





<b>Title</b>	<b>EV Landscape: Opportunities for India's Auto Component Industry</b>	
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# Table of Contents

<b>1. EV Market Overview</b>	<b>07</b>
1.1 Global Perspective	07
1.2 India Perspective	21
<b>2. E-Vehicle Segment Opportunity Overview</b>	<b>27</b>
2.1 E-Two Wheeler	27
2.2 E-Three Wheeler and E-LCV	35
2.3 E-Four Wheeler	41
2.4 E-Bus	45
2.5 Other EV Segments	49
2.6 Segmental Opportunity Mapping	51
<b>3. EV Component Opportunity Overview</b>	<b>53</b>
3.1 Introduction	53
3.2 Component Segments	57
3.2.1 Powertrain & Power Electronics	57
3.2.2 Battery & Associated Components	69
3.2.3 Connectivity & Control Systems	81
3.2.4 Other Components	91
<b>4. Recommendations</b>	<b>95</b>
<b>5. EV Manufacturing: Policy Overview</b>	<b>101</b>
<b>6. Abbreviations</b>	<b>105</b>







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# EV Market Overview

1.1 Global Perspective

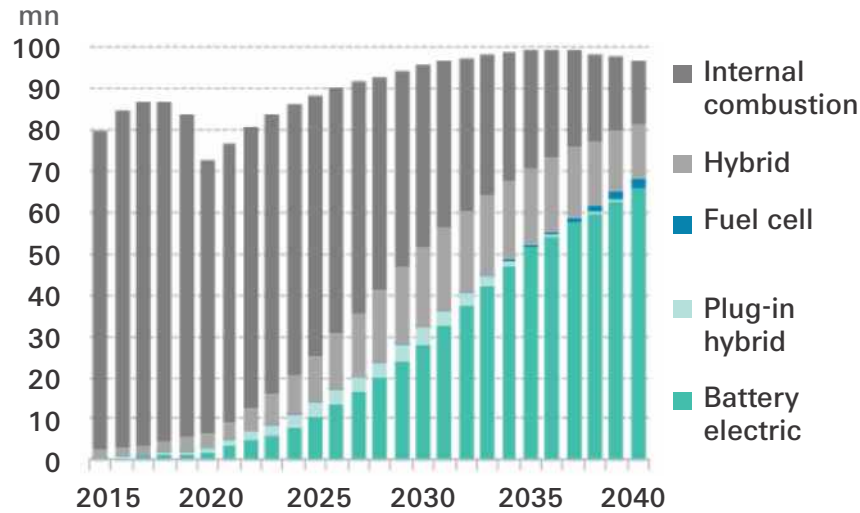
1.2 India Perspective

“ For passenger cars, xEVs to surpass sales of ICE vehicles by 2030, with EVs comprising 55%.





## Passenger Car Sales



## ICE Vehicle Sales Peaking, Electrification is set to Drive Growth

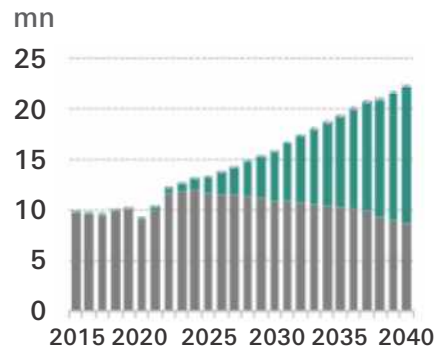
**Peak Car** for global ICE passenger cars & HCV sales has been reached in 2017, though upside exists in LCV & MCV sales.

**Recovery** to pre-Covid levels is expected by 2023 with growth driven by alternative powertrains

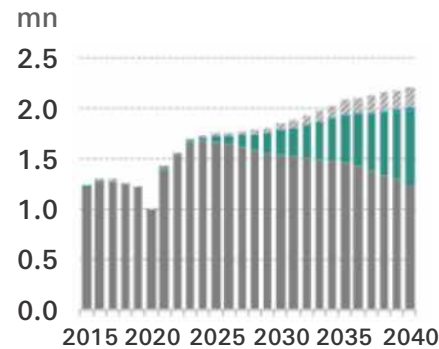
**Electric** powertrains are expected to extend overall passenger vehicle peak sales to 2036. Beyond 2030, EVs would drive growth.

## Commercial Vehicle Sales

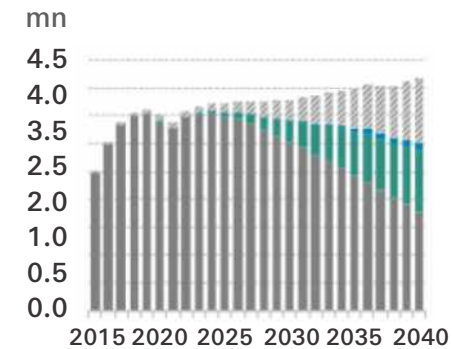
### Light-duty



### Medium-duty



### Heavy-duty



■ Diesel and gasoline ■ Electric ■ Fuel cell ■ Natural gas

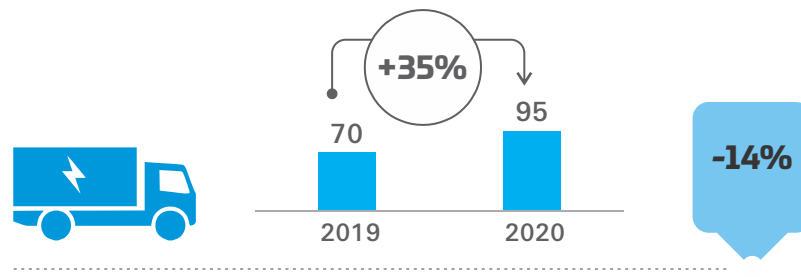
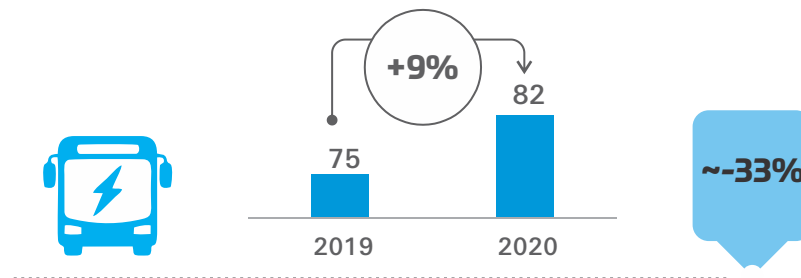
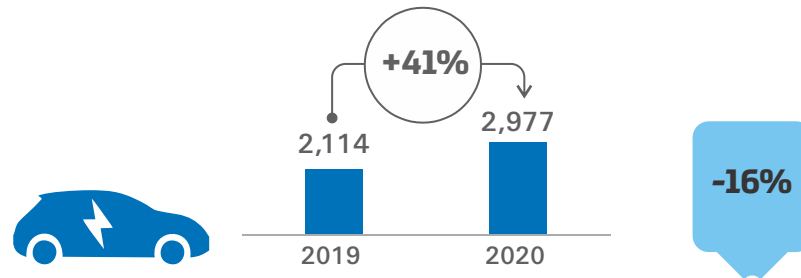
Source: Bloomberg New Energy Finance

“ 20 countries announced upcoming bans on the sales of ICE vehicles or mandated all new sales to be zero emission ones

**GLOBALLY,  
EVS HAVE BUCKED  
THE HEADWINDS  
OF 2020**



Annual Sales of EVs, ('000)  
% Change 2019-2020



## Key Drivers of EV Resilience

### 'Green' mandates

>20 countries announced bans on the sales of ICE vehicles or mandated all new sales to be zero emission ones. This follows from 127 countries adopting net-zero emissions targets.

### Stronger incentives

\$14 bn were offered by governments in purchase incentives in 2020, a 25% growth over 2019. This was largely led by Europe, while China also delayed subsidy phase-out.

### Adoption interest

Private sector demand for zero-emission commercial vehicles amplifies market signals for EVs, as many logistics firms and fleet operators adopt EVs.

### Cost Reduction

Battery prices reduced by 13% to reach \$137/kWh, and in certain instance reached below the \$100/kWh milestone. Price cap based subsidies also led to price reduction.

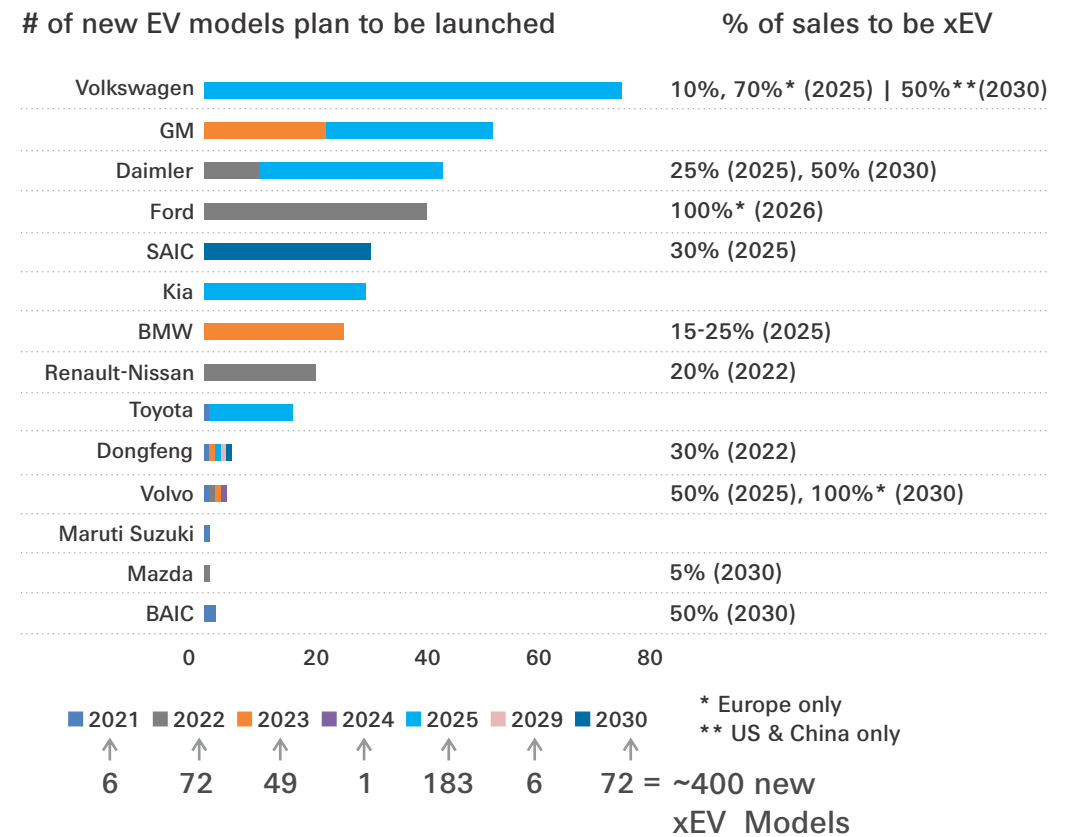
### Charging Infrastructure Expansion

45% YoY increase in publicly available chargers in FY20.

Source: International Energy Agency (Stated Policies Scenario), LMC Automotive, Technavio

# Strong OEM interest, EV Volume Sales set to rise 2.7X by 2030 over 2020

As per BCG, the top 29 OEMs plan to invest more than \$300 bn over the next 10 years for xEV production



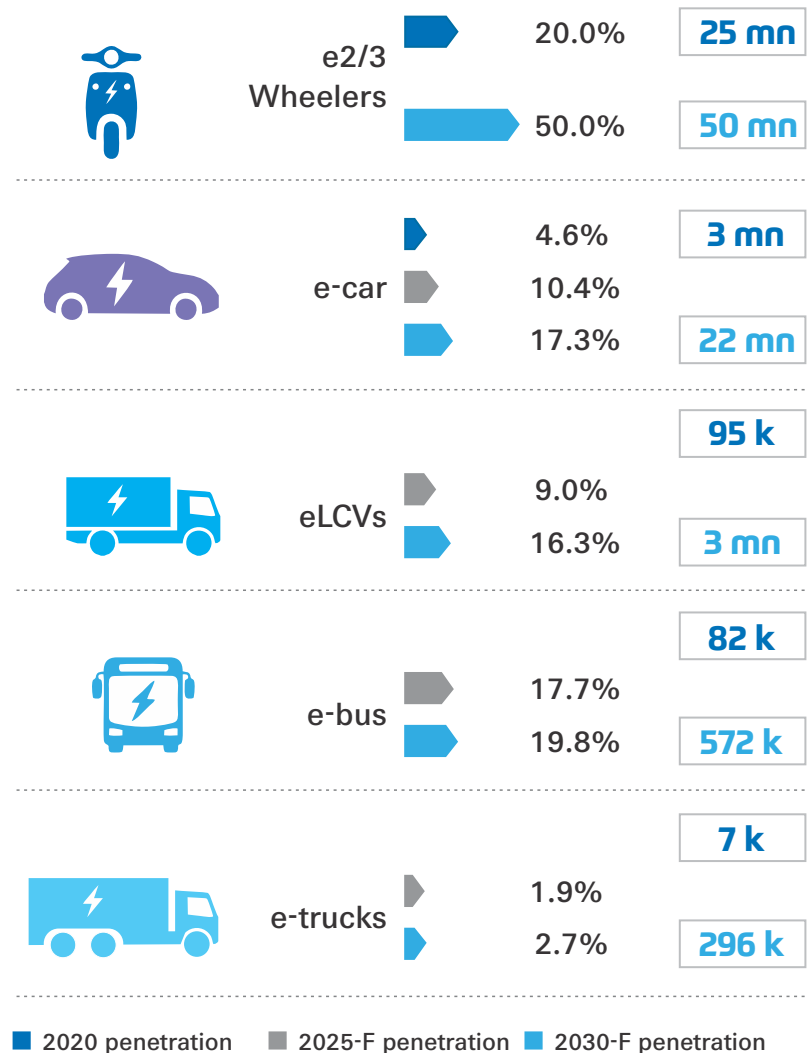
## Other Recent Announcements

- ✓ Stellantis aims for 70% e-cars sales in Europe and 35% in the US by 2030
- ✓ FAW aims for 40% e-cars sales by 2025 & 60% by 2030
- ✓ Honda aims at 40% e-car sales by 2030
- ✓ Toyota to have 2 mn BEV and FCEVs sold annually by 2030, xEVs 8 mn

Photo by Markus Spiske on Unsplash

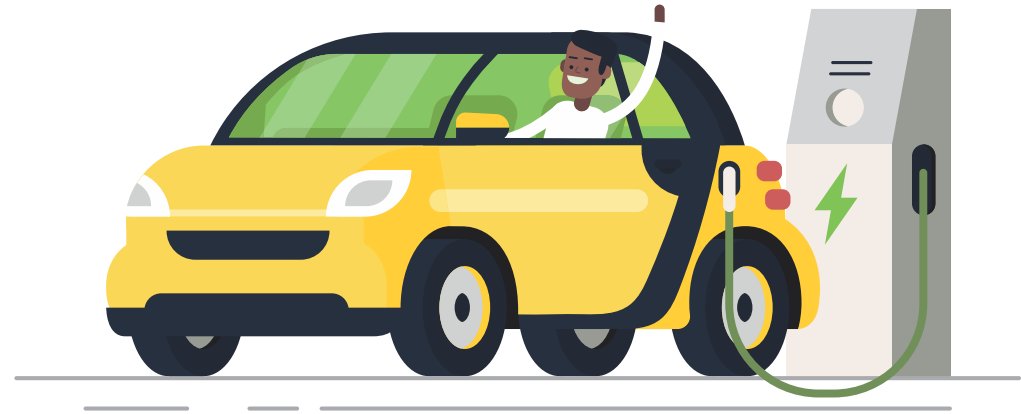
Source: International Energy Agency, BCG

EV penetration to rise across segments, annual sales to reach from present 28 mn to 76 mn by 2030\*







Source: International Energy Agency (Stated Policies Scenario)

\*Projections of EVs vary between sources, but were consistently revised upwards anywhere from 25% to 260% since 2015. As per IEA, OEM declarations continue to outpace the projections displayed here



EV-ICE price gap narrows with proliferation of EVs, increasing R&D spends, standardization of technology and reduction in battery costs. Additionally, incentives and charging infrastructure expansion spur initial adoption.

# Europe overtook China as the largest e-car market in 2020, leads in other segments too

EVs sold/ registered	2020	2025-F	2030-F
 <b>Global #1</b> (46% global share)	<b>1.4 mn</b> 2018-20 CAGR <b>90%</b>	<b>3.3 mn</b> 2020-30 CAGR <b>16%</b>	<b>5.9 mn</b>
 <b>Global #2</b> (39%)	<b>37.2 k</b> 2018-20 CAGR <b>24%</b>	<b>0.6 mn</b> 2020-2030 CAGR <b>44%</b>	<b>1.4 mn</b>
 <b>Global #2</b> (3%)	<b>2.2 k</b> 2018-20 CAGR <b>52%</b>	<b>16.6 k</b> 2020-2030 CAGR <b>31%</b>	<b>33 k</b>
 <b>Global #2</b> (6%)	<b>0.5 k</b> 2018-20 CAGR <b>215%</b>	<b>14.2 k</b> 2020-2030 CAGR <b>48%</b>	<b>22.6 k</b>

Source: International Energy Agency (Stated Policies Scenario)

## Industry Developments

- ✓ European OEMs such as Volkswagen, Mercedes-Benz, and Audi dominate e-car & e-truck markets. These are accelerating EV launches.
- ✓ Tesla is also focusing on Europe with its planned Berlin factory.
- ✓ e2W market comprises local players (Silence, Askoll & Govecs) in addition to Chinese, Taiwanese and US firms.
- ✓ Europe is becoming a hotspot for new battery capacities & recycling (CATL, Tesla).



## Policy and Incentives - Key Drivers

**Pandemic-driven economic stimulus** included a 45-57% increase in the xEV purchase incentives being provided by the largest EV markets in Europe - Germany, Spain, Italy and France - since 2017.

✓ This led to a 140% boost in e-car sales in 2020, despite 22% decline in overall car market.

✓ ~40% growth in eLCV sales was seen, while e-truck & e-bus sales increased by 23% and 9% respectively.

**The new EU emission standard** had already set the momentum previously with a 44% ecar market growth in 2019.

**ICE bans/electrification targets** have been announced in 13 European countries including Norway, Sweden, Netherlands, apart from Germany, France & UK.

**European Clean Bus Deployment Initiative** is expected to drive e-bus market.

For 2Ws, emission compliance makes ICE more expensive; e2W more attractive

**Public charger deployment** is being driven by the Alternative Fuel Infrastructure Directive. Fast chargers grew 55% to 38,000 in 2020.





Total \$2.25  
trn spend  
announced for  
zero emissions,  
clean and  
efficient energy  
till 2050

**Though US' EV market  
share slipped with softer  
regulatory support,  
forthcoming policies &  
OEM plans augur  
turnaround**



## EVs sold/ registered

	2020	2025-F	2030-F
 <b>Global #3</b> [10%] 2018-20 CAGR -10%	0.3 mn	1.2 mn	2.5 mn
 <b>Global #5</b> [1%] 2019-20 Growth -18%	0.5 k	9.1 k	44.2 k
 <b>Global #3</b> [3%] 2018-20 CAGR 51%	0.2 k	60.3 k	86.7 k

### Industry Developments

- ✓ GM to invest \$35 bn for domestic EV & AV manufacturing including two new battery cell plants, in addition to Ohio and Tennessee.
- ✓ Ganfeng Lithium Co., LG-Chem, etc. may set up capacities in/ for US.
- ✓ Ford signed an MoU for a battery JV - BlueOvalSK with Phase1 production planned by 2025 of ~ 60 GWh/yr in traction battery cells and array modules.
- ✓ Apple in early-stage talks with CATL and BYD for battery supply for its planned EV, and building manufacturing facilities in the US.

Source: International Energy Agency (Stated Policies Scenario)

## New policy impetus is expected to drive growth





**New vehicle launches** have historically driven the US market. eg. 81% jump in e-car sales on launch of Tesla Model 3.

**New EV policy** push announced in 2020 is expected to drive growth:

- ✓ It comprises total \$2.25 trn spend for zero emissions, clean and efficient energy till 2050, including for EVs. EV support includes production incentives, purchase rebates & tax incentives, and 10X increase in charging points to 500,000.
- ✓ Mineral supply agreements for batteries and electronics are also being explored. Further, US Dept. of Energy's Argonne National Laboratory is emphasizing on R&D to reduce metal usage in battery and investing in recycling projects.

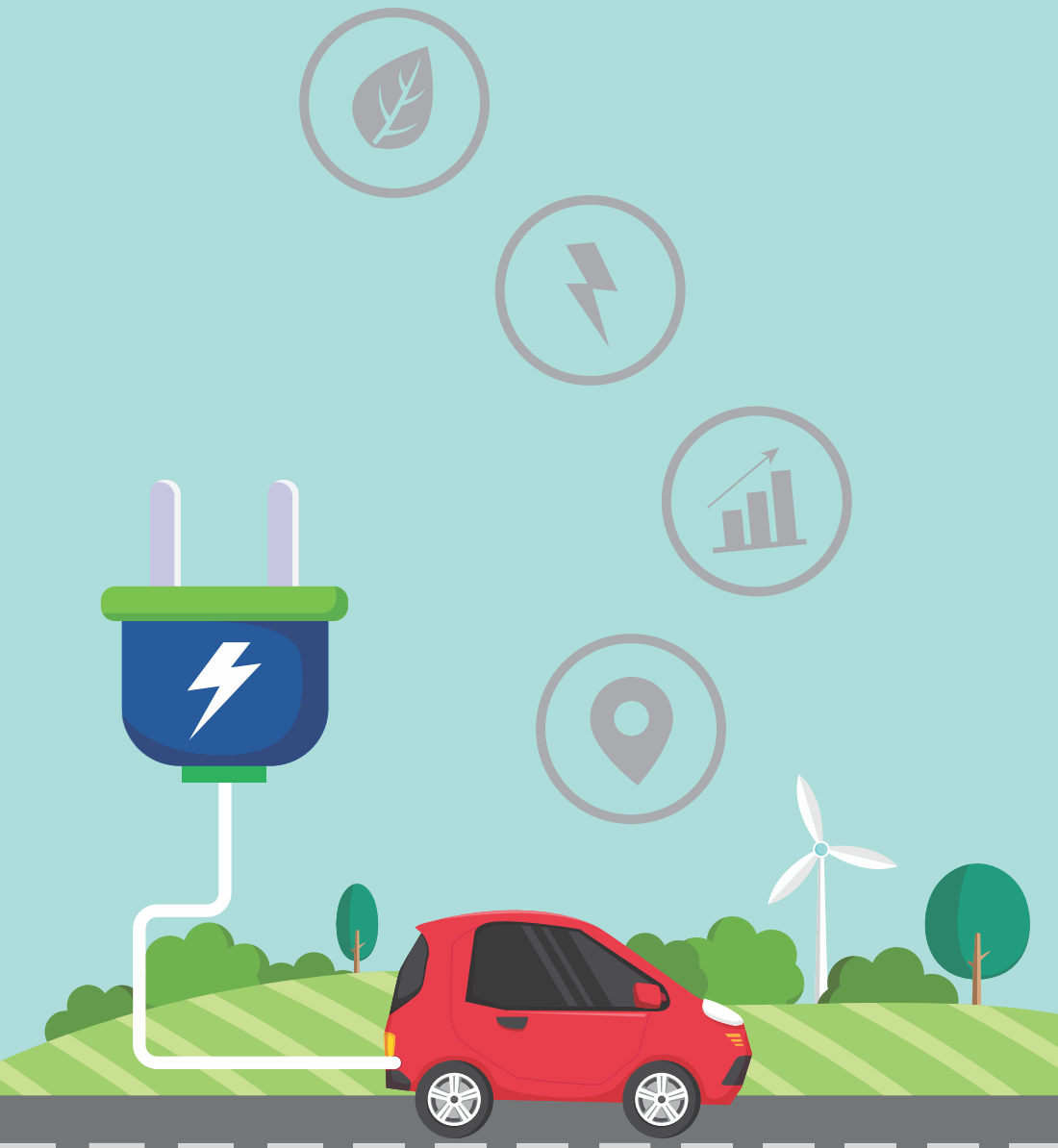
Softening of emissions regulations witnessed US market share in global e-car slipping from 21% to 10% over 2016-20, despite a 40% CAGR in sales volume over the period. The country is now ranked after China, which is 3X US e-car market.

# China drives EV supply and demand, despite shift in nature of incentives

EVs sold/ registered	2020	2025-F	2030-F
 Global #2 (39%)	1.2 mn 2018-20 CAGR 4%	4.5 mn 2020-30 CAGR 23%	8.9 mn
 Global #1 (41%)	39.2 k 2018-20 CAGR -32%	35 k 2020-2030 CAGR 7%	78.9 k
 Global #1 (95%)	77.8 k 2018-20 CAGR -8%	0.3 mn 2020-2030 CAGR 17%	0.4 mn
 Global #1 (90%)	6.7 k 2018-20 CAGR 104%	97.4 k 2020-2030 CAGR 36%	0.1 mn

## Industry Developments

- ✓ Mass market consumers have also started adopting EVs, with strong sales of smaller EV models eg. SGMW's Mini.
- ✓ Toyota Motor Corp and BYD Co. to introduce electric sedans and SUVs by 2020-2025, also collaborate on battery development.
- ✓ Renault planned a 2<sup>nd</sup> EV JV with a \$145 mn investment in JMEV
- ✓ CATL planned a battery plant and signed a 10-year NEV deal with GWM



## General Economic Demand and Strong Policy Actions - Key Drivers

**EV chargers** Total ~1.2 mn in China as of 2019; \$1.4 bn further earmarked for adding ~600,000 chargers.

**Li-ion battery:** China produces nearly two-third of all Li-ion batteries in the world and controls most of the world's lithium processing facilities.

**Subsidies & other incentives** (central & state) totaling \$60 bn have been provided till date driving development of local (e.g. NIO) & foreign players (JVs of BMW - GWM, Ford - Zotye Auto, Renault - Dongfeng; and Tesla)

- ✓ Planned phase out of subsidies has been extended to 2022 with a 10% reduction.

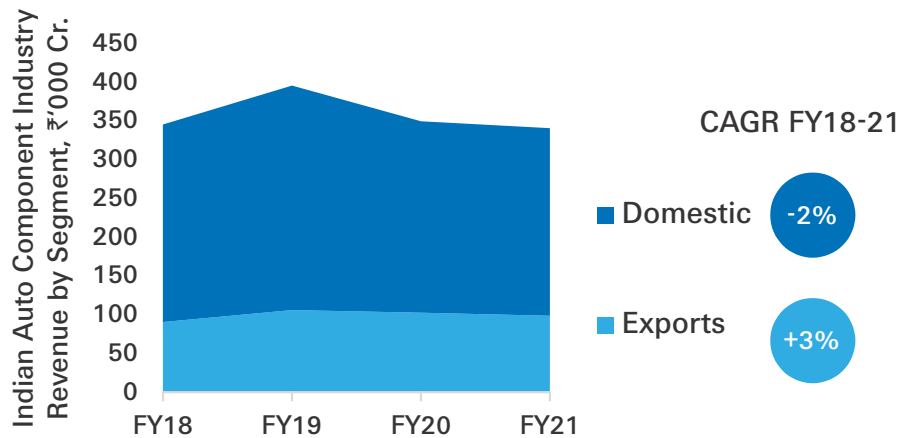
**New annual vehicle efficiency standards** introduced in 2018, support emissions credits from EV sales.

**EV sales target** of 40% of car sales by 2030.

**Ban on ICE 2 & 3 wheelers**, dedicated lanes and lack of registration requirements in many cities drove the 2017-19 surge in e2W sales.

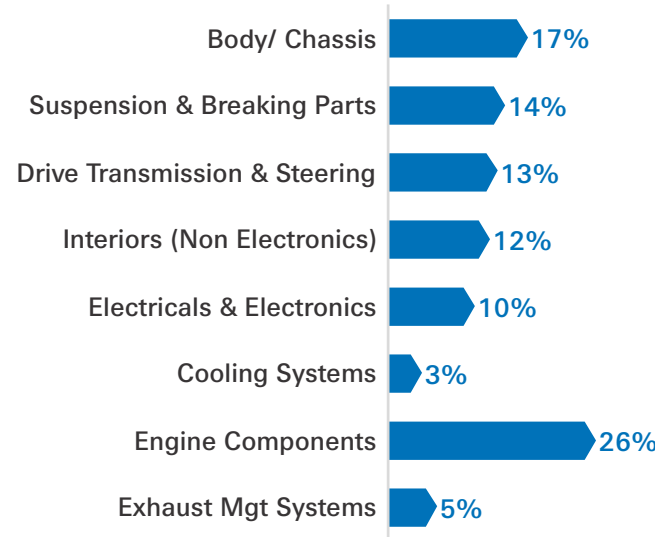
# Indian auto component players can leverage the EV opportunity to safeguard and grow in important export markets

Exports, at 29% share of revenues of Auto component industry, have remained resilient despite downturns in the domestic market



Source: CRISIL, ACMA

Share of Revenues for the Indian Auto Component Industry, FY 20



Ease of entering EV Component supply

Products can be carried forward to EVs with upgradations in capabilities and material/component sourcing

Can look to enter new segments in EV due to lower entry barriers

Indian auto component industry derives 29% of its revenues from the global market with Europe & North America accounting for 62% of exports from India. These markets would undergo significant development/ modification with electrification, hence, it is imperative for the industry to be future ready and take a closer look at the opportunities presented by electrification. This is to retain and also expand share in the global market that has supported the industry during domestic downturns.

Various approaches to entry can be explored: Many segments of the ICE auto component industry can be carried forward to EVs with some modification, while many other capabilities can be leveraged to enter EV specific segment with new products. Further, with relatively low entry barriers in the EV industry, many component manufacturers are finding it easier to move up the value chain. Many players are also finding it easier to become OEM players themselves, esp. in 2/3 wheelers where barriers to entry are lower.

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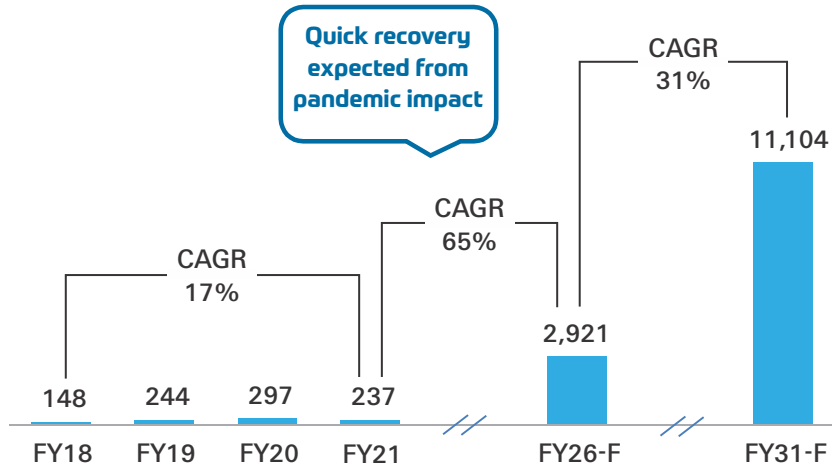
# EV Market Overview

1.1 Global Perspective

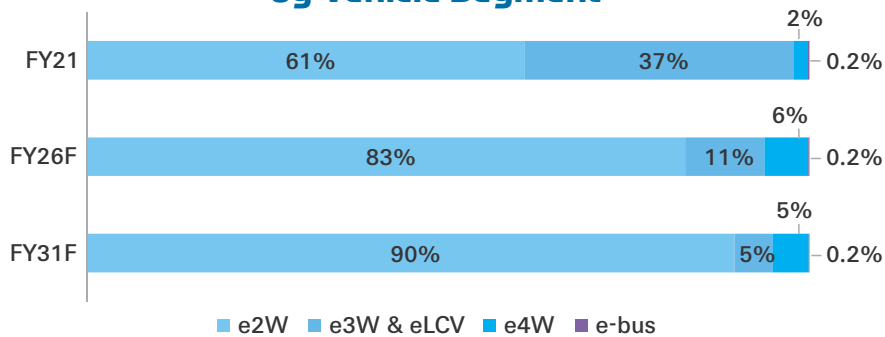
1.2 India Perspective



### India's EV Market Volume ('000)



### India's EV Market Volume Composition by Vehicle Segment



Vehicle volumes represent registered vehicles only

Source: Industry estimates, expert interviews, YES BANK Analysis

# EVs in India poised for a promising growth story





- ✓ EV adoption in India is starting to see traction, aligned with global trends but with a different segmental mix.
- ✓ Growth in e2W and e3W segments is driven by favorable TCO narrative but growth in e4W and e-bus segments is driven majorly by Government push for clean mobility.
- ✓ Clean mobility has emerged as a focus area as the Government endeavors to meet its Paris Climate Change Agreement (2015) to cut Green House Gas emissions intensity of its GDP by 33-35%.
- ✓ Central Government initiatives (FAME II, MoRTH's regulations around EV) are being complemented by State EV Policies.
- ✓ Dual objectives of CAFE regulation and reducing India's oil imports are also expected to provide impetus to e-mobility.

# DEMAND to be initially driven by Government impetus; inherent factors to drive demand in the medium to long term

	Short-term	Medium-term	Long-term
<b>Drivers</b>	Government creating market & scale		
	Government improving affordability		
	Enabling infrastructure		
	Emission reduction		
	Lifecycle costs		
	Driving comfort & variety		
<b>Challenges</b>	Consumer resistance		
	Range anxiety, charging infrastructure		
	Limited models		
	High upfront costs		
	Safety concerns		
			Power infrastructure



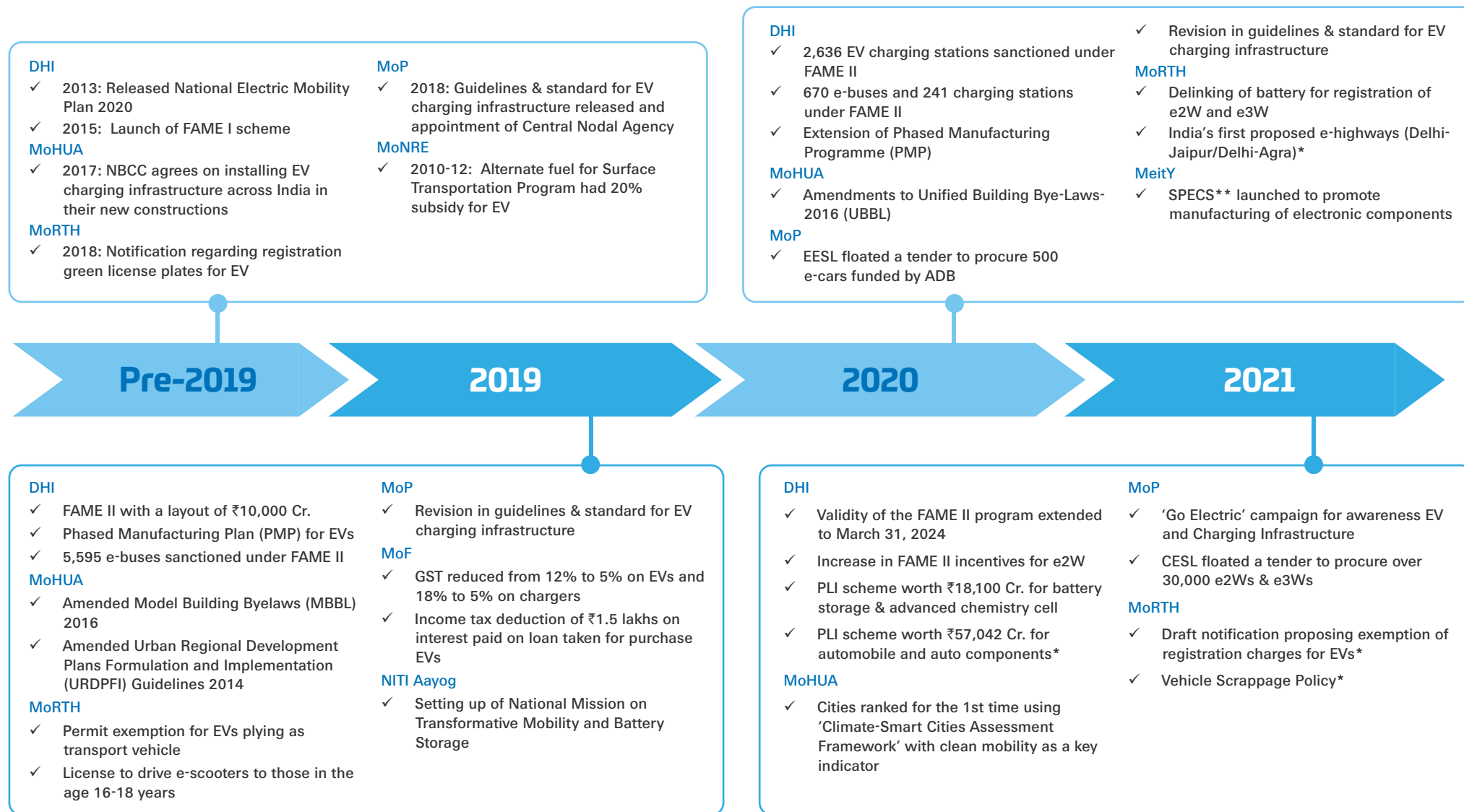


# SUPPLY-side headwinds to ease out in medium term; Government focus on localization and high penetration potential to drive growth

	Short-term	Medium-term	Long-term
<b>Drivers</b>	High market penetration potential		
	Manufacturing incentives, localization requirements		
	Lower entry barrier		
	First mover advantage		
	Reducing technology, battery prices		
<b>Challenges</b>	Inverted duty structure		
	Nascent ecosystem and limited supplier base		
	Access to raw material		
	Developing capacity & capability		
	Risk of technological obsolescence		



# DHI FAME II is among the key government-led drivers for EV adoption



\*Indicates initiatives in draft or proposed stages

\*\*Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors

A row of orange electric delivery vehicles, likely for last-mile delivery, parked in a warehouse. The vehicles are arranged in a line, receding into the background. The focus is on the front of the first vehicle, showing its headlight and front fender. The background is slightly blurred, showing the interior of a large industrial building with overhead lights.

# 02

## E-Vehicle Segment Opportunity Overview

### 2.1 E-Two Wheeler

### 2.2 E-Three Wheeler and E-LCV

### 2.3 E-Four Wheeler

### 2.4 E-Bus

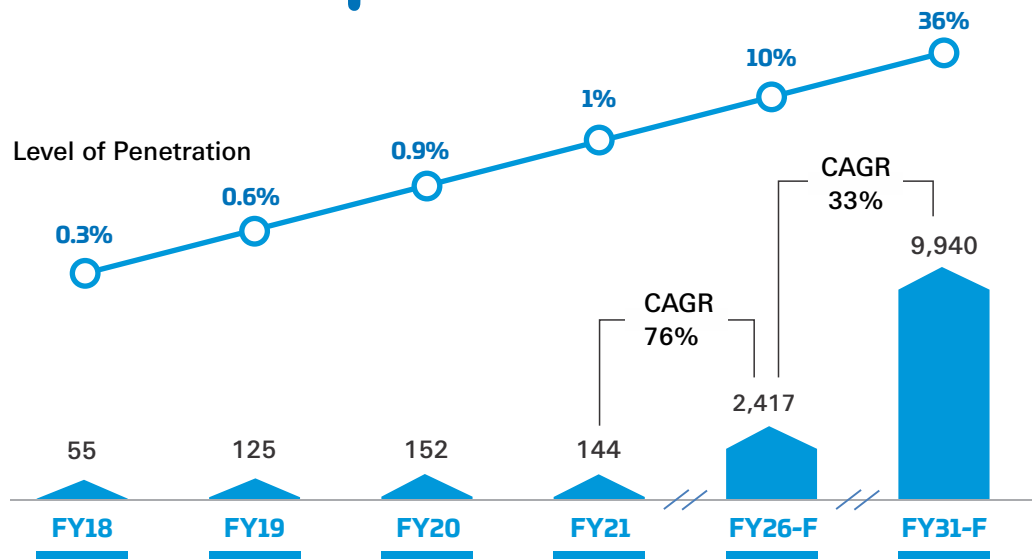
### 2.5 Other EV Segments

### 2.6 Segmental Opportunity Mapping

# e2Ws expected to lead EV penetration, reaching >2 mn and >9 mn vehicles annual sales by FY26 and FY31 respectively



e2W Sales ('000)



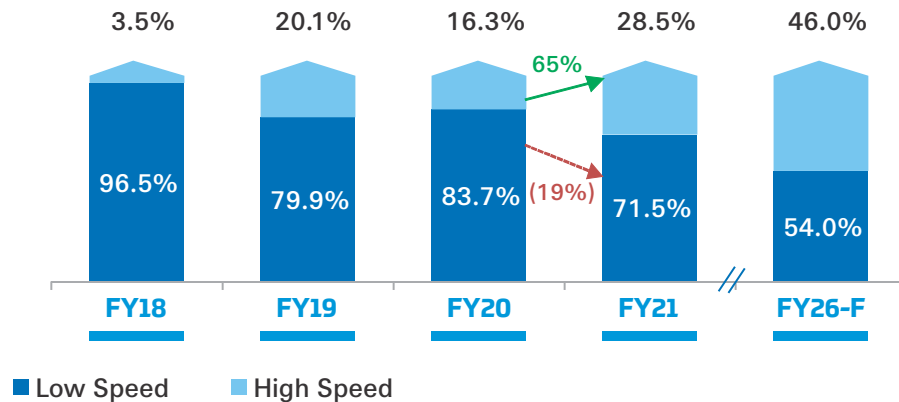
Excludes e-cycles

Source: Industry estimates, expert interviews, YES BANK Analysis

- ✓ India is world's largest two wheeler (2W) market with ~15 – 20 mn vehicles sold annually, that comprise ~80% of all types of vehicle registrations in India (FY21)
- ✓ Electrification of 2W is increasing with penetration expected to grow from ~1% to ~10% during FY21-FY26
- ✓ e2W segment has 30+ manufacturers with many new and non-traditional players entering the space. Top 3 players account for ~70% of market in high speed e2W segment
- ✓ Commercial use of e2W in last-mile and hyperlocal deliveries will drive the initial growth given the TCO parity with ICE vehicles. This is expected to be further strengthened by e2W - related ecosystem partnerships between aggregators & e-commerce entities, and fleet greening commitments of large multinational companies.
- ✓ New players entering the high speed market include OLA Electric and Ultraviolette

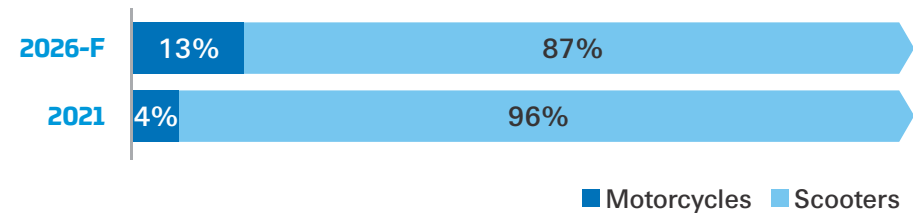
Share of high speed models in the overall e2W sales is set to rise given favorable policy push and better quality offerings. High Speed e2Ws have seen a YoY growth of ~65%, vs ~19% decline in Low Speed in FY'21.

### Trend in e2W sales mix in India



Source: ICRA, CRISIL, expert interviews

### Trend in e2W sales by segments



OEMs	Indicative list of players
ICE Auto	Bajaj Auto, Hero MotoCorp, Piaggio, TVS Motor
Pure EV & Startups	Ampere, Ather Energy, BGauss, EeVe, Emflux, Hero Electric, Jitendra EV, Lohia, Okinawa, Pure EV, Revolt, Tork Motors

# e2W penetration remained subdued during FY21, yet supported by strong drivers

**Impact**  
Short-term Long-term

**Subsidy & Regulatory**

FAME II & other regulatory announcements have triggered growth impetus in the e2W segment. Recent enhancements in adoption subsidy & delinking of batteries for EV registrations is expected to further accelerate sales.

The Government plans to launch a new charging protocol for light vehicles, including e2W, to push penetration of small format vehicles.



**TCO Positive**

On a lifetime ownership cost basis, e2Ws turn out to be cheaper over an ICE variant, especially for commercial use case. Low speed/cost e2W would achieve The TCO for high speed e2Ws is also attractive for commercial use. Growing fuel prices act as a further booster, reducing the ICE-EV price gap due to rising operational costs for ICE models.

**TCO in ₹/km**

e2W (Low Speed- Private)	1.88
e2W (High Speed- Private)	3.18
2W (Petrol- Private)	2.31
e2W (Low Speed_Commercial)	0.67
e2W (High Speed_Commercial)	1.14
2W (Petrol- Commercial)	1.27

Source: WRI India

**Daily commute**  
2W (Comm.) – 75Km | 2W (Pvt.) – 25Km



**OEM Landscape**

Over the last few years, India's e2W segment has witnessed ~\$600 mn investment, fueling the supply ecosystem. Leading firms such as Hero Electric, Ather Energy, Ampere, Okinawa, are also expanding manufacturing facilities across India.

The number of players and dealership expansion is on the rise, and key incumbent ICE players have launched their e-variants, with more planned. The world's largest 2W market can evolve actively in the e2W space.



**Low Barriers to entry**

Unlike ICE 2W vehicle manufacturing, due to lower number of components that can be relatively easily sourced with limited capex requirements, this segment is also witnessing interest from several non-traditional auto OEMs, which will eventually drive the overall supply scenario.



**Battery Swapping**

Battery Swapping is emerging as a viable alternative specially for fleet level operations, as it offers a similar refueling experience as ICE-vehicles while reducing the high upfront cost of the vehicle by 30-40%. This is also expected to enhance battery life and health given the controlled environment for charging, in addition to creating operational efficiencies for repurposing/ discarding batteries.



# Market witnessing multiple sub-segments aligned to various commuter & cargo requirements


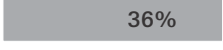

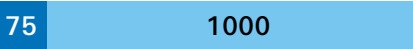



























## e2W Sub-segment Overview

Features	e-cycle (Vehicle Price: ₹20-50k)	Scooter					Motorcycle
		Low Speed ₹ 40-70k	City Speed ₹ 55-80k	High Speed ₹ 75-120k	Premium Scooters ₹120k+	Others ₹90-100k	Commuter ₹100-180k
<b>Top Speed</b>	25 kmph	25 kmph	40-55 kmph	55-80 kmph	70-85 kmph	80-100 kmph	80-95 kmph
<b>Range</b>	25-35 km	40-80 km	80-130 km	70-110 km	80-95 km	100-120 km	75-140 km
<b>Battery specs</b>	250-450 Wh	1.25-1.8 kWh	1.5-2.0 kWh	2-3.5 kWh	~3-4 kWh	4 kWh	4-6 kWh
<b>Connected features</b>	Mobile App (tracking device, sensors, etc.)	Mobile app (tracking device, sensors, etc.)	Mobile app (tracking device, sensors, etc.)	Mobile app (tracking device, sensors, OTA updates etc.)	Mobile app (tracking device, sensors, OTA updates, ride statistics, remote charge monitoring, parking assist etc.)	Mobile app (tracking device, sensors, OTA updates etc.)	Mobile app (tracking device, sensors, OTA updates etc.)
<b>Target customer segment/Usage</b>	<ul style="list-style-type: none"> <li>✓ B2C – health, commute</li> <li>✓ B2B – cargo, last mile delivery, Shared mobility</li> </ul>	<ul style="list-style-type: none"> <li>✓ B2C – commute</li> <li>✓ B2B – cargo, last mile delivery, Shared mobility</li> </ul>	<ul style="list-style-type: none"> <li>✓ B2B – cargo, last mile delivery, Shared mobility</li> </ul>	<ul style="list-style-type: none"> <li>✓ B2C – commute</li> </ul>	<ul style="list-style-type: none"> <li>✓ B2C – commute</li> </ul>	<ul style="list-style-type: none"> <li>✓ B2C – commute</li> </ul>	<ul style="list-style-type: none"> <li>✓ B2C – commute</li> </ul>
	<b>20+ companies</b>	<b>30+ companies</b>					

Source: Company announcements, expert interviews

Note: Information is indicative and not exhaustive

# Growing demand spurs OEM investment to enhance capacities and network for expanding the supply ecosystem

Players	Market Share, FY21 (high speed >25kmph)	Sales growth FY20-21	Production Capacity ('000 units/yr) Planned Expansion	Number of Dealerships	Approved Models   Range of incentive availed under FAME II (₹)	Plant Location
 <b>HEROELECTRIC</b> The smart move	 36%	 ~100%	 75      1000 ₹700 Cr. expansion plan by 2025. Additional capacity expected by 2025-26 (Jul'21)	600+	10      14,572 - 21,700	Ludhiana, PB
 <b>OKINAWA</b> Power the Change	 17%	 (31)%	 90      500 Additional capacity expected by 2021-22 (Dec'20)	500	4      17,000 - 30,000	Bhiwadi, Alwar, RJ
 <b>AMPERE</b> By GREAVES	 14%	 136%	 50      250 Plans Investment of ₹700 Cr. for e-mobility manufacturing plant in Ranipet, over 10 years (Feb'21)	500	4      26,732 - 29,000	Coimbatore, TN
 <b>ATHER</b>	 11%	 50%	 110      300 Additional capacity expected by 2023-24 (Apr'21)	~20	2      18,000 - 19,600	Bengaluru, KA Hosur, TN
 <b>REVOLT</b>	 4%	 161%	 120	11	2      27,000 - 30,000	Manesar, HR
 <b>BAJAJ</b>	 4%		Announced an investment of ₹650Cr. towards setting up a new manufacturing plant in Chakan, Pune- to manufacture e2W (Dec'20)	2		Pune, MH
 <b>BENLG</b>	 3%		 36      100 To expand manufacturing plants in Pune and Chennai (Nov'19)	52	1      23,300	Manesar, HR
 <b>TVS</b>	 2%		 12 Plans to invest ₹500-600 Cr. as capital expenditure in FY22, mostly into e2W & e3W, emerging technologies and products (Mar'21)	2	1      22,500	Hosur, TN
<b>Others (Eg.)</b>						
 Tunwal	 9%				Tunwal 5      24,000 - 28,800	Gandhi Nagar, GJ
 <b>JITENDRA</b>					Jitendra EVT 3      19,720 - 22,000	Nashik, MH

 Present Production Capacity     Additional Planned Production Capacity

Ola Electric, with its ₹2,400 Cr. plant with initial annual capacity of 20 lakh, and building of a large, dense charging network, is expected to significantly boost the market when it launches its e2W

Source: DHI, Company websites and brochures, auto industry portals, media reports, expert interviews



# Segment witnessing strong activity and investment, with several new entrants, partnerships & funding

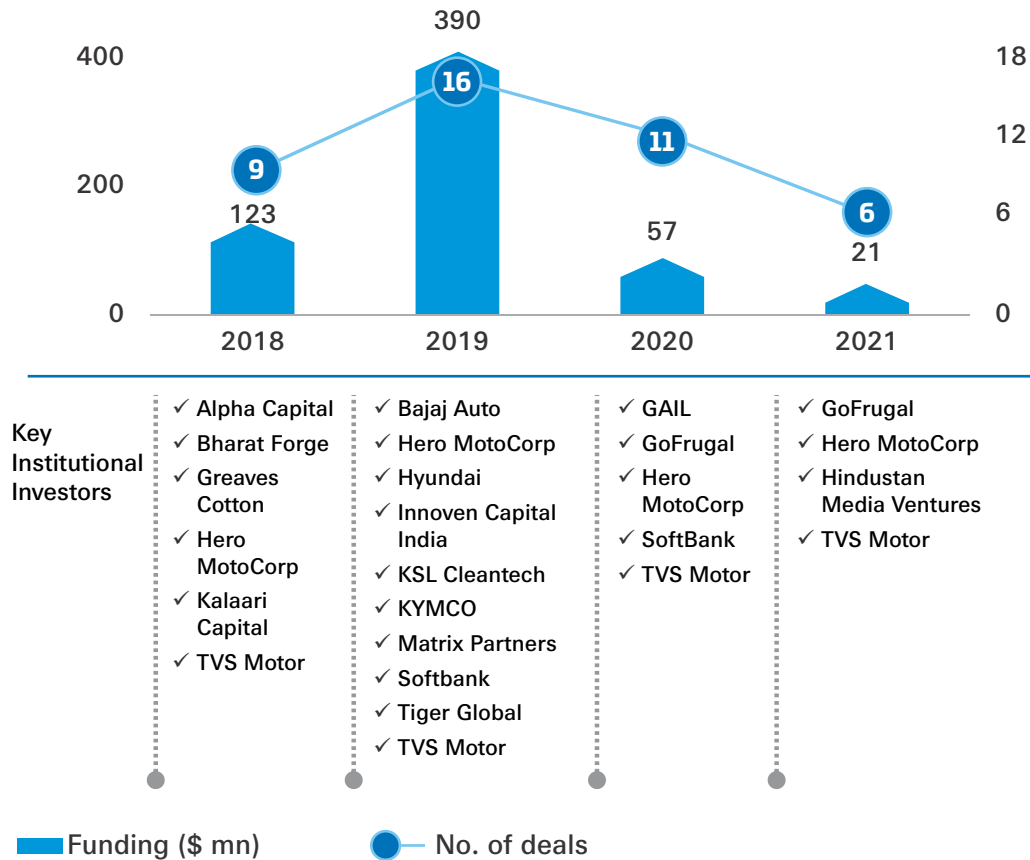


Value Chain Partnerships	
<b>Batteries and Charging Infrastructure</b>	<ul style="list-style-type: none"> <li>✓ Hero Electric – EV Motors (battery &amp; charging)</li> <li>✓ Hero – Gogoro (manufacturing and swapping network)</li> <li>✓ Honda, KTM, Piaggio, Yamaha (battery consortium alliance)</li> <li>✓ TVS – CESL (charging infrastructure)</li> <li>✓ Voltup – HPCL (swapping stations)</li> </ul>
<b>OEM Acquisitions</b>	<ul style="list-style-type: none"> <li>✓ KTM – Bajaj (platform sharing, manufacturing)</li> <li>✓ Ola Electric – Etergo (acquisition)</li> </ul>
<b>Fleet Partnerships</b>	<ul style="list-style-type: none"> <li>✓ Ampere Electric – Bounce (bike rental)</li> <li>✓ Hero Electric – eBikego (fleet scooters)</li> </ul>
<b>Sales Support Partnership</b>	<ul style="list-style-type: none"> <li>✓ CredR – Hero Electric (exchange of 2W with e2W)</li> <li>✓ cKers Finance - OTO Capital (e2W leasing)</li> </ul>
<b>Traditional Auto &amp; Business House Investments</b>	<ul style="list-style-type: none"> <li>✓ Bharat Forge - Tork Motor (investment)</li> <li>✓ Greeves Cotton – Ampere (acquisition)</li> <li>✓ Hero MotoCorp – Ather (investment)</li> <li>✓ RR Global – BGauss (launched e2W brand)</li> </ul>

## Investment Trends

Within the e2W OEM space, premium & high speed e2W manufacturing companies have received ~80% of the total investments in the e2W space in 2020

e2W market investment overview (FY18-21)



Disclosed deals only



- ✓ On demand side, increasing traction in TCO positive sub-segments, especially in commercial use vehicles, along with quality product offerings, rationalized by policy incentives are expected to drive e2W adoption.
- ✓ On the supply side, ease of entry into the e2W segment in world's largest two wheeler market offers a unique opportunity for new entrants and auto component players to move up the value chain.



02

# E-Vehicle Segment Opportunity Overview

2.1 E-Two Wheeler

**2.2 E-Three Wheeler and E-LCV**

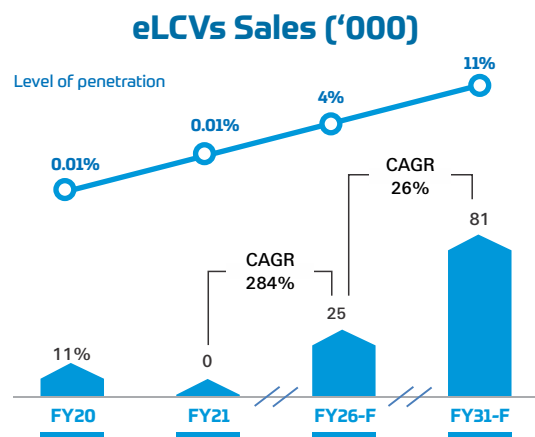
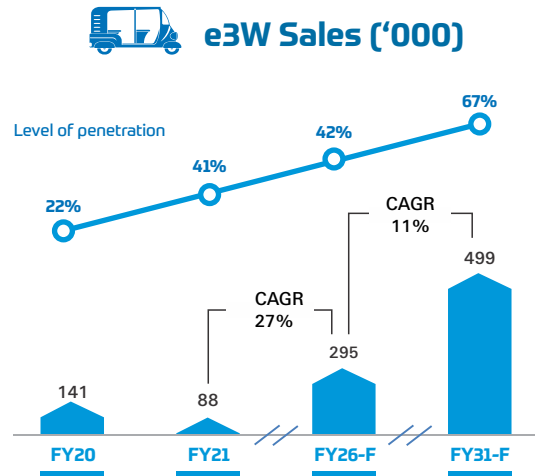
2.3 E-Four Wheeler

2.4 E-Bus

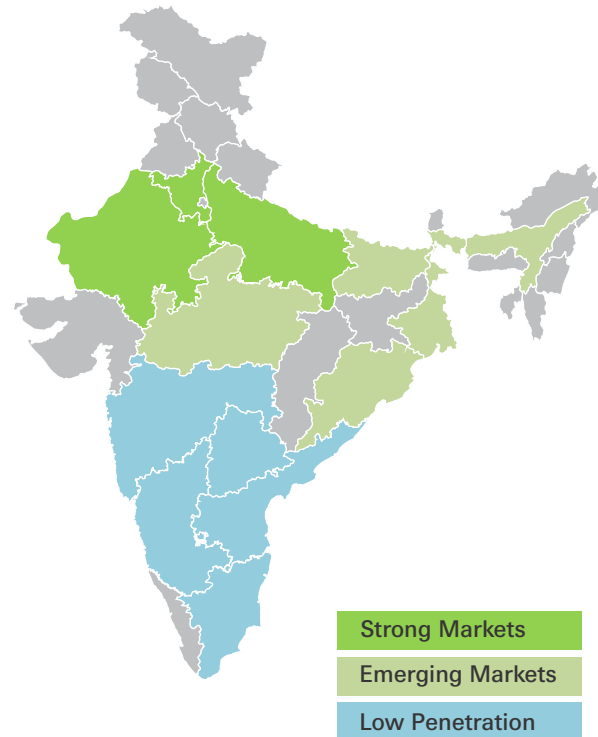
2.5 Other EV Segments

2.6 Segmental Opportunity Mapping

# Two thirds of the 3W market to be electric by 2030; LCVs expected to have 11% penetration by then



## Major Markets – e3W



- ✓ High speed e-autos, first launched in 2020, have shown significant growth driven by B2B market and shared mobility
- ✓ Electric rickshaws are replacing cycle rickshaws in tier-I and II cities
- ✓ Share of cargo e3w increased from 3.7% to 11% over FY20-21 as the category grew by 97%, even as passenger e3W declined by 43%
- ✓ Being leaders in three wheelers globally, India can also tap into export markets such as Africa for enhancing scale
- ✓ eLCVs including retrofits have started being introduced. Despite the nascent segment and limited number of players, this subsegment shows growth potential, but with the key challenge of competitive pricing for an ICE comparable performance.

Vehicle volumes represent registered vehicles only

Source: Industry estimates, expert interviews, Vahan dashboard, YES BANK Analysis

# Inherent advantages, business models and fleet greening commitments drive the segment

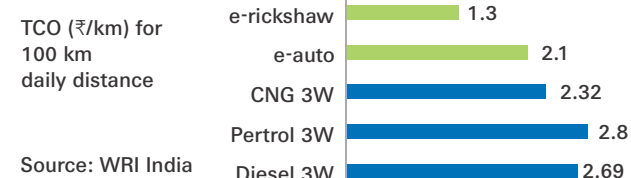
## Subsidy & Regulatory Push

Recent FAME II enhancements in adoption subsidy (₹15,000 per kWh) & delinking of batteries for EV registrations is expected to accelerate sales. Demand aggregation of 300,000 e3W by EESL shall boost initial demand accelerating industry's tipping point

Impact	
Short-term	Long-term
✓	✓

## Favorable TCO

Total Cost of Ownership (TCO) for e3W ~40% less than comparable ICE 3W owing to low operation and maintenance cost over the vehicle life and growing fuel prices. This makes it attractive for commercial use such as for hyper-local and last-mile deliveries.



✓	✓	✓
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## Battery Swapping

Battery swapping is emerging as a viable alternative, especially for fleet operations, since it offers a similar re-fueling experience as ICE vehicles, while reducing the upfront cost of the vehicle by 30-40%. This is also expected to enhance battery life and health given the controlled environment for charging, in addition to creating operational efficiencies for re-purposing/ discarding batteries.

✓	✓	
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## Replacement Market

Basis the TCO of the vehicle & increased business use case, cycle rickshaws in tier-2 and tier-3 cities are moving towards low speed e3W, driving this segment

✓	✓	
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## Localization of EV components

With significant push from Government of India, e3W industry is expected to be fully localized by FY25, further rationalizing the cost of manufacturing and driving adoption.

✓	✓	✓
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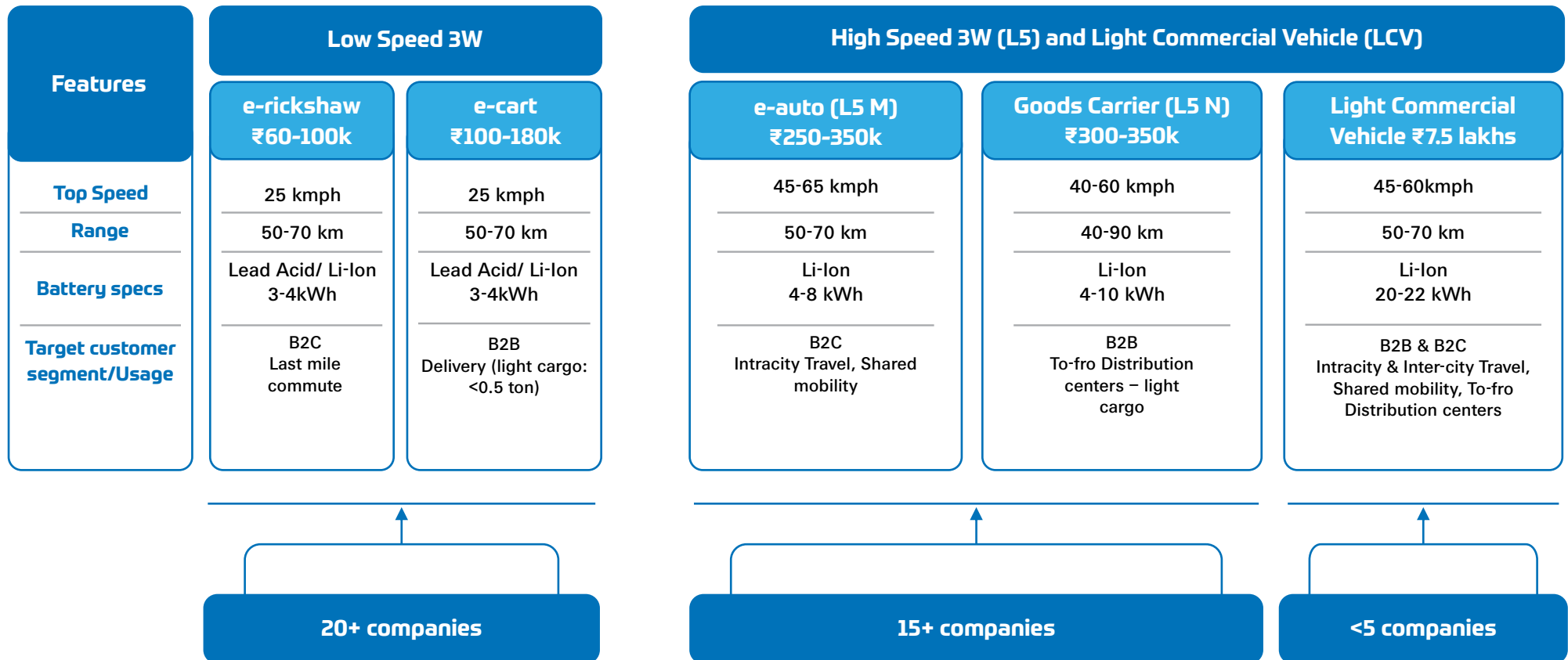
## Fleet Greening commitments & newer business models for corporate adoption

Several fleet owners and aggregators have pledged greening their fleet partly or fully by 2025. These commitments combined with newer financing models such as leasing being evaluated by OEMs are a strong demand driver especially for the cargo segment.

✓	✓	✓
---	---	---

# OEMs are launching new products to remain competitive and drive business growth










## e3W Sub-segment Overview



Source: Company announcements, expert interviews

Note: Information is indicative and not exhaustive

# Though unorganized players abound; higher end e3W are dominated by a few start-ups, and large OEMs

Top Player	Present OEM Production capacity ('000 units/yr)	No of dealers	Number of FAME II approved Models	Approved Models	Range of incentive availed under FAME II (₹)	Plant Location
 <b>PIAGGIO</b>	350	725	8	Ape E city, Ape E city fx, Ape E-xtra Fx PU, Ape ExtraFx, Ape ExtraLx, Ape E-Xtra LX PU, Ape E-xtra LX DAC, Ape E-xtra fx DAU	42k - 78k	Pune , MH
 <b>KINETIC GREEN</b> <small>100% Electric 100% Green</small>	72	60	5	Safar Smart LFP, Safar Shakti, Safar Smart, Safar Star, Safar Jumbo	34k - 82k	Pune, MH
 <b>Mahindra electric</b>	25	43	7	Treo Yaari HRT, Treo HRT, Treo SFT, Treo Yaari SFT, Treo Zor, Treo Zor FB, Treo Zor DV	34k - 74k	Mumbai , MH
 <b>CSM</b>	12	NA	1	Rage +		New Delhi
 <b>LOHIA</b>		100+	3	Narain I, Narain iCE, Humafar iB		New Delhi
 <b>VICTORY</b> <small>ELECTRIC INTERNATIONAL Manufacturers of Battery E-Autoshare, E-Car A ICAT Approved &amp; ISO Certified Company</small>		85	4	Victory Vikrant, Victory+, Victory Bhim, Victory Bhim Cleaner	38k - 42k	Jhajjar, HR
 <b>ATUL</b> AUTO LIMITED		18	2	Atul Elite + , Atul Elite Cargo	42k	Rajkot, GJ
 <b>SAARTHI</b> <small>ride with trust...</small>		45	3	Saarthi Shavak Auto, Saarthi Shavak DLX E, Saarthi F2	37k - 66k	New Delhi
 <b>E-TRIO</b>		NA	3	Touro Max Loader, Touro Mini Loader, Touro Mini Passenger	38k - 73k	Hyderabad

Established players such as Piaggio and Mahindra along with new entrants such as Etrio are availing subsidies by Government of India to push newer e3W models

Source: DHI, Company websites and brochures, auto industry portals, media reports, expert interviews

# Ecosystem partnerships, and capital flows/ investments are driving momentum in the sector

## Recent Industry Trends

### New Entrants

- ✓ Ashok Leyland is expected to roll-out its first LCV in FY22
- ✓ Tube Investments (India) partnered with a Korean firm for e3W manufacturing with an investment outlay of ₹200 Cr.
- ✓ Ampere acquired 74% stake in e-rickshaw company Bestway to enter the segment

### Fleet Contracts

- ✓ Mahindra partnered with Amazon India and deployed 100 Tero Zor vehicle in 7 cities
- ✓ ETO Motors agreed to deploy 300 units of BULKe (L5 category) to BigBasket
- ✓ Altigreen partnered with EV fleet operator MoEVing for last mile delivery of goods in Delhi

### Ecosystem Partnerships

- ✓ Sharda Motors tied up with Kinetic Green Energy for battery pack and BMS
- ✓ Revfin, a fin-tech platform, tied up with Saera Electric (Mayuri eRickshaws)
- ✓ Omega Seiki tied up with Mannapuram Finance for financing e3W

- ✓ Amidst the industry wide slowdown, this is another segment after e2W which is growing at a strong rate, with low upfront cost and good TCOs in shared mobility/ commercial transport. Adoption is more commercially viable for last mile delivery (e-rickshaws, e-carts, L5) basis the growth of e-commerce.
- ✓ Faster adoption is also witnessed in municipal corporations – given economic viability of e-rickshaws for garbage collection.
- ✓ The cargo segment, L5 category is quickly capturing the small commercial vehicles delivery logistics share, largely because of its cost factor, ease of operation and loading capacity for the growing e-commerce marketplace.

## Investment trends

Startup investments have picked up over the last couple of years with many in pipeline

### Key Capital Raise Deals, 2020-21

Year	Company	Raised	Investors
2021	GMW	\$50 mn	GEM Global
2021	OYE Rikshaw	\$3.2 mn	Matrix Partners, Alteria Capital
2020	eTrio	\$3 mn	Singapore HNIs
2020	Euler	\$2.6 mn	ADB Ventures
2020	Cell Propulsion	\$1 mn	GrowX Ventures, Micelio, Endiya Partners

Note: Disclosed deals only



A white electric car is shown from a side-rear perspective, with a white charging cable plugged into its charging port. The car is parked on a light-colored surface. The background is a soft, out-of-focus white.

02

## E-Vehicle Segment Opportunity Overview

2.1 E-Two Wheeler

2.2 E-Three Wheeler and E-LCV

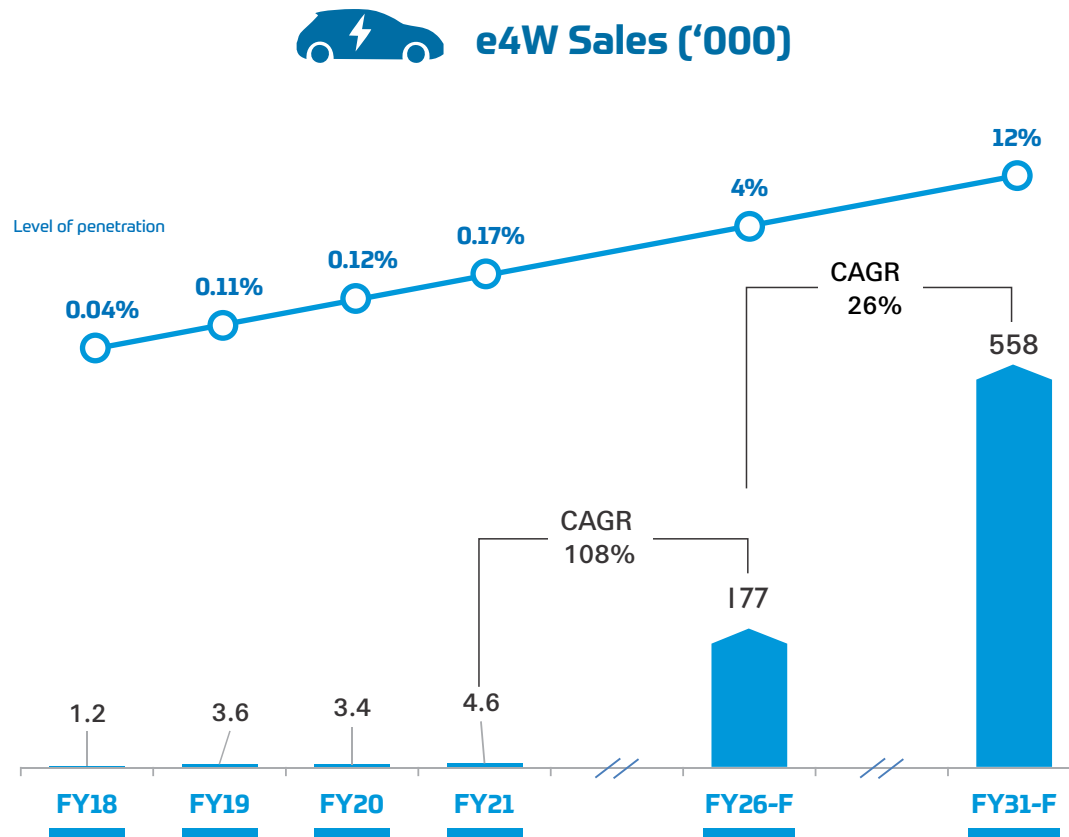
**2.3 E-Four Wheeler**

2.4 E-Bus

2.5 Other EV Segments

2.6 Segmental Opportunity Mapping

# e4W adoption in India slower than global markets; higher upfront costs, charging & range anxiety major factors



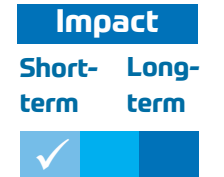
Source: Industry estimates, expert interviews, Vahan dashboard, YES BANK Analysis

- ✓ India's e4W market has witnessed 4,600+ registration in FY21, a 35% YoY growth.
- ✓ A price sensitive market, India witnessed ~78% ICE car sales in the sub ₹10 lakhs segment. With limited models in this segment, e4Ws may witness mass adoption subsequent to e2W & e3W segments.
- ✓ TCO is favorable for the commercial car segment that imply that e4W will witness better adoption rates led by taxis and fleet operations. The addressable market for e4W is low as commercial segment is ~13% of total cars sold in 2019.
- ✓ Convergence Energy Services Limited (CESL), a subsidiary of Energy Efficiency Services Limited (EESL) has been aggregating demand for deployment of e4Ws across Central & State Government entities and has deployed/under deployment 1,514 e4Ws in ~42 cities.
- ✓ FAME II incentivizes commercial e4Ws with an upfront purchase incentive of ₹10,000 per kWh.

# Commercial fleet operators supported by newer affordable models to drive initial adoption

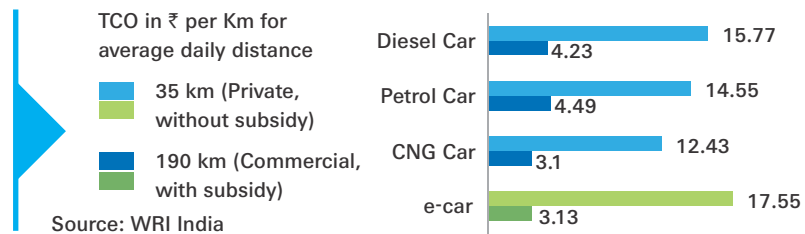
## Subsidy & Regulatory Push

FAME II offers demand incentive of ₹10,000 per kWh on commercial e4W wheelers for up to 35,000 vehicles. A total of ₹525 Cr. has been allocated under the scheme for the category. With increasing number of eligible models, commercial e4W are expected to witness uptake in the short-to-medium term.



## Favorable TCO

Industry estimates indicate a TCO comparable to CNG vehicles that is better than diesel & petrol 4W for daily average runs of ~200 km or higher. Hence, commercial fleet operators, including cab aggregators, typically in Tier I & II cities are expected to drive the initial demand for e4W. Growing fuel prices act as a booster, further reducing the EV-ICE price gap on operational basis.



## Demand aggregation

CESL is implementing a plan for aggregating e4W demand on dry & wet lease models and outright purchase. This is expected to create a consistent initial demand while driving adoption by Government and its undertakings.



## Commercial Fleet Operators

Given the favorable TCO associated with high daily utilization, several electric-only fleet operators and ride sharing platforms are emerging such as BluSmart, eee-Taxi, Lithium Urban Technologies, among others. Other established players such as Uber, Zoomcar, etc. have also committed electrifying their fleets over the mid to long term horizons.



## OEM driven models & partnerships

The sub ₹15 lakhs segment is crucial for India's market and higher sale of Tata Nexon EV can drive more launches in this segment. Also active OEM partnerships across the EV ecosystem in areas like adoption, charging infrastructure, battery management etc. will enable the initial synergies needed for market stability & consumer confidence.



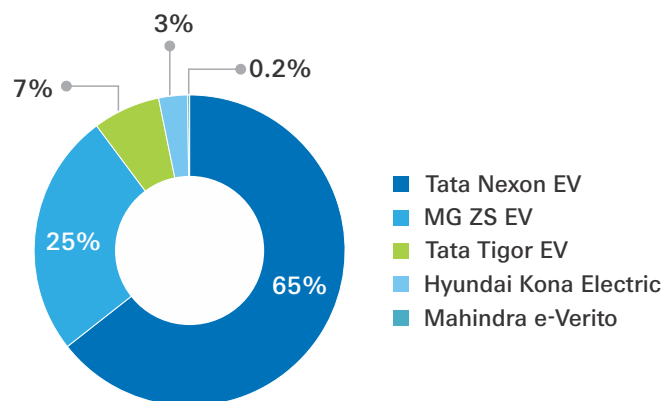
## Charging Infrastructure Development

Unlike the smaller EV segments, e4W adoption will have a stronger influence of growing charging infrastructure. DHI has already sanctioned establishment of 2,877 charging stations in India under FAME II and NHAI plans to setup over 600 charging stations across 22 states in India. Additional charging infrastructure plans by various state governments, smart cities & OEMs is expected to further drive the e4W adoption in India.



# While limited models are available in market; many major OEMs have announced EV pipelines

e4W Sales Share by Volume, FY21



- ✓ e4W market has seen limited models launched in India, with only 7 models on sale as of July 2021, including 3 models approved under FAME II scheme.
- ✓ Nearly all major OEMs have laid down EV road-maps for new vehicle launches across segments. Current market leader Tata Motors plans to launch 10 new EVs by 2025, while Jaguar is planned to be all-electric by 2025. Global EV leader Tesla also plans to launch in India.
- ✓ Upcoming new EV launches include Tata Altroz EV, Mahindra eXUV300 and eKUV100, Audi e-tron, Volvo XC40, T, Volkswagen ID4.
- ✓ OEMs providing vehicle financing options through subscription and leasing plans is rationalizing upfront purchase costs of EVs. E.g. MG Motor partnership with Zoomcar and Orix, Tata Motor's subscription plan, etc.
- ✓ Most global OEMs have developed their EV platforms (individually/ in-partnership) which are likely to be used for forthcoming EV launches eg. Volkswagen MEB, Renault-Nissan-Mitsubishi (CMF-EV), etc. Indian OEMs are also following suit.

Parameter	Tata Xpres - T EV	Mahindra eVerito	Tata Nexon EV	MG ZS EV	Hyundai Kona Electric	Mercedes Benz EQC	Jaguar I-PACE
<b>Max Speed (Km/h)</b>	80	86	120	140	154	180	200
<b>Peak Power (kW) rpm varies</b>	30	31	95	105	100	300	294
<b>Peak Torque (Nm) rpm varies</b>	105	91	245	353	395	760	696
<b>Range (Km) MIDC or WLTP</b>	213	181	312	419	452	445 - 471	470
<b>Battery Capacity (kWh)</b>	21.5	21.2	30.2	44.5	39.2	80	90
<b>Price (₹lakhs) Ex-showroom; Delhi</b>	9.58 - 9.90	10.15 - 10.49	13.99 - 16.85	20.99 - 24.18	23.78 - 23.97	104+	105.9 - 112.3

Source: DHI, Company websites and brochures, auto industry portals, media reports, expert interviews, YES BANK Analysis

# 02

## E-Vehicle Segment Opportunity Overview

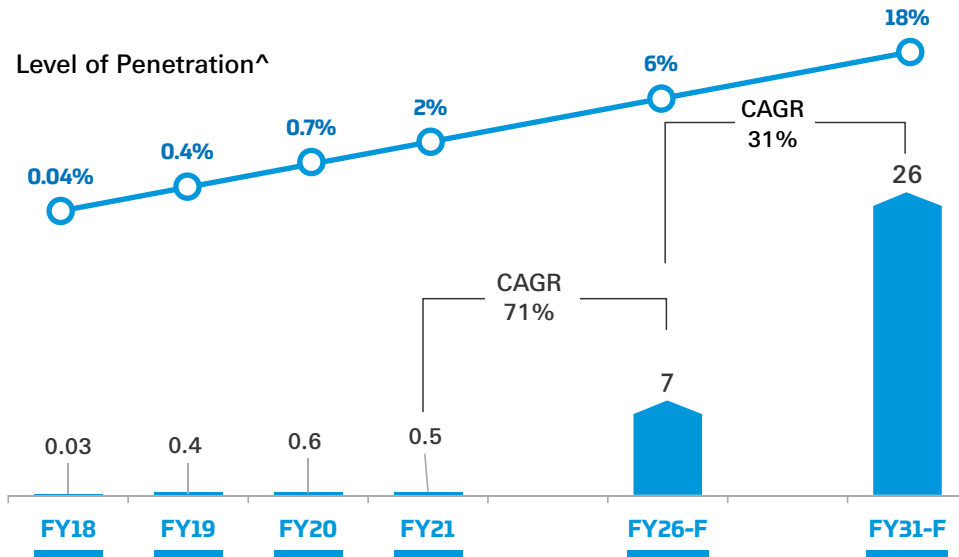
- 2.1 E-Two Wheeler
- 2.2 E-Three Wheeler and E-LCV
- 2.3 E-Four Wheeler
- 2.4 E-Bus**
- 2.5 Other EV Segments
- 2.6 Segmental Opportunity Mapping



# India's e-Bus market is led by Government procurement & FAME II incentives; to witness stronger adoption in short-mid term



e-bus Sales ('000)\*



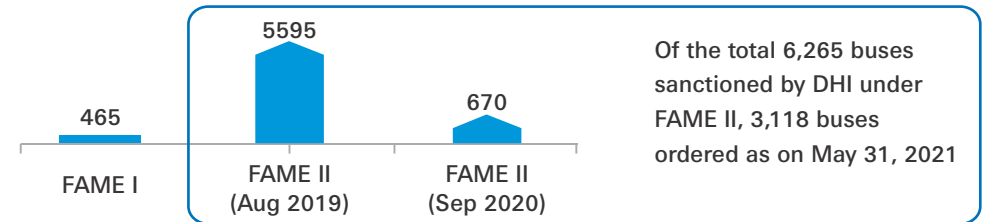
\* Delivered/ Registered Vehicles only. Further upside potential exists in the segment, especially in light of Niti Aayog's target for 40% electrification of bus sales, in case of:

- ✓ Government mandates or incentives for private sector led adoption
- ✓ Large-scale development of public charging infrastructure, fast & flash charging/ swapping, especially on highways
- ✓ Vehicle advancement and sufficient price reduction leading to better TCO parity for small distances, combined with better and innovative business models in the market

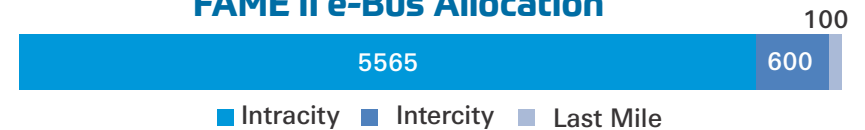
^ Penetration in the entire passenger CV market

Source: Industry estimates, expert interviews, YES BANK Analysis

e-bus Sanctioned Under FAME I and II



FAME II e-Bus Allocation



- ✓ e-bus market in India is primarily driven by Government's impetus to public transport electrification towards its sustainable mobility agenda. FAME II offers incentives for e-bus segments of '9m and below' and '9m to 12m'.
- ✓ Most e-buses on road or in pipeline have been procured by State Road Transport Undertakings (SRTUs), either under FAME Phase I and II incentives from DHI or independently.
- ✓ e-buses are expensive vis-à-vis ICE counterparts, majorly due to the large battery capacity & associated cost.
- ✓ Private sector accounts for nearly 90% of the registered bus stock in India. However, there has been limited uptake of e-buses by them.
- ✓ With the reduction in battery prices and emergence of new operating models, India is expected to emerge as a key e-bus market in the mid term, owing to the segment demand.

# Regulatory efforts, demand aggregation and focus on sustainable public transport to drive initial adoption

## Air Pollution

Diesel buses are among the most polluting vehicle categories. Continued impetus by Government for transitioning to clean mobility in public transportation to drive adoption.

**Impact**

Short-term	Long-term
✓	✓

## Subsidy & Regulatory

FAME II allocates ₹3,545 Cr. for procurement of 7,090 e-buses by SRTUs on Gross Cost Contract model. Demand incentive of ₹20,000 per kWh up to 40% of the cost of vehicle is expected to drive initial adoption.

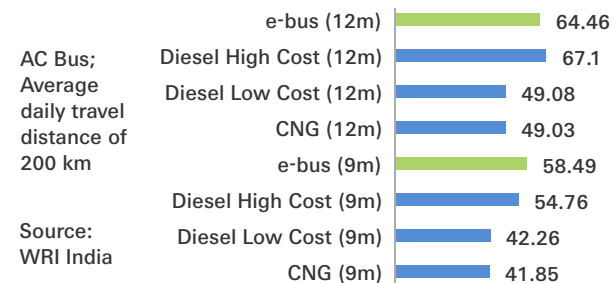
✓	✓
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## Favourable TCO

Industry estimates indicate a favorable TCO when compared with high cost diesel buses at daily average runs upwards of 200 km for 12 meter buses. However, in case of smaller buses with lower daily travel distance, e-buses may not offer favorable TCOs in comparison with low cost diesel and CNG buses.

Efficient route planning and deployment of charging infrastructure for maximum utilization will be critical for achieving positive TCOs. Rise in diesel prices is also expected to make e-bus TCO favorable.

### TCO in ₹/km



✓	✓
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## Demand Aggregation

To address the high upfront cost and to enable OEMs with long term capacity planning, DHI has recently amended FAME II and tasked EESL with demand aggregation and procurement of e-buses for nine 4 million plus cities: Mumbai, Delhi, Bengaluru, Hyderabad, Ahmedabad, Chennai, Kolkata, Surat and Pune.

✓	
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## Retrofit Kits for Conversion to EV

Some SRTUs are evaluating possibility for retrofitting ICE buses with e-powertrain. Companies across the ecosystem, such as traditional body/ component makers, startups, etc. have developed capabilities to produce such retrofit kits which reduce the upfront acquisition costs.

✓	✓
---	---

## Bus Market Potential

India has ~1.2 buses per 1,000 population. As a country which relies heavily on public & economic modes of transportation, there is an increasing focus on adding new buses on road, also benefitting e-bus adoption.

✓	✓
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# OEMs forging JVs and technical partnerships to develop capabilities & product offerings

## FAME II e-Bus Model Eligibility Criteria

Min. Range (km) AC/Non AC	120/140
Max. Electric Energy Consumption (kWh/100 km)	9m and below: <100 above 9m and up to 12m: <140
Min. Max. Speed (km / hr)	70
Min. Acceleration (m/s <sup>2</sup> )	0.8
Min. Gradeability (Degree)	9.7 (17%)

- ✓ Most incumbent OEMs have formed JV/ technical partnerships to develop capabilities, esp. in powertrain, power electronics and battery space.
- ✓ OEMs, such as JBM Auto, have developed dedicated platform for e-buses while others have integrated e-powertrain to their existing platforms, such as Tata Motors (Starbus Ultra) & VECV (Skyline Pro).
- ✓ 'Green' funds are supporting this space - Mytrah Mobility received an investment of \$1 bn in 2019 from Green Climate Fund as a loan, GreenCell Mobility (EverSource Capital backed) has partnered Mytrah Mobility & also invested in PMI Electro Mobility consortium to deploy e-buses in Rajasthan and Uttar Pradesh, respectively.
- ✓ ICE to EV conversion through retrofit kits is also witnessing action. SRTUs from Telangana and Andhra Pradesh are in the process of pilot projects. Players such as Sun Mobility, Precision Camshatfs (Emoss) have entered the conversion space.

OEM	Manufacturing Location	Partner	9m and below: Range   Top Speed	9 - 12m: Range   Top Speed
Ashok Leyland	Alwar, Viralimalai	Sun Mobility, ABB	50 - 120 km   75 kmph	50 - 120 km   75 kmph
JBM AutoManufacturing	Faridabad and Kosi	Solaris	150 - 200 km   75 kmph	150 - 200 km   75 kmph
Mytrah Mobility (Mozev)	Jaipur	Product specific partnerships Low floor bus: Skywell	-	300 km   100 kmph
Olectra	Hyderabad	BYD	200 - 300 km   70 - 80 kmph	
PMI Electro Mobility Solutions	Daruhera	Foton	168 km   -	144 km   -
Tata Motors	Dharwad	KPIT	> 150 km   75 kmph	150 - 200 km   65 - 75 kmph
VE Commercial Vehicles (VECV)	Indore	KPIT	177 km   -	

Note: Information is indicative and not exhaustive  
Source: Company announcements, expert interviews



# 02

## E-Vehicle Segment Opportunity Overview

- 2.1 E-Two Wheeler
- 2.2 E-Three Wheeler and E-LCV
- 2.3 E-Four Wheeler
- 2.4 E-Bus
- 2.5 Other EV Segments**
- 2.6 Segmental Opportunity Mapping



# Tractors, agricultural equipment, heavy commercial vehicles and boats to witness electrification in mid-to-long term

Tightening emission regulations and need for better fuel efficiencies has introduced a potential opportunity for electrifying heavy commercial vehicles, agricultural and off-highway vehicles in India. The segments are expected to benefit from increasing number of players and product offerings, combined with tapering prices due to declining battery costs & favourable TCOs.

Category	Company	Key Developments
<b>Agricultural Category</b> 	  	<ul style="list-style-type: none"> <li>✓ Sonalika Group launched an e-tractor 'Tiger Electric' in 2021</li> <li>✓ Escorts e-tractor Farmtrac (26E) received CMVR certificate in January 2021 - first for e-tractors in India; commercial launch expected soon</li> <li>✓ Cellestial e-mobility unveiled its e-tractor; Recently raised \$35mn Pre-series A funding</li> </ul>
<b>Material Handling</b> 		<ul style="list-style-type: none"> <li>✓ Launched a three-wheel electric variant of its Bravo Forklift Truck namely Bravo Forklift for the 1.6 to 2 tonne category</li> </ul>
<b>Heavy Commercial Vehicle</b> 	  	<ul style="list-style-type: none"> <li>✓ Daimler India Commercial Vehicle (DICV) to launch of an electric truck in the Indian market in 2021</li> <li>✓ Triton to setup in Telangana with an investment of ₹2,100 Cr.; product launch is expected in Apr 2022</li> <li>✓ Tata Motors to launch own commercial electric truck, the Tata Ultra T.7</li> </ul>
<b>Electric Boat</b> 	 	<ul style="list-style-type: none"> <li>✓ Cochin Shipyard launched its first electric ferry in March 2021, for which Siemens Energy is supplying drive and battery components.</li> <li>✓ Navalt Solar &amp; Electric Boats manufactures Aditya- India's first solar ferry/boat   Running cost for a day is ₹180 vs ₹8,000 per day for a diesel ferry</li> </ul>

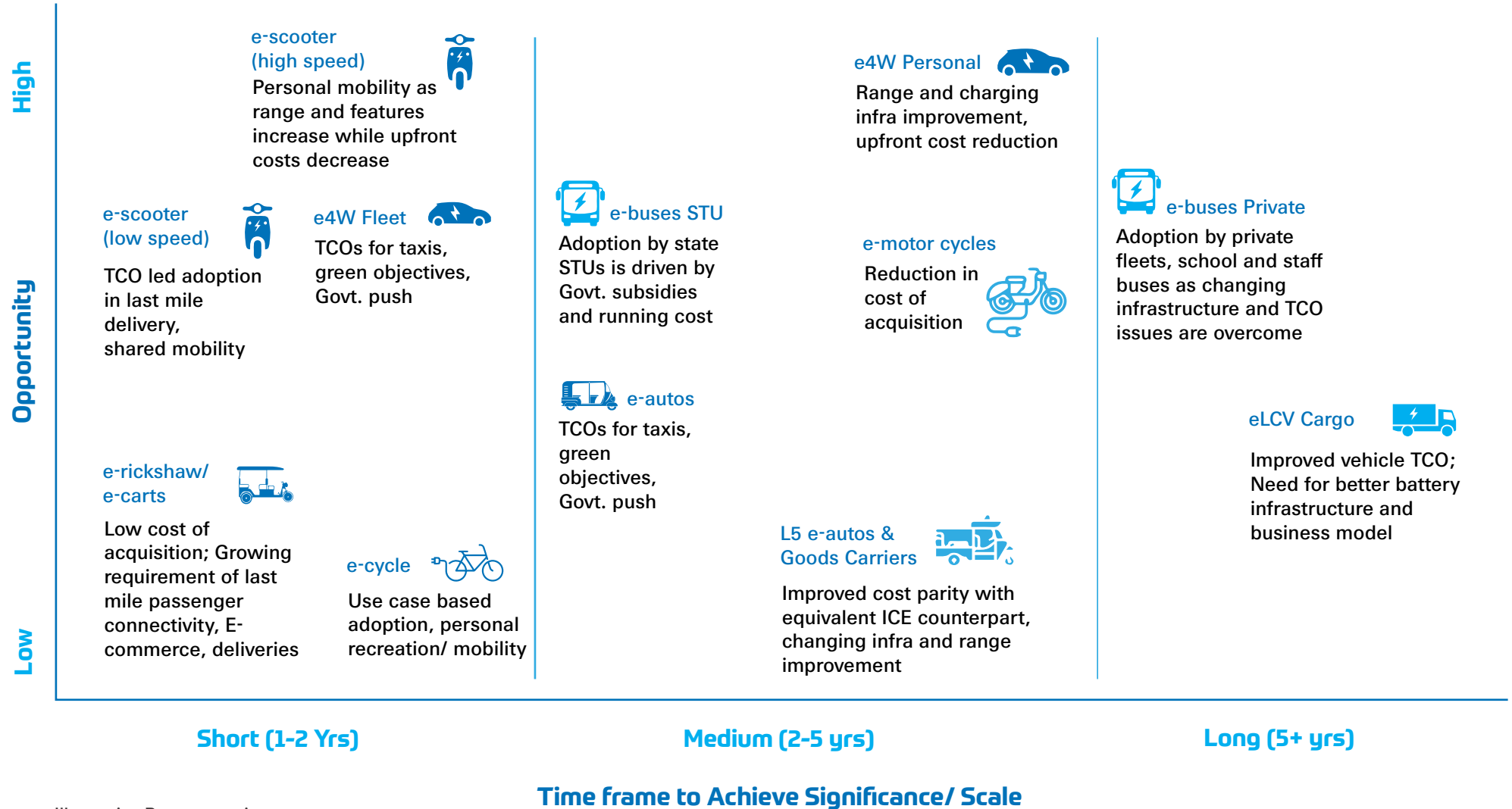
# 02

## E-Vehicle Segment Opportunity Overview

- 2.1 E-Two Wheeler
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- 2.4 E-Bus
- 2.5 Other EV Segments
- 2.6 Segmental Opportunity Mapping**



# Fleet, delivery and public transport electrification lead in the short-term; private and personal mobility to outperform these by the end of decade



Illustrative Representation



03

# EV Component Opportunity Overview

## 3.1 Introduction

## 3.2 Component Segments

3.2.1 Powertrain & Power Electronics

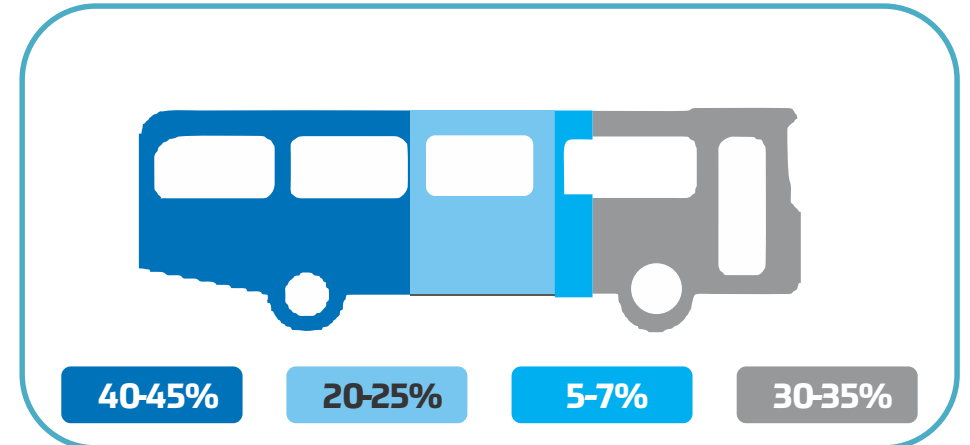
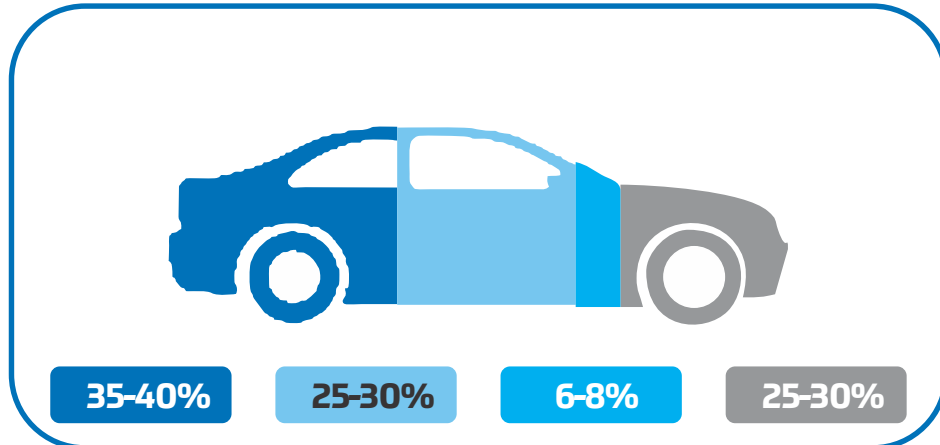
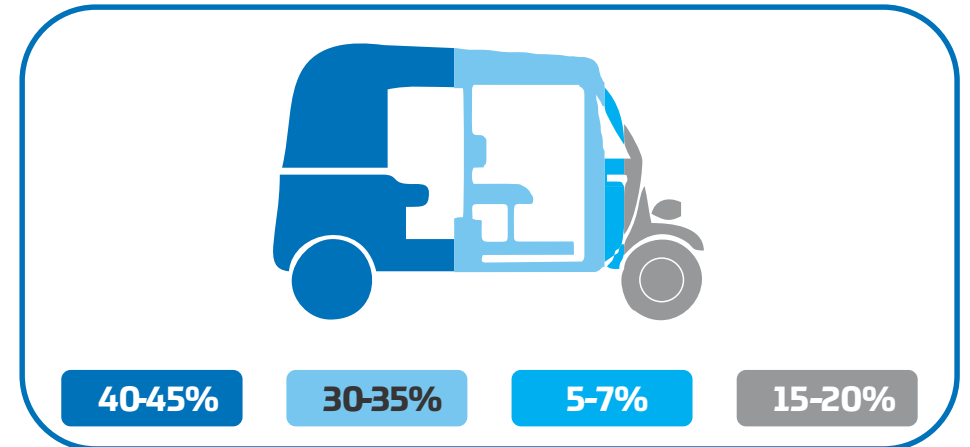
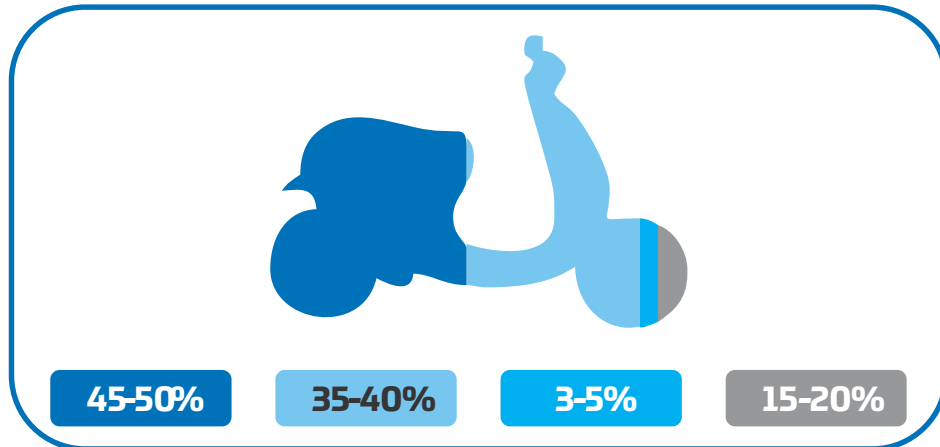
3.2.2 Battery & Associated Components

3.2.3 Connectivity & Control Systems

3.2.4 Other Components

# Component Value Proportion: E-Vehicle Segment-wise

Battery accounts of highest share of vehicle cost across segments, followed by powertrain & power electronics



Indicative cost proportions:



Source: Expert Interviews, YES BANK Analysis

(Illustrative)

# Evolving Engagement Models

As the industry moves from ICE Vehicles to EVs, engagement models between OEMs & Component Manufacturers can also evolve

## Matrix Technology Product Development

High	<b>OEM Led Development</b>	<b>OEM &amp;/or CS Led Development</b> Motors e-axle Control Systems Thermal Management Battery Tyre Assembly Controllers Wiring Harness Power Electronics Cell
	Chassis & Frame	
Low	Braking	<b>CS Led Development</b> Suspension Relatively Low Development Focus
		COMPONENT SUPPLIER (CS) Led Focus
		High

### Collaborative Approach

- ✓ With new components and technologies driving EVs (Cells, Powertrain & Electronics, Telematics etc.), various OEM - supplier engagement models are emerging with higher degree of collaboration over the traditional transactional approach.
- ✓ OEMs have adopted diverse sourcing strategies – from insourcing key components to evolved supplier partnerships and agreements.
- ✓ Besides existing parameters of cost, time and quality; other parameters such as technology strength, R&D capabilities, development and design validation, lifetime ownership of component performance, level of value chain integration, etc. will gain more importance in choosing suppliers.

### Technology Development

- ✓ Component suppliers into technology development & research for newer components introduced by EV, hold significant bargaining power over OEM technology adoption curve due to high development & commercialization cost and risk of technology redundancy.

### Solution Approach

- ✓ 'System integrators' or 'Solution providers' will increasingly play a key role in supplying to OEMs. Solutions such as 'battery - BMS - thermal management - PDU - connectors', 'motorcontroller - transmission - convertors - control units', etc. may come to the fore.
- ✓ Component suppliers with solution/ system based approach & strong hold over technology development can ensure business consistency.





03

# EV Component Opportunity Overview

3.1 Introduction

3.2 Component Segments

**3.2.1 Powertrain & Power Electronics**

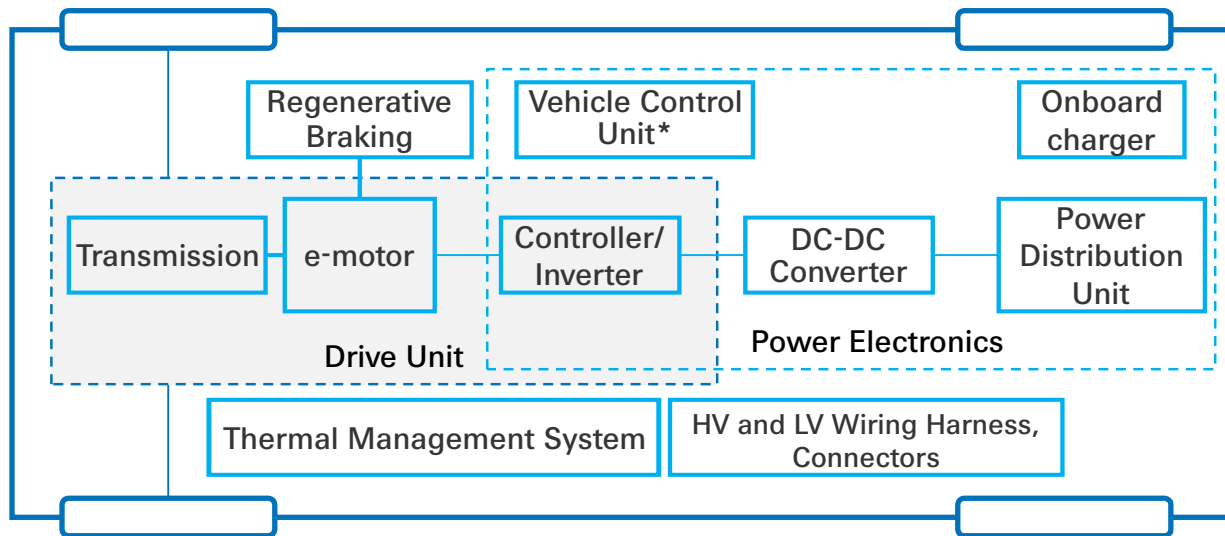
3.2.2 Battery & Associated Components

3.2.3 Connectivity & Control Systems

3.2.4 Other Components



# Powertrain & power electronics propel EVs and are among the most critical components with 20-30% share in cost



## ICE components upgraded for EV application






- ✓ **Wiring Harness:** Assembly of wiring needed across the vehicle. EVs require appropriate HV wiring harnesses for HV & high current applications while preventing electro magnetic interference
- ✓ **Transmission:** Transfers power and torque from the motor to wheels. In an axle, it is combined with the differential. Most EVs segments typically use a single speed gear
- ✓ **Thermal Management System:** Heat management system for cooling the motor, and power electronics especially in HV applications where there is a high temperature gradient

## EV Specific Components

- ✓ **Motor:** Converts electrical energy to mechanical energy which is transmitted to the wheels through axle propel the EV. On releasing the throttle or braking, motor also performs regenerative braking function to charge the battery
- ✓ **Controller & Inverter:** Controls motor dynamics – speed and torque, and converts the DC from battery to AC (for AC motors)
- ✓ **Onboard Charger:** Converts AC from EVSE to DC for battery charging; manages interaction with EVSE
- ✓ **Power Distribution Unit (PDU):** Distributes power to drive unit and auxiliary components as per HV & LV application
- ✓ **DC-DC Converter:** Converts input DC to higher/ lower voltage as per application

\*Detailed out in the Control & Connectivity section

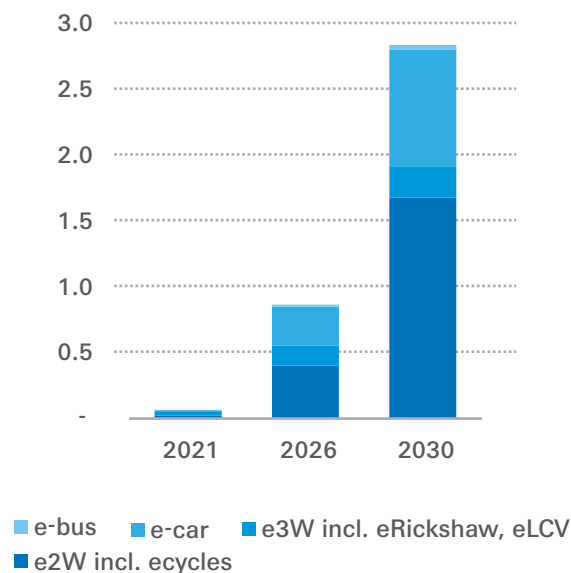
## Typical Motor Specifications

Vehicle Segment	General Technology	General Technology	Voltage
	BLDC Motor, PMSM Hub/ Mid-mount	Low speed: 250 W -1 kW City/High Speed: 1 kW – 3+ kW	48 - 72V
	BLDC Motor, PMSM, AC Induction Axle	<1 kW - 4+ kW	48 - 72V
	PMSM, AC Induction Axle	5+ kW	48 - 72V
	PMSM, AC Induction Axle	50+ kW	96 - 300+V
	AC Induction, PMSM Axle	Below 9m: 80+ kW 9m and above: 100+ kW	350 - 800V

BLDC: Brushless DC; PMSM: Permanent Magnet Synchronous Motor; HV: High Voltage; LV: Low Voltage; AC: Alternating Current; DC: Direct Current

Source: Industry Estimates, expert interviews, YES BANK Analysis

### EV Motor & Controller Market Size in India, by Vehicle Categories, \$ bn



Motor & Controller represent ~2/3rd of the total powertrain and power electronics market, with the transmission, DC-DC converter, on-board charger, PDU, VCU, Thermal Mgt & Wiring Harness representing the balance 30-40%

# India-specific requirement and Government push for domestic value addition are driving the industry

## Key Drivers

### Impact

Short-term Long-term

#### Crucial Functionality

Powertrain & power electronics replaces the engine in EVs. Players impacted by this & OEMs who would want to retain competence of this crucial functionality, will drive development in this space.



#### Drive for Performance

Power train performance (power density) is key to EV product performance and impacts its competitive positioning & relative differentiation in the market. This will drive strong research & development in PT.



#### India's unique driving conditions

India's unique driving conditions w.r.t. driving patterns, ambient temperatures & cost consciousness calls for redesigning powertrain & components for optimal efficiencies to suit these requirements in finer budgets, driving the local product development & research.



#### Supply chain Stability

A strong local supply chain of essential functionality like powertrain is crucial both for manufacturing and after-sales market & servicing, further driving growth in local PT supply ecosystem.



#### Regulatory support for Localization

- ✓ FAME II eligibility mandates localization of drivetrain components as per the Phased Manufacturing Program (e-motor, controller/ inverter, onboard charger, DC-DC converter, wheel rim with hub motor, MCB/ circuit breakers/ electric safety devices, power & control wiring harness and connectors).
- ✓ Powertrain component imports (AC/DC Motor, Motor Controller/Inverter and Power Control Unit) were scheduled to attract BCD of 15% from Apr'21 onwards.



#### Supply Side Incentives

MeitY's SPECS scheme offers upto 25% capital subsidy on eligible capital expenditure for components such as BLDC motors, connectors and power electronics components such as PCB, discrete power & compound semiconductors and ICs.



# Motor Technology upgrades will be led by power & torque density improvements; and power electronics by capabilities

## Motor Technologies

- ✓ **BLDC** motors are preferred for <5 kW applications due to light weight, compact design, high efficiency and easier control
- ✓ **PMSM** is increasingly being preferred over AC induction and BLDC motors for 5+ kW applications, including performance e2W. They offer higher efficiency, no torque ripple, and better performance in both high and low speed of operation



**Future Trend:** More efficient/ low cost PM technologies - axial flux, PM assisted synchronous reluctance are in development

- ✓ Materials such as **aluminum** and **carbon** will find increased usage for better performance, power and light-weighting

**Future Trend:** R&D ongoing for reducing rare earth magnet dependency & related environmental impact:

- ✓ **Switched Reluctance Motors** with no permanent magnet
- ✓ **Samarium Cobalt** magnets which do not use **Dysprosium** – a scarce rare earth element used in Neodymium magnets

## Power Electronics

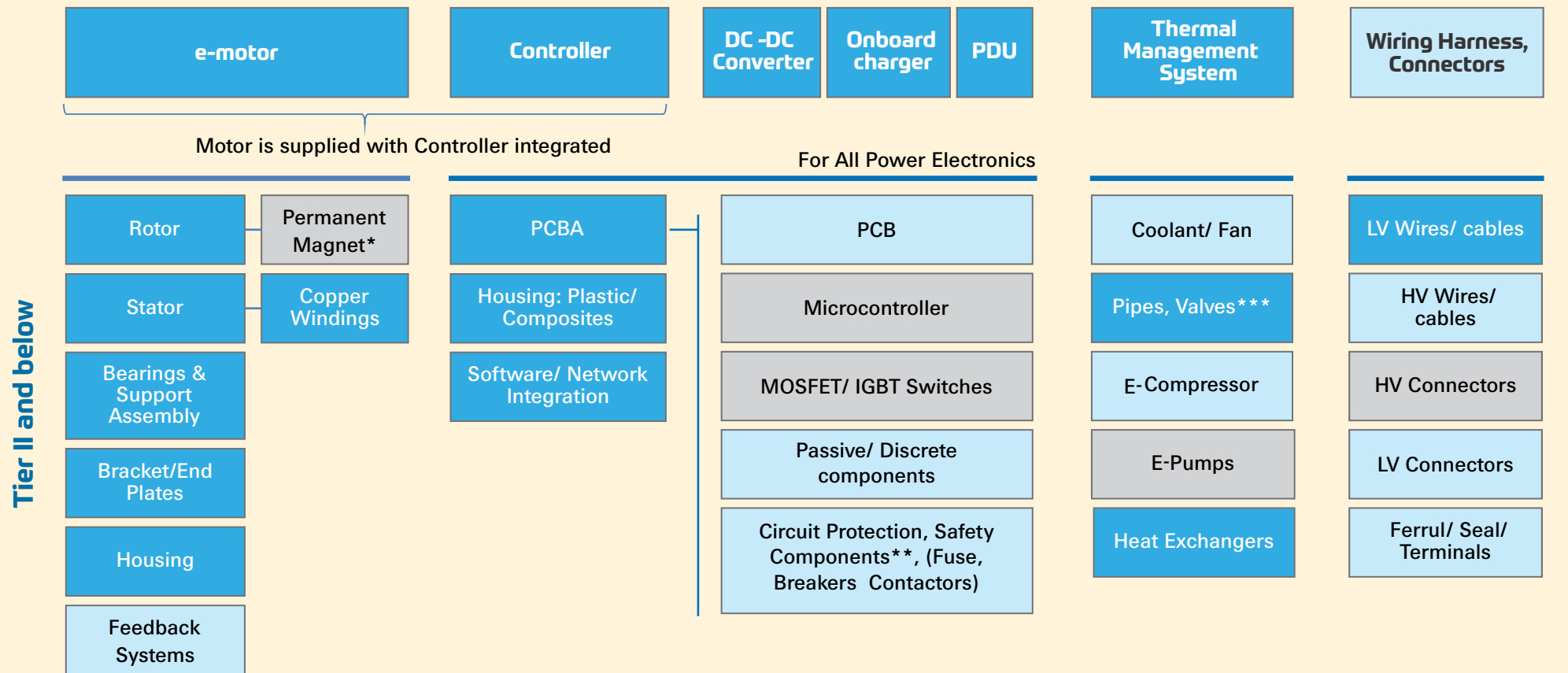
- ✓ **MOSFETs** are used for low and medium power applications such as e2W and e3W
- ✓ For high voltage and high power applications, **IGBTs** are preferred options



**Future Trend:** Gradual shift in material underway:

- ✓ Shift from Silicon Oxide to **Silicon Carbide (SiC)** due to superior properties in high voltage, switching frequency and temperature applications
- ✓ **Gallium Nitride (GaN)** devices expected in long-term
- ✓ Components with limited dynamic functionalities, such as DC-DC converters, will gradually move towards **standardization**
- ✓ Increased usage of technologies such as AI, ML, analytics will take place at component level

# Opportunities exist across components at Tier1 & 2 levels, especially to strengthen local value chain



\* for magnet based motors  
 \*\* especially in PDU and Onboard Charger  
 \*\*\* for liquid cooled systems

Note: Thermal management section has been detailed out in the Battery & Associated Components section

# 'Upskill and Upgrade' of capabilities can help in leveraging opportunities

	e-motor	Controller	DC -DC Converter	Onboard charger	PDU	Thermal Management System	Wiring Harness, Connectors
General Manufacturing/ Development Capabilities	<ul style="list-style-type: none"> <li>✓ Design</li> <li>✓ Die casting</li> <li>✓ Lamination</li> <li>✓ Stacking</li> <li>✓ Winding</li> <li>✓ Assembling + Magnet assembly</li> <li>✓ Rotorbalancing</li> <li>✓ Testing, Integration</li> </ul>	<ul style="list-style-type: none"> <li>✓ Hardware design, testing and integration with software</li> <li>✓ Knowledge of EVs and use cases</li> <li>✓ PCB Design</li> <li>✓ Electronic Assembly</li> <li>✓ Software design, development and implementation</li> </ul>				<ul style="list-style-type: none"> <li>✓ Capabilities and knowledge of cooling systems, form factors, technology for heat transfer</li> <li>✓ Proficiency in simulation and testing</li> <li>✓ System Integration</li> <li>✓ Hardware components</li> </ul>	<ul style="list-style-type: none"> <li>Wiring Harness               <ul style="list-style-type: none"> <li>✓ Design</li> <li>✓ Cutting</li> <li>✓ Stripping</li> <li>✓ Crimping</li> <li>✓ Assembly</li> <li>✓ Testing</li> </ul> </li> <li>Connectors               <ul style="list-style-type: none"> <li>✓ Molding</li> <li>✓ Assembling</li> <li>✓ Testing</li> </ul> </li> </ul>
Standards & Certifications	<ul style="list-style-type: none"> <li>✓ Motors and power electronics: ARAI AIS-038, AIS-039, AIS-040, AIS-041, AIS-049</li> <li>✓ EV retrofit kits: AIS-123</li> <li>✓ Electromagnetic compatibility &amp; immunity: AIS-004</li> <li>✓ Global standards: ISO 21782 series (for motors), SAE, AEC, CE</li> <li>✓ IP certification for dust and liquid intrusion protection</li> </ul>						

Relative Investment Required ● Low ● Medium ● High

# Component players are using inorganic routes to enhance capabilities, in both domestic & international markets

## OEMs seek control over powertrain esp. for high power applications

- ✓ OEMs have stricter control over powertrain in premium and performance vehicles, with some insourcing key components, such as Mahindra and Tata Motors. Standardized products continue to be outsourced/ imported.
- ✓ Globally, OEMs are collaborating for joint development of drive units eg. Jaguar Land Rover – BMW, Ford - Volkswagen, GM - Honda, etc.

## Tier 1s focus on Integrated offerings and solutions

- ✓ Motors and controllers are usually an integrated offering. Tier-1s, such as Bosch, Sona Comstar, etc. combine motor and controller with transmission to offer an e-axle for easier integration into the vehicle systems.
- ✓ As the industry matures, component manufacturers are expected to increasingly adopt a solution perspective. Other electronic components are also expected to be offered in integrated modules.

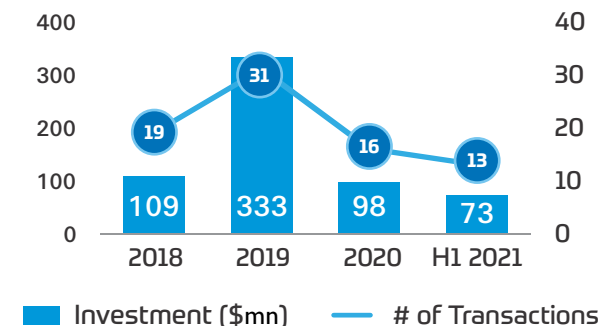
## Component players gain capabilities via JVs, M&A and tech. partnerships

- ✓ Tier I & II companies are collaborating across value chain for access to technology, eg. Padmini VNA - Saietta (axial flux e2W motors), Sterling Tools JV with Jiangsu Gtake (motor controllers), KPIT - Eaton (power electronics), PSA-Avtec (transmission)etc.
- ✓ Selective acquisitions and overseas JVs have also taken place, including for access to global markets, eg. Precision Camshafts acquired Emoss (CV powertrains), Bharat Forge's German JV with REFU Elektronik (power electronics).

## Startups working on innovative technologies being supported by OEMs, Tier 1s as well as PE/VC players

- ✓ Globally, startups in powertrain, retrofitment and thermal management received \$613 mn in investments in 79 transactions since 2018. Cell Propulsion and Altigreen Propulsion Labs have been amongst the most funded Indian startups.
- ✓ Players such as Renault, Meritor, Dana, Sterling Tools, Hirschvogel Automotive Group and Hitech Gears have made strategic investments in powertrain startups.
- ✓ Few OEMs and component makers have partnered programs to support innovative startups, such as Sona Comstar's partnership with IIT Delhi, Maruti Suzuki's innovation lab with GHV Accelerator and partnership with IIM Bangalore incubator, etc.

## Global Powertrain Startup Investments



Note: Disclosed deals only



# Competitive intensity is increasing in motor & controller; through power electronics remain specialized

Component	Competitive Structure			Indicative Players	Competitive Dynamics
	Player Size	Mkt. Dominance	# of Players		
Motor	Large			BorgWarner*, Continental*, Dana*, Lucas TVS, MAHLE Electric Drives, Marsilli, Nidec, SEG Automotive, Sona Comstar*, Valeo, ZF*	While large players are present in this space, OEMs requirement for customized and low cost solutions offers space for emerging players, especially with low volume orders.
	Emerging			Altigreen Propulsion Labs, C-EAD, Compage Automation, EMF Innovations, Entuple E-mobility, Virya Mobility	
Controller	Large			BorgWarner, Curtis, Dana, Napino, Nidec, SEG Automotive, Sona Comstar, Sterling Gtake, Valeo	Key large and medium players have integrated hardware and software capabilities and also bundled their offering with the motor. Emerging companies, especially startups play in the designing of advanced solutions for customized requirement of OEMs/ motor manufacturers.
	Emerging			C-EAD, Greenerg Mobility, iPEC, Sedemac Mechatronics, Virya Mobility	
DC-DC Converter	Large			ABB, Actia, BorgWarner, Curtis Instruments, Delta Electronics, Flash Electronics, Napino, Uno Minda, Valeo, Yazaki	The market is fairly crowded, and as the component is likely to approach standardization, there is relatively limited scope for emerging companies, to offer differentiation benefits. Scope exists for integrating product with larger PT solutions provider for custom packaged solutions.
	Emerging			Axiom, Interface Microsystems, Sedemac Mechatronics, Virya Mobility	
Onboard Charger	Large			BorgWarner, Continental, Curtis Instruments, Infineon Technologies, Napino, Panasonic, Uno Minda, Valeo	Large and medium players with hardware design, manufacturing and R&D capabilities hold advantage. Emerging companies and startups can gain foothold with technology (partnerships/ inhouse), customized offerings and competitive pricing. Strong global supply chain is also required for import dependent components such as HV Wiring Harness & Connectors.
	Emerging			iPEC, Virya Mobility	
Power Distribution Unit	Large			Aptiv, Continental, Delta Electronics, Eaton, Panasonic, TDK Electronics, TE Connectivity, Yazaki	
	Emerging			Virya Mobility	
Wiring Harness	Large			Amphenol, Aptiv, Lear Automotive, Minda Furukawa Electric, Motherson, Yazaki	
	Emerging				

Competitive Intensity: ● High ● Medium ● Low

Low Medium High

\*offer e-axle; Emerging firms include SMEs and startups

# Partnerships & collaborations are the key for gradual enhancement of capabilities and scale

## Short-term

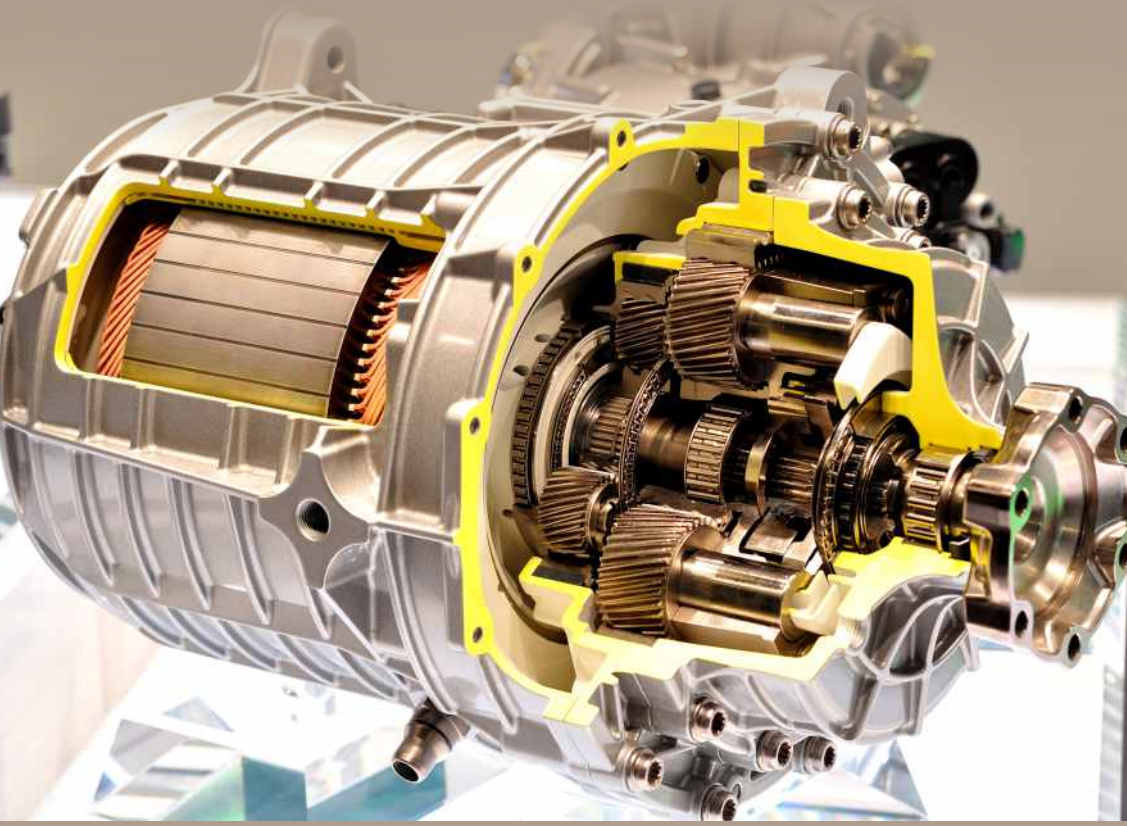
- ✓ BLDC and PMS Motors, their sub-components (rotors, stators, bearings, windings, etc.) and wiring harnesses are expected to offer initial scale, given their demand
- ✓ MeitY SPECS scheme can be leveraged to invest in electronics component manufacturing. Passive components (resistors, capacitors), discrete semiconductors (transistors, diodes), power semiconductors (FETs, MOSFETs), BLDC motors, etc. have low investment threshold
- ✓ Power electronics **design & software capabilities** are crucial, needs focus on building capability to differentiate
- ✓ Evaluating/Investing in **startups** working in developing technology & customized products across PT segment – e-motors (low/no magnet), controller, Onboard charger etc. may reap benefits
- ✓ Staggered investments in **flexible manufacturing** setups (eg: flexible lines, semi-automatic) can support the lower MOQs scenario expected initially

## Medium-term

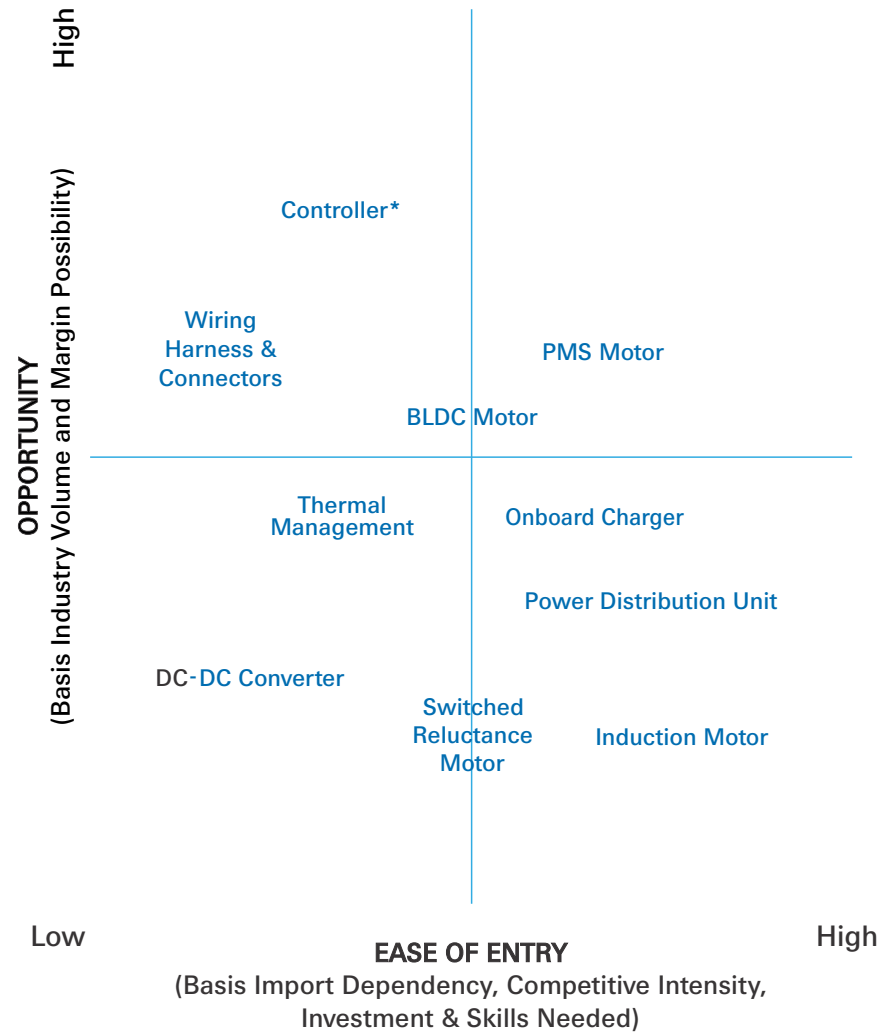
- ✓ Develop **technology strength/ partnerships (local, global)** for strong & consistent product USPs with export focus
- ✓ Collaborate **across component segments**, especially power electronics, for design and system integration capabilities; develop **integrated solutions offerings** to emerge as a solutions provider for OEMs
- ✓ Develop **modular solutions** with standard hardware and leverage software capabilities to offer feature differentiation
- ✓ Increase **R&D expenditure** for technology & solution development for stronger export positioning

## Long-term

- ✓ Focus on **vertical integration** as volumes increase to benefit from economies of scale. Partnerships/ JVs for localizing **electronics hardware** will be crucial
- ✓ Target commercializing **new technologies** and **materials**



## Opportunity Vs. Ease of Entry



\*Controller is configured as per the motor and is an integrated offering  
Illustrative Representation





03

# EV Component Opportunity Overview

3.1 Introduction

3.2 Component Segments

3.2.1 Powertrain & Power Electronics

**3.2.2 Battery & Associated Components**

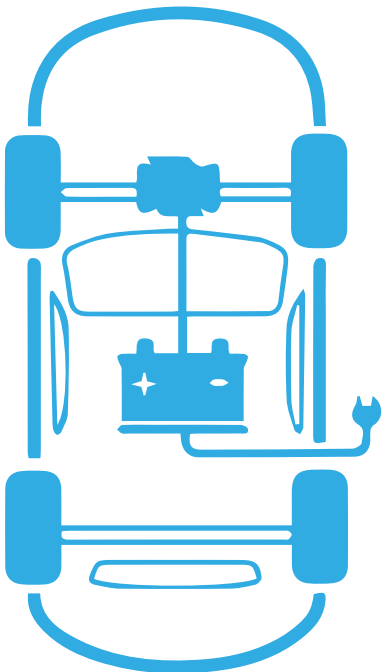
3.2.3 Connectivity & Control Systems

3.2.4 Other Components

# Battery is the most sensitive & expensive EV component with ~40% share in cost

Battery impacts key adoption factors such as range, safety, charge time & cost. Lithium-ion cells are popular due to their high energy density and lower cost.

## Battery Components



Cell & Module

✓ **Cell & Module:** Cell forms the core component of a battery pack, comprising cathode, anode, separator and electrolyte. Structurally, cell can be Prismatic, Pouch or Cylindrical. Popular lithium chemistries include NCA, NMC, LMO, LTO, LFP\* etc.



Thermal Management

✓ **Battery Management System:** Monitors the battery pack's state of charge & health. It protects against faults, optimizes charging & discharging, monitors rate of use. It also undertakes cell balancing, preventing only few cells from getting stressed.



Battery Management System

✓ **Thermal Management:** Regulates battery pack to operate in the desired temperature range, for optimum performance and life. Can be air cooled or liquid cooled using coolants.



Housing & Connectors

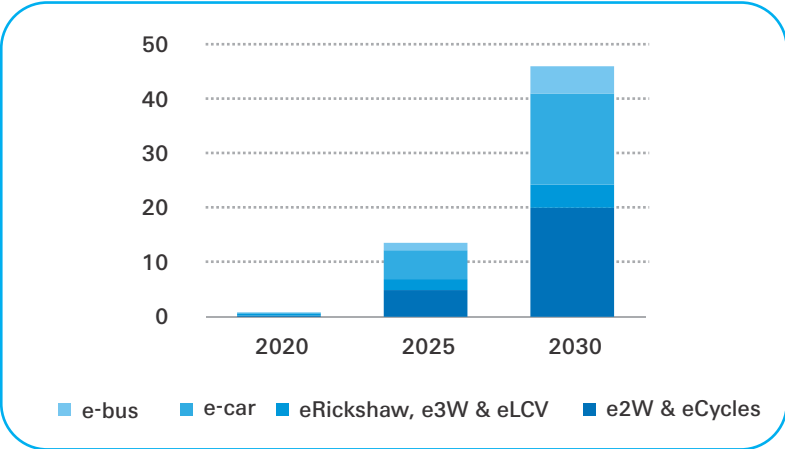
✓ **Housing:** Forms the outer casing of the battery that holds the module assembly together and ensures battery protection.

✓ **Connector:** The electro-mechanical part that interfaces the battery to electronic devices.

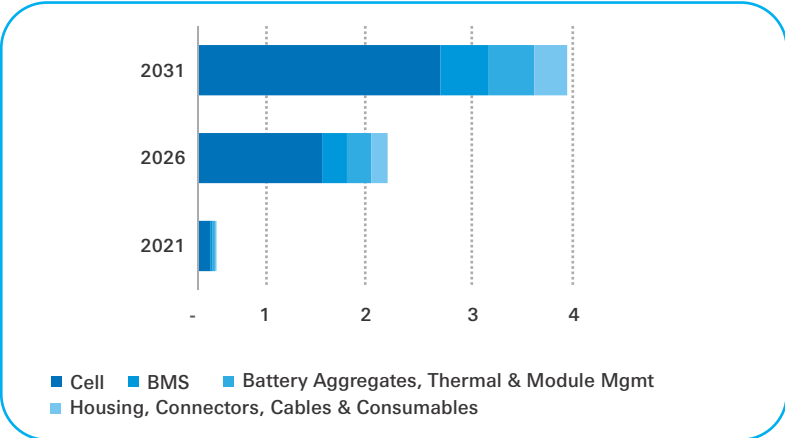
\*NCA = Lithium nickel cobalt aluminium; NMC/NCM= Lithium-Nickel-Manganese-Cobalt; LMO = Lithium Manganese Oxide; LTO= Lithium-titanate-oxide; LFP = Lithium Iron Phosphate

...continued






EV Battery Market Size in India, by Vehicle Categories, GWh



EV Battery Market Size in India, by Product Categories, \$ bn



### Battery Specifications

Category	Capacity, kWh	Energy Consumption, Wh/km
	1 - 3	24 - 30
	3 - 12	43 - 57
	20 - 50	150 - 210
	15 - 150	450 - 750
	50 - 300	1,100 - 1,500

# Market demand and government incentives are driving growth in the sector

## Key Drivers

**Critical Component; Rising EV Demand**

- ✓ Battery forms ~40% of the vehicle price and drives key adoption measures like range, cycle life, safety, pricing. The constant need to improve these factors will drive product development and growth.
- ✓ Rising EV demand will correspondingly drive the need for batteries. Globally, battery demand driven by EVs has grown from 52% of total to 75% over 2018-20 period. It is further expected at 87% by 2030 witnessing a 24% CAGR over 2020-30 period with increasing EV adoption, India - the world's largest 2w & 3w market offers significant local demand.

**Wide Application Spectrum; New Business Models**

- ✓ With increasing Renewable Energy generation & requirement for grid stability, the need for static storage (domestic, commercial & grid level) will drive battery demand
- ✓ New business models such as battery swapping, battery as a service, battery repurposing will drive EV demand given additional units needed for circulation (~1.3X), and also enables new service centric revenue streams

**Indian Condition**

- ✓ India's ambient temperature conditions combined with driving patterns & vehicle segment mix shall drive development of custom batteries R&D.

**Lower Entry Barrier in Select Segments**

- ✓ While cell making is heavy on investment & technology, battery manufacturing is relatively lighter on both these parameters, thereby lowering the entry barrier and attracting non-traditional battery manufacturers & startups.

**Policy Push**

- ✓ Government notification delinking battery from vehicle during sale, and increased adoption incentive (FAME II) linked to advanced batteries; coupled with supply side facilitation measures such as increased import duty on cells and battery pack, and incentives like PLI for Advance Cell Chemistries will push the cell, battery localization and EV offtake.

**Strengthening & Localizing Supply Chain**

- ✓ With commitments of setting up cell manufacturing facilities announced in India, local battery manufacturing can receive the necessary fillip due to localization of key input materials/ components. Measures to secure supply of key minerals through Khanij Bidesh India Ltd will strengthen this further.

## Impact

Short-term Long-term





# BMS & other battery elements are expected to remain relatively standard on technology, unlike in case of cell chemistry

## Technology Trends

### Battery Management Systems

- ✓ Continuous improvement in BMS algorithms, features & architecture to improve battery management & safety thus improving battery life
- ✓ Future Trends - Wireless BMS

### Thermal Management

- ✓ Advancement in liquid cooling - innovation in coolants, Piping Systems & Architectures basis battery design
- ✓ Integration of all thermal management systems for increased efficiency
- ✓ Future Trends - Immersion cooling where the battery is directly submerged in specialized coolants

### Non-Lithium Ion Energy Storage

- ✓ Future Trends - To improve energy density, reduce dependence on select minerals and align with use cases: Ultra Capacitor | Fuel Cells | Metal-Air etc., are in focus

### Battery Pack Design

- ✓ Swappable batteries are driving changes to pack design
- ✓ Future Trends - Battery pack design is considered to have significant scope to create efficiency. Globally, pack cost is reducing faster than cell cost, (25% v/s 22% CAGR since 2015) implying improved efficiencies

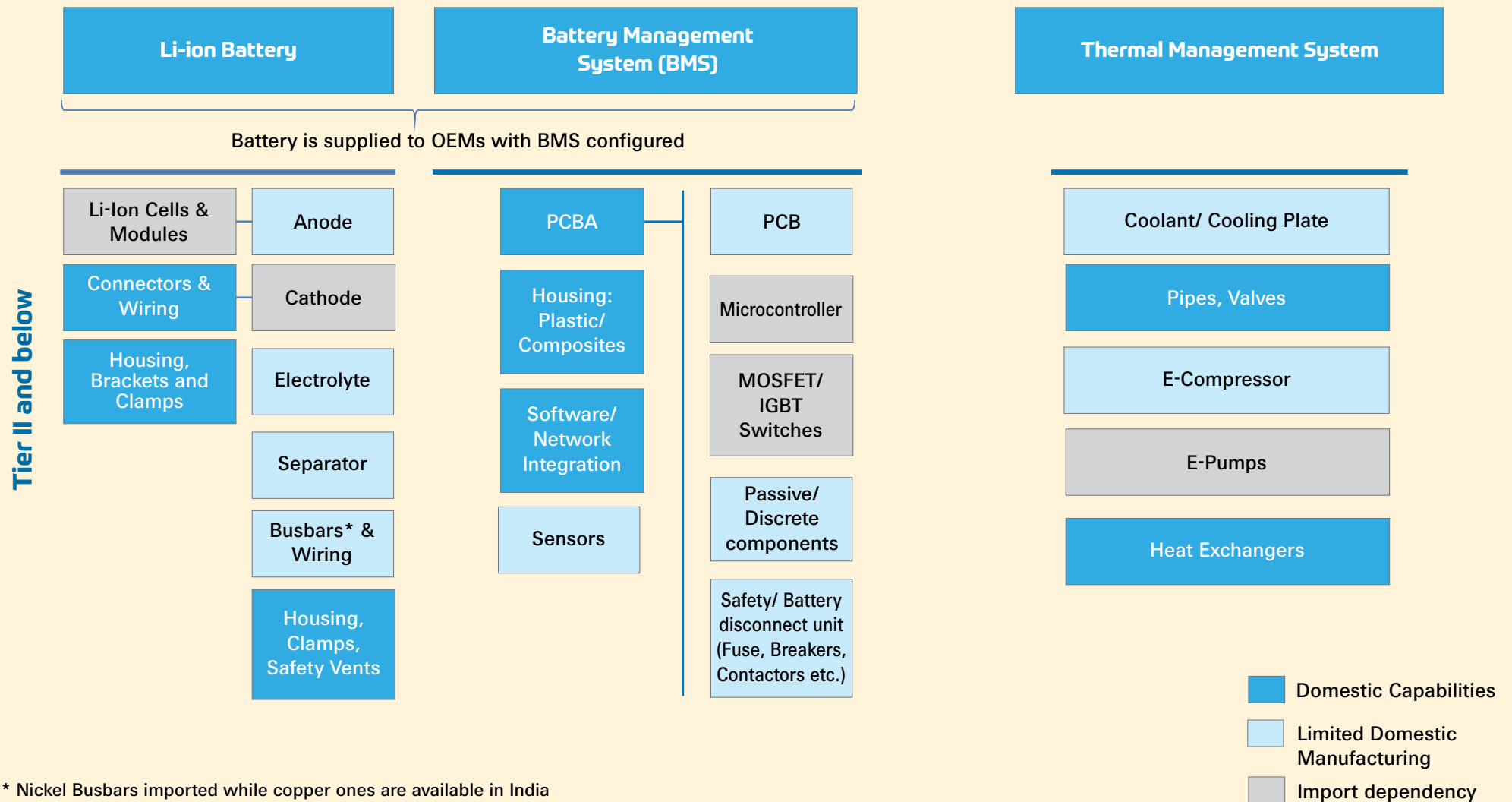
### Cell Chemistries – Lithium Ion

- ✓ R&D in Li-ion chemistries across cathode, anode and electrolyte material to improve energy density, costs, cycle life & reduce dependence on select minerals. Areas of focus include NMC and Nickel rich NMC, LTO chemistries
- ✓ Future Trends - Li-S | Solid-state | Graphene

### Battery Recycling

- ✓ Future Trends - End of life battery material retrieval for reuse in new batteries for environmental considerations, reducing import & mining dependence

# Mechanical, electrical, electronic & chemical/material players may tap opportunities for localizing the value chain



# Domain knowledge and access to electronics design assembly & testing are needed to enter Tier 1 level

	Li-ion Battery	Battery Management System (BMS)	Thermal Management System
General Manufacturing/ Development Capabilities	<ul style="list-style-type: none"> <li>✓ Cell sorting</li> <li>✓ Welding technique for stacking cells</li> <li>✓ Assembly technique for auxiliary components such as BMS, cooling system, etc.</li> <li>✓ Packing for safety and protection</li> <li>✓ Testing methods for cell, BMS, etc.</li> <li>✓ BIS certification to import Li-ion cells</li> </ul>	<ul style="list-style-type: none"> <li>✓ Hardware design, testing and integration with software</li> <li>✓ Proficiency in developing estimation techniques for SoC and SoH* advanced algorithms for supervisory and fault detection</li> <li>✓ Knowledge of cells, EVs and use cases, and temperature management techniques</li> <li>✓ Electronic Assembly</li> </ul>	<ul style="list-style-type: none"> <li>✓ Capabilities and knowledge of cooling systems, form factors, technology for heat transfer</li> <li>✓ Proficiency in simulation and testing</li> <li>✓ System integration</li> <li>✓ Hardware components</li> <li>✓ Knowledge of electronic control</li> </ul>
Standards & Certifications	<ul style="list-style-type: none"> <li>✓ Battery Packs: ARAI AIS-156, AIS-048-AMD No 1 &amp; 2; IS Standards for electrical and mechanical safety</li> <li>✓ Battery Management Systems: A ISO 26262, IEC 61508</li> <li>✓ Electromagnetic compatibility &amp; immunity: AIS-004</li> <li>✓ Global standards: ISO 12405-4:2018</li> </ul>		

Relative Investment Required ● Low ● Medium ● High

\*SOC: State of Charge, SOH: State of Health

# Battery players are leveraging partnerships & fund-raise to cater to OEMs & enter new models

## OEMs integrating backward

- ✓ Given the criticality of battery, certain OEMs have entered the battery space by procuring cells to manufacture battery packs (Mahindra using Jendemark assembly line and in collaboration with LG Chem, Pure EV supported by CSIR CECRI, similar model by Ola Electric, Ather).
- ✓ Select OEMs have entered cell manufacturing with technical support/ partnerships/ group companies (Maruti-Toshiba-Denso JV AEPPL, TATA Chemicals).

## Emerging Tier 1 in Battery space

- ✓ For certain OEMs, battery manufacturing is often outsourced – ‘make v/s buy’ also varies by player, e.g. MG Motors, Hyundai, Volvo etc., continue to outsource. OEM provides specifications, while branding, warranty & product development may be battery pack manufacturer’s domain.
- ✓ Emerging companies such as Exicom, iPower, Lohum, Trontek, Coslight manufacture battery pack locally by importing/procuring cells.
- ✓ Cell manufacturing is also expected to be localized in the mid-long term given recent announcements (Exide - Leclanche, Amara Raja – ISRO, Tata Chemicals, BHEL among other).

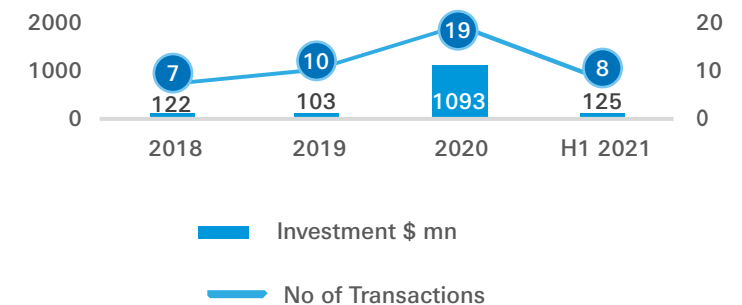
## New Business Models

- ✓ Battery Swapping/ Leasing/ Battery as a Service (BaaS) models are emerging where battery service players either partner with OEMs (Gogoro-Hero MotoCorp) or strategic partners (Sun Mobility-Tata Power DDL & IOCL, VoltUp-HPCL) for developing swapping infrastructure.
- ✓ Second life for EV batteries is an emerging opportunity in the mid-term for batteries that have exhausted their primary EV use & has potential capacity that can be evaluated for static storage (domestic, commercial & grid level) applications (Lohum Cleantech, Nunam).
- ✓ Recycling batteries after they have reached their end of life is a potential mid-long-term opportunity for players that are able to create facilities at scale (Tata Chemical’s Li-ion recycle facility for recovering cathode active materials).

## M&A, PE/ VC Investments

- ✓ Battery technology and BMS companies have globally been a hotspot for investment, raising >\$1 bn globally in 2020 alone. Indian start-ups such as ION Energy, Grinntech and Lohum Cleatech have received significant funding.
- ✓ ION Energy has also acquired French battery management company Freemens SAS in Feb 2018, for technology capabilities in BMS.

## Global Investments in Battery Space



Note: Disclosed deals only

# Competition is heightening in BMS and Battery Pack; while thermal management and battery repurposing remain niche

Area	Competitive Structure			Indicative Players	Competitive Dynamics
	Player Size	Mkt Dominance	# of players		
Battery pack	Large			Amara Raja, Exide, Exicom, Livguard, Octilion, Okaya	Scope for emerging firms in low power battery assembly is high, and may remain for smaller, price competitive & customized orders generally in unorganized/ regional markets. Firms with larger production and R&D investment may dominate organized, high volume segments as the industry matures
	Emerging			Grinntech, Inverted Energy, Ion Energy, iPower, Napino, Lohum, Trontek	
BMS	Large			Lithium Valence (Sensata), Napino, Varroc	BMS is currently fragmented with a few large and emerging players and competition from Chinese imports. Lack of strong dominance from incumbents offer opportunities for new entrants with capabilities to offer customization at lower volumes
	Emerging			AMP, Eumeron, ION Energy	
Thermal Management	Large			Dana, Hanon, MAHLE, Pranav Vikas, Valeo	Limited players in the market, generally leveraging on ICE experience. While opportunity exists, relatively higher cost of capability development for high voltage applications, higher electronic & software capability may required limit the potential new entries in the market
	Emerging			Limited domestic manufacturing	
Connectors	Large			Anderson, Amphenol, Aptiv, Chogory, Rosenberger	Market is fragmented, with presence of larger MNCs and Chinese imports. This offers domestic opportunity for Indian large & emerging enterprises, with the ability to offer quality products with appropriate capabilities (inhouse/ partnered)
	Emerging			Limited domestic manufacturing	
BaaS/ Swapping	Large			Amara Raja, Exicom, Gogoro, Ola Electric, Sun Mobility	New players have entered the market that offers opportunities to scale with increasing e2W & e3W adoption. Given the price of batteries, opportunity could be capital intensive with USPs around battery quality, strong ecosystem partnerships with battery/ cell manufacturers, utility providers, investors clubbed with unique financing models
	Emerging			Esmito, Emuron, Lithion Power, Numocity, RACE Energy, VoltUp	
Repurpose/ Recycle	Large			Gravita, TATA Chemicals, Umicore	While a few large companies have entered, many others are pursuing a wait & watch approach given the mid-long term nature of opportunity. Strong R&D, sourcing, testing & manufacturing capabilities may hold advantage
	Emerging			Attero, Cygni Energy, Lohum, Ziptrax	

Competitive Intensity: ● High ● Medium ● Low Low Medium High

# Development of mechanical components, battery assembly and BMS capabilities can be focused on in the short-mid term

## Short-Mid term

- ✓ Demand for **local supply of quality batteries** with robust & custom BMS is an opportunity requiring right ecosystem partnerships for cells & BMS
- ✓ Battery **housing** can be faster opportunity leveraging existing capabilities. **Connectors** is an opportunity across EV segments & require local supply chain
- ✓ Staggered investments in flexible manufacturing setups and **modular & scalable product designs** will be key
- ✓ **Startups** have emerged across the battery development, BMS & Battery services. Startups can fasten technology development cycle & time to market
- ✓ Use case dynamics favor e2W & e3W segments for **battery swapping/ BaaS** models (esp. commercial use). Forging battery service partnerships with demand driving agencies will be key for Charging Infrastructure deployment plan and utilization economics
- ✓ **BMS** - Leveraging country's strong software & electronics capabilities is essential for developing robust & scalable BMS solutions, also presenting a potential global opportunity
- ✓ **Thermal Management Systems** – Developing local thermal management solutions for EVs is an important opportunity needing joint efforts of OEMs, Tier 1 (Powertrain, Battery) & thermal management system providers.
- ✓ In the thermal management space, local supply of e-compressors, e-pumps and e-motors are potential opportunities with appropriate technology capabilities

## Mid-Long term

- ✓ Battery **repurposing** will be a key mid to long term opportunity with multiple revenue models (repurposing to recycling). However, battery collection/ mobilization strategy needs to be jointly streamlined in advance along with OEMs & Battery Manufacturers to limit logistics overheads
- ✓ Battery manufacturers can forge repurposing & **recycling** partnership as they deploy batteries in EV to streamline operational processes for collections, testing, re-deploying & recycling

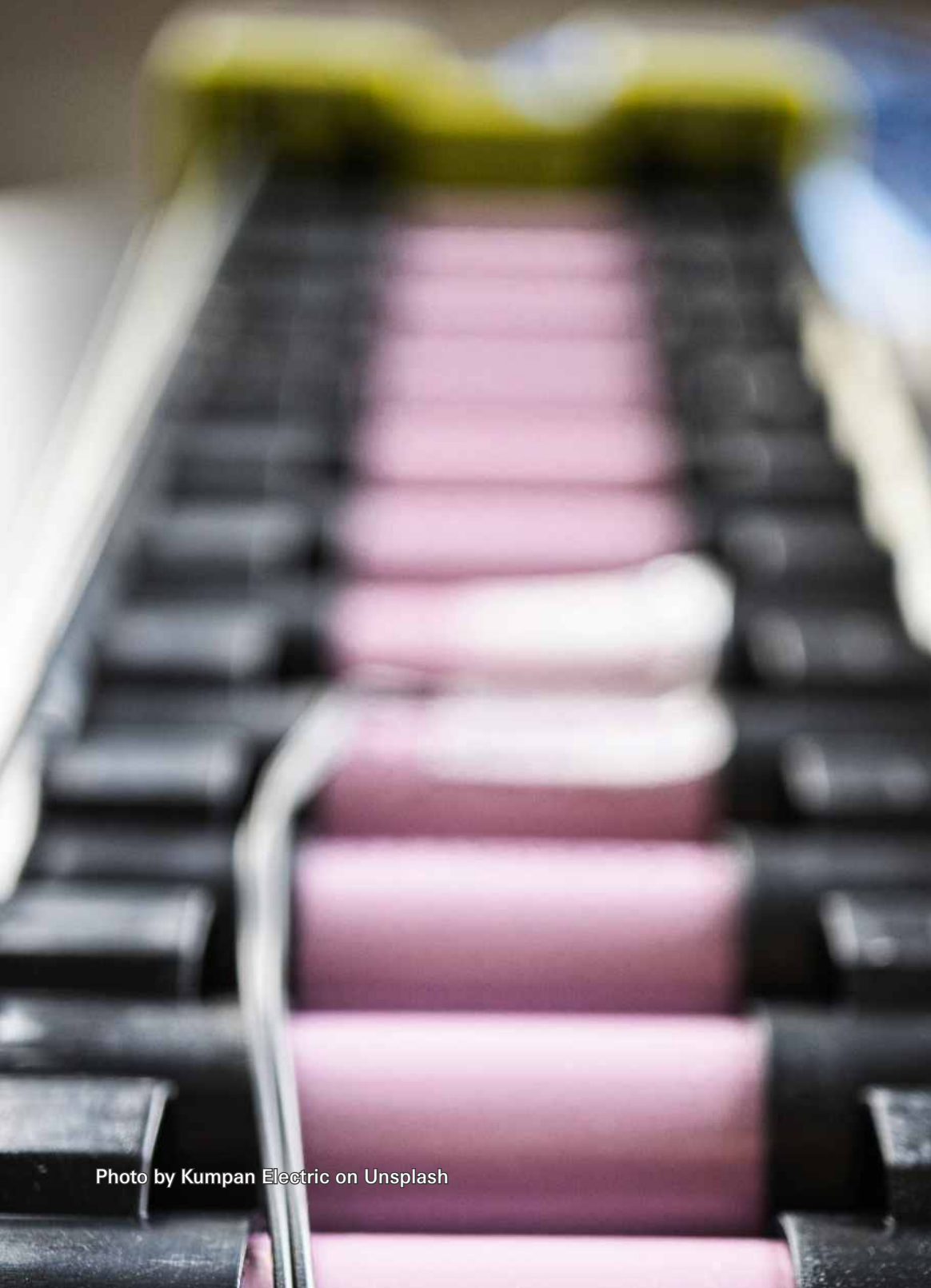
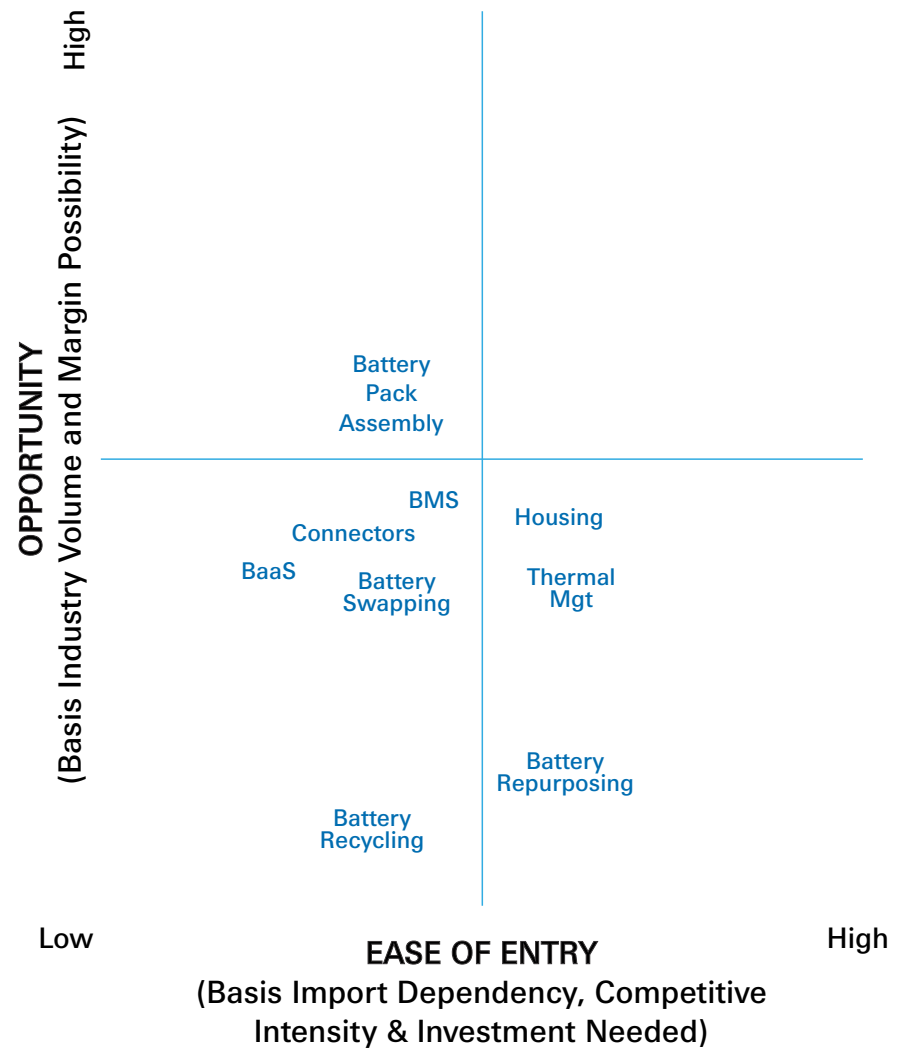


Photo by Kumpan Electric on Unsplash

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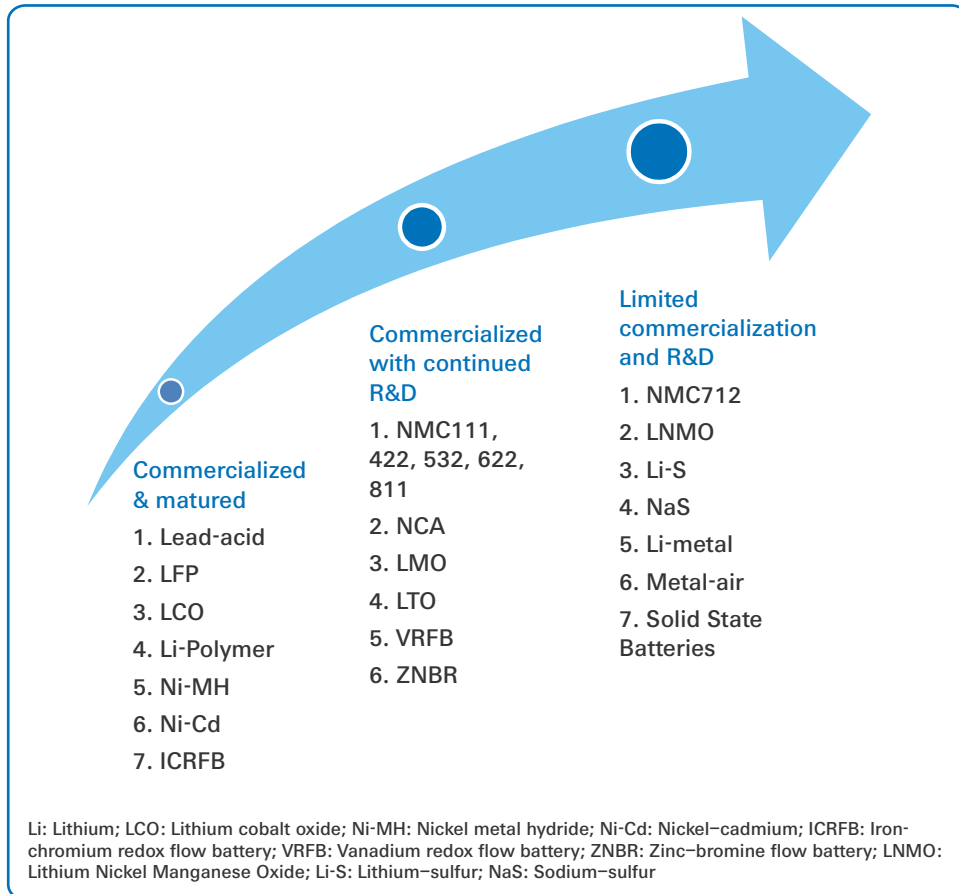
### Opportunity Vs. Ease of Entry



Illustrative representation

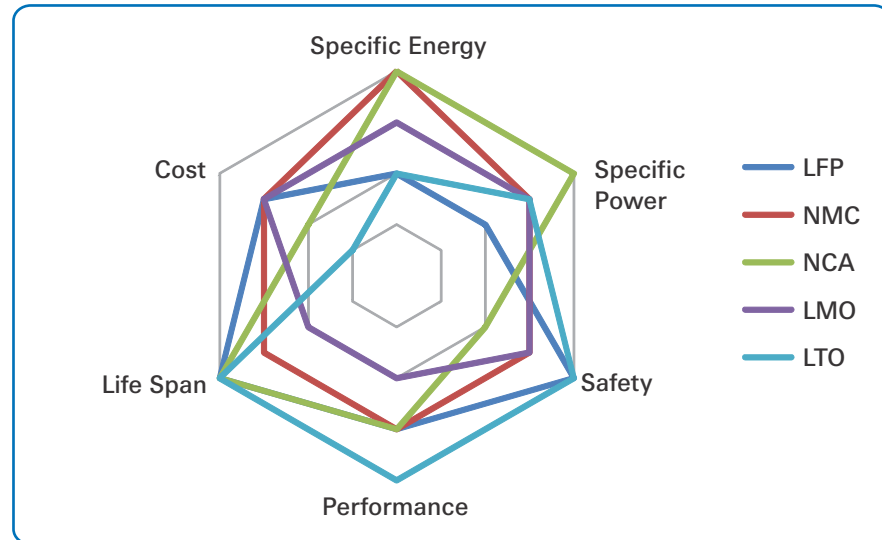
# Choice of Cell chemistry and form factors vary with use case; Li-ion chemistries are commercialized while other technologies under development

## Cell Chemistry Commercialization



Source: Deloitte, BCG

## Cell Chemistry Characteristics Comparison



## Cell Form Factors

	Cylindrical	Prismatic	Pouch
Electrode Arrangement	Wound	Wound	Stacked
Mechanical Strength	High	Medium	Low
Specific Energy	Medium	Medium	High
Energy Density	Medium	High	Medium

Low Medium High



03

# EV Component Opportunity Overview

3.1 Introduction

3.2 Component Segments

3.2.1 Powertrain & Power Electronics

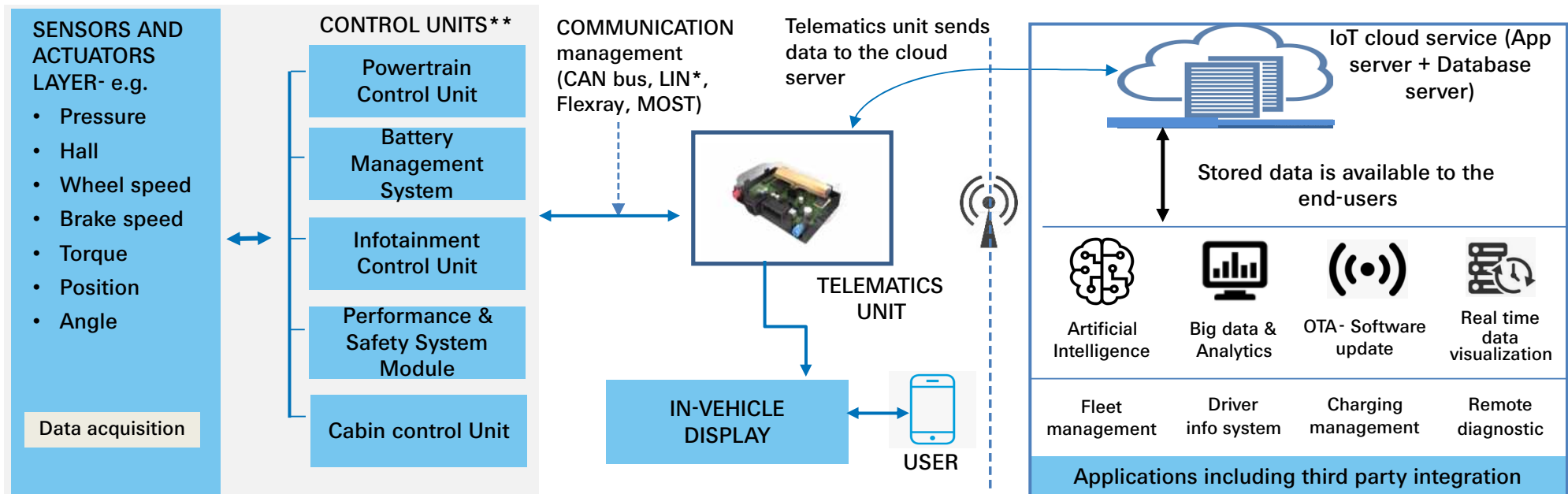
3.2.2 Battery & Associated Components

**3.2.3 Connectivity & Control Systems**

3.2.4 Other Components



# Connectivity & Control Systems enable EV intelligence & efficiency; deeper integration with EVs will redefine performance and safety



## Security

Sensors and control units share data to telematics device through CAN bus / other communication medium to collect vehicle data such as battery temperature, vehicle speed, diagnostics, real time location, etc.

Telematics control unit transmits the information to the IoT cloud server, (two way comm.) and manages user dashboard etc. The communication is established through cellular, LTE, GPS / other networks

IoT cloud server is where the data is stored in the databases for processing. The information is then accessed by applications for data analytics, decisions making & feedback involving TCU^

\*LIN- Local Interconnect Network; ^TCU – Telematics Control Unit  
 \*\*Powertrain controller and Battery Management System have been covered in previous sections

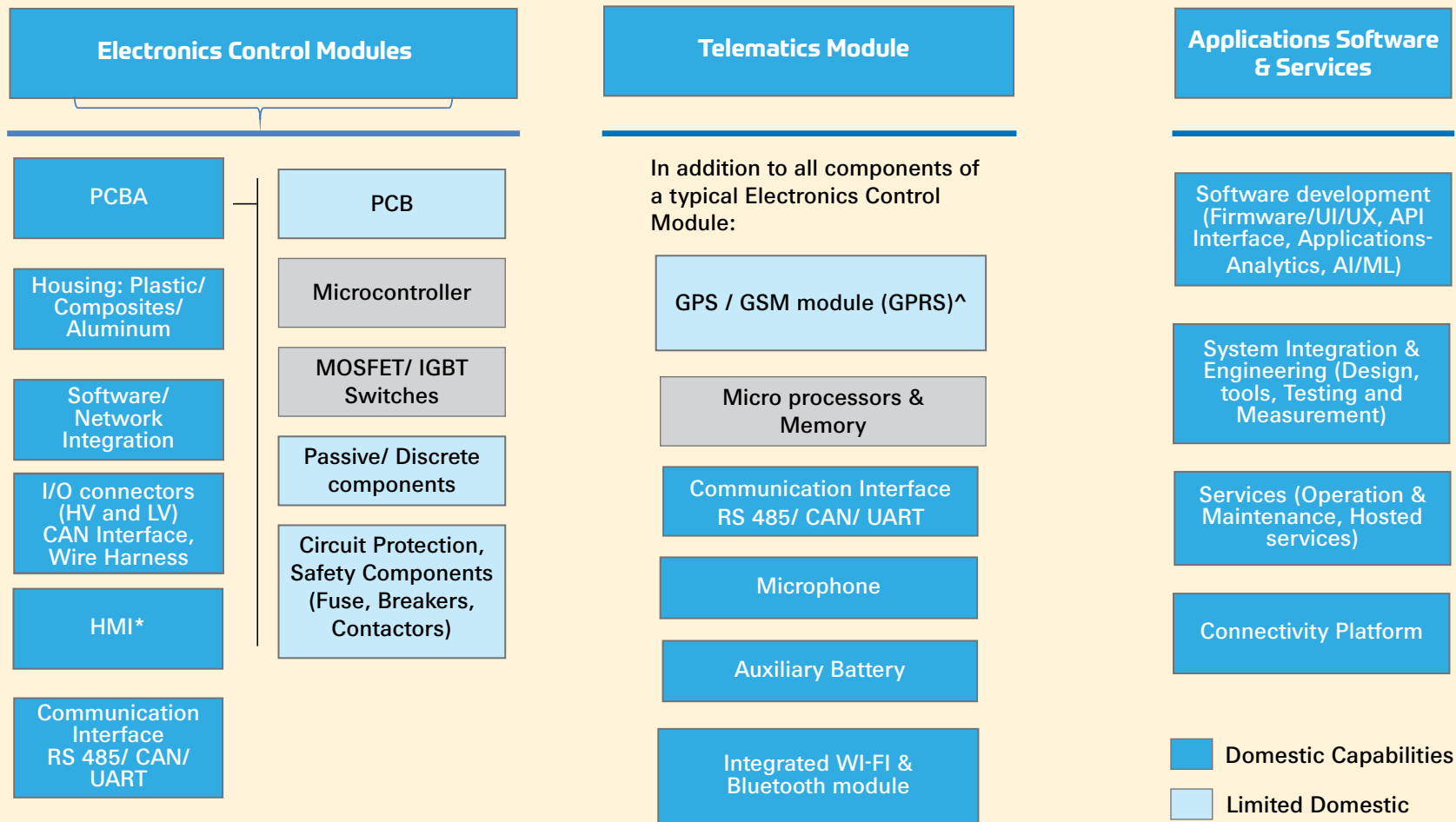
# This will be driven by need for safety, product improvements & technological advancements

Impact	
Short-term	Long-term

<b>Increasing safety and security</b>	Connectivity & control systems increase passenger safety, vehicle safety & vehicle performance – all areas of especial focus in EVs. Eg. real time warnings, advance sharing of critical information, managing safety of charging, onboard & remote diagnostics and predictive maintenance etc.	
<b>Government Mandates</b>	Vehicle tracking & emergency buttons in public transport and commercial vehicles are mandated by the AIS-140 standard. MORTH has indicated possible ADAS mandate in all cars by 2022 & enabling GPS based toll collection by 2023.	
<b>Personalized experience for Customer</b>	Electrification and connectivity are reshaping customer expectations and driving OEMs to increasingly turn to software applications to address them. E.g. navigation systems & charging station proximity, intuitive dashboards, distance before next charge required, power utilization, geofencing, etc.	
<b>Data-driven Business Streams</b>	Vehicle and driver behavior data supports not only manufacturers (vehicle performance & warranties) and application providers, but several stakeholders including fleet operators (optimize vehicle productivity & driver behavior), financial institutions (retail & institutional credit, asset monitoring), insurance agencies (refining insurance products), charging solution providers (charging solutions) etc in developing custom products and business models. IRDAI has also endorsed telematics-driven usage based motor insurance plans.	
<b>Technological Advancement</b>	Fast increasing capability to capture data accurately, transfer it on real-time basis, process it in split seconds and take prompt/ proactive remedial action will drive the field of connected and control systems for better products. This combined with continuously decreasing hardware prices and improved network connectivity to 5G will drive economies.	

Apart from the OEM line fitment revenues, revenue from SaaS and data driven streams are multiplying the market value

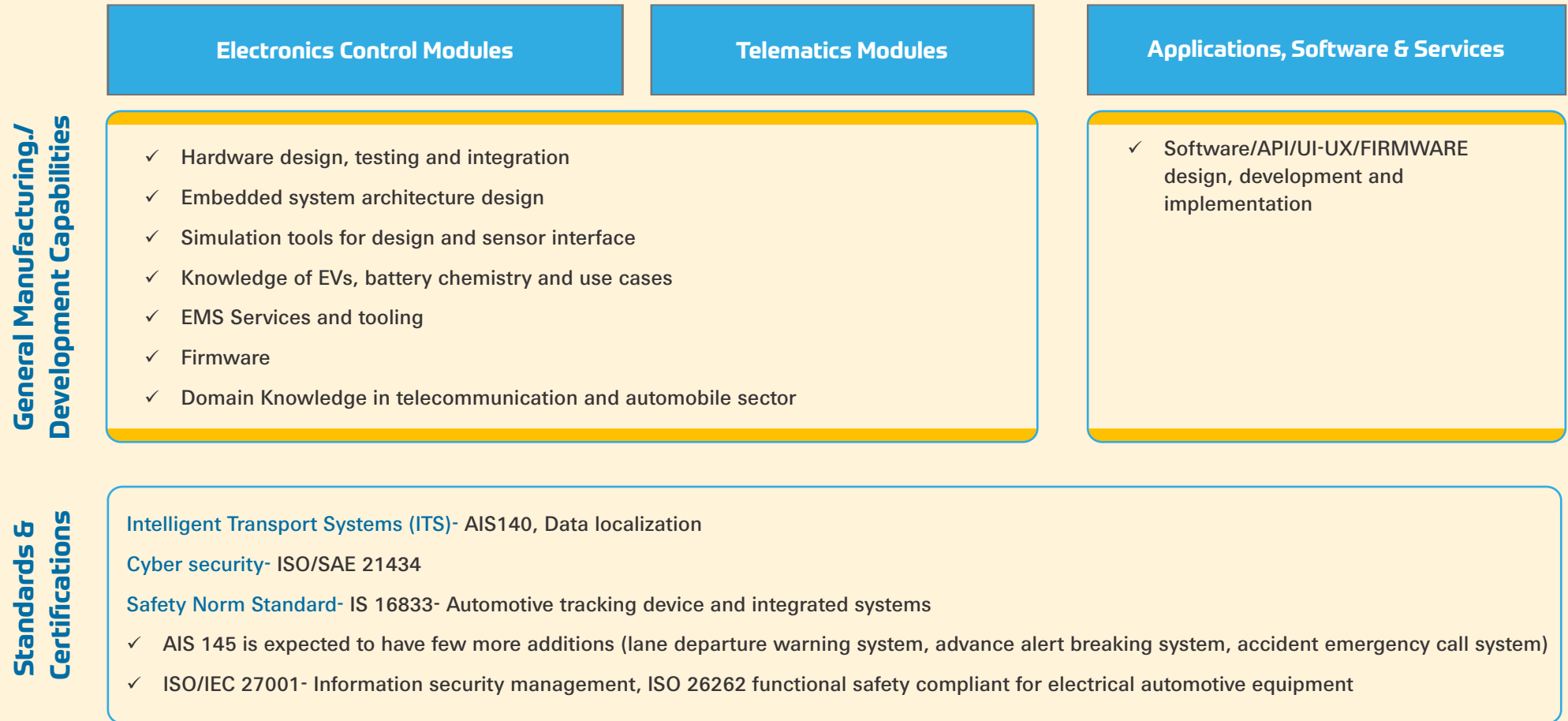
# Potential opportunities exist at both Tier 1 and Component levels



\*HMI may also be part of module specific to telematics

^In India, GPS/GSM module are manufactured by limited players

# Capability development centers around system integration, software development and domain knowledge



Relative Investment Required ● Low ● Medium ● High

# The field requires continuous innovation and expansion in functionalities to retain hold in the market

## Electronics Control Modules

- ✓ Firmware with ability to be updated over the air | Advancement in the software, power electronics and electrical/electronic (E/E) components
- ✓ **Domain Control Units (DCUs)/ Vehicle Control Units (VCUs)** are the next level of evolution, consolidating the functionality of several individual control units with better cost-efficiencies
- ✓ **Embedded IoT Telematics systems** within individual control modules, enabling direct connectivity with the cloud. E.g. IoT enabled BMS, IoT enabled VCU, eliminating need for a separate telematics device



### Future Trends:

- ✓ Smart Edge Sensors
- ✓ AI/ML integration

## Telematics Modules

- ✓ **Adoption of AI/ML** (intelligence based navigation, automated inspection of components etc.); **Onboard** diagnostics/ decision making; Real time predictive analytics & maintenance
- ✓ Enhancement in **security** features
- ✓ Subscription based services and aftermarket solutions
- ✓ Increased functionality for multiple use cases



### Future Trends:

- ✓ **Connectivity enhancement:** Enhancement of e-Sims & infrastructure | 5G enabled devices | Edge computing
- ✓ **V2X:** From presently Vehicle to User, infrastructure and cloud network, V2X may expand to Vehicle to Vehicle, Pedestrian, and Power Grids
- ✓ **ADAS** (Advanced driver-assistance systems) and **DAS** (Driver Assistance System), Voice enablement systems, **PAS** (Parking Assistance System)
- ✓ Next-generation vehicle tracking systems
- ✓ Prognostics
- ✓ Digital TWIN

## Applications, Software & Services

# Newer engagement models in flux for enhanced capability & stronger market hold

## New Engagement models & Players

With technological advancement:

- ✓ The traditional **OEM-Tier 1 engagement models** are evolving - ranging between OEM driven models to Original Device Manufacturer (ODM) driven models depending on the technological hold/ bargaining power in the OEM line fitment segment.
- ✓ Additionally, aftermarket fitment, for logistics/ fleet players is another significant opportunity

## Partnerships, Consortium arrangement

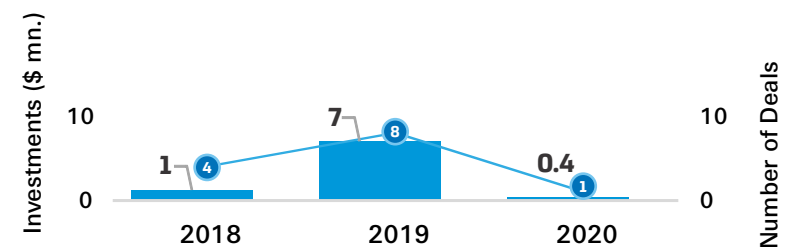
- ✓ Due to emerging technologies and digital transformation in the automotive space, various companies across the value chain (OEMs, chipset vendors, third party software stack providers, system integrators etc.) **form partnerships/consortia to drive innovation and transformation**. E.g. Ford and Toyota Motor Corp., later joined by Mazda, PSA group, Fuji, and Suzuki, formed the Smart Device Link Consortium—an open source platform to provide consumer with a choice of connect and control smart phones apps with their vehicle on the roads.

## Increasing analytics in mobility

- ✓ A number of e2W players have been **partnering technology providers (telematics and IoT solutions) to enhance vehicle features**, E.g. Ather partnered with Google Cloud for cloud solutions, Okinawa partnered Aeris Mobility IoT platform.
- ✓ Financial institutions have announced vehicle finance products utilizing telematics Eg. Revfin

## M&A, Investment, JVs and launch of new companies

- ✓ **Large OEMs and Tier 1 players are acquiring/ investing in niche telematics/SaaS based platform firms to enhance capabilities**, e.g. TVS acquired Intellicar, Varroc's stake acquisition in CarlQ (connected vehicle product), Bridgestone's acquisition of TomTom Telematics (digital fleet solution), ZF's Wabco acquisition (telematics & fleet management solutions among others), Minda acquired KPIT H/W products business, Lithium Urban Technologies acquired SmartCommute (SaaS platform provider offering real time tracking, cab routing, etc.)
- ✓ Qualcomm, JioGenNext, Mahindra, One97mobility hub etc. have **led investments in India's telematics startups**
- ✓ **Auto component manufacturers are forming JVs with technology providers** to strengthen their capabilities. E.g. Spark Minda formed a JV with INFAC Electronics to develop antenna systems indigenously, Samvardhana Motherson Group formed a new company Rollr as a provider of connected vehicle solutions



Note: Disclosed deals only

# Hardware remains concentrated, however multiple players are entering in software and services

Area	Competitive Structure			Indicative Players	Competitive Dynamics
	Player Size	Mkt Dominance	# of players		
Application Software and Solution Provider	Large			Intellicar (TVS), L&T Nxt, Minda iconnect, Trimble	Multiple customer segments eg. OEMs, fleet players, aftermarket etc. and asset light requirements allows number of players to enter, increasing crowded nature of the market. Continuous innovation is key to sustaining and growth in the segment
	Emerging			Blackbuck, Fareye, FleetX, Invers, InfoTrack, Loconav, Telematics4u, Zeliot	
Software (Firmware)	Large			Harman (infotainment), KPIT, Trimble	Software development capability, domain technicality, and integration requirements with hardware/ use case restricts new entrants. OEMs may also want to develop inhouse capability
	Emerging			Embitel, Holisol	
Network providers	Large and Emerging			Airtel, Jio, Vodafone	Market is dominated by large players
Comm. Aggregators	Large and Emerging			Idemia, Sensorise, Tata Communication Ltd	A few large communication and electronics (chip-card) players have developed specialized capability for this and dominate the segment
Cloud Service provider & Platform providers	Large			AWS, Google Cloud, IBM, Microsoft Azure	Market is dominated by incumbent players
Telematics, Infotainment control modules	Large			Bosch, BorgWarner, Continental, Denso, Harman, Minda, Rollr (Motherson Sumi), Visteon, Valeo, Varroc, Trimble	While large suppliers have strong alliances with top OEMs, but some scope for newer telematics, battery & infotainment module manufacturers exists given the continuous evolution and feature-driven nature of this segment.
	Emerging			Aeris Communication, iTriangle, Teltonika	
Powertrain, Chassis & Body Control Module	Large			Bosch, Borgwarner, Continental, Denso, Hella, Hyundai Kefico, Pricol, Visteon	OEMs typically have contracts with large global Tier 1s, or they may look to develop capability in-house. In the short term, smaller OEMs with limited volumes and custom requirements may be open to new suppliers

Competitive Intensity: ● High ● Medium ● Low    Less Medium High



# Applications, software and services with domain & development capabilities offer scope for entry & growth

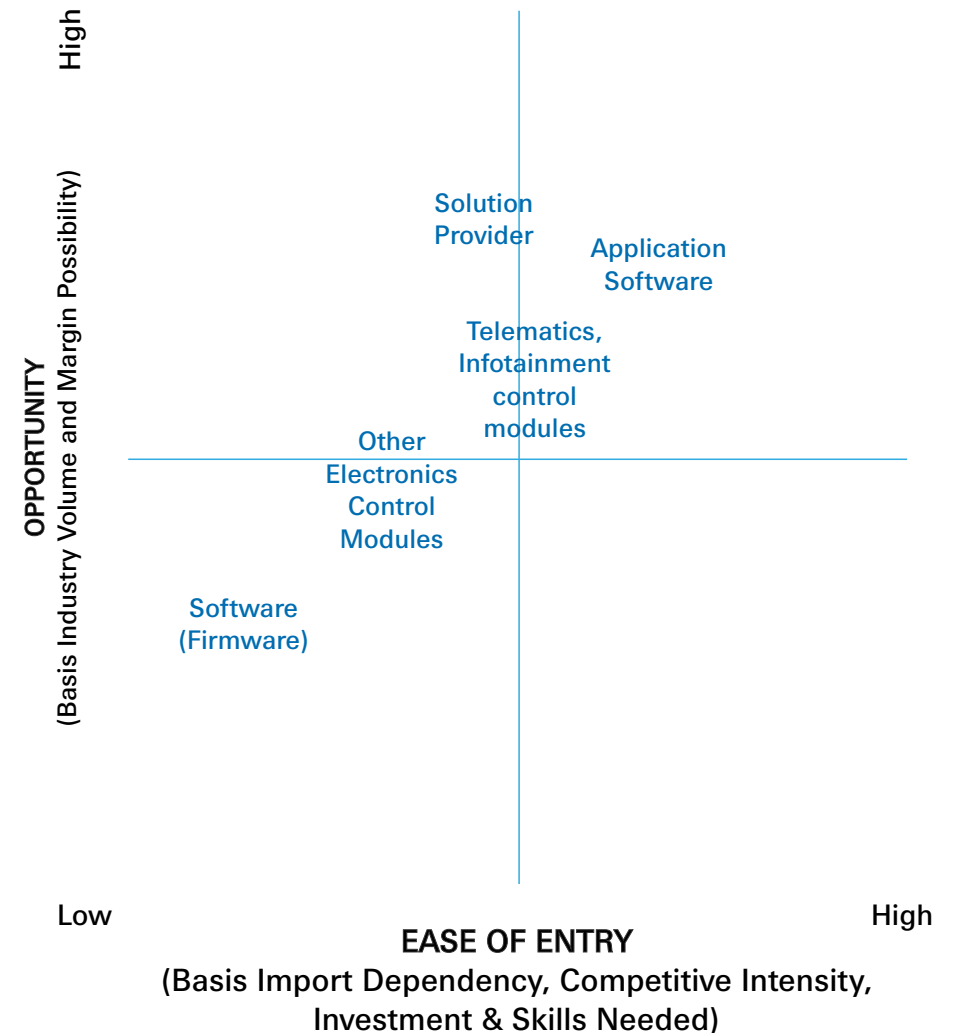
## Short to Mid term

- ✓ **Software Development capabilities** can be leveraged along with building strong auto domain expertise for developing platforms & applications for specific use cases.
- ✓ **System integration** (hardware, software & analytics) capability is key for provision of integrated solution & services
- ✓ **Data driven business models** can benefit stakeholders across EV, auto sector. It is imperative for enhancing functional analytics talent pools to develop such model in-house. through partnerships
- ✓ **Evaluating domain specific startup entities** in the telematics, connectivity & analytics based solutions can provide a head start/ entry in the space, while working towards functionality improvements for larger customer wallet share/ tapping new segments

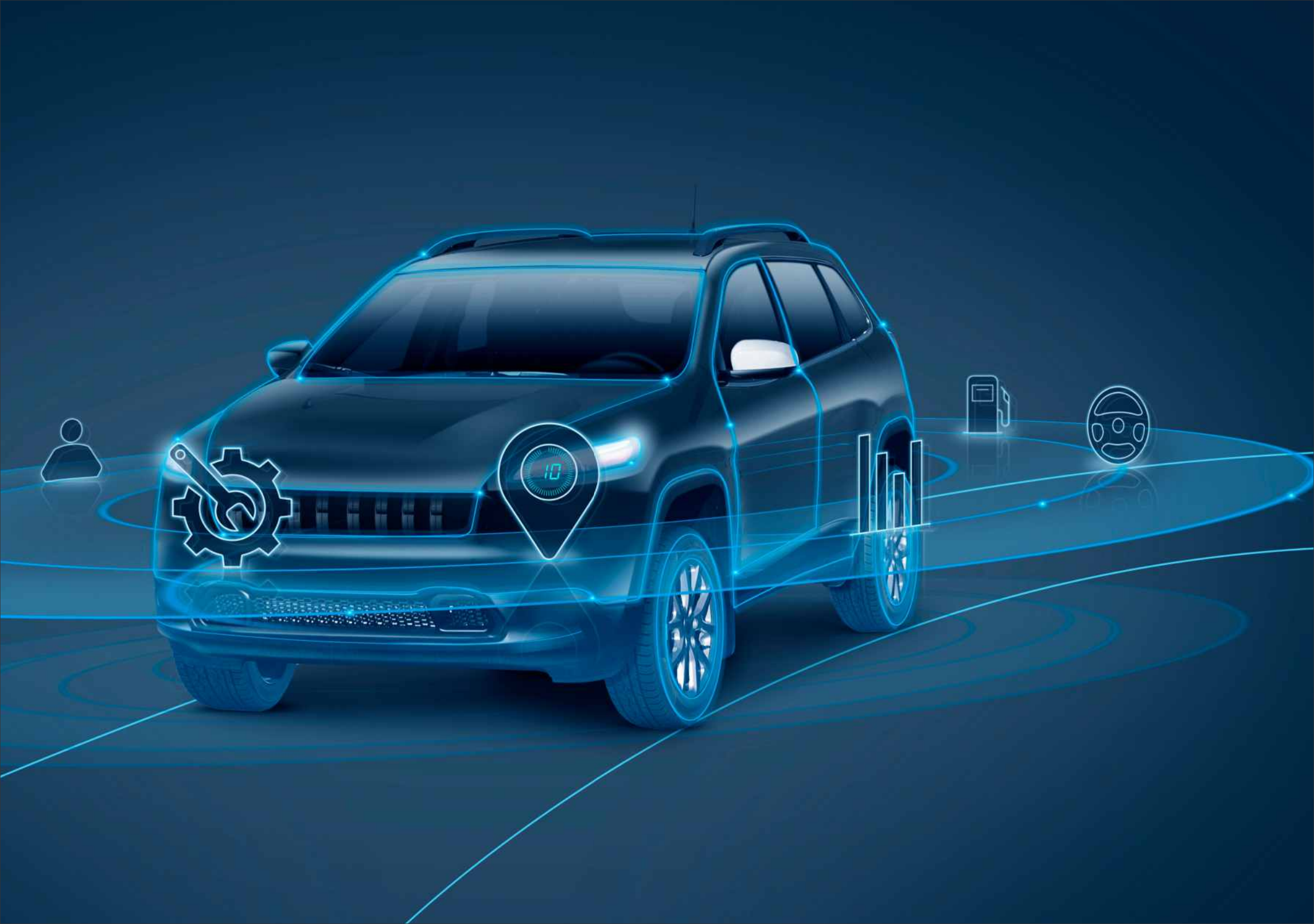
## Mid to long term

- ✓ Software Development capabilities can be strengthened for **developing full stack services**
- ✓ Consistent incremental value add through **functionality improvement or new innovation solutions** would be imperative for retaining market footprint in data driven business services
- ✓ **Collaborations** with hardware providers and other value chain partners can be explored for a better localization & offering an integrated connectivity solution over specific modules

## Opportunity Vs. Ease of Entry



Illustrative Representation





03

# EV Component Opportunity Overview

3.1 Introduction

3.2 Component Segments

3.2.1 Powertrain & Power Electronics

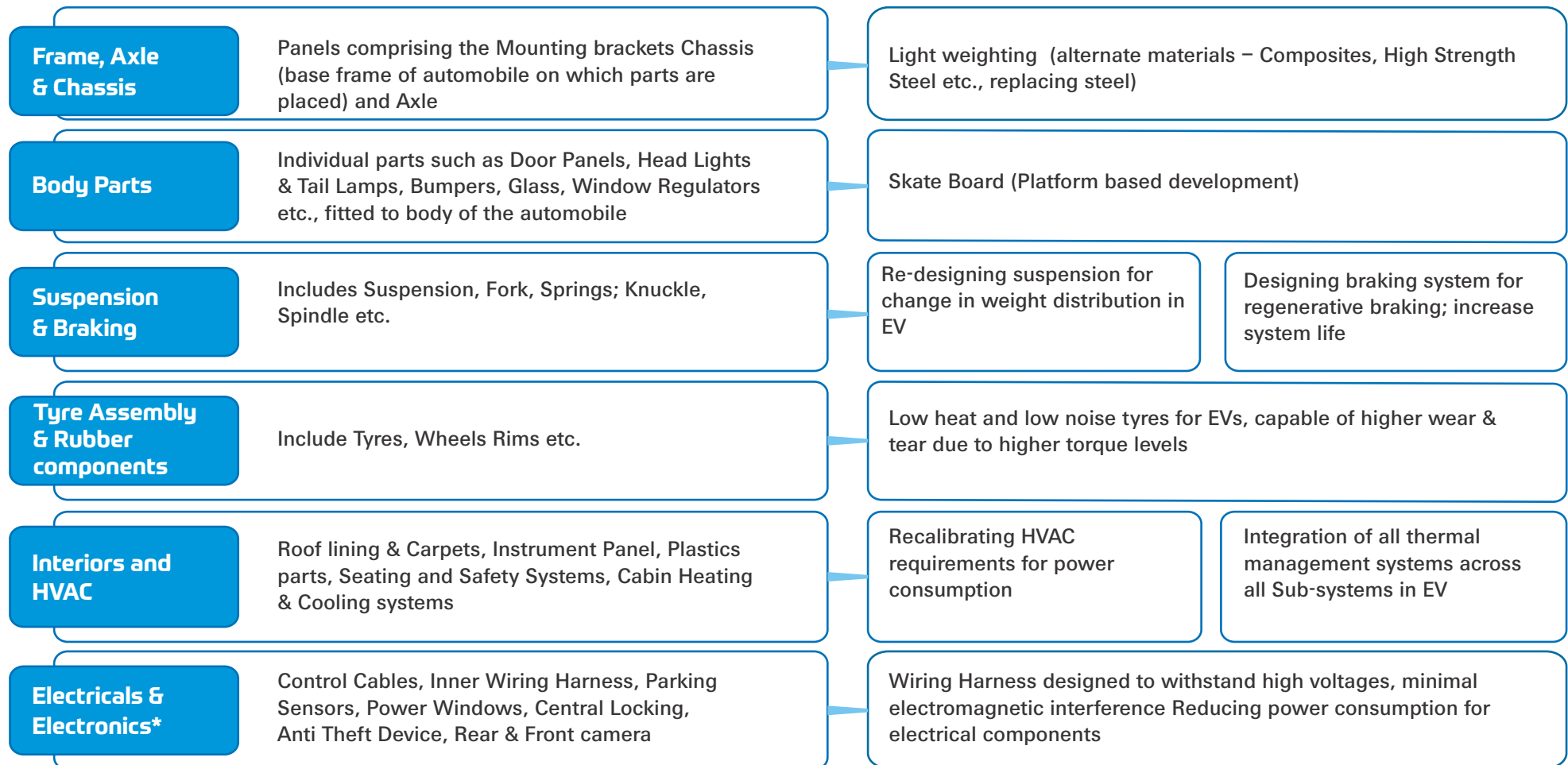
3.2.2 Battery & Associated Components

3.2.3 Connectivity & Control Systems

**3.2.4 Other Components**

# Other Body Parts may be carried over to EVs with similar technology & capability; fine-tuning design and materials over short-mid term to improve EV applicability

## General technology trends for fine-tuning to EV compatibility<sup>^</sup>



\*Excluding connectivity and control systems, power electronics and other products related to the powertrain, which have been detailed in the respective sections

<sup>^</sup> May also be relevant for new product development in ICE, but can be more pronounced in EV context

# Existing auto component manufacturers have already started tapping this incremental growth market, representing 25% of the EV cost



Photo by Jannes Glas on Unsplash

## Key Industry Trends

### Tapping International Market

- ✓ Brakes India launched electric parking brake for Global OEMs and a first launch of its kind in Indian market
- ✓ Varroc Lighting System (VLS) supplies exterior lighting solutions to TESLA Model S Sedan and Model X crossover

### M&A and JVs to gain capability

- ✓ Anand Group forged JV with Far-UK for light weighting technology
- ✓ Lumax Auto Tech entered JV with Alpine Co Ltd (Japan) for producing electric devices and components
- ✓ Remson Industries acquired Magal Cables for \$4.45 mn, expanding into thermal management system, engineering systems and thermostatic elements

### Contract Manufacturing

- ✓ Autoline India entered collaboration with Kinetic Green to manufacture electric cycles to be marketed by the latter

### EV-specific products

- ✓ Most tyre manufacturers have launched EV variants which have a structural & design adaptation,
- ✓ Suspension and brake players such as Gabriel India have also entered contracts to design products for EV OEMs

# R&D and export focus can fuel business sustainance and growth

## Short - Mid term

- ✓ As EV market expands in India and internationally, a **significant incremental opportunity** opens up for auto component manufacturers for local supply contracts as well as exports, given the frugal & competitive nature of the Indian component industry
- ✓ **Product adaptions** to meet the EV use case requirements needs to be a priority to forge supply contract in the EV space. Eg: Axles, Braking system, Suspensions, Lighter materials etc.
- ✓ While the product enhancements can be developed inhouse or through partnerships/ ToTs, the pace of technology change in EVs presents higher degree of risk of technology obsolescence. Hence consistent & **focused R&D efforts** (with IP focus) can ensure business sustenance and relevance.
- ✓ Given the nascent stage of the EV industry, most micro & small enterprises players have lower order quantities that may not qualify MoQ levels of several component players, posing strong sourcing challenges to small EV players also impacting their mortality. Openness to accommodate smaller contracts can also **support component manufacturers in fine-tuning their capabilities** to EV requirements that can be leveraged for larger local & export contracts in the medium term
- ✓ **The global EV opportunity**, especially in the existing key export markets of Europe & America, currently offer a significant multiple of the local EV opportunity, with ~1.7 mn e4W & ~40,000 eLCV & above vehicles. By FY26 these numbers are expected to reach ~4.5 mn & ~1.1 mn offering significant growth & scale opportunity requiring nimble strategy to start early
- ✓ **Contract manufacturing** can be a potential business opportunity in the EV space from system assemblies to vehicle assembly. This can also help create scale in sourcing by consolidating lower fragmented volumes across vehicle segments & players. Given the relatively simpler production lines needed, existing facilities can be utilized, while aiding component players in moving up the value chain from a Tier level supply to contract manufacturing in the B2B setup.

04

## Recommendations

REGEN



## Central Government



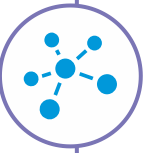
### Strategic Roadmap for EV and Component Manufacturing

Time-bound **action oriented plan**, aligned to vision of EV development in India & mapped against resources & capabilities, leading to mid-long term demand & supply side policy interventions.



### EV Component focused Segmental Committee

A platform with wide representation of **policy makers, EV component industry, technology research agencies, and startups** to deliberate on broad-based ecosystem development for enhancing competitiveness, driving standards and localization.



### Convergence

Overarching framework for **channelizing policy and its implementation** through target setting, sector & sub-sector focused schemes, R&D and innovation led initiatives, startup facilitation, skill development efforts & associated incentivization.

- ✓ Setting up of additional **test capacities/ labs** for technical guidance, designing, simulation testing of EV components, systems in addition to the commendable ARAI EV CoE can create access to increasing startups and EV developers across India.
- ✓ **Channeling funding** from various GoI schemes, multi-laterals, grants by development institutions, etc. in a coordinated manner for developing the ecosystem at large, including startups.





## State & Local Governments



### Policy Grounding

Release **operational guidelines** for state EV policies with institutional mechanisms that encourage nodal approach for policy implementation; **Fiscal allocation** with timebound action for grounding of adoption and supply side initiatives.



### Industrial Infrastructure

Consider dedicated **EV and EV component manufacturing zones** with proximity advantage, adequate common infrastructure and preferably plug-n-play facilities; focus on **specific nodes of EV/ Auto value-chain** as per strengths and opportunities.

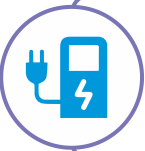
- ✓ Nissan in partnership with Envision AESC, a leading battery tech firm, has recently announced a EV Hub, EV36Zero with an investment of £1 bn. The hub would be used to produce Nissan's electric crossover and Envision AESC's advanced technology battery giga-factory. Both of these would be powered by 132 MW onsite wind & solar energy microgrid and supply surplus to Sunderland city too, thereby accelerating Nissan's journey towards carbon neutrality.



### Government Level Adoption

Lead change by time-bound electrification of **official, passenger transport and municipal fleets** thereby creating **ripple effect** for demand and supply ecosystem.

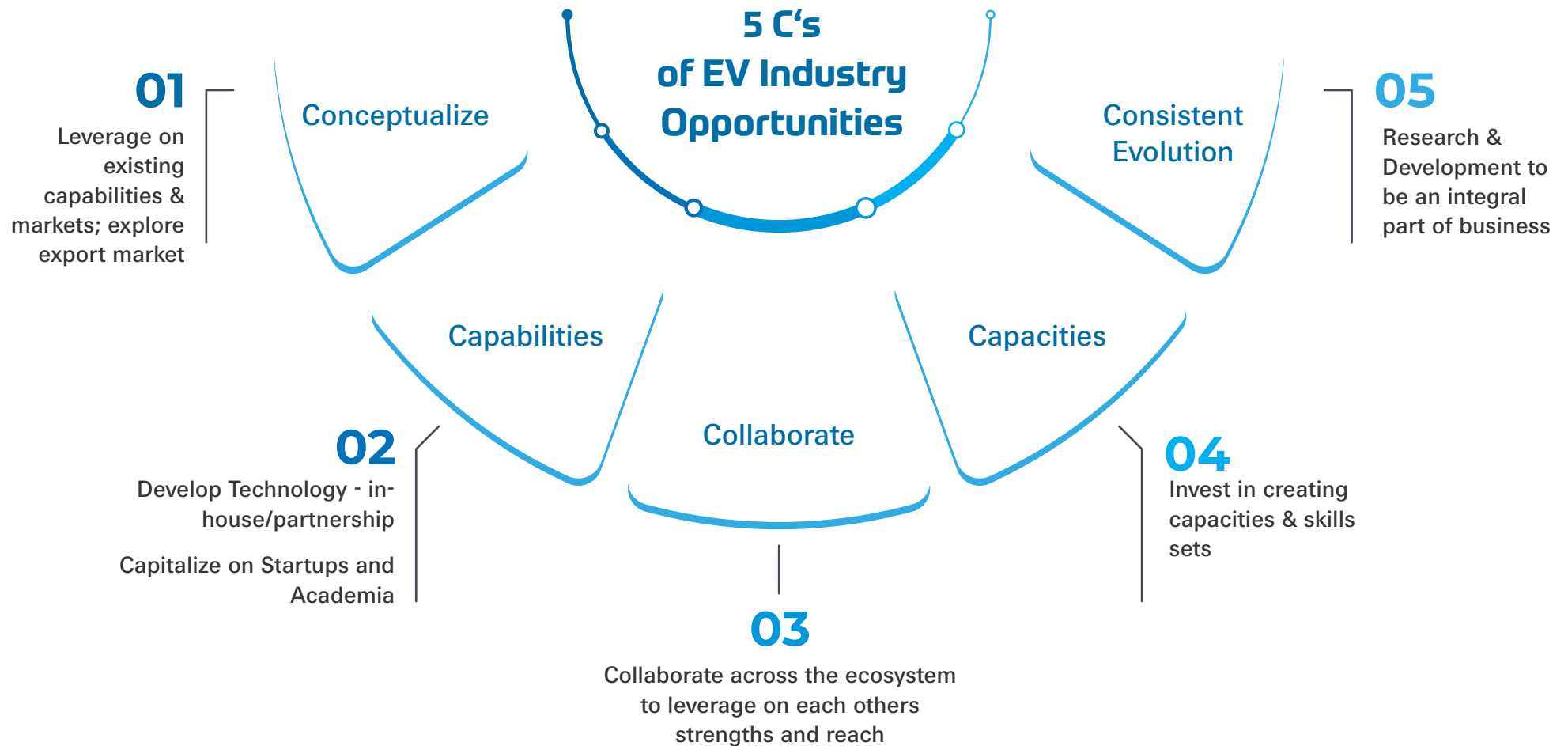
- ✓ New York City government operates 25,000 on-road vehicles, possibly the largest municipal fleet in world. About half of these units are light duty vehicles which already include 2,000 electric units, supported by over 1,000 chargers. Also, the City Department of Sanitation (DSNY) has started operating electric waste collection trucks and sweeping units, while retrofitting some others.



### Charging Infrastructure Planning and Implementation

Enable growth of charging infrastructure through special tariffs, power availability and land pool facilitation in major cities and along highways.

# What can companies do to be a part of this emerging story?





# Industry

## 1. Conceptualize



### Evaluate, Leverage and Strategize

Develop a strategic plan by evaluating vertical or horizontal integration opportunities while leveraging existing capabilities such as buyer/supplier growth plan alignment, existing client base, technology expertise, high number of users etc.

- ✓ Greaves Cotton, an engine manufacturer, forayed into 2W by acquisition of Ampere
- ✓ Exide Industries transitioned from lead acid to Li-ion, aligned to its OEM customer base
- ✓ Uno-Minda, primarily into lighting, horns and switches, diversified into various sensors, battery control module and telematics
- ✓ Ashok Leyland's global strategy on Electric Commercial Vehicles will be operationalized under Switch Mobility while OHM Global Mobility would focus on Mobility as a service

## 2. Capabilities



### Technology and Startups

Agility towards technology transfer, acquisition through national/ international partners, start-ups and academic/ research institutions & prudent alignment to local use-case.

- ✓ PCL, one of the largest camshaft manufacturer, acquired EMOSS for its truck and bus EV retrofit technology
- ✓ IIT Madras- CBEEV and IITM Research Park ex incubatees include Ather and Grintech
- ✓ IIT Delhi - CART support R&D and PG courses; has collaboration with Sona Comstar
- ✓ OLA Electric acquired Etergo, a Dutch firm for e2W technology & growth
- ✓ Hero MotoCorp, has invested in Ather Energy creating a space for Hero MotoCorp in premium e2W segment

## 3. Collaborate

Nimbleness in forging collaboration with firms across EV ecosystem in areas including Charging Infra, Energy storage, Telematics, IoT & Control Systems, Software/ Applications, Auto components, BFSI, User segments etc.



### Market Led

- ✓ HPCL partnered with Tata Power to establish EV Charging network on its retail outlets
- ✓ Mahindra & Mahindra partnered with Amazon India for 'greening' the latter's last mile delivery fleet



### Technology

- ✓ Hero MotoCorp partnered with Gogoro - a global leader in e2W & battery swapping
- ✓ Ion Energy, acquired Freemens (French firm) for advanced cloud based BMS



### Strategic

- ✓ BYD UK partnered with Alexander Dennis Ltd. to deliver e-bus in UK
- ✓ Volvo Group, Daimler Truck, and Traton Group partner to operate public charging network for heavy-duty CVs across Europe



### Value-chain

- ✓ Ashok Leyland partnered ABB for developing fast charging for e-buses
- ✓ Panasonic partnered with Tesla to supply batteries

## 4. Capacities



### Investments

Leverage the investment policy push across state government and utilize supply side incentives offered by central & state governments for rationalized capital costs while boosting the EV industry confidence.

- ✓ OLA is on verge of 1st phase of its ₹2,354 Cr. e2W manufacturing facility in Krishnagiri district, Tamil Nadu
- ✓ Ampere Vehicles has committed an investment of ₹700 Cr. over 10 years in its facility at Ranipet; roll-out of 2W is expected by end of this year
- ✓ Ather Energy has started production from Hosur with an additional investment plan of ₹635 Cr. over 5 years
- ✓ DANA TM4 has started production of high voltage motors and inverters for e-buses from its newly established Chakan, Pune plant



### Human Capital

Industry-led course design and content development in close collaboration with academia and Skill Council for formally trained & certified professionals across EV value chain

- ✓ Autobot Academy has introduced a new EV programme 'EV Engineering: Architecture and Components' in collaboration with MG Motor and ASDC
- ✓ Hero Electric has already trained over 4,000 'road-side mechanics' and aims to train over 20,000 by 2023

## 5. Consistent Evolution



### Research & Development and Innovation

EVs have also redefined a new paradigm in mobility, challenging the technology boundaries demanding greater efficiencies, improved precisions, higher cycles, lighter materials and better competitiveness, triggering endless possibilities for technology. Aiming at the ACES vehicles, EV industry is expected to follow the trajectory taken by the electronics industry. Hence focusing on continuous research & development with strong in-house capability and suitable academic/ research partnership will ensure continued market sustenance.

- ✓ Bharat Forge has established R&D facility in UK, in MIRA Technology Park, the UK's leading automotive technology park and Enterprise Zone, where it will be developing components & sub-systems focused on electric powertrain solutions. This would complement the Power Electronics Facility at Kalyani Centre for Technology & Innovation (KCTI) in Pune

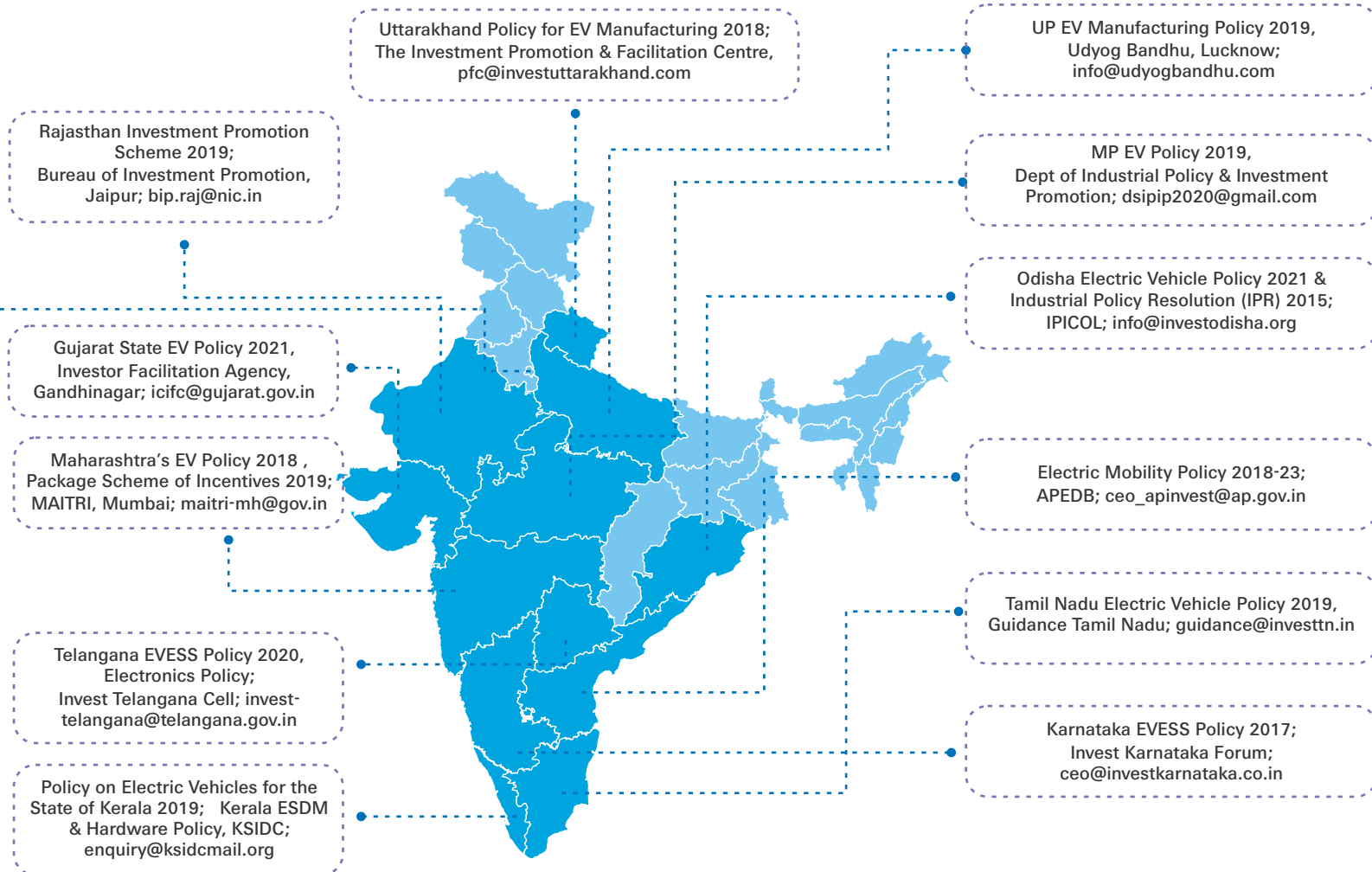
A close-up photograph of an electric vehicle's charging port. A black and white charging cable is plugged into the port, which is illuminated with a blue light. The car's body is dark and reflective, and a wheel is visible in the background.

05

## EV Manufacturing: Policy Overview

# EV Manufacturing: Policy Overview

**INVEST INDIA**  
 – National Investment Promotion & Facilitation Agency;  
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Other states are either in the process of developing/ revising their policies or have adoption centric EV policy

# Government Policies – EV Investment Perspective\*

## Central Government

- ✓ PLI Scheme on 'National Program on Advanced Chemistry Cell (ACC) Battery Storage' (DHI) – ₹18,100 Cr.
- ✓ Scheme for Promotion of Manufacturing of Electronics Components & Semiconductors (SPECs) (MeitY) - Subsidy @25% CAPEX

## Incentives (exemption/ reimbursement) from State Governments generally include

- Capital Subsidy
- Capital Interest Subsidy
- Technology Transfer & Environment Protection Incentives
- Infrastructure Subsidy - land & land development cost
- Stamp Duty Exemption
- Debt Interest Subsidy for land & infrastructure
- SGST Reimbursement
- Power Tariff Subsidy/ Electricity Duty Exemption
- R&D Grant, Patent Grant
- Special Package Incentives for EV (select states)

## Andhra Pradesh

Capital Subsidy @10% in each segment of EV (e2w, e3w, e4w, e-buses), battery & charging equipment, hydrogen storage & fueling equipment manufacturing

## Kerala

25% for investment upto ₹100 Cr. for EV manufacturers as applicable to ESDM sector

## Gujarat

Graded incentives for large/ mega/ ultra-mega industry @6%-12% basis talukas classification; Infrastructure Subsidy @25% for EV private parks (@50% in Vanbandhu Talukas)

## Madhya Pradesh

Capital Subsidy @ 25% for charging equipment/ machinery; Infrastructure Subsidy @ 50% for effluent/ sewage/ pollution treatment

## Karnataka

Capital Subsidy up to ₹50 lakhs for MSMEs in EV component & EV battery manufacturing, and up to ₹20 Cr. for large/ mega/ ultra/ super mega EV cell manufacturing, EV battery pack/ module manufacturing.

## Maharashtra

Customized package of incentives with extra incentives for Pioneer Units (first two mega projects for manufacturing of EV, EV components & battery)

### Odisha

Capital Subsidy @5% for new small & micro EV battery manufacturing unit (30% for SC- / ST- / women-led); Exemption from land premium

### Rajasthan

Capital Subsidy @25% of investment (up to ₹50 lakhs) for unit investing ₹25 Cr. or more in EV manufacturing

### Tamil Nadu

15% Capital Subsidy for intermediate products for manufacture of EV & charging infrastructure; higher capital subsidy of 20% of investment over 20 years for EV battery manufacturing units

### Telangana

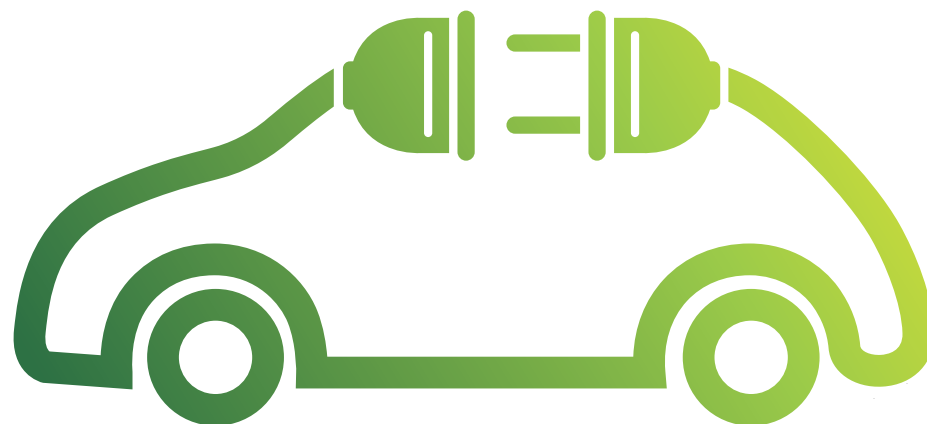
Capital Subsidy @20% capped at ₹30 Cr. for Mega Enterprises & ₹10 Cr. for electronics & subsidiaries

### Uttar Pradesh

Capital Subsidy on fixed capital investment @25% for charging stations; @15% for ESDM units (additional 10% for EV & auto electronics); Capital Interest Subsidy for 5 years @50% for battery recycling plants

### Uttarakhand

Land Concession in SIIDCUL Industrial area @ 5% for large industrial investment; @15% for large industry; @25% for mega industry & 30% for ultra mega industry





# Abbreviations

\$	US Dollar
AC	Alternating Current
ADAS	Advanced driver-assistance systems
AEC	Automotive Electronics Council
AI	Artificial Intelligence
AIS	Automotive Industry Standards
API	Application Programming Interface
ARAI	Automotive Research Association of India
B2B	Business-to-business
B2C	Business-to-consumer
BaaS	Battery-as-a-Service
BCD	Basic Customs Duty
BHEL	Bharat Heavy Electricals Limited
BLDC	Brushless DC
BMS	Battery management system
bn	Billion
CAFE	Corporate Average Fuel Economy
CAGR	Compound Annual Growth Rate
CAN Bus	Controller Area Network Bus
CECRI	Central Electro Chemical Research Institute
CESL	Convergence Energy Services Limited
CNG	Compressed natural gas
CoE	Center of Excellence
Cr.	Crore
CSIR	Council of Scientific & Industrial Research
DAS	Driver Assistance System
DC	Direct Current

DCU	Domain Control Units
DHI	Department of Heavy Industry, Ministry of Heavy Industries & Public Enterprises
EESL	Energy Efficiency Services Limited
EMS	Electronics Manufacturing Services
EV	Electric Vehicle
EVSE	Electric vehicle supply equipment
FAME	Faster Adoption and Manufacturing of Electric Vehicles in India
FET	Field-effect Transistor
GaN	Gallium Nitride
GHG	Greenhouse Gas
Gol	Government of India
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile
H/W	Hardware
HCV	Heavy Commercial Vehicle
HMI	Human-Machine Interface
HPCL	Hindustan Petroleum Corporation Limited
HS	High Speed
HV	High Voltage
HVAC	Heating, Ventilation, and Air Conditioning
I/O	Input/Output
IC	Integrated Circuit
ICE	Internal Combustion Engine
ICRFB	Iron-chromium redox flow battery
IEA	International Energy Agency

IEC	International Electrotechnical Commission
IGBT	Insulated-gate bipolar transistor
IOCL	Indian Oil Corporation Limited
IoT	Internet of things
IP	Intellectual Property
IP Certification	Ingress Protection Certification
IRDAI	Insurance Regulatory and Development Authority of India
ISO	International Organization for Standardization
ISRO	Indian Space Research Organisation
IVI	In-Vehicle Infotainment
JV	Joint Venture
km	Kilometre
kmph	Kilometre per hour
kWh	Kilowatt Hour
LCO	Lithium cobalt oxide
LCV	Light Commercial Vehicle
LFP	Lithium iron phosphate
Li	Lithium
LIN	Local Interconnect Network
Li-S	Lithium-sulfur
LMO	Lithium manganese oxide
LNMO	Lithium Nickel Manganese Oxide
LS	Low Speed
LTE	Long-Term Evolution
LTO	Lithium-titanate-oxide
LV	Low Voltage
m	metre
M&A	Mergers & Acquisitions
Max.	Maximum

MCB	Miniature Circuit Breaker
MCV	Medium Commercial Vehicle
MeitY	Ministry of Electronics and Information Technology
MIDC	Modified Indian Driving Cycle
Min.	Minimum
ML	Machine Learning
mn	Million
MoF	Ministry of New & Renewable Energy
MoHUA	Ministry of Housing and Urban Affairs
MoNRE	Ministry of Natural Resources & Environment
MoP	Ministry of Power
MOQ	Minimum quantity order
MoRTH	Ministry of Road Transport & Highways
MOSFET	Metal-oxide-semiconductor Field-effect Transistor
MOST	Media Oriented System Transport
MW	Mega Watt
NaS	Sodium-sulfur
NHAI	National Highways Authority of India
Ni-Cd	Nickel-cadmium
Ni-MH	Nickel metal hydride
NMC	Nickel manganese cobalt
O&M	Operations & Maintenance
ODM	Original Device Manufacturer
OEM	Original Equipment Manufacturer
OTA	Over-the-air
PAS	Parking Assistance System
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PDU	Power distribution unit

...continued

PLI	Production Linked Incentive
PM	Permanent Magnet
PMSM	Permanent magnet synchronous motor
PT	Powertrain
R&D	Research and development
Rol	Return on investment
RPM	Revolutions per minute
SaaS	Software-as-a-Service
SAE	Society of Automotive Engineers
SiC	Silicon Carbide
SME	Small and Medium Enterprises
SoC	State of Charge
SoH	State of Health
SPECS	Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors
STRU	State Road Transport Undertakings
T1	Tier 1

TCO	Total Cost of Ownership
TCU	Telematics Control Unit
TMS	Thermal Management System
UART	Universal Asynchronous Receiver/Transmitter
UI-UX	User interface - User experience
USP	Unique selling proposition
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-everything
VCU	Vehicle Control Unit
VRFB	Vanadium redox flow battery
Wh	Watt-hour
WLTP	Worldwide Harmonized Light Vehicles Test Procedure
xEV	Hybrid Electric Vehicle, Plug-in Hybrid Electric Vehicle, Electric Vehicle
YoY	Year-on-Year
ZNBR	Zinc-bromine flow battery



The Automotive Component Manufacturers Association of India (ACMA) is the apex body representing the interest of the Indian Auto Component Industry. Its membership of over 850 manufacturers contributes to more than 85 per cent of the auto component industry's turnover in the organised sector. ACMA is an ISO 9001:2015 Certified Association.

ACMA's charter is to develop a globally competitive Indian Auto Component Industry & strengthen its role in national economic development as also promote business through international alliances. ACMA's active involvement in trade promotion, technology up-gradation, quality enhancement & collection and dissemination of information has made it a vital catalyst for the component industry's development in India. Its other activities include participation in international trade fairs, sending trade delegations overseas and bringing out publications on various subjects related to the automotive industry.

ACMA is represented on a number of panels, committees and councils of the Government of India through which it helps in the formulation of policies pertaining to the Indian automotive industry.

Further information and data on the Indian automotive industry is available on the ACMA Website: [www.acma.in](http://www.acma.in)



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#### **Corporate & Government Advisory (CGA)**

YES BANK is deeply committed to India's transition towards sustainable mobility and development of a robust EV value chain in the country. The Corporate & Government Advisory (CGA) group has been engaging with Central & State Governments and industry players to offer policy, strategic and business advisory services. CGA is working with various State Governments for developing/ reviewing their State EV Policy and investment promotion initiatives for EV-led manufacturing. The group has also supported several STUs, CTUs, Smart Cities and ULBs for deployment of e-buses and creation of charging infrastructure. CGA is also advising various industry players in developing their EV plans, through tailored advisory & market entry services.

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