufactur-ers, coupled with evolving battery technology, contributes to an absence of clear insights into product quality	●	○	●	●	○

● High applicability of challenge ○ Low applicability of challenge

Source(s): NITI Aayog report

4.5.3 EV financing benefits

EV financiers may have access to and availability of vehicle usage data, battery data and rider data on a continuous basis. This allows the financier to understand the vehicle usage and helps assess if the vehicle is earning enough to pay back. Battery data helps to understand the state of health (SOH) and accurately determine the secondhand resale value of a battery. Rider data enables the financier to identify cohorts of riskier riders across various cuts such as job, age, and geography.

Moreover, engine immobilizers allow the financier to have higher control over the asset in case there is a high risk of default.

Exhibit 4.5.4

Advantages, risks, and risk mitigation measures of EV financiers

Inherent advantages of EV financing to financiers

Availability of data	**Vehicle usage data**	Allows the financier to understand the vehicle usage and helps if the vehicle is earning enough to pay back
	Battery data	Helps to understand the SOH and accurately determine the second hand resale value of a battery
	Rider data	Allows the financier to identify cohort of riders - by job, age, and geography that are riskier
Software Controlled Vehicle	**Tracking**	Given EVs are primarily software-controlled, the vehicle's systems are continuously monitored and managed
	Higher control	Functions such as START/STOP allow for the financier to have higher control over the asset in case there is a high risk of default
	Hybrid use cases	Geolocation boundaries, tracking also allow for complex and hybrid use cases to be financed

Concerns of EV financiers that lead to low confidence

Business model risks

- **Utilization risk: High fixed and low variable costs** implies that EV cargo fleets are viable at high utilization levels ⟶ financing is dependent on future cash flows.
- **Customer risk: Credit history**, repayment capability family history, education level is not healthy for individual buyers.
- **Operations and maintenance risk:** Lack of awareness of **maintenance requirements/absence of trained mechanics.**

Asset risks

- **Technology risk: Absence of reliable data** (range, asset life), uncertainty of **possible obsolescence** of current technology.
- **Policy risk: Low awareness** of government policies, difficulties in **accessing incentives, geopolitical risk to EV supply chains post COVID.**
- **Manufacturer risk:** Indian OEMs are **not established, no historical data** on product performance and service.
- **Resale risk: Nascent ecosystem**, technological upgradations, unstructured secondary market ⟶ **reduced resale value.**

Risk mitigation measures taken by EV financiers

- **High interest rates:** Few banks and financiers provide loans for EVs and charge **high rates** to mitigate risks. E.g., interest rates for **E2W are as high as 15% p.a.**
- **Low Loan-to-Value ratio:** Low LTV ensures that financiers **can recover substantial costs** despite potentially low resale value.
- **Shorter loan tenures:** Owing to various business model and asset risks, EV buyers are **unable** to obtain loans with **tenures comparable to ICE vehicles.**
- **EV financing options:** Apart from SBI, Axis and Union bank (passenger EV loans) **very few FIs** have **specialized products for EVs**. However, **several banks have subsidized their EV financing.**
- **Immobilizers:** Usage of **engine immobilizers** to counter **irregularities/defaults** is another risk mitigation strategy that financiers may resort to.

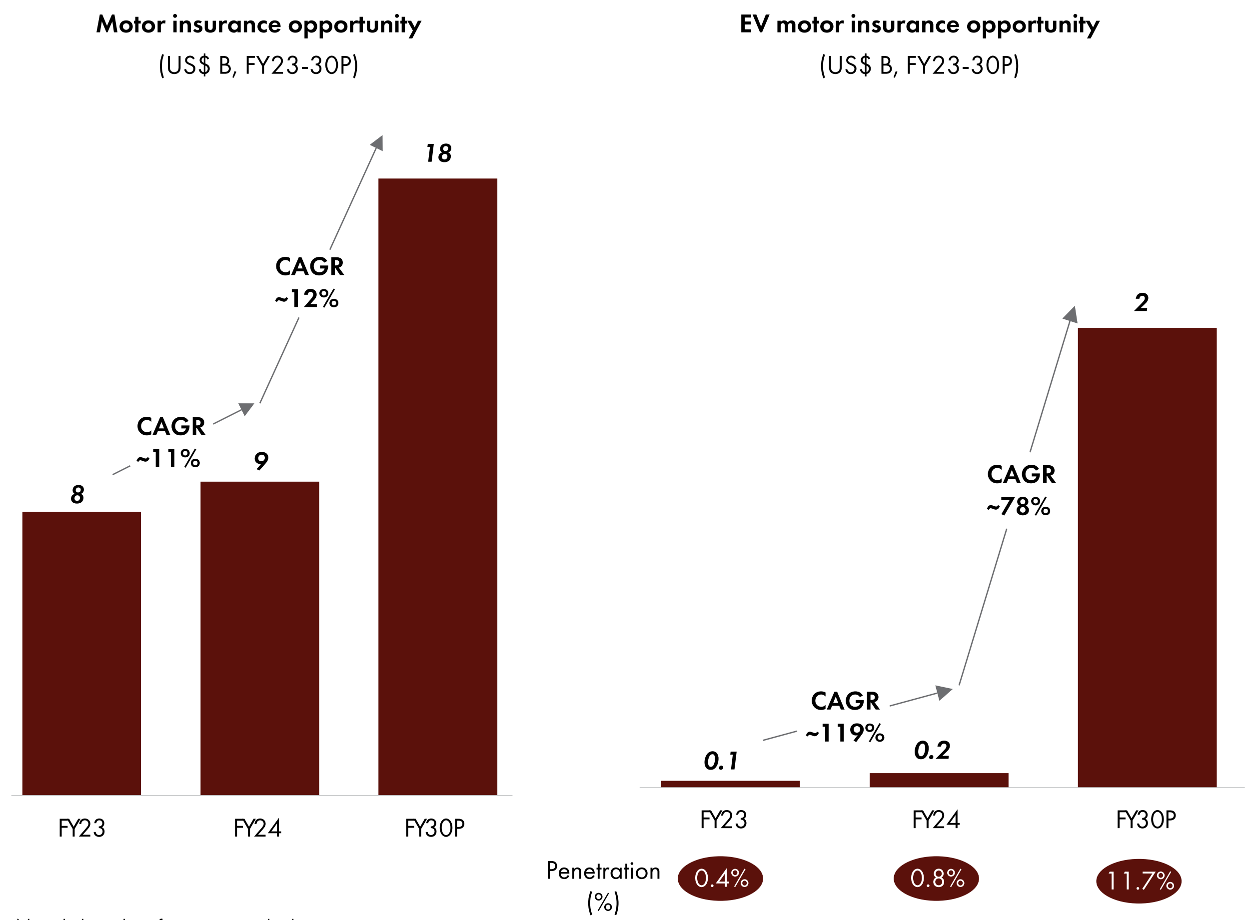
4.6 EV insurance

The overall motor insurance opportunity was valued at US$ 9B in FY24 (11% YoY growth from FY23) and is expected to reach US$ 18B by FY30, growing at a CAGR of 12%. The percentage of EV insurance penetration in the overall motor insurance opportunity is expected to increase from 0.8% in FY24 to 12% in FY30, amounting to a total EV motor insurance opportunity value of US$ 2B by then. This opportunity growth is largely driven by the increase in EV penetration, which will naturally increase the demand for insurance.

Currently, EVs tend to be more expensive when compared to ICE counterparts, and include components like electric motors, batteries, and charging sockets, which require extra care. Therefore, in addition to the basic coverage provided by insurance plans for conventional vehicles, EV insurance also includes replacement costs and maintenance expenses, making EV insurance cost higher compared to ICE. However, as the price gap between EVs and ICE vehicles narrows down in the future, the insurance charged value for EVs is also expected to decrease. Government initiatives, such as the Insurance Regulatory and Development Authority of India's (IRDAI) mandated 15% subsidy on third-party premiums for EVs and a 7.5% subsidy on hybrid vehicles, further contribute to enhancing insurance affordability.

Exhibit 4.6.1

Motor insurance and EV motor insurance opportunity



Note(s): Includes value of imports, TP - Third party
Source(s): ACMA, CRISIL

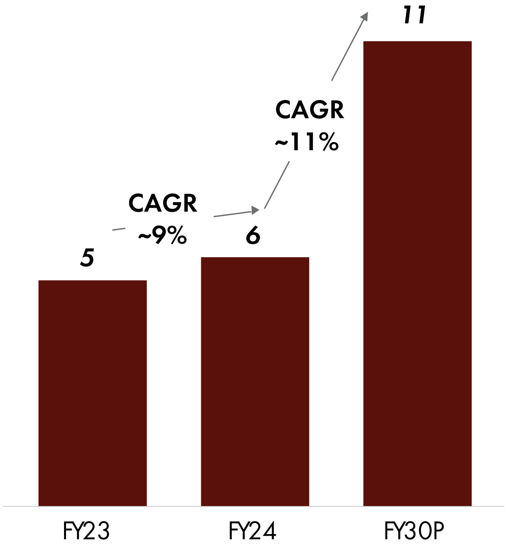
4.7 Aftersales service ecosystem

India's auto aftersales service opportunity was valued at US$ 6B in FY24 and is projected to grow to US$ 11B by FY30 at a CAGR of 11%. Service part of the total auto aftermarket is roughly 35%, with rest of the opportunity attributed to the components used during the service. The EV aftersales service opportunity was valued at US$ 100M in FY24 and is expected to reach US$ 800M by FY30, growing at a CAGR of 42% between the same duration.

Exhibit 4.7.1

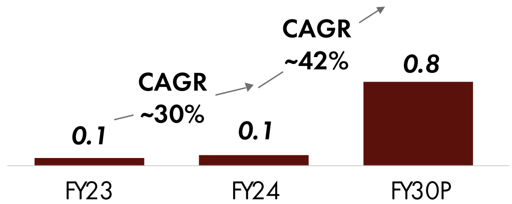
Aftersales service opportunity in India

Auto aftersales service opportunity in India
(US$ B, FY23-30P)



Total aftermarket (US$ B)	16	17	31
Aftersales service penetration (%)	33%	34%	35%

EV aftersales service opportunity in India
(US$ B, FY23-30P)



Total aftermarket (US$ B)	0.4	0.6	5.2
EV aftersales service penetration (%)	15%	15%	15%

4.8 Software solutions

For a successful transition to electric mobility, software technology will play a pivotal role as an enabler. Not only for EVs, but software overall creates better utilization of vehicles thereby reducing fossil fuels requirement and passing on economic benefits to the businesses as well as consumers. Five major software service systems will be critical in this transition:

- BMS – Battery Management Systems
- CMS – Charging Management Systems
- FMS – Fleet Management Software
- TMS – Transport Management Software
- PMS – Parking Management Systems

4.8.1 Battery Management System (BMS)

BMS is crucial for maintaining the safe and reliable operation of batteries, particularly in EVs. The BMS helps in extending battery lifespan by preventing and regulating its overcharging and discharging. It also provides accurate measurements of State of Charge (SoC) and State of Health (SoH), giving users a clear understanding of the battery's condition.

The intricate design of a BMS involves several key blocks, including thermal management for temperature regulation, a cell equalizer for balancing cell voltages, a measurement unit for precise monitoring, and capabilities estimation for assessing the overall performance of the battery. There are multiple players operating in the BMS segment, with some key players shown in the exhibit below.

Exhibit 4.8.1

BMS landscape

BMS is categorized into three categories based on design, topology, and voltage. The design aspect is further classified into a protection circuit model - ensuring basic safeguards, and a more sophisticated battery management system that integrates control circuitry and display modules for advanced functionalities. The topology-based classification further divides it into centralized and decentralized systems reflecting diverse approaches to monitoring and controlling battery cells. The voltage-based categorization is segregated as Low voltage and High voltage BMS. High-voltage BMS has HV Class 2 and HV Class 3, as per different voltage ranges, addressing the varying needs of EVs.

4.8.2 Charging Management System (CMS)

CMS plays a crucial role in the EV world by helping users find charging stations, reserve sessions, and manage EV charging smoothly. It oversees various tasks like handling invoices, making billing easier, and monitoring energy use efficiently. One standout feature is its ability to automate accounting processes, creating accurate reports without the need for manual data entry.

CMS also identifies user patterns, adjusting charging schedules accordingly. It is used by different groups like charge point operators, EV users, and fleet owners, making communication easier and saving time and money for everyone involved.

Exhibit 4.8.2

CMS benefits and market landscape

Locate charging stations
Enables users to locate the closest charging stations, reserve a charging session, and make payments

Manage EV charging operations
Oversees EV charging operations, manages EV charging invoices, handles energy management, etc

Account and billing
Generates billing, auditing, and financial reports, eliminating the necessity for manual data entry

Pattern identification
System discerns the client's usage patterns and usage times accurately.

Automation and reporting
Automates the daily operations and reporting of EV charging points

Customers of CMS

CPOs | OEMs | EV users | EV merchants and drivers | Fleet owners

CMS

telio ev, orangemantra, GRIDEN, ElectricPe, YoCharge, kazam, charzer, Shell Recharge, RapidEVChargE, statiq, TATA POWER EZ CHARGE, TCS HOBS™, nextbrain

Furthermore, CMS plays a pivotal role in energy optimization, thereby reducing operational costs. By maximizing the efficiency of the charging process and minimizing downtime at charge points, CMS helps prevent overcharging and ensures better operating margins for the charging point operators. The user-centric feature of locating nearby charging points adds an additional layer of convenience, allowing users to access a comprehensive list of stations within a specified radius.

4.8.3 Fleet Management Software (FMS)

FMS is a vital tool for optimizing EV fleets. It offers features like fuel management, maintenance tracking, and real-time monitoring, ensuring smooth operations. FMS plays a key role in contract management, maintenance tracking, fuel management, and driver behavior analytics.

Telematics, a part of FMS, aids in asset tracking, route optimization, compliance management, and vehicle diagnostics, contributing to efficient operations and resource utilization.

Exhibit 4.8.3

FMS landscape

FMS

TCS DigiFleet, WebNMS, Trimble Transportation, ANS, iMAXX, WheelsEye, Volty, Intellicar, Intangles, LocoNav, LogiNext, TrackNerd

FMS benefits include informed decision-making, fuel cost savings, and predictive maintenance. It uses trip data to plan EV range, reducing range anxiety. Analyzing fuel consumption helps calculate potential savings from switching to EVs. Predictive maintenance detects issues early, minimizing downtime and costs.

FMS also optimizes fleet utilization by monitoring miles travelled and generating trip reports. It enhances driver safety by tracking behaviors like seat belt usage, speeding, and harsh braking. In conclusion, FMS is crucial for operational efficiency, cost savings, and safety in EV fleets.

4.8.4 Transportation Management System (TMS)

TMS serves as a central hub for streamlining logistics operations and optimizing energy consumption. It helps businesses plan, execute, and optimize the physical movement of goods for both incoming and outgoing, make sure the shipment is compliant, and proper documentation is available, thereby improving the overall efficiency of transportation processes.

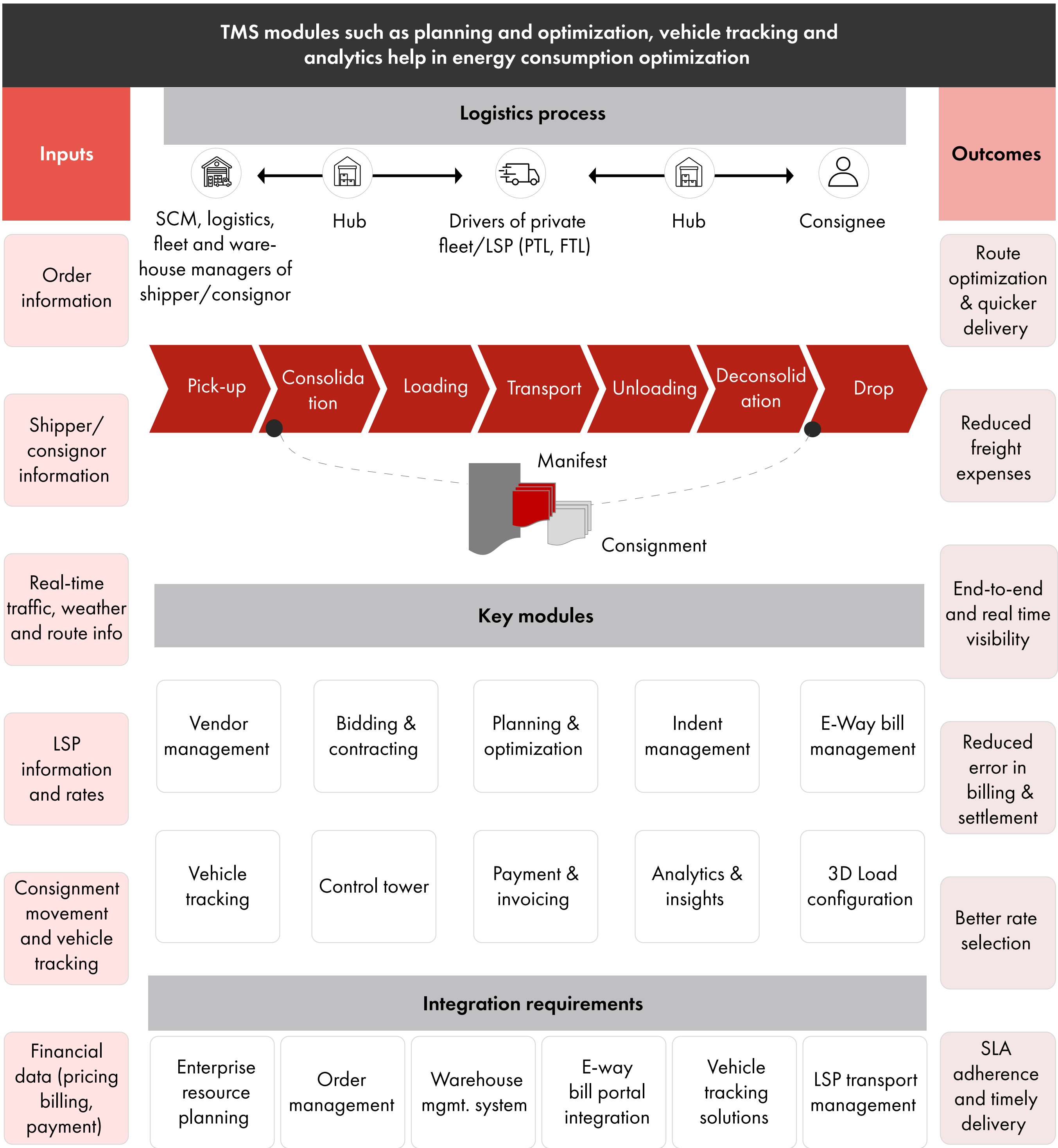
TMS operates by processing various inputs such as order information, real-time traffic, weather conditions, route details, logistics service provider (LSP) information, and financial data. The logistics process involves collaboration among supply chain managers, logistics managers, fleet managers, and warehouse managers, ensuring a smooth flow from the consignor to the consignee through stages like consolidation, loading, transport, unloading, deconsolidation, and drop.

Exhibit 4.8.4

TMS landscape and logistic process

TMS

fleetx, pando, Freight Tiger, WebXpress, BlueYonder, Oracle Transportation Management, SAP



Implementing a robust TMS yields significant benefits, including route optimization for quicker deliveries, reduced freight expenses, end-to-end real-time visibility, minimized errors in billing and settlement, impr oved rate selection, adherence to Service Level Agreements (SLAs), and timely deliveries.

TMS plays a pivotal role in modern logistics, offering essential tools and insights for companies to navigate transportation complex-ities, enhance operational efficiency, and provide exceptional service to customers. As the logistics landscape evolves, TMS remains a key opportunity in shaping the future of efficient and sustainable transportation solutions.

4.8.5 Parking Management System (PMS)

PMS simplifies parking facility administration through automation, providing real-time insights into space occupancy. It utilizes IoT, RFID, and biometric technology, that lets the user utilize parking areas proficiently, reducing time to search the free parking spaces. PMS uses real-time monitoring to automate parking functions. It optimizes space, customizes allocations, and facilitates EV charging.

PMS brings various advantages, including enhanced user experience, improved security, revenue generation, and data-driven decisions. For businesses, it means increased availability, transparent allocation, and streamlined EV charging. Residential societies benefit from monetization opportunities and optimized parking.

Exhibit 4.8.5

PMS landscape

PMS

PARK+ | parkable | Qspec | WAYLEADR

4.8.6 Electric mobility software solutions opportunity

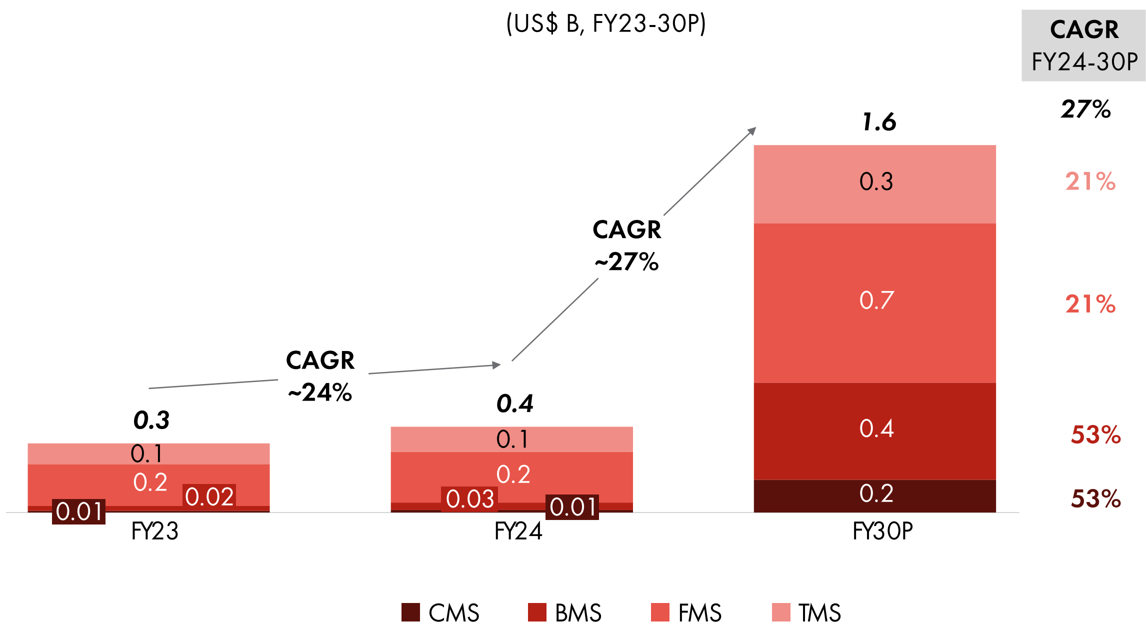
The software solutions opportunity size is estimated at US$ 0.4B in FY24, expected to grow at a CAGR of 27% reaching US$ 1.6B by FY30. Both the charger management software and battery management software solutions opportunities are expected to grow at 53% from FY23-30, primarily driven by growth in EV demand, while the TMS and FMS is expected to grow at a rate of 21%, driven by higher emphasis of businesses on operational efficiency.

Exhibit 4.8.6

Electric mobility software solutions opportunity in India

Electric mobility software solutions in India

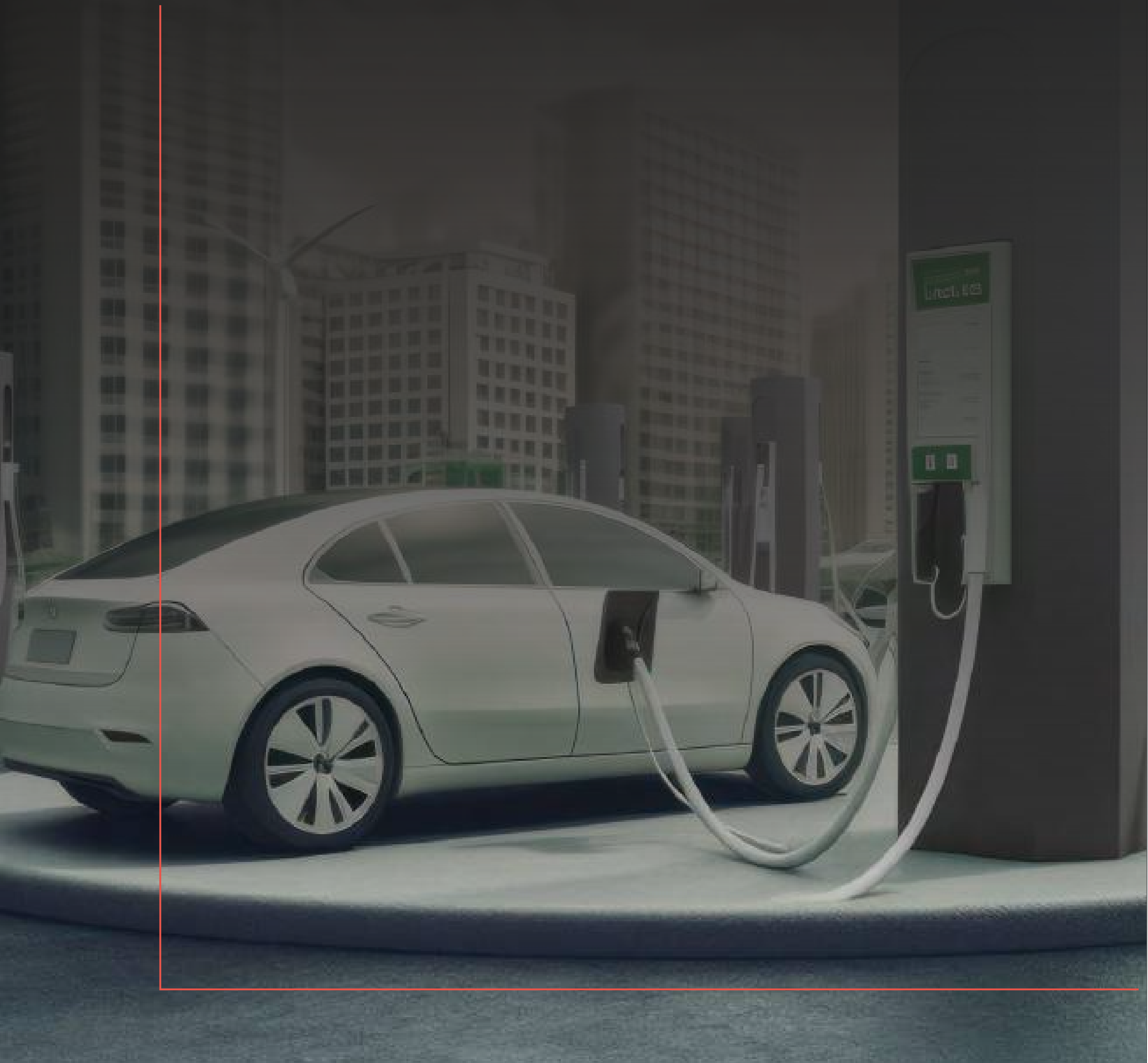
(US$ B, FY23-30P)



Note(s): For FY24 run rate as per initial 10 months

05

REGULATORY LANDSCAPE FOR EV ECOSYSTEM



5.1 Regulations by the Central Government

The Central Government has adopted a comprehensive two-fold strategy aimed at promoting EV adoption across India, targeting both the supply and demand sides. On the supply side, incentives are concentrated on supporting R&D in energy systems, which includes initiatives such as the Production Linked Incentive program. This government initiative offers financial incentives to enhance manufacturing by rewarding companies based on their incremental sales or production.

To boost demand, the government is providing subsidies along with exemptions from income tax and road taxes.

5.1.1 Supply-side incentives

The government is implementing various incentives to bolster the development of EV supply in India. One such initiative is the advanced cell chemistry battery storage (ACC) Production Linked Incentive scheme, with an allocated budget of US$ 2B until FY29. Under this scheme, the Ministry of Heavy Industries has granted contracts to produce 50 GWh of battery storage capacity to three successful bidders: Rajesh Export, Ola Electric, and Reliance New Energy.

Furthermore, the PLI for the automotive and auto component sector, with an estimated US$ 3B allocation until FY27, comprises two sub-schemes: the Champion OEM Scheme and the Component Champion Scheme. These sub-schemes aim to bolster domestic manufacturing capabilities for EVs.

Another supportive measure involves government funding, which covers up to 20-25% of the R&D expenses incurred by companies engaged in researching new EV technologies. Additionally, both the Central Government and certain State Governments have announced a complete waiver of stamp duty and registration fees for EV production, providing incentives for manufacturers to invest in EV manufacturing.

5.1.2 Demand-side incentives

To encourage the adoption of EVs in India, the Central Government has implemented various demand-side incentives. The FAME II subsidy, offering a subsidy on EVs sold (INR 10K per kWh), is disbursed by both the Central and State Governments to OEMs, who in turn pass it on to customers. The total outlay for this initiative is US$ 1.2B, with 90% allocated for vehicle purchases and the remaining on charging infrastructure. However, as of February 2023, only around 30% of the budget has been utilized.

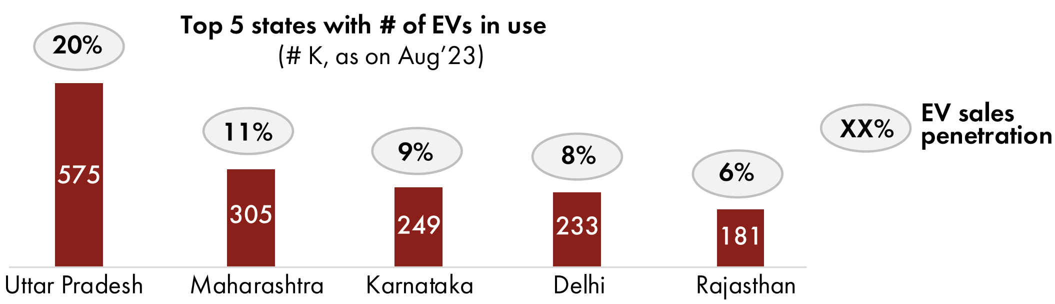
Moreover, EVs enjoy exemptions from road tax in selected states, and customers can benefit from income tax exemptions (up to INR 150K under Section 80 EEB of the Income Tax Act). In addition, interest-free loans are available to government employees until December 2025, with subsidized loans (20-25 basis points lower) offered by banks to private individuals. These measures significantly reduce the financial burden on EV buyers, fostering increased affordability and driving adoption rates across the country.

5.2 Regulations by various State Governments

State Governments are actively implementing measures to boost EV adoption, focusing on three fundamental pillars: supply-side, demand-side, and infrastructure. These initiatives aim to strengthen EV manufacturing, encourage consumer uptake, and develop a robust charging network across regions. Uttar Pradesh, Maharashtra, Karnataka, Delhi, and Rajasthan are the five key regions having the highest number of EVs across India.

Exhibit 5.2.1

State-wise EV adoption and penetration



Source(s): Government websites and policy documents

5.2.1 Uttar Pradesh

To promote local EV manufacturing, the state government is offering benefits such as capital subsidy, stamp duty reimbursement, and incentives for patent registration fees. Additionally, to increase the EV demand, the government has introduced incentives such as purchase subsidies and road tax exemptions, making EVs more affordable for consumers. Furthermore, the government has set a target for a 100% shift to EVs for government vehicles in 17 cities by 2030. To support this transition, the government is offering capital subsidies up to 20% for the first 1-2K swapping/charging stations, ensuring the establishment of strong EV charging infrastructure for Uttar Pradesh.

5.2.2 Maharashtra

The Maharashtra government has implemented a diverse set of measures to promote EV adoption. A budget of over US$ 110M has been allocated to support EV manufacturing, and plans are in place to establish a giga factory to leverage incentives under the PLI ACC scheme. To boost EV adoption, the government has introduced a comprehensive set of incentives with the goal of achieving 10% electrification by 2025. Furthermore, fiscal support is being provided, covering 50-60% of the costs (with a cap on subsidies), for the construction of public and semi-public charging stations.

5.2.3 Karnataka

To boost EV production, the Karnataka government is establishing an EV fund and dedicated EV clusters. Additionally, a 1% subsidy is offered for local EV component manufacturing. To encourage EV adoption among consumers, the government provides incentives for E3Ws, along with state tax breaks and road tax exemptions. Furthermore, to enhance the charging infrastructure in the state, a capital subsidy of 25% of the value of the equipment/machinery (or fixed capital investment) is provided, with a capped subsidy.

5.2.4 Delhi

The government is actively promoting EV adoption through various programs and incentives. For instance, employing the 'feebate' concept, where inefficient, polluting vehicles incur a surcharge, while efficient ones receive rebates, encouraging a shift towards greener options. For consumers, the Delhi government provides fiscal incentives such as purchase benefits, interest subvention on loans, and waivers on road tax and other fees. Additionally, grants of 100%, up to US$ 70-75 (INR 6,000), are provided for private charging points, and SGST reimbursements are offered for public charging stations, thereby encouraging the development of charging infrastructure.

5.2.5 Rajasthan

The state offers exemptions from electricity duty, land tax, market fees, and stamp duty until 2027, to encourage local EV production. On the consumer front, Rajasthan has allocated US$ 5M for SGST reimbursement and upfront incentives for all EVs, ensuring consumer participation. Additionally, it offers 100% exemption and SGST reimbursements for setting up charging stations, thus, supporting infrastructure growth.

5.3 EV targets across states in India

Transitioning to EVs significantly contributes to a wide range of sustainability goals for states. To accelerate the adoption of battery EVs in their respective regions, State Governments have implemented various policies and set ambitious targets. Several initiatives with a focus on increasing BEV registrations and sales across all vehicle segments, integrating EVs into government and commercial fleets, and establishing charging stations, have been launched. For instance, Chandigarh aims to set up 100 EV charging stations and 100% penetration of E-Buses by 2026. Madhya Pradesh targets a 100% shift to EVs for government vehicles by 2028. While Tamil Nadu plans to establish a charging station at every 25 km interval by 2029, the overarching objective is to achieve 100% electric mobility in the coming years.

Exhibit 5.3.1

State Government target and pledges to achieve electric mobility

State government targets and pledges

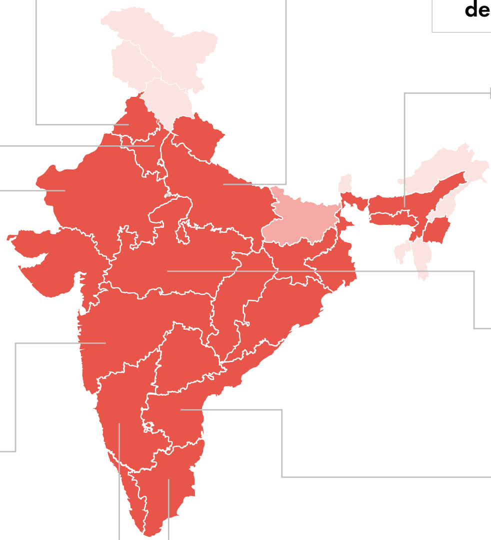
Chandigarh 2021 | 2026
- Promoting usage of **electric bicycles** as a replacement of 2/4W
- **100 EV charging station** and 100% electric fuel buses

Delhi 2020 | 2024
- BEVs to contribute **25% of all vehicle registrations**
- At least 50% E-Buses for fleet
- Delivery service providers to have 100% electric fleet operations (2025)
- Public charging facilities within every 3 kms

Rajasthan 2022 | 2027
- **15% 2W, 30% 3W and 5% 4W electric-vehicle share** in new vehicle registrations
- Phased transitions to E-Buses used in routes connecting priority cities

Maharashtra 2021 | 2025
- **10% EV share** out of all registrations
- 25% electric fleet operators
- Setup at least **50 charging stations per M** population

Karnataka 2019 | 2030
- Aims to achieve **100% E-Mobility** in auto-rickshaws, cab aggregators, corporate fleets, and school buses/vans
- **1K EV buses, 112 EV charging stations** every 50 kms



Uttar Pradesh 2019 | 2024
- **10L EVs** across all segment, **1K E-Buses by 2030**
- 50% EV mobility in goods transportation
- Aims to be a **research and development hub** for EVs

Assam 2021 | 2030
- Deployment of first **2L EVs** for individual/commercial use
- Convert 100% of public transport bus fleet into E-Buses (BEV)
- **100% of government vehicles** to be converted to EVs

Madhya Pradesh 2019 | 2028
- 100% electric commercial and logistics fleet
- 100% E-Buses
- 100% government vehicles

Andhra Pradesh 2021 | 2024
- **1000K total EVs** across all segments, 100% electric fleet in electric mobility cities
- **100% E-Buses** by 2029
- Target to have **100K slow and fast charging stations**

Tamil Nadu 2019 | 2029
- Convert shared mobility and commercial fleet to EVs
- 1 charging station at every 25 km interval

Year of release | Target year

Policy adopted
Draft policy
No Policy

Source(s): Government websites and policy documents

5.4 Global analogues

5.4.1 Case study: China

China leads the world in EV sales, with approximately 5.9M sales recorded in FY22, constituting over 60% of all new EV registrations globally. The development of the EV ecosystem in China is primarily driven by an increasing focus on reducing vehicular emissions, efforts to diminish dependency on oil imports, and advancements in EV manufacturing.

Another significant factor contributing to the surge in EV adoption is a series of strategic initiatives implemented by the government. These initiatives include tax exemptions on EV registrations, the Zero Emission Vehicle (ZEV) mandate to achieve 40% of all sales as EV sales by 2030, and plans to shift 80% of commercial fleets (including public transport, rental, logistics, and delivery vehicles) to EVs.

Moreover, China currently supplies 85% of the world's cobalt, 30% of batteries, and 25% of rare earth metals, positioning the country at the forefront of the global EV ecosystem.

Exhibit 5.4.1

China's initiatives for EV adoption

Tax exemptions, ZEVs, subsidies are some of the policies adopted by the government to promote EV adoption	
Tax exemption	• In April 2020, the government introduced a 10% service tax waiver for EVs • Waived 50% of vehicle registration fees for EVs
Zero emission vehicle mandate	• Automakers to ensure 40% of all sales are electric by 2030 • Jilin city in China to reach an annual production capacity of around 1M NEVs, by 2025
Subsidies	• Recently government announced the reduction in subsidies **by 30% in 2022** for purchasing • NEVs* Subsidies will be completely withdrawn by the end of the year
New auto factory requirements	• All new vehicle factories are required to include capacity for the construction of EVs (few exemptions), thereby discouraging the construction of factories for manufacturing only ICE vehicles
Support for charging infrastructure	• Provides **funding and mandate standards for EV charging stations and posts** • Shenzhen is targeting **43K fast chargers and 790K slow chargers by 2025** and Chongqing is targeting 240K chargers • China had ~ **2K battery swapping** stations by the end of 2022 and goal is to have **charging infrastructure for 20M EVs by 2025**
Commercial fleet	• Aims to have 80% NEVs in public transport, rental, logistics and delivery vehicle sales by 2025
Additional benefits	• Many municipalities provide **license plates for EVs** faster and cheaper than for conventional vehicles • **Free and preferential parking** spaces for EVs • Incentives to replace ICE with NEV, providing vouchers for NEV purchases

Increasing manufacturing units, charging infrastructure, and government policies are the key drivers

- Increasing manufacturing companies
- Increasing charging infrastructure
- Government policies/initiatives
- Reducing dependence on oil imports
- Growing focus on reducing vehicular emissions

China provides 85% cobalt, 30% batteries and 25% rare earth metals globally	
Batteries	CATL (Chinese battery maker) controls about 30% of the world's EV market
Cobalt	Chinese refineries supply ~85% of the world's battery ready cobalt
Rare earth metals	China is the leading exporting country (~25%) of rare earth metals globally

Note(s): *NEVs - New energy vehicles

5.4.2 Case study: USA

The USA has experienced a notable surge in EV sales, positioning itself as the second-largest market globally after China, with approximately 990K EVs sold in FY22. This shift towards EV adoption is primarily propelled by an increasing emphasis on reducing vehicular emissions, escalating gasoline prices, supportive government policies, and the introduction of new EV models in the market.

Government support for widespread EV adoption in the USA is evident through various initiatives, including tax exemptions, zero registration fees, preferential parking for EVs, implementation of a ZEV mandate to achieve a 100% share of EVs in vehicle sales by 2050, and budget allocations aimed at establishing charging infrastructure across the country.

Exhibit 5.4.2

USA's initiatives for EV adoption

Tax exemptions, ZEVs, subsidies are some of the policies adopted by the government to promote EV adoption	
Tax exemption and tax credits	• IRA passed in 2022 with the aim of building clean energy economy, **US$ 369B allocated** for climate investments • IRA provides Advanced Manufacturing Production Tax Credits for domestic battery production. The US government offers **subsidies of up to US$45 per kWh** • **Washington** and **New Jersey exempted tax** on electric cars • Louisiana and Maryland offer tax credits of up to **US$ 2.5-3K per vehicle** *(The EV tax credit is NOT available for all automakers e.g.: tax credits for General Motors and Tesla have been completely phased out)*
Zero emission vehicle mandate	• A certain percent of all vehicles sold by a manufacturer each year must be **full battery-electric, hydrogen fuel cell, and plug- in hybrid-EVs (PHEV)** • **30% ZEV** sales for all new M&HCV by **2030** and **100% by 2050 in 15 states** • **Any vehicle sold from 2035 onwards must be a zero-emission vehicle (ZEV) or PHEV**
Incentives (Monetary and non-monetary)	• **Zero or low** registration fees • Toll reduction • **Free and preferential** parking spaces for EVs • Incentive of up to **US$ 7.5K per EV purchase,** ~US$ 4K if the battery meets the critical mineral requirement, and another ~US$ 4K if it meets the component requirement
Discounts/rebates	• California **offers discounts** on lightweight zero-emission cars and PHEV • California Air Resources Board offers point-of-sale rebates of up to **US$ 750** for purchase or lease of new all-electric or PHEV through Clean Fuel Reward Program
Support on charging infrastructure	• **500K chargers no more than 80 km** apart along major routes by 2030 • President Biden recently signed an infrastructure bill into law containing **US$ 7.5B** aimed at increasing the number of charging stations by **10X** within the next decade

USA mainly imports batteries (mainly from China), cobalt (~75% import)and other rare earth metals (100%)

Reducing vehicular emissions, government policies, and new models are the key drivers
Growing focus on reducing vehicular emissions Government target: **50% of new vehicles sales** to be electric by **2030**
Exciting new vehicle models. For instance: **General Motors's Hummer** EV pre-orders sold out in 10 minutes
Government policies/initiatives
High gasoline prices whereas regulated and hence, stable electricity prices
Increasing charging infrastructure

Key growth inhibitors for slowdown of EV market in the USA	
Covid pandemic	• Low demand for oil and bottomed-out oil prices make ICE vehicles cheaper than EVs to operate in the USA • Pandemic has decreased consumer purchasing power
Government policy	• Phaseout of federal tax credits for EVs • Federal government plans to decrease the fuel-economy standard and is relaxing CO_2-emission targets • In US gasoline tax is lower as compared to other major economies
Geopolitics and macro-economics	• Increasing commodities prices due to the Russia Ukraine war and rising inflation has led to vehicles being more costly thus suppressing demand

5.5 Outlook for India

Drawing inspiration from global counterparts and analyzing strategies employed by governments in leading EV nations, India can integrate certain pivotal regulations within its regulatory framework.

To promote EV demand, the government can offer toll incentives, parking incentives, and implement a feebate system at the central level. Concurrently, to encourage EV manufacturing, the government can initiate retrofitting programs, establish a strategic research and development agenda for EVs, and allocate specific fiscal resources to fund policies and incentives.

Moreover, for enhancing the charging infrastructure, stations can be set up under corporate social responsibility (CSR) initiatives, allowing load balancing and grid-optimized utilization through charging infrastructure and charging point operators. These regulations, spanning across the dimensions of supply, demand, and infrastructure, can help pave the way for an accelerated transition towards a sustainable and thriving EV ecosystem in India.

Exhibit 5.5.1

Government regulations - Future outlook

Demand-side

- **Toll-free incentives** (both bordering state to agree) and integrated with Fastag e.g., Scandinavian countries
- **Parking incentives**
  - Free and/or discounted parking for EV users (e.g., Seoul, Nanchang)
  - Smart parking for EVs
  - **E-permits for EV commercial fleets** with passage for dedicated lanes
- For busy districts in the city, a **congestion fee** may be levied on non-EVs
- Access to **dedicated, fast-moving lanes for EV public transport**
- Open Charge Point Interface (OCPI) protocol to support the national agreement on **interoperability of charge points**
- **Bonus-malus (or feebate) tax system**: Polluting vehicles incur a surcharge (malus) while clean vehicles receive a rebate (bonus) e.g., France, Sweden, and Norway
- **Accelerated depreciation** for company EV cars/fleets: Need to cover it in Companies Act 2013 as well as Income Tax Act 1961
- **'EVCARD'** related multimodal EV fleet incentives (China) – preloaded card with progressive incentive structure for EV vehicle transport usage

Supply-side

- **Retrofitting** – Process, procedures, fitments, standards, empanelment of agencies etc. States such as Andhra Pradesh, Madhya Pradesh and Delhi have already set targets and incentives to promote conversion of existing vehicles to EVs
- **Allocation** of specific **fiscal resources** to fund policy incentives and initiatives
- Regulations for investment in EV related **technical courses in universities + dedicated apprenticeship** programs
- **Green zones creation** (e.g., New York and California have targeted zones only for EVs, London's ultra low emission zone ULEZ); Andhra Pradesh, Kerala, Punjab and Uttar Pradesh have already addressed it in their policy to encourage EV zones
- Formulate clear policies on sustainable end-of-life and disposal practices for the industry
- **Leveraging critical mineral resources** to promote localization of E-Mobility value chain
  - Ensure consistent availability of critical and strategic EV and battery raw materials to strengthen mineral security
  - Enable mining of neodymium in India for producing permanent magnets
  - Develop national **strategic R&D agenda** for EV

Infrastructure

- **EV charging stations under CSR Initiatives**
- **New models:** Land allocation to setup large charging stations at strategic locations :
  - Café/ATMs
  - Convenience store/groceries
  - Air pressure and tyre changing services
- Develop **Hi-Tech EV component corridors,** along existing auto belts, in partnership with state governments
- **Charging infra for far flung areas/HT connections**
  - Cost split for additional civil work to have direct feeder b/w DISCOMS and CPOs is unclear
- **Reuse of EV Batteries** for stationary applications such as
  - Storage for solar PV systems
  - Solar PV based street lighting
  - UPS
  - Energy storage for microgrid
  - Rare elements such as lithium and cobalt are harmful
- **Load balancing/grid optimized utilization** via charging infrastruc-ture CPOs
  - Manage charging
  - Electricity grid upgrades with growing charging loads

Low impact → High impact

06

CONSUMER PERCEPTION AND CHOICES

6.1 Key purchase criteria for buying EVs

6.1.1 Commercial vehicles

The CV opportunity is driven by a diverse range of customers, often comprising small businesses or individuals, who prioritize cost-effectiveness, range, vehicle performance, and payload capacity. Customers, often operating on tight budgets, seek CVs that offer a balance of affordability and value. They prioritize cost per kilometer, which includes purchase price, maintenance costs, and energy consumption. Durability and longevity are important parameters, as fleet operators demand vehicles that can withstand rigorous use over extended periods.

Exhibit 6.1.1

Challenges hindering EV adoption among CV

Key purchase criteria	Description	E3W passenger	E3W cargo	E-LCV	E-Bus
Total Cost of Ownership (TCO)	• TCO includes **purchase price, operating cost, and resale value**	◕	◕	●	●
Range and battery performance	• Adequate range on a single charge and long battery life	◑	◕	●	●
Vehicle performance and payload capacity	• **Vehicle performance:** Adequate peed, acceleration, and overall performance for commercial use • **Payload capacity:** Sufficient capacity to carry the required load for goods and passengers	◑	◕	●	●
Charging infrastructure	• Access to a **reliable network** of charging infrastructure	◑	◕	◕	◕
Charging speed	• Fast-charging options for **quick turnaround times**	◑	◕	◕	◕
Durability and longevity	• Sturdiness and durability of the vehicle to withstand the demands of commercial use	◑	◕	◕	◕
Financing options	• Availability of financing options and flexibility in payment terms	◑	◑	◕	◕
Customization	• Availability of customizable features to meet specific business requirements and optimize operations	◔	◑	◕	◕
Aftersales support	• **Comprehensive warranty** and **aftersales support** from the manufacturer	◔	◑	◑	◑
Telematics	• Availability of advanced telematics for tracking and monitoring vehicle performance	◔	◑	◑	◑

> *"Range of 100 km+ is required to suit my needs. Good aftersales service is also important since it makes it possible for me to operate my business smoothly."*
>
> *- E3W cargo driver*

> *"Cost per kg is a key purchasing criterion for our business. We also need the vehicle to maintain a range of 90-100 km while being able to carry ~700 kg payload."*
>
> *- E-LCV driver*

> *"Financing played a crucial role in the buying decision due to the significant initiala cquisition cost, making upfront payment challenging."*
>
> *- E4W customer*

Low impact ○ ◔ ◑ ◕ ● High impact

6.1.2 Passenger vehicles

The needs of customers opting for a PV vary depending on the use-case. For instance, individuals who typically purchase PVs for personal or family use prioritize driving comfort, safety, and cost-effectiveness. The availability and accessibility of charging infrastructure, both at home and in public, plays a pivotal role in the practicality of EV ownership. The selection criteria also depend on financial aspects such as price, total cost of ownership of the vehicle, and potential incentives/rebates. For 2W customers, key purchase criteria include battery life, vehicle performance, and maintenance. On the other hand, brand positioning, safety features, and comfort are the top considerations for 4W customers. When comparing 4W customers to their 2W counterparts, factors such as government subsidies, maintenance requirements, and customizations hold greater importance.

Exhibit 6.1.2

Key purchase criteria (KPC) for PVs

Key purchase criteria	Description	2W	4W
Total Cost of Ownership (TCO)	• TCO includes **purchase price, operating cost, and resale value**	◕	◕
Range and battery performance	• Adequate range on a single charge and long battery life	◕	◕
Charging infrastructure	• Availability and accessibility of charging infrastructure, including both **home charging options and public chargin stations**	◕	◕
Brand reputation	• Reputation of the manufacturer for **reliability, service, and product quality**	◕	◕
Safety	• Safety features such as **airbags, anti-lock brakes, stability control, and other advanced safety technologies**	◕	◕
Government incentives and subsidies	• Government incentives, subsidies, and tax benefits	◑	◕
Comfort and features	• **Design, interior space, comfort** and overall ergonomics to ensure a comfortable driving experience	◑	◕
Maintenance requirement	• Maintenance requirements and costs associated with **routine servicing and potential repairs**	◑	◕
Financing options	• Availability of financing options and flexibility in payment terms	◑	◑
Charging speed	• Fast-charging options for **quick turnaround times**	◑	◑
Aftersales support	• **Comprehensive warranty** and **aftersales support** from the manufacturer	◑	◑
Customization option	• Adequate range on a single charge and long battery life	◔	◑

"For my daily 120 km work commute, I need an electric car with sufficient range to cover the distance on one charge. This is one of the key factors influencing my purchasing decision."

- E4W customer

"The primary factors impacting my buying decision are the substantial initial cost of EVs & the availability of sufficient charging stations within the city."

- E4W customer

"I focused on renowned brands when selecting an electric two-wheeler to ensure product quality and reliable aftersales support."

- E2W customer

Low impact ○ ◔ ◑ ◕ ● High impact

6.2 Pain points

EVs, both in the commercial and passenger vehicle segments, face several key challenges that impact their widespread adoption.

A primary concern among potential buyers is the limited driving range of EVs compared to traditional counterparts. The easy availability and accessibility of charging infrastructure is a hurdle, with fast-charging stations not yet widely present. Although charging times are improving, they still pose inconveniences for users, particularly in commercial applications where downtime affects productivity.

The upfront cost of EVs is higher due to expensive battery technology, and concerns persist regarding the long-term durability and replacement costs of batteries, especially in the e-LCV and E-Bus segments that require large battery packs. Limited model variety and the lack of technology standardization further hinder the adoption of EVs. Government policies, incentives, and the environmental impact of battery manufacturing and disposal present substantial challenges to the advancement of electric mobility.

Exhibit 6.2.1

Pain points of customers using CVs and PVs

		Commercial vehicle				Passenger vehicle	
Criteria	**Brief description**	**E3W passenger**	**E3W cargo**	**E-LCV**	**E-Bus**	**2W**	**4W**
Range	• Limited range per charge • Range anxiety	Medium	High impact	High impact	High impact	Medium	High impact
Charging infrastructure	• Inadequate charging infra. primarily in rural areas • Lack of infra. compatibility for E-LCV and E-Bus	Medium	High impact	High impact	High impact	Medium	Medium
Charging time	• Higher charging time especially for vehicles with larger battery packs	Medium	Medium	High impact	High impact	Medium	High impact
Initial cost	• High upfront cost for Evs	Medium	Medium	High impact	High impact	Low impact	High impact
Payload constraints	• Limited payload capacity to carry the required load for goods and passengers	Low impact	Medium	High impact	High impact	Low impact	Low impact
Technical issues	• Quality of vehicle is an issue (instances of reduced range and component failures during monsoon) • Safety concerns	Medium	Medium	Medium	Medium	Low impact	Medium
Battery replacement cost	• High battery replacement cost, especially for vehicles with larger battery packs	Low impact	Medium	High impact	High impact	Low impact	Medium
Variety and models	• Limited availability of model	Low impact	Low impact	Medium	Medium	Medium	Medium
Operational efficiency	• Operational efficiencies are not comparable to ICE vehicles, particularly in E-LCVs and E-Buses	Low impact	Low impact	Medium	Medium	Low impact	Low impact

Degree of pain

Low impact ● ● ● High impact

"I cannot plan extra trips given the battery size, regular charging takes hours, and we must plug the vehicle in after every trip. Also, driving through highways and flyovers is dangerous since the vehicle tends to sway due to the load. Overall, I prefer the older petrol vehicle as it offers more flexibility."

- E-LCV driver,
Logistics Provider

"For Flipkart, Amazon and the likes to meet their goals of 100% electrification – there is still a long way to go in terms of infrastructure – charging stations, standardized chargers, fast charging, repair and maintenance garages, spare part."

- Chief Strategy Officer
EV Rental Services

"While the variable cost drops significantly, the limited range and high charging time reduces the number of trips / shipments per day, thereby eventually outweighing the fuel replacement cost advantage."

- Operations Head
E-commerce platform

"Most of our shipping volume is in tier 2 and tier 3 cities but it shall take several years for charging facilities to reach those areas. Hence, while we do see a distinct cost advantage, we have enrolled a few vehicles in metro cities."

- Chief Strategy Officer
Last Mile Delivery Services

6.3 Post purchase experience

Consumer feedback after buying an EV varies depending on the specific EV model and the person's expectations. However, certain recurring themes arise from consumer feedback regarding EVs, including reduced maintenance costs, decreased downtime, and a sense of contributing positively to the environment.

Despite these compelling advantages, EVs also present certain challenges that are yet to be addressed. One primary concern is the higher upfront purchase cost of EVs compared to ICE vehicles. While the cost gap is narrowing as EV technology advances, the initial investment still poses a barrier for some customers.

Another major challenge is the unavailability of spare parts for EVs and a shortage of qualified workforce/mechanics with expertise in repairing EV-specific components.

Exhibit 6.3.1

Aftersales feedback of customers

Pain point	Description	Current situation	Expected situation	Why does it not impact ICE
Unavailability of spare parts	• Given the supply issues, OEMs have not been able to provide spare parts to the dealers • Waiting period of up to 15 days was observed	●	◔	• They have well established supply lines
Shortage of qualified workforce	• Since the segment is fairly recent, there are not many skilled mechanics who have expertise in repairing EV specific components	◑	○	• Given ICE has been here for decades, the manpower are suitably trained
Battery degradation concerns	• Many customers worry about the replacement cost of battery as it is the major cost component in EV	◕	◔	• ICE vehicles are not equipped with batteries and use gasoline or diesel engines to generate power
Absence of 3rd party/informal aftersales network	• As the technology is new and spare parts are not readily and openly available in the market, servicing in non-metro and cities would be a challenge	●	◑	• Being a massively adopted and old product, multiple third party garages are available in small towns/rural areas

Low impact ○ ◔ ◑ ◕ ● High impact

07

TECHNOLOGICAL TRENDS

The electric mobility landscape is undergoing a rapid transformation driven by innovations across the ecosystem. The following exhibit summarizes the anticipated impact of these innovations affecting various categories and subcategories. EV batteries and EV charging are the two key areas that are likely to witness significant impact because of the technological disruptions.

Exhibit 7.1

Technology trends across key categories

Category	Sub-category	Technology trend(s)	Key players	Impact on EV ecosystem
EV components	Battery	• Development of solid-state batteries and lithium-sulphur batteries • Development of recycling techniques and second-life batteries • Development of longer lifespan batteries	CYMBET, Prieto, QuantumScape	●
	Electric motor	• Development of axial flux motors and in-wheel motors	YASA	◕
	Braking system	• Development of regenerative braking system	Lucas TVS, Altigreen, Bosch	◑
Sales/ Purchase	Financing	• Use of geofencing, IoT and vehicle tracking device to leverage data for financing • Automated deductions to make the regular payments	SBI, Shriram	◕
Driving	Driving assistance	• Development of ADAS (Advanced driver assistance systems)	FORVIA, WABCO	◕
	Fleet management	• Use telematics to optimize the fleet management	Webfleet, Tech Mahindra, Trimble	◕
EV charging	Charging technologies	• Development of plug and charge system and smart EV charging • Development of vehicle to grid technology • Move to Open Charge Point Protocol (OCPP 2.0.1)	exicom, Delta, EVRE, Tata Power	●
Aftersales	Maintenance and repair	• Set-up of EV complaint workshops • Use of robotics in auto repair and 3D printing to print customized tools • Development of self-healing materials • AR/VR to perform intricate repairs with virtual tools and sensors	Bosch Service, Tata Motors Service, First Choice	◕
Alternate fuels	Hydrogen and biofuels	• Development of hydrogen fuel cells and blending biofuels	IndianOil, praj	◕
	Hybrid vehicles	• Vehicles that have an internal mechanism to switch from electric motors to internal combustion engines	MG, Honda, Suzuki, Toyota	◕

Low impact ○ ◔ ◑ ◕ ● High impact

7.1 Trends in EV components

7.1.1 Battery

Advancements in battery technology are unfolding with the development of solid-state and lithium-sulfur batteries, promising higher energy density, increased efficiency, and enhanced safety. Industry leaders such as Toyota and BMW, alongside innovative startups like Quantum Scape and Solid Power, are actively investing in these breakthroughs. Researchers at the University of Texas have achieved a battery with up to four times more energy storage compared to a lithium-ion battery of similar weight.

Simultaneously, initiatives by Tesla and Redwood Materials are reshaping sustainability efforts through refined battery recycling methods and the exploration of second-life batteries repurposed for home energy applications, underlining the industry's commitment to eco-friendly practices.

Moreover, ongoing efforts in enhancing battery longevity through improved chemistry and manufacturing techniques aim to produce longer-lasting batteries, thereby reducing the frequency of replacements and driving down the overall cost of EV ownership.

7.1.2 Electric motor

A significant shift towards axial flux and in-wheel motors is underway, showcasing superior power and efficiency compared to traditional counterparts. Renault has collaborated with Whylot to integrate these advanced motor technologies into hybrid vehicles by 2025.

7.1.3 Regenerative braking

The regenerative braking system technology actively captures and converts kinetic energy, thus increasing the vehicle range and reducing maintenance costs by minimizing wear and tear on conventional brakes.

7.2 Evolution in EV financing

Geofencing techniques, IoT and vehicle tracking devices and battery subscription services, are the innovations transforming the EV financing landscape.

- **Geofencing techniques:** Enable finance companies to set specific parameters, leveraging geotagging to underwrite loans for individuals lacking credit history.
- **Integration of IoT and vehicle tracking devices:** This has revolutionized loan underwriting by assessing vehicle quality, monitoring battery health, and analyzing utilization data for commercial vehicles.
- **Battery subscription services:** Finance companies are providing EV batteries on subscription to reduce upfront cost for customers.

7.3 Trends in driving assistance and fleet management systems

Driving assistance and fleet management are witnessing a shift through telematics and AI-based technologies.

- **Telematics:** These advancements enable drivers and fleet owners by offering application-based monitoring, real-time driving pattern analysis, and remote vehicle diagnostics.
- **Advanced Driver Assistance Systems (ADAS)**: This provides alerts, warnings and autonomously takes actions to prevent potential accidents, thereby enhancing fleet safety and efficiency.

7.4 Advancements in EV charging

EV charging is undergoing a significant evolution to meet the growing demand for efficiency and convenience. Innovations in fast charging technologies like hypercharging and Megawatt systems for CVs aim to drastically reduce charging times. The exploration of wireless charging, employing magnetic resonance coupling and inductive charging systems, as well as experiments with electric roads, showcases promising advancements. Smart charging systems, backed by artificial Intelligence (AI) and IoT sensors, now integrate Vehicle-to-Grid (V2G) technology, optimizing current flow during peak and non-peak hours.

7.5 Trends in EV aftersales market

Predictive maintenance driven by AI and IoT accurately predicts vehicle failures, while self-healing materials and robotic repairs contribute to enhanced sustainability. Augmented reality (AR) and virtual reality (VR) assist mechanics in performing intricate repairs, while 3D printing offers cost-effective and customizable tools, reshaping the aftersales support landscape in the EV industry.

7.6 Alternate fuels

India heavily relies on traditional fossil fuels like diesel, petrol, and LPG, constituting about 70% of its energy consumption. Rising fuel prices, increasing carbon emissions, and growing environmental concerns have prompted India, like other countries, to explore renewable alternatives. Biofuels such as ethanol and biodiesel are alternatives which can used in various modes of transportation.

Exhibit 7.6.1

Green vs. fossil fuels

Alternate fuels

Alternate renewable fuels are being developed, with varying degree of feasibility to replace the different types of fossil fuels

	Biofuel		Hydrogen energy	Hybrid EVs
	Ethanol	**Biodiesel**	**H_2 power**	**HEVs and PHEVs**
Government target	• Achieve 20% ethanol blending by 2025-26	• 0.1% blending rate in FY23 to 5% by FY30	• Develop hydrogen as a transportation fuel	• Reduce tailpipe emissions by increasing HEV and PHEV adoption
Production capacity (M litres, FY23)	12,440	190	-	-
Expected production capacity (M litres)	15,510 (FY26P)	5,400 (FY30P)	-	-
Impact	• Ethanol-blended gasoline **decreases CO and HC emissions** by 30-50% and 20% in 2W and 4W • Additional **source of income for farmers** from waste like cotton stalk, wheat straw • **OMCs** will save up on **total fuel costs** by reducing imports and blending relatively cheaper ethanol	• If 5% target will be achieved **GHG emissions** will be **reduced to ~32M tCO2e per year** from 2030 • Increase in demand will increase income for **producers** and provides opportunity to tap in new domestic/global markets • Biodiesel blends offer up to 30% **improved fuel lubricity** and a higher cetane rating (51 cetane)	• FCEVs can run **300 miles and refuel in 10 minutes**, while EVs have a 200-mile range and take 45 minutes to fast/DC charge • Lithium shortage is anticipated by 2030 therefore FCEV adoption can be a **good alternative** for lithium • FCEV refueling costs is US$ 0.14/km higher than EV costs of US$ 0.03/km	• **HEV reduces** the overall **emissions by ~15% over the vehicle lifetime** when compared to ICE vehicles • **Upfront cost of HEV and PHEV is lower than** upfront cost of BEVs, enabling faster adoption • **HEVs and PHEVs address the range anxiety challenge** of faced in BEVs by allowing drivers to switch from electric to gasoline
Level of adoption	◔	◔	○	●
Long term solution	◔	◔	◕	◔
Level of modification in current vehicle	◔	◔	●	◕

Low impact ○ ◔ ◑ ◕ ● High impact

Note(s): CO - Carbon monoxide, HC - Hydrogen carbon, OMC - Oil manufacturing company, FCEV - Fuel cell EV, HEV: Hybrid EV, PHEV: Plug-in hybrid EV

Source(s): PP&AC report, IEA report

7.6.1 Ethanol

Ethanol, also referred to as bioethanol, is a sustainable, renewable fuel produced through the fermentation of organic materials, including crops, grains, sugarcane, and agricultural waste. It possesses about two-thirds of the calorific value of gasoline.

Ethanol blending refers to mixing ethanol with petrol in specified ratios, such as E10 (10% ethanol + 90% petrol) and E20 (20% ethanol + 80% petrol). The E10 blend showcases a slightly lower calorific value of 44.2 MJ/Kg compared to 44.4 MJ/Kg in pure gasoline (E0).

The government aims for country wide E20 adoption by 2025. The shift to E10 ethanol blending in India has brought significant benefits, including reduction in GHG emissions by 32M metric tons since 2014 and savings of INR 54K Cr. on fossil fuel imports. It has also boosted farmers' income and spurred economic growth through the establishment of over 100 new ethanol distilleries.

7.6.2 Biodiesel

Biodiesel, a renewable fuel produced via transesterification (where vegetable oil/animal fat reacts with alcohol) is a cleaner substitute for traditional hydrocarbon-based diesel. Biodiesel is mixed with diesel in specific ratios, such as B5, B10, and B20 (5%, 10%, and 20% biodiesel blended with traditional diesel respectively).

While biodiesel possesses approximately $9/10^{th}$ of the calorific value of traditional diesel, it significantly outperforms traditional fuel in terms of environmental impact. Biodiesel reduces GHG emissions by 50-75%, resulting in lower CO_2 and hydrocarbon emissions, particularly in B5 fuel. Additionally, vehicles generally require no major modifications for compatibility with B5 biodiesel. The adoption of B5 biodiesel in India, is estimated to reduce 32M tons of CO_2 emissions annually till 2030 and also enable significant financial savings of around INR 42K Cr. on import bills.

7.6.3 Green hydrogen

Hydrogen is a clean fuel, producing no GHG emissions during combustion. Fuel Cell EVs (FCEVs) are a type of EV that utilizes hydrogen gas to generate electricity and power the electric engine. FCEVs can cover 300 miles on a single refuel in just 10 minutes. The potential for widespread adoption of FCEVs seems promising due to abundant hydrogen availability and their extended driving range. However, challenges related to hydrogen extraction, initial expenses, complete modification of vehicles to use hydrogen fuel, and insufficient infrastructure present significant hurdles to their adoption.

7.6.4 Hybrid vehicles

Hybrid vehicles have an electric motor, a battery, an internal combustion motor, and a gas tank. A plug-in hybrid EV (PHEV) uses both gasoline and electricity for fuel. They provide multiple advantages over complete EVs in terms of driving range, they have better fuel economy and a passive battery regeneration system.

08

NEW OPPORTUNITIES AHEAD AND STRATEGIC CHOICES

The growth of EVs has paved the way for new opportunities within the EV landscape, creating openings for diverse array of businesses ranging from large-scale opportunities to medium-sized and specialized niches. These emerging opportunities can be categorized into five overarching themes: connected and autonomous cars, Mobility as a Service (MaaS) & ecosystem solutions, EV exports, local manufacturing, and sustainability. These themes offer avenues for innovation and market expansion. It is only thrilling to see the kind of disruption and innovation that this sector beholds.

Exhibit 8.1

Emerging themes in EV landscape

Themes	Description	Opportunities: Large-scale	Opportunities: Mid-scale	Opportunities: Niche
Connected and autonomous	• EVs with connectivity to internet are connected cars, while EVs that support self-driving are autonomous	• Subscription based services	• Customized financing • Telematics for predictive maintenance and insurance • IoT in logistics and freight • Advanced driver assistance system (ADAS) and connected cars	• Autonomous valet parking • Emergency assistance • Distributed computing
Mobility as a Service (MaaS) and ecosystem solutions	• Integrates various electric transport modes and ecosystem solutions on a single platform, promoting seamless and eco-friendly travel	• Smart charging and Vehicle-to-Grid integration (V2G) • Electrifying beyond roads	• Urban air mobility and Electric Vertical Takeoff and Landing (E-VTOL) • Shared autonomous vehicles • Autonomous cargo ships • Autonomous taxis	• Preference-based personalization • Dynamic wireless charging infrastructure
EV exports	• Export opportunity available for EV technology and components	• EV and battery export • Domestic manufacturing for global EV players • Auto components export • Semiconductor and electronics manufacturing	• Software and IT architecture exports	• Battery management
Local manufacturing hub	• Develop in-house capabilities and tech to manufacture EV components locally and reduce import dependence • Becoming world's high-tech factory for EV manufacturing and supply	• Motor • manufacturing for 2W, 3W, and 4W • Battery manufacturing	• Power electronics • Battery pack assembly • Silicon-based anode	• EV retrofitting kits • Blockchain-based supply chain management • Advanced battery chemistry
Sustainability economy and carbon credits	• Alternate source of revenue for climate conscious EV players	• Revenues from carbon credits sale • Used EV market • Battery recycling facilities • Adoption of plugin hybrids an hybrids	• AI-driven Impact Assessment • IoT devices-based carbon credit management	• Revenue through renewable sources of electricity generation • Component refurbishment • Carbon credit marketplace

Note(s): Niche includes opportunities < US$ 1B; mid-scale includes US$ 1-5B; large-scale includes more than US$ 5B

8.1 Connected and autonomous cars

Connected cars are vehicles integrated with internet connectivity, facilitating real-time data sharing and remote control. When this technology is integrated with EVs, numerous opportunities arise for OEMs and service providers. For manufacturers, this can entail offering subscription-based services such as remote diagnostics, over-the-air updates to continually enhance driving experience, and emergency assistance to enable faster response times to save lives. The logistics and freight sector can greatly leverage connected and autonomous cars to streamline operations and reduce costs. Financial institutions can offer telematics-based insurance and tailored financing options to EV owners.

Exhibit 8.1.1

Emerging opportunities: Connected and automated cars

	Large-scale	Mid-scale	Niche
Opportunities	• **Subscription based services:** For features like over-the-air software updates, premium entertainment content, and advanced driver assistance packages.	• **Customized financing:** Offer more personalized and competitive financing terms based on the usage driver behavior and vehicle health. • **Telematics for predictive maintenance and insurance:** Leverage data analytics to anticipate vehicle failures moreover providers can offer usage-based insurance plans for EV owners. • **IoT in logistics & freight**: Remotely monitor the temperature and ensure quality of cargo specifically can be used for pharmaceuticals, frozen food and other temperature sensitive items. • **Advanced driver assistance system (ADAS) and connected cars:** Connected car technologies and solutions to enhance the driving experience, improve safety, and address various challenges.	• **Autonomous valet parking:** Drive the car to a charging station during work hours and return it to parking spot before commuting home. • **Emergency assistance:** Transmit critical crash data, including location and severity,to emergecy response centers in the event of a collision which enables faster response times & save lives. • **Distributed computing:** Leveraging the idle compute power of millions of parked EVs for distributed computing.
Key players in India and globally (Illustrative)	RIVIAN, TESLA, Polestar	Revfin, Volty IoT Solutions, ELPRO, KPIT, CAPITAL, iALERT, SENSITECH, TATA ELXSI	TESLA, BOSCH, ReadyAssist, TESLA

Note(s): Niche includes opportunities <US$ 1B; mid-scale includes US$ 1-5B; large-scale includes >US$ 5B

8.2 Mobility as a Service (MaaS) and ecosystem solutions

MaaS involves integrating various electric transportation modes onto a single platform. This includes electric cars, scooters, bikes, and even pod taxis. Users would be able to access these different modes of transport seamlessly through a smartphone app. By making it easier for people to get around without needing to own a car, MaaS has the potential to reduce traffic congestion and air pollution in Indian cities. Moreover, ecosystem solutions hold potential to solve EV infrastructure challenges and develop innovative service opportunities.

Large-scale opportunities for EV MaaS and ecosystem solutions include smart charging & vehicle to grid integration and electrifying beyond roads. Niche opportunities, such as personalization and wireless charging infrastructure, also exist. The mid-scale business includes innovations like autonomous taxis and ships, urban air mobility (EV take-off and landing), electrifying utility vehicles for construction, agriculture, industrial use, etc. and shared autonomous vehicles (SAVs).

Exhibit 8.2.1

Emerging opportunities: Mobility as a Service and ecosystem solutions

	Large-scale	Mid-scale	Niche
Opportunities	• **Smart charging and Vehicle-to-Grid integration (V2G):** Bi-directional charging capabilities, dynamic charging prices and other grid-friendly charging algorithms. • **Electrifying beyond roads:** E-Aircrafts, E-Ships, E-UTVs, etc. are emerging providing cleaner solutions for diverse applications (construction, travel, agriculture, etc.).	• **Urban air mobility and Electric Vertical Takeoff and Landing (E-VTOL):** Deployment of air taxis and urban air mobility solutions using E-VTOL. • **Shared autonomous vehicles:** SAVs operate without human intervention, and their global revenues in urban areas are projected to reach ~US$ 1.6T annually by 2030. • **Autonomous cargo ships:** Unmanned electric cargo ships, like Yara Birkeland, reduce emissions and labor costs significantly, with an expected 90% savings in crew expenses. • **Autonomous taxis:** Fleet of autonomous EVs running as autonomous-taxis in idle time/night, with the potential to be10-40% cheaper than private nonautonomous cars.	• **Preference-based personalization:** All occupants enjoy personalized controls. In 2030, 45% of new car sales may offer personalized controls, individualized infotainment, and ctext- based advertising, reaching level 3[1] or higher in connectivity. • **Dynamic wireless charging infrastructure:** Induction charging in roads for EVs to enable convenient and automated charging while driving.
Key players in India and globally (Illustrative)	Nissan Motor Corporation, Airbus, BMW, Polaris, enel x, John Deere	Airbus, Polaris, John Deere, ati, RekiSe, Flux Auto	netradyne, WiTricity, Honda, Mercedes-Benz, Bosch, electreon

Note(s): [1]80-100% personalization, risky driving practices are detected and communicated via voice messages for improved safety; niche includes opportunities <US$ 1B; mid-scale includes US$ 1-5B; large-scale includes >US$ 5B

8.3 EV exports

India's push for EVs offers a prime opportunity across multiple fronts for Indian entrepreneurs and facilitates their global market expansion. Indian businesses can strengthen the manufacturing and export of EVs along with EV components and software technologies while leveraging workforce and IT expertise. Exploring EV manufacturing in cost-effective states and leveraging government initiatives like PLI drives the potential for competitive manufacturing for global markets. Additionally, India's semiconductor and electronics potential, backed by government focus and foreign investment, positions the country as an emerging manufacturing and export hub for EVs.

India's IT prowess extends to the software and IT architecture that powers connected vehicles and charging infrastructure. To solidify its future in EVs, India is strategically developing expertise in battery lifecycle management, encompassing battery cycling and second-life solutions. By seizing this multifaceted opportunity, India is poised to become a dominant player in the global EV market.

Exhibit 8.3.1

Emerging opportunities: EV exports

	Large-scale	Mid-scale	Niche
Opportunities	• **EV and battery export (specifically for 2W and 3W LCV)** India players can capture the transi tion from ICE to EV market in international market setting EV manufacturing in some of the low-cost Latin and African countries. • **Domestic manufacturing by global EV players:** Companies like Tesla setting manufacturing in India and exporting to global market will create job opportunities. • **Auto components export:** Indian auto component manufacturers are known for producing a diverse range of components, from engine parts and electrical systems to transmission and braking systems. • **Semiconductor and electronics manufacturing:** - Indian companies can become an alternative to Chinese companies as many countries adopt China-plus- one diversification strategy - Electronics and semiconductor industries have received >60% of overall FDI investment over the last three years.	• **Software & IT architecture exports:** - Modern vehicles integration with embedded software is key to EVs - Capabilities and experience of Indian IT companies will lead them to design in wheel motors, controllers and other electronics need	• **Battery management:** Various companies in India are involved in battery-related technologies, energy storage, and electric mobility, which encompasses aspects of battery cycling, maintenance, and optimization.
Key players in India and globally (Illustrative)			

Note(s): Niche includes opportunities <US$ 1B; mid-scale includes US$ 1-5B; large-scale includes >US$ 5B

8.4 Local manufacturing hub

Government initiatives such as 'Make in India' are catalyzing a significant transformation in the development, manufacturing, and assembly of EV components and batteries. Large-scale opportunities include motor and battery manufacturing while mid-scale opportunities include power electronics and battery pack assembly. India holds substantial potential to emerge as a manufacturing hub for EV components and batteries. Additionally, niche opportunities such as EV retrofitting, blockchain-based supply chain management, and innovating for advanced battery chemistry have the potential to create additional business value concurrently.

Exhibit 8.4.1

Emerging opportunities: Local manufacturing hub

	Large-scale	Mid-scale	Niche
Opportunities	• **Motor manufacturing (2W, 3W, and 4W):** Greater focus on motors manufacturing which reduces import dependence. • **Battery manufacturing:** Incentives by government to set up integrated batteries and cell manufacturing plants in India.	• **Power electronics:** India is witnessing global manufacturers entering for power electronics components, system assembly, and SMT lines and presents potential for domestic players. • **Battery pack assembly:** Several OEMs have started to perform battery pack assembly tasks in-house, attracting more new-age players in the market. • **Silicon-based anode** within a liquid/solid state battery enable better Li absorption.	• **EV retrofitting kits:** Manufacturing SKD kits for converting ICE vehicles to EVs is an attractive business to extend the lifespan of ICE vehicles and has recently observed a surge in demand. • **Blockchain-based supply chain management:** Ensuring traceability and authenticity of components and materials used in EV production. • **Advanced battery chemistry:** R&D of next-generation battery chemistries for improved energy density, faster charging, and longer lifespan.
Key players in India and globally (Illustrative)	Sona Comstar, ZF, Cygni, Luminous, Enedym, Exicom	Hyundai Mobis, Trontek, Log9, ABB, Future, Epsilon	Altigreen, EVM, GoGreenBOV, Lithium, E-Trio, IBM, Shipchain, Chronicled, Log9, Tesla

Note(s): Niche includes opportunities <US$ 1B; mid-scale includes US$ 1-5B; large-scale includes >US$ 5B

8.5 Sustainability economy and carbon credits

Organizations have the potential to earn carbon credits as an incentive for reducing carbon emissions via EVs and switching to renewable sources of energy for the charging infrastructure, effectively minimizing their carbon footprint. This practice can serve as a substantial opportunity for revenue growth, alongside businesses boosting the sustainable economy like battery recycling and the used EV market. Furthermore, it will lead to the development of carbon credit marketplaces, thereby giving rise to mid-scale opportunities such as IoT-based carbon credit management and AI-based impact analysis. Moreover, with the increased adoption of EVs, it will also be interesting to witness how the story of hybrids and PHEVs play out, in turn creating a large-scale business opportunity.

Exhibit 8.5.1

Emerging opportunities: Sustainable economy and carbon credits

	Large-scale	Mid-scale	Niche
Opportunities	• **Revenues from carbon credits sale:** Tesla generated a remarkable US$1.8B in 2022 by selling earned carbon credits, assisting companies striving to meet regulatory targets. • **Used EV market:** With millions of EVs being phased out in a year by 2030, capturing the pre-owned EV market presents an opportunity as it allows customers to reduce their upfront costs. • **Battery recycling facilities:** Process of reusing and recovering valuable materials from used batteries and reducing wastage. • **Adoption of plugin hybrids and mild/full hybrids:** Hybrids EVs are gaining traction as well as they mitigate many problems like range-anxiety, refueling, lower upfront cost, etc. while still offering a electric mobility solution.	• **AI-Driven Impact Assessment:** Promising business opportunity lies in offering advanced modeling for assessing the long-term impact of carbon credit projects, coupled with comprehensive carbon credit management services. • **IoT devices-based carbon credit management:** The Real-time collection and reporting of data from IoT-connected sources will enhance the verification process and credibility of carbon credit projects.	• **Revenue through renewable sources of electricity generation:** Charging infrastructure providers can switch to renewable energy sources like solar, thereby enabling the EV industry to generate higher revenue. • **Component refurbishment:** Recycling of EV specific components to be sold in the aftermarket can serve as a business case for existing OEMs as well as new age players. • **Carbon credit marketplaces:** Platforms for trading carbon credits with the integration of technologies like blockchain that offer crypto carbon credit tokens.
Key players in India and globally (Illustrative)	JSW, Torrent Power, Kalpa Taru, Tesla, CarMax, EXIGO, Ziptrax, Toyota, VW, Honda	Pachama, TCS Tata Consultancy Services	EDF renewables, Sterling & Wilson, Adani Renewables, Attero, BatX Energies, OffsetFarm, Seki, Climate Impact X

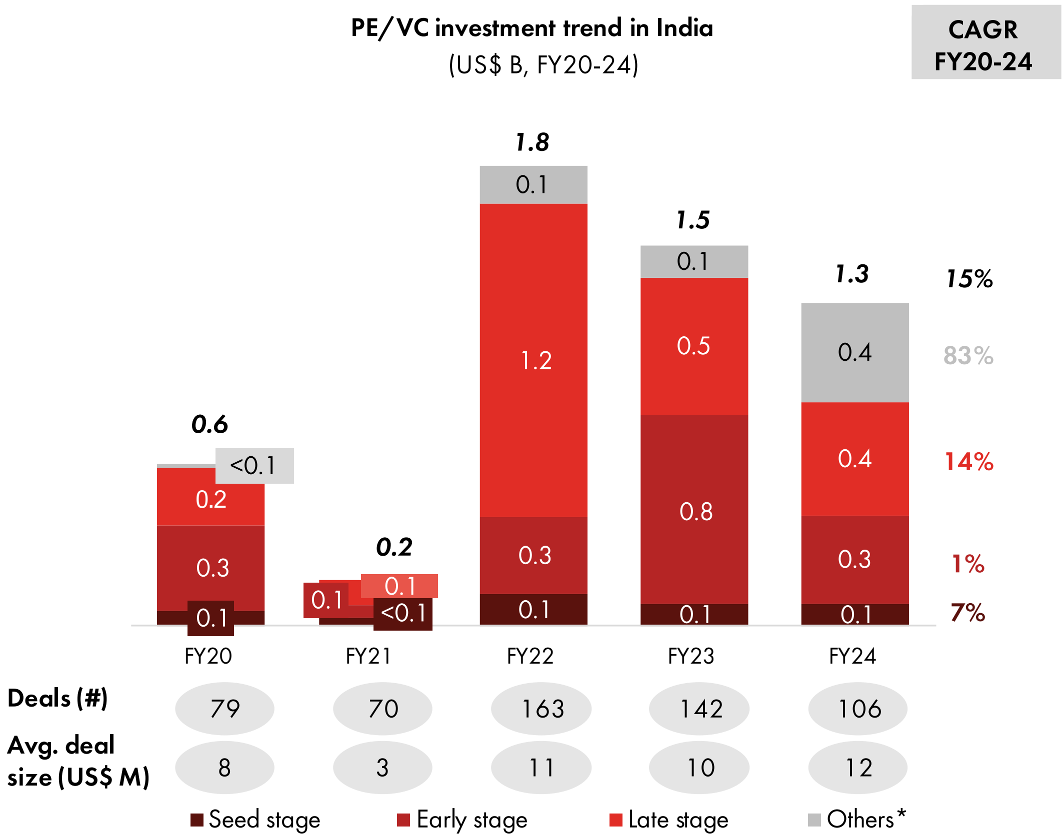
Note(s): Niche includes opportunities <US$ 1B; mid-scale includes US$ 1-5B; large-scale includes >US$ 5B

09

RECENT INVESTMENTS IN ELECTRIC MOBILITY SPACE

Exhibit 9.1

PE/VC investments in Indian electric mobility



Key highlights of the EV investment sector

Key highlights	Description
Proven business models outshined	Late-stage deals grew the fastest and doubled as companies **seeking funds for capacity and geographical expansion dominated the deal share**
OEMs are leading the charge	OEMs such as Tata, Mahindra, Ola, and Ather, etc. accounted for **over 70% of the total deal value** in the EV market in 2023
Increase in deal size	Increased capital allocation to the sector as the average deal size increased from **US$ 8M in FY20 to US$12M in FY24**
Strong FDI inflow	**With 100% FDI allowance**, the electric mobility sector has **attracted US$ 33B in FDIs between 2000 and 2023** as the ESG theme continues to attract investors

Note(s): *Others include equity, debt, grants etc.; NEMMP - National Electric Mobility Mission Plan; NECMP: National Clean Mobility Program

India has been a favorable investment destination for EV ecosystem investments over the past five years with a total of ~US$ 5.5B funding received across 550+ rounds in the last five years starting from FY20. The investments surged in FY22 and have been stable for the past 2 years, however, when compared to a pre-pandemic base of FY20 we observe a steady overall CAGR of 15%.

Investing in India offers key advantages such as access to a rapidly expanding market, support from government policies, investing in companies with proven business models, a skilled workforce, and the potential for strategic partnerships with Indian companies and global players.

Some prominent players who have received multiple fundings are OLA Electric, Ather Energy, Mahindra Electric, and BluSmart.

Exhibit 9.2

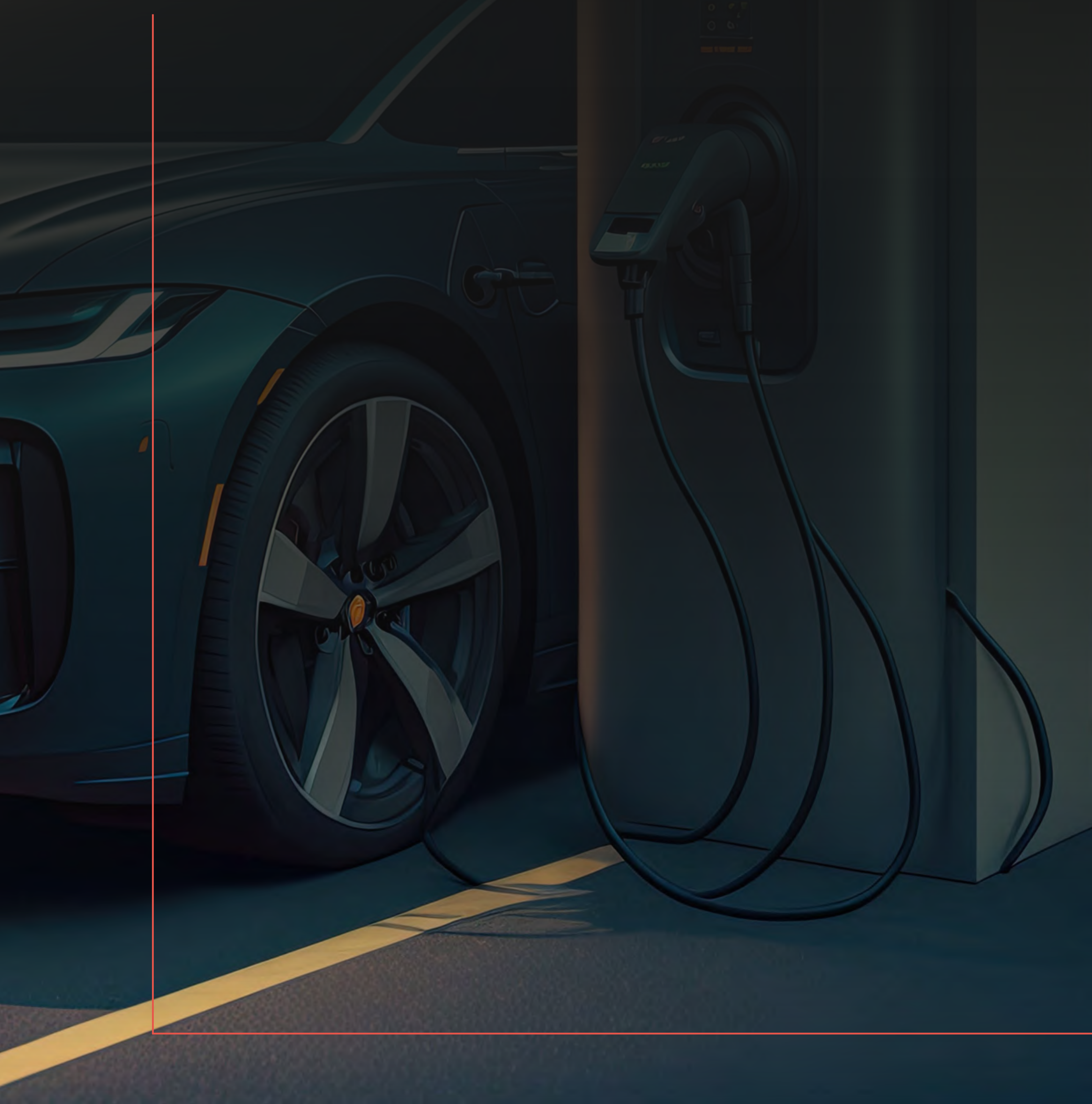
Electric mobility investment landscape

Company		Funding date	Stage	Amount (US$ M)	Lead investors	Founded in
MAHINDRA ELECTRIC	Mahindra Electric	Aug 03, 2023	Undiscl-osed	145	Temasek Holdings	2023
OLA	Ola Electric	Oct 07, 2023	Series E	143	Temasek, Blue Investments, DIG Investments, Tiger Global	2017
ATHER	Ather Energy	Sep 05, 2023	Series E	108	Hero MotoCorp, GIC	2013
TI INDIA	TI Clean Mobility	Mar 30, 2023	Series D	72	Murugappa Group firm Tube Investments of India and SBI	2022
CHARGE ZONE	Charge Zone	Mar 20,2023	Series A	54	BlueOrchard	2018
LOHUM	Lohum	Mar 13, 2024	Series B	54	Singularity VC	2017
mahindra LAST MILE MOBILITY	Mahindra Last Mile Mobility	Jan 11, 2024	Series B	50	NIIF	1994
Kabira Mobility	Kabira Mobility	Mar 17, 2023	Series A	50	Al-Abdulla Group	2019
magenta	Magenta Mobility	Feb 10, 2023	Series B	40	Morgan Stanley, BP Ventures	2022
River	River	Feb 06, 2024	Series B	40	Yamaha Motor, Lowercarbon Capital	2020
BatterySmart	Battery Smart	Jul 06, 2023	Series B	33	Tiger Global Management, Ecosystem Integrity Fund, Blume	2019
PMI	PMI Electro Mobility	Oct 19, 2023	Series C	30	Piramal Enterprises	2017
statiq	Statiq	Jun 23, 2022	Series A	26	Shell Ventures	2020
ELECTRA EV	Electra EV	Oct 06, 2022	Series B	25	GEF Capital Partners	2017
yulu	Yulu	Feb 23, 2023	Series B	19	Magna, Bajaj Auto	2017
EULER	Euler Motors	Nov 06, 2023	Series C	14	British International Investment, GIC, Blume Ventures	2018

Note(s): Deals from Jun'22 to Feb'24 have been considered, illustrative deals

10

KEY IMPLICATIONS FOR STAKEHOLDERS



The next five years are going to be extremely eventful in the electric mobility transition. It might be slower, it could be faster, but it will happen. At Praxis Global Alliance, we strongly believe in the opportunity and the readiness organizations must create for it.

Exhibit 10.1

Key implications for stakeholders across the EV value chain

Vehicle OEMs	Components	Logistics	Transportation	Financing and insurance	Ecosystem solutions
• **Navigate the transition to EV product portfolio** across organization's capabilities • **Invest and create the right portfolio,** continually improving range, performance, safety, and life • Drive **innovation in customer acquisition** and retail/**distribution channels** • **Localize supply chain** and manufacturing to drive lower costs • **Invest in consumer perception** and brand building • **Create deep R&D capabilities** in EV assembly and vehicle design • Augment and setup **omnichannel EV distribution** networks	• **Invest along with OEMs in technology and R&D** across the new EV products paradigm • **Tap the export opportunity** to build economies of scale across key emerging markets • **Modernize and innovate factories** for clean transition • **Setup new and compelling commercial excellence models** for driving share of wallet across key OEMs • **Invest in battery recycling, after market distribution,** and other new age capabilities in non-OEM segments	• **Build customer facing solutions** and technology to drive super experience and stickiness • **Continually invest and pilot EVs** across fleet and expand routes/geographies strategically • **Develop charging network** across key clusters across various models • **Invest in software technology** to manage fleet with EVs and ICE • **Invest in driver training and network planning** • **Raise capital** to manage incremental investments	• **Build customer facing solutions** and technology to drive super experience and stickiness • **Build multi-channel and integrated** transportation solutions that offer seamless service • **Continually invest and pilot** EVs across fleet and expand geographies strategically • **Develop charging network** across key clusters across various models • **Invest in software technology** to manage fleet with EVs and ICE • **Raise capital** to manage incremental investments	• **Invest in category knowledge, data collection,** analysis, and actuarial to drive superior product economics • **Build specific products and a carefully crafted GTM** model across them • **Invest in D2C** and other new age channels to reach customers quickly • **Invest in building new age soltions/** entering new age business models like leasing, asset management, and other capex to opex models	• **Continually invest in R&D and digital innovation** • **Raise capital to fund innovation** and go to market plans • **Maintain technological and organizational nimbleness** to successfully sustain a rapid pace of tech advancement • **Build capacity early and enter strategic markets** specially in areas like charging • **Build deep B2B enterprise sales and commercial models** to create a steady flow of business

11

CONCLUSION

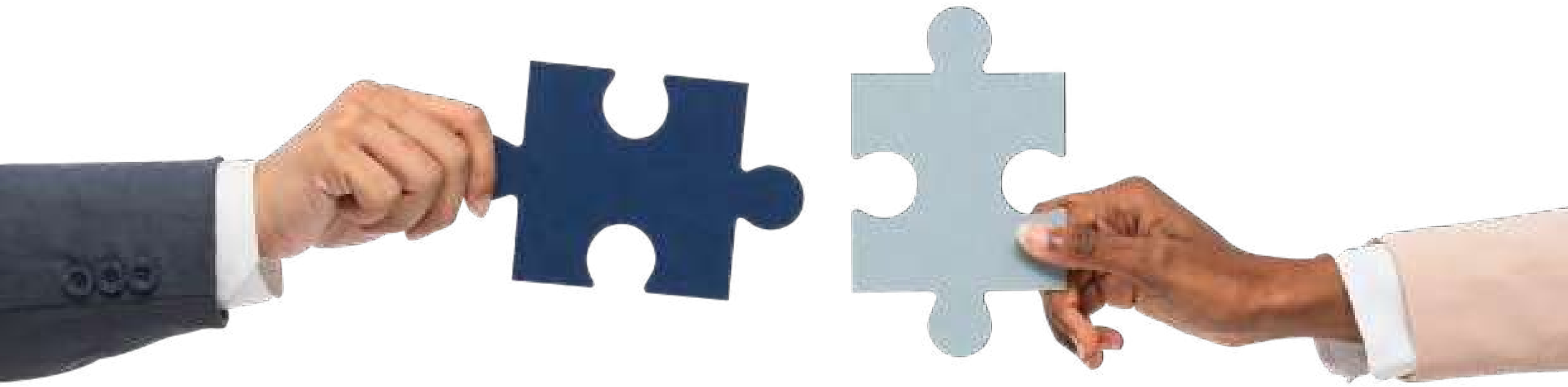
> "Nothing is more powerful than an idea whose time has come." – **Victor Hugo**

The imperative to embrace electric mobility in India is indisputable. As one of the leading global contributors to GHG emissions, there is an urgent need for action to curb environmental impact and confront the escalating climate crisis. The transport sector, which accounts for a substantial portion of these emissions, underscores the pivotal necessity of transitioning to cleaner modes of transportation.

As India's population and urban centers continue to expand, the need for clean transportation options becomes increasingly urgent to mitigate air pollution, reduce carbon footprint, and cultivate healthier living environments.

Crucially, the transition to electric mobility necessitates a collective effort from policymakers, industry stakeholders, and the public. Promoting the adoption of EVs, enhancing charging infrastructure, incentivizing clean energy technologies, and fostering public awareness campaigns are essential steps toward realizing a cleaner and more sustainable mobility landscape in India. Government initiatives aimed at promoting electric mobility reflect a commitment to this goal. The transition to EVs demands commitment, innovation, and collaboration.

Embracing electric mobility is not merely an option; it is an imperative for India's future. So, we must embrace rather than brace for this change.



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About us

Praxis Global Alliance is the next-gen management consulting firm revolutionizing how consulting projects are delivered. It delivers practical solutions to the toughest business problems by uniquely combining domain practitioner expertise, AI-led research approaches, and digital technologies. The company operates three business units, including Praxis Global Alliance Transactions, offering pre-deal support, commercial due diligence, post-acquisition value creation, Praxis Global Alliance Strategy and Transformation for practitioner-led business advisory and consulting, and PraxDigital™ delivering data engineering and analytics, AI, OpenData and visualization solutions to clients across verticals.

With a presence across 6 locations in India, UAE, and Saudi Arabia, Praxis Global Alliance has successfully served over 40 countries with a dedicated team of consultants and data scientists. Team Praxis works with C-suite to the front-line executives across business streams, helping them with end-to-end business enablement, organizational transformation, and revenue maximization support in an agile environment.

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We will be happy to share perspectives

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