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Automobiles & Components

Sector

NEUTRAL

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THEME

BSE-30: 39,123

Electric vehicles—question is when, not if? The automobile industry is at the cusp of a revolution with adoption of cleaner vehicles (electric and plug-in hybrid) over petrol/diesel vehicles. We believe while China, Europe and the US will be faster to adopt electric vehicles, the Indian market will also embrace these vehicles as battery costs come down. We expect 28% of automobiles (except commercial vehicles) in India to shift to EVs by FY2030 with scooters and three-wheelers adopting electric much faster than other segments.

Scooters and three-wheelers will adopt electric faster than passenger cars

We forecast 28% of automobiles (except commercial vehicles) will shift to electric and plug-in hybrid by FY2030. Scooters, three-wheelers and buses will likely shift faster to electric than other modes of transport. The key reasons for steady improvement in electric vehicle adoption will be—(1) electric vehicles will likely achieve total cost of ownership breakeven (assuming first replacement happens in 5 years) versus ICE vehicles in India by CY2025 (in scooters and three-wheelers total cost of ownership (TCO) has already been achieved), (2) the government FAME-II policy will accelerate the shift towards EVs, (3) the government plans to set up charging infrastructure across the country and (4) the OEMs plan to launch a number of electric vehicles in CY2020, which will offer significantly better performance than the current EVs in India.

OEMs' profitability will suffer initially as adoption rises in electric vehicles

Profitability in electric vehicles will likely be negative in the initial few years due to (1) lack of economies of scale and (2) potentially aggressive pricing by OEMs to increase adoption levels of EVs. As the electric two-wheeler market will largely be controlled by existing OEMs only, we expect profitability on electric vehicle sales to converge towards current profitability over a period of time with increase in scale and reduction in costs. Having said that, (1) profitability from sale of spare parts will be at risk for OEMs as EVs have much lesser moving parts and require much lower maintenance costs and (2) profitability will also be impacted due to decline in residual value of internal combustion engines (ICE) vehicles, which can put pressure on pricing of ICE vehicles.

Impact on auto ancillaries will be negative for suppliers with engine and transmission parts

In terms of the impact on auto ancillaries, the shift towards EVs would be negative for 'traditional' automotive component suppliers due to lack of an engine and reduction in transmission content in EVs (60% of vehicle cost in ICE). However, tire manufacturers, companies with presence in interior and exterior parts such as bumpers, door panel, instrument panel, seats, rear-view mirrors, among others, will not be much impacted by the shift towards electric vehicles.

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TABLE OF CONTENTS

ADOPTION OF ELECTRIC VEHICLES: QUESTION IS WHEN, NOT IF?

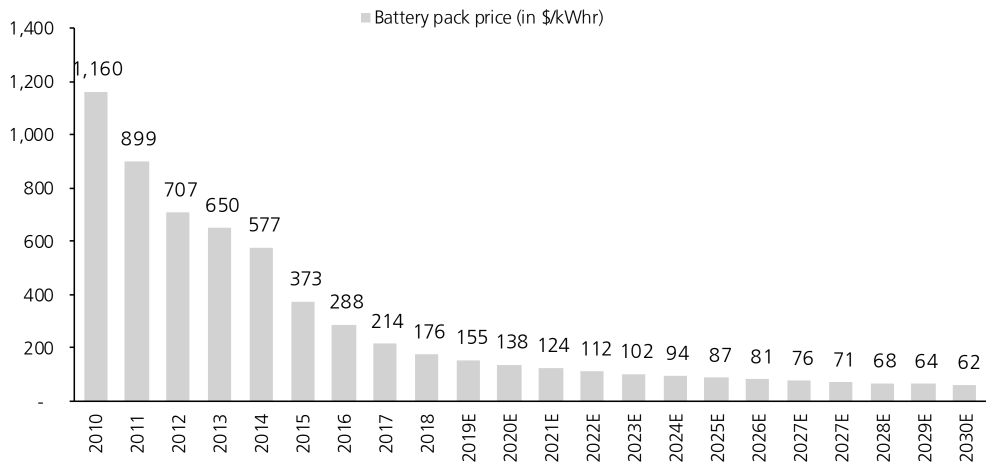
The share of electric vehicles in the automobile industry is likely to increase significantly driven by falling lithium ion battery costs, government support to electric technology and development of charging infrastructure across the globe. China, Europe and the US will remain the key markets for electric vehicles, while in India adoption will gradually increase.

The key reasons for faster adoption of electric vehicles globally are discussed below.

Sharp decline in lithium ion battery prices globally leading to decline in prices of electric vehicles

One of the important drivers of an EV's total cost of ownership (TCO) matching internal combustion vehicles (ICE) is the cost of the battery pack (contributes ~50% of electric vehicle cost currently). The price of the battery pack has fallen by 85% since CY2010. However, the cost of the battery pack is still a major hurdle for faster adoption of EVs. Lithium battery prices are expected to fall to US$94 per kW-hr by CY2024 and US$62 per kW-hr by CY2030 (as per Bloomberg Intelligence estimates) mainly led by (1) higher volumes due to mass market adoption, (2) use of alternate materials instead of expensive materials like cobalt. Currently NMC111 (nickel, magnesium and cobalt in the ratio of 1:1:1) chemical is used in automotive EV lithium ion battery but by CY2020, NMC811 composition will be used, which will significantly reduce usage of cobalt in the battery, and (3) increase in battery cell density, which will further reduce the cost of battery. Lower battery pack prices will eventually lead to lower TCO for EVs as compared to ICEs.

Exhibit 1: Battery pack prices are expected to fall to $94 per kW-hr in CY2024 and to $62 per kW-hr in CY2030
Historical and forecasted prices of battery pack, calendar year-ends, 2010-30 (in US$/ kW-hr)



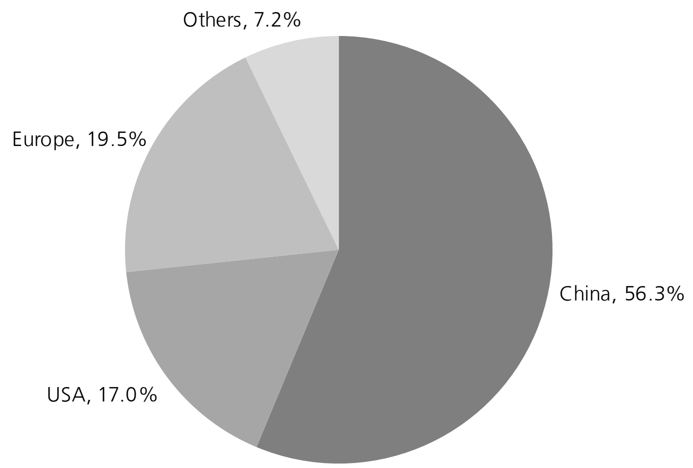
Source: Bloomberg NEF, Kotak Institutional Equities

Government supporting electric vehicles with incentives

Global plug-in hybrid and electric vehicle sales were 2.1 mn units in CY2018 (64% higher than CY2017), which was ~2% of global automotive sales. China leads the race with sales of 1.2 mn units (+78% yoy) followed by the US with sales of 0.35 mn (+79% yoy) and Europe with sales of 0.4 mn (+34%) in CY2018. Some smaller markets like Scandinavian countries supported EV sales through incentives, including (1) Norway, where 40% of the new car sales were plug-in hybrids and electric, (2) Iceland had 17.5% of new car sales as EVs and (3) 7.2% of car sales were EVs in Sweden in CY2018. Higher sales volume was mainly led by governments' (1) heavy investments in EV infrastructure and mobility solutions to encourage supply and (2) subsidies, tax breaks and special driving privileges to incentivize demand. Many governments are incentivizing to opt for electric mobility, each with their own schemes (refer to Exhibit 3). Certain governments have eased the burden on purchase, lease and road taxes to make EVs more attractive to consumers. Other benefits include the use of special driving lanes, preferential or free parking and waiving of toll fees.

Exhibit 2: China, US and Europe together comprise ~93% of the global electric vehicle sales in CY2018

Geographic mix of electric vehicle sales, calendar year-end, 2018 (in %)



Source: Inside EVs, Kotak Institutional Equities

Exhibit 3: Norway has the best policy on EV

EV subsidy scheme by various governments, calendar year-end, 2018

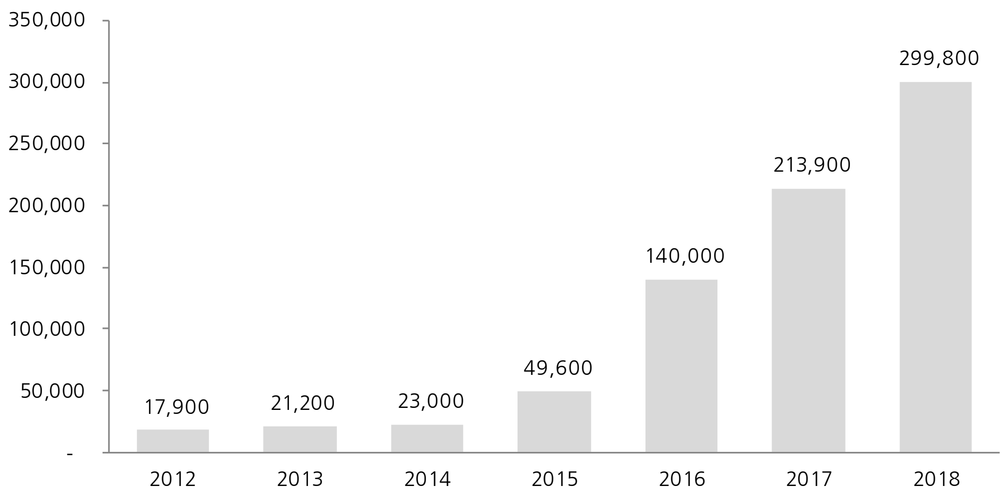
Country/State	Subsidy criteria	Incentives
United States of America	A tax credit is available for the purchase of a new qualified PEV that draws propulsion using a traction battery that has at least five kilowatt-hours (kWh) of capacity, uses an external source of energy to recharge the battery, has a gross vehicle weight rating of up to 14,000 pounds, and meets specified emission standards. The minimum credit amount is $2,500, and the credit may be up to $7,500, based on each vehicle's traction battery capacity and the gross vehicle weight rating. The credit will begin to be phased out for each manufacturer in the second quarter following the calendar quarter in which a minimum of 200,000 qualified PEVs have been sold by that manufacturer for use in the United States. This tax credit applies to vehicles acquired after December 31, 2009.	$2,500 to $7,500 (This subsidies are available up and above the respective state-subsidies given by each state)
California	In order to be eligible for eletric vehicle rebate program, annual household income must be equal or below the income caps defined as: (1) $150,000 for single filers, (2) $204,000 for head-of-household filers and (3) $300,000 for joint filers. Income which exceed the above levels are eligibile for fuel cell electric vehicle rebates only. An addition $2,000 is availabe for lower-income with household income less than 300% of the Fed poverty level.	Battery electric vehicles (BEV) - $2,500 Plug-in hybrid electric vehicles (PHEV)- $1,500 Hydrogen fuel cell electric vehicles (FCEV)- $ 5,000
New York	Drive clean rebate for electric cars depends on the EPA all electric range for the car model in New York	Greater than 120 miles - $2,000 40-119 miles - $1,700 20-39 miles - $1,100 Less than 20 miles - $500 Electric cars with manufacturer's suggested retail price greater than $60,000- $500
Norway	Since the early 1990s, Norwegian government have gradually introduced incentives for vehicles with zero emission.	Incentives include: (1) No purchase/import taxes, (2) exemption from 25% VAT on purchase, (3) No annual road tax, (4) 50% of the price for fossil fuel cars on ferries, public parking and toll roads, (5) 40% reduced company car tax and (6) access to bus lanes
China	The subsidies can be availed only for models for pure battery electric cars with a driving range above 250 kilometers	Greater than 400 km - CNY25,000 300-400 km - CNY18,000 20-250-300 km - CNY 18,000
India	FAME II was recently incorporated with capital outlay for Rs100 bn spread over the three years. The capital will be incured towards demand incentives and charging infrastructure. The demand incentive is linked to the battery capacity. Also, the subsides are capped at 20% of the cost of cars. 35,000 cars can avail subsidy benefits under FAME II scheme.	Rs 10,000 per kWhr for all vehicles (capped at 20% of the vehicles cost)

Source: Kotak Institutional Equities

Sharp increase in electric charging infrastructure globally

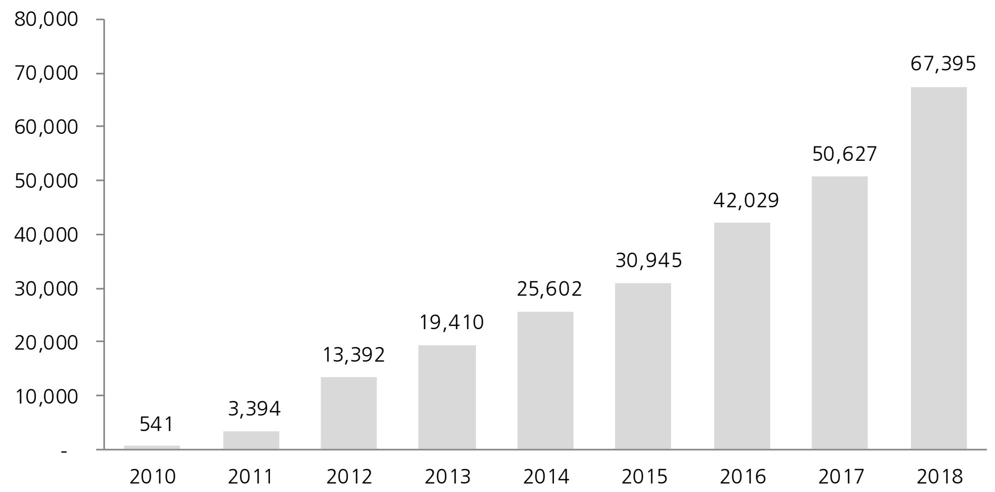
Electric charging infrastructure will play a key role in faster adoption of EVs globally. In the past few years, vehicle sales in some countries have been constrained by lack of public charging infrastructure. Although most EV charging takes place at home or work, availability of public EV charging infrastructure is an important consideration for EV buyers mainly due to (1) lack of dedicated parking spot near home, (2) quick charging capabilities and (3) eliminate the fear of range anxiety among customers. However, recently EV charging infrastructure is growing rapidly across the US, China and Europe. In January 2019, the Chinese Electric Vehicle Charging Infrastructure Promotion Agency reported 300,000 units of public chargers, up from 214,000 units last year. China has 2X the amount of charging stations than EU and ~4.5X that of the US.

Exhibit 4: Number of charging posts have exponentially increased from CY2015
Number of public and dedicated fleet EV posts in China, calendar year-ends, 2012-18 (in units)



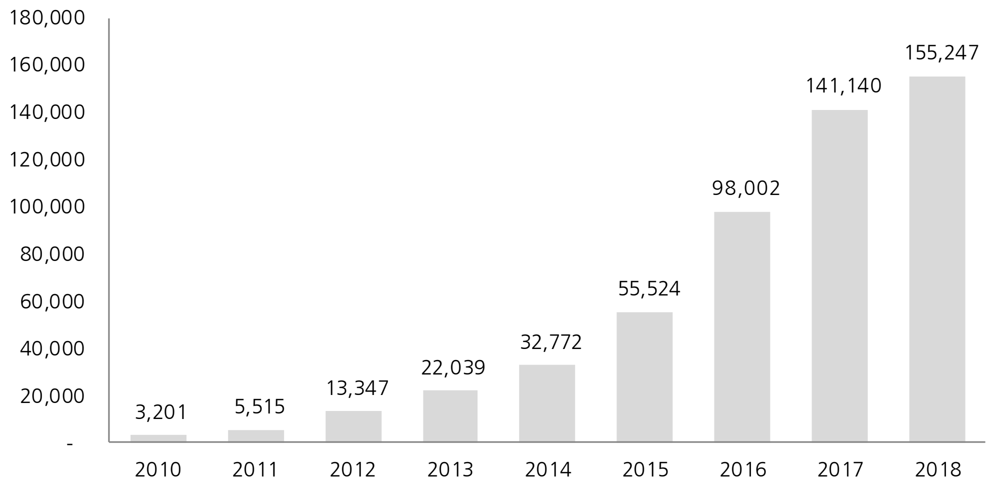
Source: China EV Charging Alliance, Kotak Institutional Equities

Exhibit 5: US has ~67,000 public charging ports as on January 1, 2019
Number of public and dedicated fleet EV posts in US, calendar year-end, 2010-18 (in units)



Source: Alternative Fuels Data Center, US Department of Energy, Kotak Institutional Equities

Exhibit 6: Europe charging stations have grown at a CAGR of 62% over CY2010-18
Number of public EV charging stations in Europe, calendar year-ends, 2010-18 (in units)



Source: Inside EVs, Statista, Kotak Institutional Equities

Driving experience of luxury electric cars superior to petrol/diesel cars

Tesla has redefined the electric car space with the launch of Model S. Model S is the leader in the luxury car segment in the US and beats Mercedes S-Class by a margin. Model S is similar priced as S-Class and has superior performance than S-Class. Model S has better acceleration than S-Class and reaches peak power at lower RPM than S-Class. Electric cars are quieter than petrol cars and have better pickup due to high power at lower torque, which makes the driving experience even more thrilling.

In the middle price segment in the US, Toyota Avalon has better performance than the Volkswagen Golf electric (refer to Exhibit 8). Performance of electric vehicles in the mass market segment is improving as battery prices are coming down.

Exhibit 7: Tesla Model S performance is superior than Mercedes Benz S450
Comparison of the features of Tesla Model S versus Mercedes Benz S450, April 2019

	Mercedes Benz S450 AMT Petrol	Tesla Model S
Cost to consumer ($)	91,250	89,750
Engine		
Engine Type	8 cyclinder engine	NA
Displacement	4 Litres	NA
Power	463 hp @ 5250 rpm	Motor 1: 502.9 hp (peak); Motor 2: 258.8 hp (peak)
Torque	516 lb-ft @ 2000 rpm	Motor 1: 442.5 lb-ft (peak); Motor 2: 243.4 lb-ft (peak)
Brakes		
Brakes front	4-wheel ABS	Ventilated discs
Brakes rear	4-wheel ABS	Ventilated discs
Performance		
Mileage	17 miles per galon	315 miles per charge
Top speed (mph)	130	163
0-60 mph (sec)	5.4	3
0-100 mph (sec)	13.2	3.2
Suspension		
Suspension-front	Active suspension system with multi-link	Smart Air suspension
Suspension-rear	Active suspension system with multi-link	Smart Air suspension
Tyres		
Tyre size (Front)	245/45ZR19	245/45R 19
Tyre size (Rear)	275/40ZR19	245/45R 19
Wheel size (inch)	19	19
Dimensions		
Length*Width*Height (inch)	206.9*74.8 * 58.8	196*77.3*56.9
Ground clearance (inch)	5	5.5
Kerb weight (lbs)	4,731	4,941
Battery Features		
Type of battery	NA	Lithium-ion
Manufacturer	NA	Panasonic
Battery capacity	NA	100kWhr
Charging time	NA	upto 80% in 40 minutes using supercharger
Voltage	NA	400 V
Other Key Features		
Standard warranty (Years)	4	4
Standard warranty (miles)	50,000	50,000
Battery warranty (Years)	NA	8

Source: Company, Kotak Institutional Equities

Exhibit 8: Toyota Avalon has a mileage of 125-186.4 miles per charge with a peak power of 134.1 hp
Comparison of the features of Toyota Avalon versus Volkswagen e-Golf, April 2019

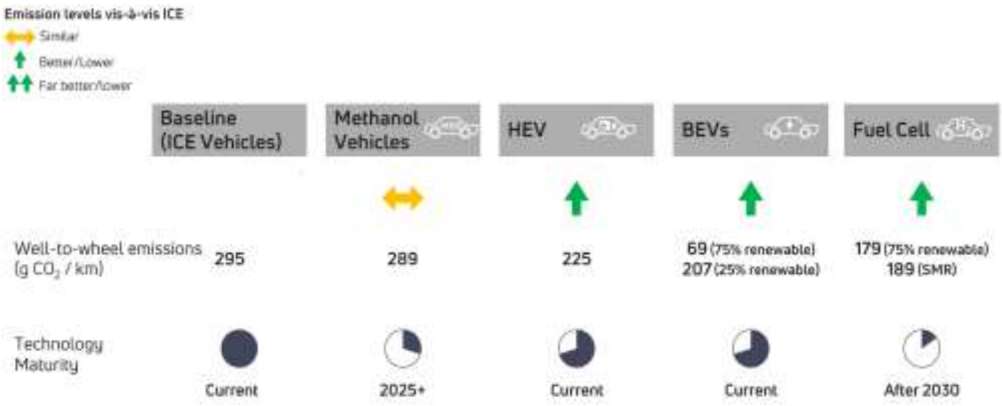
	Toyota Avalon XSE Petrol	Volkswagen e-Golf SE
Cost to consumer ($)	36,580	38,895
Engine		
Engine Type	6 cyclinder engine	NA
Displacement	3.5 Litres	NA
Power	301 hp @ 6600 rpm	134.1 hp @ 3300 rpm
Torque	267 lb-ft @ 4700 rpm	213.9 ft-lb (peak)
Brakes		
Brakes front	4-wheel discs	Ventilated discs
Brakes rear	4-wheel discs	Ventilated discs
Performance		
Mileage	22 miles per galon	125- 186.4 miles per charge
Top speed (mph)	116	93.2
0-100 mph (sec)	7.4	9.6
Suspension		
Suspension-front	MacPherson Strut	MacPherson strut with telescopic shock absorbers
Suspension-rear	Multi-link	Multi-link with telescopic shock absorbers
Tyres		
Tyre size (Front)	P245/40VR19	205/55R16 19
Tyre size (Rear)	P245/40VR19	205/55R16 19
Wheel size (inch)	19	19
Dimensions		
Length*Width*Height (inch)	195.9*72.8 * 56.5	168.1*70.8*58.3
Ground clearance (inch)	5.3	5.6
Kerb weight (lbs)	3,638	3,560
Battery Features		
Type of battery	NA	Lithium-ion
Manufacturer	NA	Samsung SDI
Battery capacity	NA	35.8 kWhr
Charging time	NA	upto 80% in 34 minutes using CCS fast charging 50W
Voltage	NA	323 V
Other Key Features		
Standard warranty (Years)	3	6
Standard warranty (miles)	36,000	72,000
Battery warranty (Years)	NA	8
Battery warranty (miles)	NA	99,360

Source: Company, Kotak Institutional Equities

Electric vehicles are cleaner than ICE vehicles

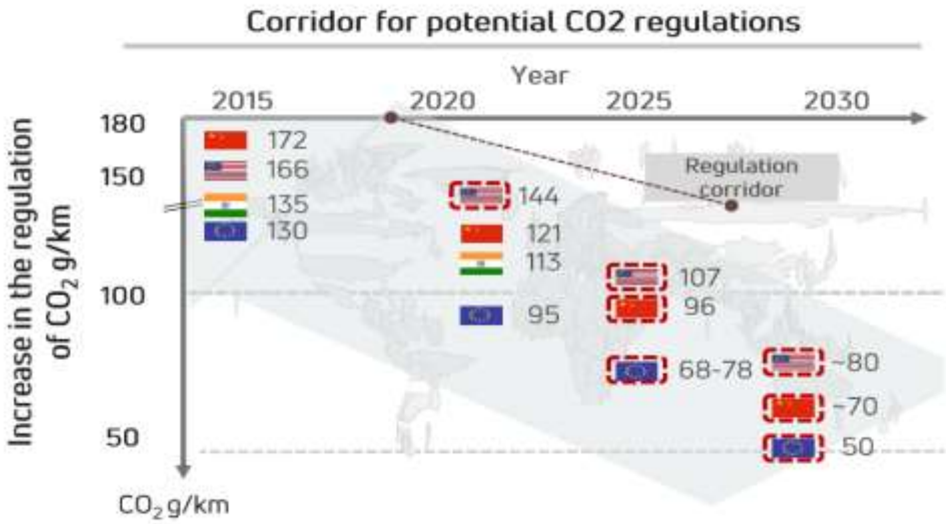
CO2 emissions are much lower in hybrid and battery electric vehicles compared to an ICE vehicle. As highlighted in Exhibit 9 below, well-to-wheel CO2 emissions (includes upstream emissions of greenhouse gases from electricity production for an EV) of an ICE vehicle is 295 g/km as compared to 225g/km for a hybrid vehicle and 69-207g/km for a electric vehicle (assuming 75%/25% of electricity is generated from renewable energy sources). Further, we note that governments across the globe are coming up with stringent CO2 regulations, which restricts the average fleet CO2 emissions for an OEM. For example—from CY2021, the EU fleet-wide average emission target for new cars will be 95g CO2/km (earlier target was set in CY2015 at 130g CO2/km). Europe will make these targets even more stringent over the next 10 years (China and the US also have stringent regulations—refer to Exhibit 10 for details). Therefore, to meet the new CO2 targets, it is imperative for an OEM to gradually shift towards EVs; requirement of quantum of shift towards EVs to meet regulatory norms would depend on the potential CO2 regulations adopted by countries globally.

Exhibit 9: CO2 emissions are much lower in hybrid and battery electric vehicles compared to ICE
CO2 emissions from ICE vehicles, hybrid and electric vehicles



Source: Tata Motors, Kotak Institutional Equities

Exhibit 10: CO2 emission regulations are becoming much stricter globally
CO2 emission regulations globally over the next 10 years



Source: Tata Motors, Kotak Institutional Equities

UNDERSTANDING CHINA'S ELECTRIC VEHICLE INDUSTRY

Electric vehicle sales in China have grown at phenomenal pace over the past five years with more than 1 mn passenger EVs sold in CY2018 (~4% of total passenger vehicles sales) from just 15,000 units in CY2013. Key growth drivers are (1) strong government support in terms of direct subsidies to buyers (up to 40-50% of vehicle price), sales tax exemptions and also purchase of EVs for public services by the government (buses, taxis, etc.) and (2) exemption from purchase of EVs in bigger cities where there is restriction on issuance of overall number of new license plates (such cities account for more than 50% of overall EV sales in China). We note that in April 2019, the government reduced subsidies on EVs by almost 50-60% (no subsidy now for low-range EVs) and it also plans to abolish subsidies completely after CY2020. We believe that this could pose challenges for industry growth going ahead and could also impact financial viability of companies.

Passenger electric vehicle sales in China crossed 1 mn units in CY2018

Electric passenger vehicle sales in China have grown at 132% CAGR over the past five years (68% CAGR over the past three years) and crossed 1 mn units in CY2018, which is more than total EV sales in Europe and the US, put together. We note that sales of passenger EVs in China grew by almost 70% yoy in CY2018 even though overall passenger vehicle market declined by 4% yoy—electric vehicles sales accounted for 4% of overall passenger vehicle industry in CY2018 (refer to Exhibit 11 for details). Domestic Chinese OEMs have more than 90-95% market share in the EV segment—BYD, Kandi, Zhidou, Zotye, BAIC are major players in the segment. Imported models of companies such as Tesla and BMW have very low market share due to tariff on imported models (25%) and the import models are excluded from subsidies and sales tax exemption. We note that unlike developed markets where EV penetration is much higher in the luxury segment (courtesy Tesla), in China, bulk of the EV sales are in low and mid-priced segments with pre-subsidy prices ranging from RMB80,000 to RMB200,000; this could largely be due to (1) higher percentage subsidy in these models and (2) inability of low-end car buyers to purchase ICE vehicles in top cities where there is restriction on number of license plates that can be registered every year (refer to Exhibits 12-14 for details).

Growth drivers: government support and lack of restriction on EV license plates

We discuss below two major drivers for such strong growth of electric passenger vehicle sales in China.

- **Higher government subsidies.** Due to dire need to control pollution levels, the government has made significant efforts to promote electric vehicle sales in China. In CY2010, the government announced its scheme to provide subsidies for purchase of an electric vehicle of up to RMB60,000 per vehicle (translated to 30-50% of vehicle cost)—such high incentive encouraged several domestic OEMs and suppliers to enter into the segment and set up lithium-ion battery and electric vehicle manufacturing capacities. As per news reports, currently there are almost 500 registered manufacturers for EVs in China (global player such as GM, VW, BMW, Audi and Tesla have also chalked out extensive plans to enter the EV segment in China) with annual capacity of around 4 mn units. Higher subsidies and competitive pricing of EVs in the market due to presence of multiple local players has led to significant spurt in sales of EVs in China over the past five years. Additionally, the government has provided support through sales tax exemptions on electric vehicles, direct purchase of EVs by the government for public utilities, etc. to kick-start the industry. As per independent industry reports, total cumulative government support for electric vehicle industry (including passenger vehicles and buses) could be around RMB395 bn (~US$60 bn).

Over the years, a subsidy policy has evolved in China with greater focus on vehicles with higher range (in terms of kms run per charge)—for example, in CY2010, when subsidiary was announced, there was no restriction on vehicle range but in CY2017, the government made it mandatory for battery electric vehicles to have range of at least 100 kms, which was increased to 150 kms in CY2018 and further to 250 kms in CY2019 (refer to Exhibit 15 for details). This is a move in the right direction as it would encourage sales of better electric vehicles and would give impetus to stronger players in the industry (leading to higher economies of scale but the flipside could be concerns around financial viability or bankruptcies of several small companies).

- **Lack of restriction on license plates for EVs in major cities.** In addition to cash subsidies to car buyers, several bigger cities provide favorable policies such as the assured issuance of a vehicle license and increased access to carpool lanes to EV purchasers. For example, in several top cities in China such as Beijing, Tianjin, Shanghai, Hangzhou, Guangzhou, Shenzhen, and Guiyang, etc., there is a cap on the number of vehicle licenses issued each month in order to regulate the number of vehicles (done to reduce congestion and pollution problems). Buyers of EVs, however, are exempt from this restriction and assured of receiving a license along with the purchase of the vehicle. This is a significant incentive to purchase EV particularly for those who want to buy an entry-level vehicle (as they cannot afford to pay higher prices for license plates). As per city-wise sales data (Source: ICCT), almost 50% of electric vehicles in China are sold in cities where there is restriction on license plates imposed by the government (refer to Exhibit 17 for EV sales data by cities/provinces).

Withdrawal of subsidies key challenge for sustaining strong future growth

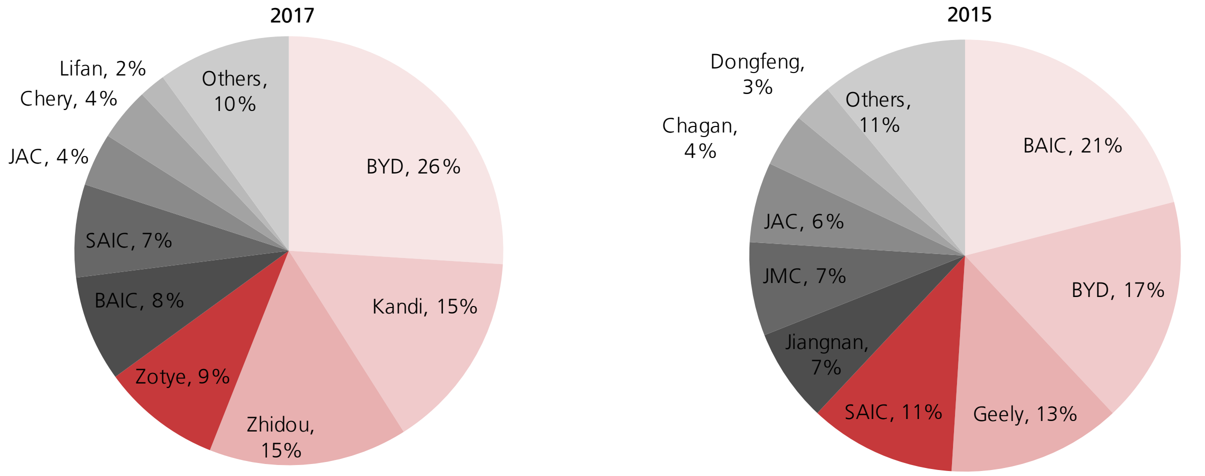
As discussed above, significant government subsidies have been one of the major reasons for strong growth in EV sales over the past five years. We note that in April 2019, government reduced subsidies on EVs by almost 50-60% (no subsidy now for low-range EVs) and it also plans to abolish subsidies completely after CY2020. In April 2019, subsidy for pure battery electric cars with driving ranges of 400 km (250 miles) and above was cut by 50% to RMB25,000/vehicle from RMB50,000/vehicle earlier. Further, in order to qualify for any subsidy, electric cars need to have a range of at least 250 km as compared to minimum range of 150 km as per earlier policy. Thus, there have been steeper cuts in subsidy for mid-range electric vehicles (150-250 km range) while purchase of low-range EVs (below 150km range) will not get any subsidies from the government. We note that growth in electric vehicle sales came down single digits in May 2019 post reduction in subsidies by the government. Additionally, we believe that withdrawal of subsidies for low to mid-range vehicles could significantly impact financials of smaller companies and could also lead to bankruptcies as well.

Exhibit 11: EV car sales form 4% of the total car sales in China in 2018
EV and total car sales in China, calendar year-ends, 2013-18 (units, %)

	2013	2014	2015	2016	2017	2018
Sale volume						
China EV car sales (units)	15,004	61,984	214,283	333,418	600,174	1,016,002
China total car sales (units)	17,407,424	19,652,266	20,482,454	24,788,366	25,387,109	24,384,121
EV as a % of total car sales	0.1	0.3	1.0	1.3	2.4	4.2

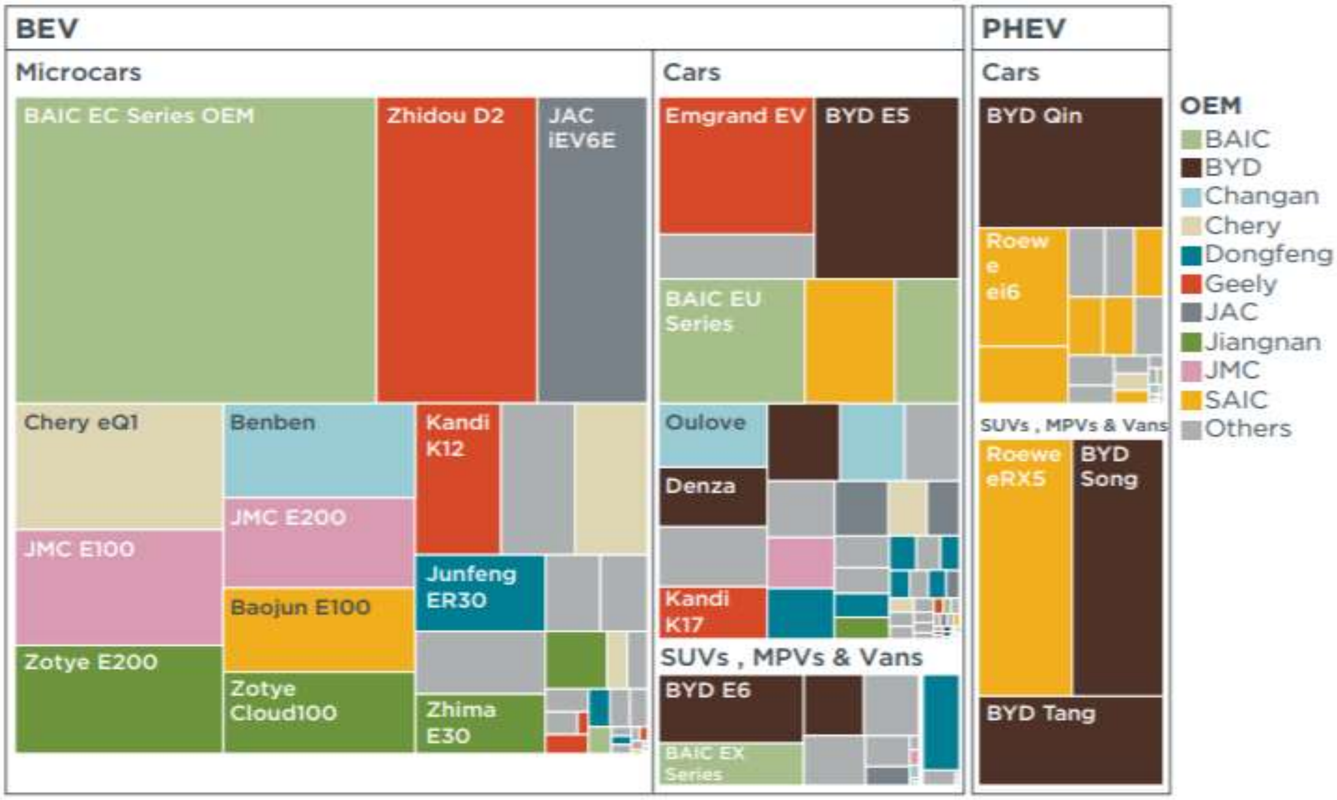
Source: CAAM, LMAC, Kotak Institutional Equities

Exhibit 12: BYD is the leading player in EV in China
Company-wise breakup of EV car sales in China, calendar year-ends, 2015-17 (%)



Source: ICCT, Kotak Institutional Equities

Exhibit 13: In 2017, 68% of the BEV sales were micro cars in China
Vehicle segments of BEVs and PHEVs by sales in China, calendar year-end, 2017



Source: ICCT, Kotak Institutional Equities

Exhibit 14: Majority of the EV sales in China are of low to mid-priced models (before subsidy prices of RMB80,000-200,000)
Price of major EV and PHEV models in China (RMB)

NEV Models				PHEV Models			
Company	Model	Range (km)	Price before subisidies (RMB)	Company	Model	Range (km)	Price before subisidies (RMB)
Changan	Benni Mini	150	82,800	Changan	Eado	60	160,900
ZhiDou	D3	210	89,800	GAC	GA3 PHEV	63	164,800
Baojun	E100	155	93,900	Geely	Emgrand	60	165,900
Zotye	TT	150	105,000	Chery	Arrizio 7e	50	179,900
ZhiDou	D3 Premium	310	109,800	BYD	Qin PHEV	55	185,900
JAC	IEV6E	155	118,500	GAC	GA5 PHEV	70	199,300
Yulon	EV2	150	119,800	Roewe	Ei6 PHEV	53	201,800
JMC	E160	152	136,800	GAC Mitsubishi	Qizhi	58	209,800
Changhe	X5	260	143,000	GAC	GS4 PHEV	58	209,800
Kandi	K10	150	150,800	BYD	Song DM	70	215,900
BAIC	EC180	180	151,800	Roewe	e550	60	239,800
Changan	Benni	180	154,800	Roewe	e950	60	255,900
Kandi	K12	155	158,800	Changan Ford	Mondeo	52	319,800
Dongfeng	E30L	150	164,800	Audi	A3 e-tron	50	399,800
Chery	eQ	200	169,900	BMW	i3 Rex	80	550,800
Dongfeng	S50 EV	255	188,500	Audi	Q7 e-tron	55	928,800
Changan	Eado	200	192,300				
Geely	Emgrand	400	195,800				
BYD	e5	305	195,900				
Zotye ZhiDou	Z500	200	209,800				
Dongfeng	E70	351	212,800				
BYD	Qin EV300	300	235,900				
BMW	i3	246	422,800				
Tesla	Model S 75D	490	742,300				

Source: CAAM, Kotak Institutional Equities

Exhibit 15: Chinese central government cut its EV car subsidies by ~55% in CY2019
Chinese Subsidy Rates for NEV Passenger Cars, calendar year-ends, 2010-19

		2010		2017		2018		2019	
		BEV	PHEV	BEV	PHEV	BEV	PHEV	BEV	PHEV
Central Government									
Eligibility Requirements	Battery Power (kW-hr)	15	10	—	—	—	—	—	—
	Range (km)	—	—	100	50	150	50	250	250
	Lowest Speed Over 30 Minutes (km/hr)	—	—	100	—	100	—	—	—
	Energy Intensity (wh/kg)	—	—	90	—	105	—	125	—
Amount (RMB thousands)		Up to 60	Up to 50	20-44	20-25	15-50	22	7.5-25	9
Provincial Governments									
From 2017, 50% of central gov't		—	—	Up to 22	10-12.5	7.5-25	11	—	—
Total Subsidy (RMB thousands)		Up to 60	Up to 50	30-66	30-37.5	22.5-75	33	7.5-25	9

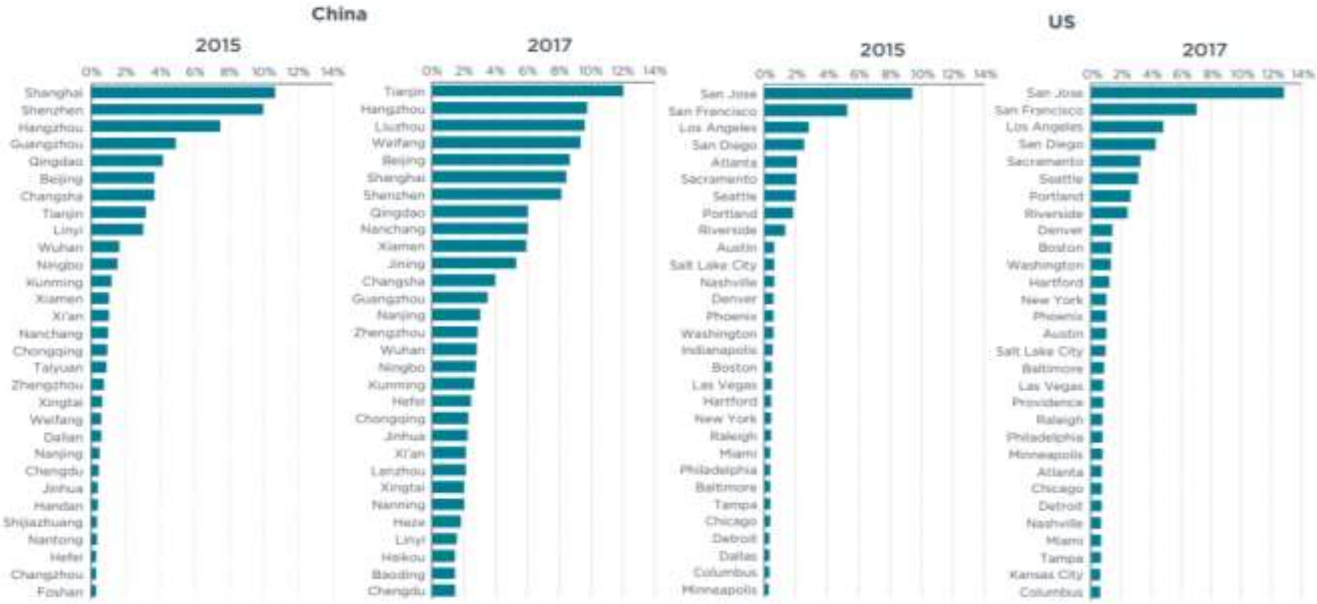
Source: CAAM, Kotak Institutional Equities

Exhibit 16: China has spent approximated RMB394 bn for electrification plan over CY2009-17
China government spending on electrification of cars, calendar year-ends, 2009-17 (RMB bn)

Type	Amount (RMB billions)
Sales subsidies	245.0
Infrastructure subsidies	15.0
Research & Development	12.9
Government procurement	50.3
Sales tax exemption	70.0
Total	393.7
Total vehicle sales	929.1
Government spending as percentage of total sales	42.4

Source: Industry reports (CSIS estimates), Kotak Institutional Equities

Exhibit 17: In China, the top 30 cities collectively represented 72% of the national electric car market in 2017
Top 30 cities EV sales break up in China and US, calendar year-ends, 2015-17 (%)



Source: ICCT, Kotak Institutional Equities

ELECTRIC VEHICLE ADOPTION IN INDIA WILL SEE A STEADY RISE

We believe adoption of electric vehicles in India will increase at a steady pace due to falling lithium ion battery prices globally, government support to electric technology and development of charging infrastructure. EV adoption has been slow to pick up in India due to low adequate government support to EVs, high cost of ownership versus ICEs, lower availability of public charging infrastructure and relatively inferior performance of electric vehicles versus ICEs currently available in the market. We expect that a significant part of scooters and three-wheelers will shift to electric by FY2030, even as adoption in passenger vehicles will be slow.

We forecast 28% of automobiles (excluding commercial vehicles) will shift to electric and plug-in hybrid by FY2030. Scooters, three-wheelers and buses will likely shift faster to electric than other modes of transport. The key reasons for steady improvement in electric vehicle adoption will be—(1) electric vehicles will likely achieve total cost of ownership breakeven (assuming first replacement happens in 5 years) versus ICE vehicles in India by CY2025 (in scooters and thee-wheelers TCO has already been achieved), (2) the government FAME-II policy will accelerate the shift towards EVs, (3) the government plans to set up charging infrastructure across the country although currently charging infrastructure is at nascent stage and (4) OEMs plan to launch a number of electric vehicles in CY2020, which will offer significantly better performance than the current electric vehicles in India.

Exhibit 18: We expect electric vehicles to form 28% of the total industry volumes by FY2030
Annual volume forecasts for automotive demand, March fiscal year-ends, 2019-30 (mn units, %)

	Auto	ICE	Electric	Electric fleet proportion (%)
2019	25.3	25.2	0.1	
2022	30.2	29.3	0.9	3.1
2025	35.1	30.6	4.6	13.0
2030	40.2	29.1	11.1	27.6
CAGR (%)	**3.6**	**1.1**	**50.5**	

Source: Kotak Institutional Equities estimates

Exhibit 19: We expect electric vehicles to form 12% of the total auto industry population by FY2030
Annual population forecasts for automotive industry, March fiscal year-ends, 2019-30 (mn units, %)

	Auto	ICE	Electric	Electric fleet proportion (%)
2019	175.1	175.1	—	
2022	265.1	263.7	1.5	0.6
2025	326.5	316.1	10.4	3.2
2030	439.9	388.5	51.3	11.7
CAGR (%)	**7.3**	**6.3**		

Source: Kotak Institutional Equities estimates

TCO of electric vehicles are converging versus ICE vehicles

We analyzed the total cost of ownership of ICE vehicles versus electric vehicles over 50,000 kms of vehicle run to understand the cost of ownership of electric vehicles. Electric vehicles are more expensive than petrol vehicles but if we compare the cost of ownership levels of electric vehicles, we come to the following conclusions.

- **TCO of electric scooters are lower than petrol scooters.** We compared cost of ownership of Ather S340 scooter with Honda Activa 110cc. Ather S340 is ₹33,903 more expensive than Activa (including incentive by the government) but the running cost saving is ₹78,125 (based on charging from normal charger at home) over 50,000 kms. Hence customer can break even on his higher capital cost on Ather S340 at around 22,000 kms (typically 2 years assuming 10,000 kms run annually). If we remove government incentive of ₹22,000, electric scooter is ₹55,903 expensive than Activa, then the breakeven increases to 3.3 years. Hence in terms of cost of ownership, electric scooters have become cheaper than petrol scooters as the life of lithium ion battery is 15 years while a life of a petrol scooter is 10 years. Post BS-VI, the cost of petrol scooter will increase by ₹7,000, then the breakeven for Ather S340 versus Honda Activa will reduce to 1.6 years (with government incentives) and 2.9 years (without government incentives).

  Scooter is also a product that is widely used in urban India where the power availability is significantly better than rural India. In FY2030, we estimate battery prices will drop from $250/kW-hr currently to $100/kW-hr led by scale benefits and higher specific and volumetric energy density as battery chemistry improves, which will reduce the price of e-scooter by ₹23,750. Thus, customers can break even in less than one year (without government subsidies) in FY2030. In FY2030, we expect urban and rural mix in the scooter segment to be 50:50 and we estimate 75% of the urban customers and 25% of the rural customers (due to charging infrastructure constraints and poor quality of power supply in the rural areas) will shift towards electric scooters. Hence **we estimate that 50% of scooters will shift to electric by FY2030**. Currently the shift towards electric scooters is not significant because of limited production capacity of existing players like Hero electric, Ather Energy, and Okinawa, etc. while the bigger players like Hero, Honda, Bajaj and TVS Motors haven't launched electric scooters yet. However, most of these players are planning to launch electric scooters in the next one year. The government has restricted incentives under the FAME-II scheme to only 1 mn two-wheelers over FY2019-22 but we believe that the shift to electric scooters could happen without incentives as well.

Exhibit 20: We expect electric vehicles to form 32% of the total two-wheeler volumes by FY2030
Annual volume forecasts for two-wheelers, March fiscal year-ends, 2019-30 (mn units, %)

	Two-wheelers	ICE	Electric	Electric fleet proportion in 2-Wh (%)
2019	21.2	21.1	0.1	0.3
2022	25.2	24.4	0.8	3.3
2025	28.9	24.7	4.2	14.5
2030	31.3	21.2	10.1	32.3
CAGR (%)	3.1	0.0	49.4	

Source: Kotak Institutional Equities estimates

Exhibit 21: We expect electric vehicles to form 13.5% of the total two-wheeler population by FY2030
Annual population forecasts for two-wheelers, March fiscal year-ends, 2019-30 (mn units, %)

	Two-wheelers	ICE	Electric	Electric fleet proportion in 2-Wh (%)
2019	142.8	142.8	—	
2022	219.0	217.7	1.3	0.6
2025	268.8	259.2	9.5	3.5
2030	347.7	300.7	47.0	13.5
CAGR (%)	7.1	5.9		

Source: Kotak Institutional Equities estimates

Exhibit 22: E-scooter is more affordable compared to gasoline scooter over 50,000 kms run
Comparison of the cost of ownership of an electric scooter with that of a gasoline scooter, April 2019, prices of electricity and vehicle as of Mumbai

	Ather Energy e-scooter (S340)	Honda Activa
On-road price (Rs)	135,230	79,327
Incentives (Rs)	22,000	—
Cost to consumer (Rs)	**113,230**	**79,327**
Battery size (Kwh)	2.7	
Electricity cost (Rs/kwh)	8.0	
Range at full charge (km)	55	
Electricity cost (Rs/km)	0.4	
Electricity cost (Rs)	19,636	—
Fuel cost (Rs)	—	98,125
Maintenance cost (Rs)	2,500	7,500
Total cost of ownership of vehicle over 50,000 kms (Rs)	**135,366**	**184,952**
Cost of ownership/month (Rs)	**2,256**	**3,083**
Cost of ownership/year (Rs)	**27,073**	**36,990**

Source: Kotak Institutional Equities estimates

Exhibit 23: In FY2030, e-scooter customer will be able to break even at less than 1 year
Comparison of the cost of ownership of an electric scooter with that of a gasoline scooter, March fiscal year-end, 2030

	Ather Energy e-scooter (S340)	Honda Activa
On-road price (Rs)	111,480	98,633
Incentives	—	—
Cost to consumer (Rs)	**111,480**	**98,633**
Battery size (Kwh)	2.7	
Electricity cost (Rs/kwh)	13.7	
Range at full charge (km)	55	
Electricity cost (Rs/km)	0.7	
Electricity cost (Rs)	33,585	—
Fuel cost (Rs)	—	98,125
Maintenance cost (Rs)	3,849	11,546
Total cost of ownership of vehicle over 50,000 kms (Rs)	**148,913**	**208,304**
Cost of ownership/month (Rs)	**2,482**	**3,472**
Cost of ownership/year (Rs)	**29,783**	**41,661**

Source: Kotak Institutional Equities estimates

Exhibit 24: We expect rural mix to improve to 60% in the two-wheeler segment by FY2030
Urban-rural mix, March fiscal year-ends, 2019-30E (mn units, %)

	Two-wheeler volumes (mn units)		Mix (%)	
Year	Urban	Rural	Urban	Rural
2019	10.2	11.0	48.1	51.9
2020E	10.5	11.8	47.2	52.8
2021E	10.8	12.6	46.3	53.7
2022E	11.0	14.2	43.7	56.3
2023E	11.2	15.5	42.0	58.0
2024E	11.5	16.3	41.2	58.8
2025E	11.6	17.3	40.0	60.0
2026E	11.8	17.7	40.0	60.0
2027E	12.0	18.0	40.0	60.0
2028E	12.3	18.4	40.0	60.0
2029E	12.5	18.8	40.0	60.0
2030E	12.8	19.1	40.0	60.0
2019-30E CAGR (%)	2.1	5.2		

Source: Kotak Institutional Equities estimates

- **TCO of electric motorcycles higher than petrol motorcycles due to higher size of batteries.** We compared cost of ownership of an electric motorcycle with Hero 125cc Super Splendor. There are no electric motorcycles in the market but we are assuming estimated price of the Tork6X for our calculations. Tork6X will likely be ₹55,056 more expensive than Super Splendor after including incentives by the government but the running cost saving would be ₹58,364 (based on charging from normal charger) over 50,000 kms. Hence customer can break even on his higher capital cost on Tork6X at around 47,000 kms (typically 4.7 years assuming average 10,000 kms run annually). If we remove the government incentive of ₹22,000, electric motorcycle is ₹77,056 expensive than Super Splendor, then the breakeven increases to 6.6 years. Hence, in terms of cost of ownership, electric motorcycles are still expensive than petrol scooters due to higher size of lithium ion battery in electric motorcycles versus electric scooters. Electric motorcycles require more power than electric scooters.

  Post BS-VI, the cost of petrol bike will increase by ₹7,000, then the breakeven for electric bike versus Hero Super Splendor will reduce to 4.1 years (with government incentives) and 6 years (without government incentives).

  Commuter bikes are used both in urban and rural India. Currently the shift towards electric bikes is not significant because of lack of product availability in the market while the bigger players like Hero, Honda, Bajaj and TVS Motors haven't launched electric bikes. However most of these players are planning to launch electric bikes over the next 2-3 years. We estimate that the shift in electric motorcycles will start happening when the electric battery cost falls below US$200/kW-hr levels, which is likely to happen by CY2023 in India. In FY2030, we expect battery prices to fall to US$100/kW-hr and we believe the shift to electric will not happen in premium motorcycle segment (due to inability of e-motorcycle to provide high power) and economy segment (breakeven would be closer to four years due to lower prices of economy segment gasoline bikes). Hence, we expect executive segment (which is 60% of the motorcycle segment) to shift towards electric. We expect customers to reach breakeven in ~3.2 years (without government subsidies) in FY2030. In FY2030, we expect urban and rural mix in the motorcycle segment to be around 33% and 67%, respectively and we estimate 70% of the urban customers and 15% of the rural customers (due to charging infrastructure constraints and poor quality of power supply in the rural areas) will shift towards electric motorcycles. **We estimate that 20% of motorcycles will shift to electric by FY2030 in India.**

Exhibit 25: Gasoline motorcycles are at par as compared to electric motorcycle in TCO
Comparison of the cost of ownership of an electric motorcycle with that of a 100cc petrol bike, April 2019, Prices of electricity and vehicle as of Mumbai

	E-motorcycle (Lithium ion battery)	Hero Splendor
On-road price (Rs)	150,000	72,944
Incentives (Rs)	22,000	—
Cost to consumer (Rs)	**128,000**	**72,944**
Battery size (Kwh)	4.5	
Electricity cost (Rs/kwh)	8.0	
Range at full charge (km)	100	
Electricity cost (Rs/km)	0.4	
Electricity cost (Rs)	18,000	—
Fuel cost (Rs)	—	71,364
Insurance cost (Rs)		
Maintenance cost (Rs)	2,500	7,500
Total cost of ownership of vehicle over 50,000 kms (Rs)	**148,500**	**151,808**

Source: Kotak Institutional Equities estimates

Exhibit 26: In FY2030, e-motorcycle customer will be able to break even in ~3.2 years
Comparison of the cost of ownership of an e-motorcycle with that of a gasoline motorcycle, March fiscal year-end, 2030

	E-motorcycle (Lithium ion battery)	Hero Splendor
On-road price (Rs)	110,416	90,697
Incentives	—	—
Cost to consumer (Rs)	**110,416**	**90,697**
Battery size (Kwh)	7.0	
Electricity cost (Rs/kwh)	13.7	
Range at full charge (km)	100	
Electricity cost (Rs/km)	1.0	
Electricity cost (Rs)	47,890	—
Fuel cost (Rs)	—	71,364
Insurance cost (Rs)		
Maintenance cost (Rs)	3,849	11,546
Total cost of ownership of vehicle over 50,000 kms (Rs)	**162,154**	**173,606**

Source: Kotak Institutional Equities estimates

- **Three-wheelers may shift to electric sooner than expected.** We compared cost of ownership of electric three-wheeler (Mahindra Treo) with CNG three-wheeler of Bajaj Auto. As per our calculations, Mahindra Treo is ₹40,372 more expensive than CNG three-wheeler after including incentives by the government but the running cost saving is ₹45,495 (based on charging from normal charger) over 50,000 kms. A three-wheeler runs at least 25,000 kms annually, so we estimate that the customer will recover his higher capital cost in 2 years. Even if we exclude the government incentive, the customer will recover his upfront capital cost in 4 years. A customer runs a three-wheeler at least for 10-15 years, so it is quite possible that customer will shift to electric provided electric three-wheeler could match the performance of CNG three-wheeler.

  Post BS-VI, the cost of CNG three-wheeler will increase by ₹5,000, then the breakeven for electric three-wheeler versus CNG three-wheeler will reduce to less than 2 years (with government incentives) and less than 4 years (without government incentives).

  By 2030, we expect battery prices to fall to US$100/kW-hr, which will result in upfront cost of e-rickshaw lower than that of CNG/diesel rickshaw. Hence, we expect e-rickshaw to become cheaper than CNG/diesel rickshaw by FY2030. However, we believe infrastructure constraints in the rural areas will hinder complete transition towards e-rickshaws. **Hence, we expect that 52% of three-wheelers will shift to electric by FY2030 in India.**

Exhibit 27: We expect electric vehicles to form 52% of the total three-wheeler volumes by FY2030
Annual volume forecasts for three-wheelers, March fiscal year-ends, 2019-30 (mn units, %)

	3W	ICE	Electric	Electric fleet proportion (%)
2019	0.7	0.7	—	
2022	0.8	0.7	0.1	8.0
2025	0.9	0.6	0.3	28.0
2030	1.1	0.5	0.6	52.0
CAGR (%)	**3.8**	**(1.9)**		

Source: Kotak Institutional Equities estimates

Exhibit 28: We expect electric vehicles to form 30% of the total three-wheeler population by FY2030
Annual population forecasts for three-wheelers, March fiscal year-ends, 2019-30 (mn units, %)

	3W	ICE	Electric	Electric fleet proportion (%)
2019	5.4	5.4	—	
2022	6.2	6.1	0.1	1.5
2025	7.2	6.6	0.6	8.3
2030	9.3	6.5	2.8	30.2
CAGR (%)	**4.2**	**1.4**		

Source: Kotak Institutional Equities estimates

Exhibit 29: E-three wheelers are cheaper than CNG three-wheelers on total cost of ownership
Comparison of the cost of ownership of an electric three-wheeler with that of a CNG three-wheeler, April 2019, Prices of electricity and vehicle as of Mumbai

	Mahindra Treo SFT	Bajaj RE CNG
On road price (Rs)	325,053	234,681
Incentives (Rs)	50,000	—
Cost to consumer (Rs)	**275,053**	**234,681**
Battery size (Kwh)	7.4	
Electricity cost (Rs/kwh)	8	
Range at full charge (km)	130	
Electricity cost (Rs/km)	0.5	
Electricity cost (Rs)	22,677	—
Fuel cost (Rs)	—	63,171
Maintenance cost (Rs)	5,000	10,000
Total cost of ownership of vehicle over 50,000 kms (Rs)	**302,730**	**307,852**

Source: Kotak Institutional Equities estimates

Exhibit 30: Upfront capital cost of e-rickshaws will be lower than CNG/diesel rickshaws by FY2030
Comparison of the cost of ownership of an e-rickshaw with that of a CNG rickshaw, March fiscal year-end, 2030

	Mahindra Treo SFT	Bajaj RE CNG
On road price (Rs)	260,053	291,796
Incentives (Rs)	—	—
Cost to consumer (Rs)	**260,053**	**291,796**
Battery size (Kwh)	7.4	
Electricity cost (Rs/kwh)	8	
Range at full charge (km)	130	
Electricity cost (Rs/km)	0.5	
Electricity cost (Rs)	22,677	—
Fuel cost (Rs)	—	63,171
Maintenance cost (Rs)	7,697	15,395
Total cost of ownership of vehicle over 50,000 kms (Rs)	**290,427**	**370,362**

Source: Kotak Institutional Equities estimates

- **Shift to electric in passenger vehicle segment will be muted.** We compared cost of ownership of electric passenger vehicle with Maruti Swift VXi petrol. We have computed cost of electric car with 40 kW-hr battery capacity, which can give a range of 200 kms on single charge for comparison with a hatchback for our analysis.

  Electric car will likely be ₹585,500 more expensive than Maruti Suzuki VXi petrol after including incentive by the government, but the running cost saving is ₹128,000 (based on charging from normal charger) over 50,000 kms. Hence, customer can break even on his higher capital cost at around 228,000 kms (typically 23 years assuming average 10,000 kms run annually). If we remove government incentive of ₹110,000, electric car is ₹695,500 more expensive than Swift and the breakeven increases to 27 years. Hence, in terms of cost of ownership electric cars are still very expensive than petrol cars due to higher size of lithium ion battery in electric cars.

Post BS-VI, the cost of petrol Swift will increase by ₹14,000, then the breakeven for electric car versus petrol car will reduce to 22 years (with government incentives) and 26.5 years (without government incentives). When the lithium ion battery price reduces to US$100/kW-hr by CY2030 from US$250/kW-hr currently, the electric car cost will reduce by ₹350,000 and assuming petrol car price increases by 20% by then from current levels, then also the breakeven for electric car versus petrol car will only reduce to 5 years. Hence we believe in the personal car segment, shift to electric cars will be very limited until the government gives significant incentives. The charging of cars at home also takes 8-10 hours to charge an 11 kW-hr battery currently in Mahindra e20, which is not practical. So the cars will need to incorporate DC chargers and inverters for fast charging of cars at home and the government will need to install fast chargers across cities to support electric cars.

In the taxi segment, the economics is more favorable for electric taxis than in personal segment due to higher usage of cars in the taxi segment. A taxi operator drives around 30,000 kms a year and we assume an electric car will need at least 200 km range in the electric car with a DC charger and inverter for fast charging. As per calculations, the taxi operator can break even his upfront capital cost after 55,000 kms at current cost, which is approximately 1.8 years. A taxi driver drives the taxi at least for 60,000 kms, so the economics for electric car should work in the taxi segment. The availability of charging infrastructure will be essential for the electric cars to pick up pace in the taxi segment.

However, the economics will still be unfavorable for electric cars in this segment even when battery costs reduce to US$100/kW-hr from current US$250/kW-hr as the breakeven will still be around ~5.4 years (without government incentives). We believe transition to electrification in the car segment will take more time and will mostly happen in the fleet segment initially, given the government's aggressive push towards electrifying the automotive industry**. Hence, we estimate that only 5% of passenger vehicles will shift to electric by FY2030 in India, which will be mostly taxi segment.** The taxi segment forms 7-8% of passenger vehicle industry in India currently.

Exhibit 31: We expect electric vehicles to form only 5% of the total PVs volumes by FY2030
Annual volume forecasts for PVs, March fiscal year-ends, 2019-30 (mn units, %)

	PV	ICE	Electric	Electric fleet proportion (%)
2019	3.4	3.4	—	
2022	4.2	4.1	0.0	0.7
2025	5.3	5.2	0.1	2.0
2030	7.6	7.2	0.4	5.0
CAGR (%)	**6.4**	**6.0**		

Source: Kotak Institutional Equities estimates

Exhibit 32: We expect electric vehicles to form 2% of the total PV population by FY2030
Annual population forecasts for PVs, March fiscal year-ends, 2019-30 (mn units, %)

	PV	ICE	Electric	Electric fleet proportion (%)
2019	26.3	26.3	—	
2022	39.3	39.2	0.1	0.2
2025	49.9	49.6	0.3	0.6
2030	82.0	80.6	1.5	1.8
CAGR (%)	**9.1**	**9.0**		

Source: Kotak Institutional Equities estimates

Exhibit 33: Electric cars cost of ownership is significantly higher than petrol cars
Comparison of the cost of ownership of an electric car versus petrol car, April 2019, prices of electricity and vehicle as of Mumbai

	Model electric car	Maruti Swift Vxi
On road price (Rs)	1,395,547	700,074
Incentives	110,000	—
Cost to consumer	**1,285,547**	**714,074**
Battery size (Kwh)	40	
Electricity cost (Rs/kwh)	8	
Range at full charge (km)	200	
Electricity cost (Rs/km)	1.6	—
Electricity/Fuel cost (Rs)	80,000	280,536
Insurance cost (Rs)	151,178	53,786
Maintenance cost (Rs)	25,000	50,000
Total cost of ownership of vehicle over 50,000 kms (Rs)	**1,541,725**	**1,098,395**

Source: Kotak Institutional Equities estimates

Exhibit 34: In taxi segment, cost of ownership of electric car is also high currently
Comparison of the cost of ownership of an electric car versus CNG car in taxi segment, April 2019, prices of electricity and vehicle as of Mumbai

	Model electric car taxi	Ertiga petrol Vxi
On road price (Rs)	1,400,000	949,350
Incentives	110,000	—
Cost to consumer	**1,290,000**	**949,350**
Battery size (Kwh)	40	
Electricity cost (Rs/kwh)	8	
Range at full charge (km)	200	
Electricity cost (Rs/km)	1.6	—
Electricity/Fuel cost (Rs)	80,000	325,000
Insurance cost (Rs)	151,178	72,937
Maintenance cost (Rs)	25,000	50,000
Total cost of ownership of vehicle over 50,000 kms (Rs)	**1,546,178**	**1,397,287**

Source: Kotak Institutional Equities estimates

Exhibit 35: In FY2030, e-car customer will be able to break even in ~5.4 years
Comparison of the cost of ownership of an e-car with that of a gasoline car, March fiscal year-end, 2030

	Model electric car	Maruti Swift Vxi
On road price (Rs)	1,045,547	870,454
Incentives	0	—
Cost to consumer	**1,045,547**	**870,454**
Battery size (Kwh)	40	
Electricity cost (Rs/kwh)	14	
Range at full charge (km)	200	
Electricity cost (Rs/km)	2.7	—
Electricity/Fuel cost (Rs)	136,827	280,536
Insurance cost (Rs)	113,263	94,295
Maintenance cost (Rs)	38,486	76,973
Total cost of ownership of vehicle over 50,000 kms (Rs)	**1,334,123**	**1,322,257**

Source: Kotak Institutional Equities estimates

- **Electric buses are significantly costlier than ICE buses and even luxury buses.** The shift to electric buses will be purely driven by government incentives and support as cost of vehicles is significantly higher than normal CNG buses and even luxury buses. **We estimate only 10% of buses will shift to electric by FY2030 due to budget constraints of the state governments.**

Exhibit 36: We expect electric vehicles to form 10% of the total bus volumes by FY2030
Annual volume forecasts for bus, March fiscal year-ends, 2019-30 (units, %)

	Buses	ICE	Electric	Electric fleet proportion (%)
2019	39,421	39,421	—	
2022	47,374	44,374	3,000	6.3
2025	63,055	58,055	5,000	7.9
2030	101,551	91,551	10,000	9.8
CAGR (%)	7.6	6.7		

Source: Kotak Institutional Equities estimates

Exhibit 37: We expect electric vehicles to form 7% of the total bus population by FY2030
Annual population forecasts for bus, March fiscal year-ends, 2019-30 (units, %)

	Buses	ICE	Electric	Electric fleet proportion (%)
2019	583,172	583,172	—	
2022	637,044	630,044	7,000	1.1
2025	693,403	673,503	19,900	2.9
2030	897,845	837,945	59,900	6.7
CAGR (%)	3.4	2.8		

Source: Kotak Institutional Equities estimates

Exhibit 38: Electric bus cost of ownership is significantly higher than diesel bus
Comparison of the cost of ownership of an electric bus with that of a diesel bus, April 2019

	Goldstone-BYD K7 bus	Volvo 8400 (diesel)
On road price (Rs)	16,100,000	8,117,920
Incentives	3,912,000	—
Cost to consumer (Rs)	**12,188,000**	**8,117,920**
Battery size (Kwh)	195.6	
Electricity cost (Rs/kwh)	6	
Range at full charge (km)	218	
Electricity cost (Rs/km)	5.4	
Electricity cost (Rs)	269,174	—
Fuel cost (Rs)	—	1,155,833
Maintenance cost (Rs)	100,000	200,000
Total cost of ownership of vehicle over 50,000 kms (Rs)	**12,557,174**	**9,473,753**

Source: Kotak Institutional Equities estimates

FAME-II scheme by Government of India is a step in right direction but more investment is required to achieve targets set out by the government

The Government of India has outlined an investment of ₹100 bn under the FAME-II scheme over three years (FY2020-22 period) to encourage faster adoption of electric and hybrid vehicles. Out of this ₹100 bn, ₹86 bn will be used for subsidizing electric vehicle purchase. The government expects this scheme would help electric and hybrid vehicles to achieve a scale of 1.56 mn vehicles in 3 years mainly in 2-wheeler and 3-wheeler segments. Essentially, the government expects only 2% of 2-wheeler and 3-wheeler domestic passenger vehicle volumes to shift towards electric and plug-in hybrids by FY2022. Under the FAME-I scheme, the government had spent only ₹8 bn in FY2016 and FY2017. FAME-II policy has fixed the overall incentive at ₹10,000/kW-hr (capped at 20% of vehicle cost) for all vehicles except buses and ₹20,000/kW-hr (capped at 40% of vehicle cost) for buses. The government is also planning to link incentives to localization plan of EV components. As highlighted in Exhibit 33, Tata Motors plans to localize EV components in India quite aggressively but major localization of battery cells and battery management systems will likely happen after FY2023. Localization of battery cells and battery management system is essential to drive down costs and accelerate the shift towards electric vehicles, especially in the four-wheeler segment.

We estimate 26% of automobiles (except commercial vehicles) will shift to electric by FY2030 and we estimate the government will need to spend US$40 bn over FY2020-30 period to encourage adoption of electric vehicles assuming the government will give incentives for electric vehicles until CY2025, post CY2025, we believe electric vehicles will achieve TCO breakeven with ICE vehicles. Savings on oil imports by the shift towards electric vehicles will be US$25 bn over FY2020-30, while the incentives given by the government will be higher to increase adoption of EVs.

Exhibit 39: FAME-II policy has ₹100 bn expenditure plan for three years to encourage faster adoption of electric and hybrid vehicles
FAME-II policy details, financial year-ends, 2020-22 (₹ mn)

Component	2020	2021	2022	Total
FAME-II: Policy details				
Demand incentives	8,220	45,870	31,870	85,960
Charging Infrastructure	3,000	4,000	3,000	10,000
Adminstrative infrastructure	120	130	130	380
Total	**11,340**	**50,000**	**35,000**	**96,340**
Committed expenditure of Phase-I	3,660	—	—	3,660
Total for FAME-II	**100,000**			

Source: Central Government, Kotak Institutional Equities

Exhibit 40: FAME-II policy aims to provide incentives to 1.6 mn units worth ₹85,960 mn over the period of three years
FAME-II incentive break-up by vehicle segment, financial year-ends, 2019-22

Vehicle segment	Maximum vehicle to be supported (units)	Approximate battery size (in kWhr)	Total approximate incentive per vehicle (Rs/vehicle)	Maximum ex-factory price to avail incentive (Rs)	Total support from DHI (Rs mn)
2-wheelers	1,000,000	2.0	20,000	150,000	20,000
3-wheelers	500,000	5.0	50,000	500,000	25,000
4-wheelers	35,000	15.0	150,000	1,500,000	5,250
4-wheelers (SHEV)	20,000	1.3	13,000	1,500,000	260
e-Bus	7,090	250.0	5,000,000	20,000,000	35,450
Total	**1,562,090**				**85,960**

Source: Central Government, Kotak Institutional Equities

Exhibit 41: FAME-I policy had ₹7,950 mn expenditure plan for two years
FAME-I policy details, financial year-ends, 2016-17 (₹ mn)

Component	2016	2017	Total
FAME-I: Policy details			
Demand incentives	1,550	3,400	4,950
Charging Infrastructure	100	200	300
Technology platform	700	1,200	1,900
Pilot projects	200	500	700
IEC/ Operations	50	50	100
Total for FAME-I	**2,600**	**5,350**	**7,950**

Source: Central Government, Kotak Institutional Equities

Exhibit 42: FAME-I policy had provided maximum incentive of ₹17,000- ₹22,000/ scooter
Two-wheeler incentives under FAME-I policy, financial year-ends, 2016-19 (₹ mn)

	Level-1	Level-2
Scooter		
Mild HEV (Conventional Battery)	1,800	2,000
Mild HEV (Advance Battery)	3,600	4,300
Plug-in HEV (Advance Battery)	13,000	15,600
BEV (Conventional Battery)*	7,500	9,400
BEV (Advance Battery)*	17,000	22,000
Motorcycle		
Mild HEV (Conventional Battery)	3,500	4,200
Mild HEV (Advance Battery)	5,200	6,200
Plug-in HEV (Advance Battery)	15,000	18,000
BEV (Conventional Battery)*	9,600	12,000
BEV (Advance Battery)*	23,000	29,000

Notes:
(a) In case of BEW 2W, 'Level 1' incentive is applicable for 2 wheeler with maximum power of 250 watts and 'Level 2' incentive is applicable for others BEV 2W

Source: Central Government, Kotak Institutional Equities

Exhibit 43: FAME-I policy had provided maximum incentive of ₹54,000-₹61,000/ three-wheeler
Three-wheeler incentives under FAME-I policy, financial year-ends, 2016-19 (₹ mn)

	Level-1	Level-2
CNG/ Diesel variant		
Mild HEV (Conventional Battery)	3,300	4,000
Mild HEV (Advance Battery)	6,500	7,800
Plug-in HEV (Conventional Battery)	25,000	30,000
Plug-in HEV (Advance Battery)	38,000	46,000
BEV (Conventional Battery)	11,000	13,000
BEV (Advance Battery)	45,000	54,000
Petrol variant		
Mild HEV (Conventional Battery)	3,300	4,000
Mild HEV (Advance Battery)	6,500	7,800
Plug-in HEV (Conventional Battery)	25,000	30,000
Plug-in HEV (Advance Battery)	38,000	46,000
BEV (Conventional Battery)	21,000	25,000
BEV (Advance Battery)	51,000	61,000

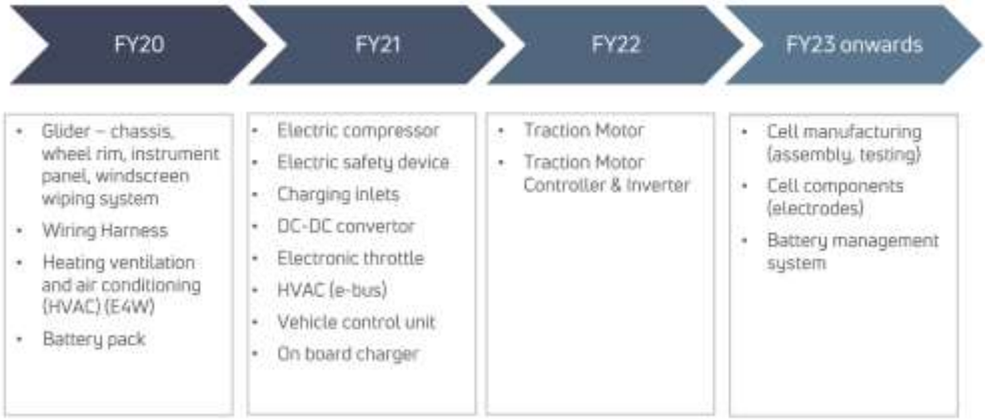
Source: Central Government, Kotak Institutional Equities

Exhibit 44: FAME-I policy had provided maximum incentive of ₹6.1-₹6.6 mn/ bus
Bus incentives under FAME-I policy, financial year-ends, 2016-19 (₹ mn)

	Level-1	Level-2
CNG variant		
Mild HEV (Advance Battery)	3,400,000	4,100,000
Strong HEV (Advance Battery)	5,500,000	6,600,000
Diesel variant		
Mild HEV (Advance Battery)	3,000,000	3,600,000
Strong HEV (Advance Battery)	5,100,000	6,100,000

Source: Central Government, Kotak Institutional Equities

Exhibit 45: Tata Motors has aggressive localization plans to reduce costs of an electric vehicle
Localization plans of Tata Motors in electric vehicle segment, March fiscal year-ends, 2020-23



Source: Tata Motors, Kotak Institutional Equities

Standardization of chargers and charging infrastructure will be key for faster adoption

We believe standardization of electric charge technology will emerge as the focal point for development of the EVs in India. On December 14, 2018, the Ministry of Power circulated guidelines for creation of standardized EV charging infrastructure in India. As per the circular, private charging will be permitted at residences and offices and every public charging station will have to follow minimum infrastructure (refer to Exhibit 46). All the requirements for the public charging stations are at par with current international standards. Different countries use their own style of charging standards—CHAdeMO (Japan, US), CCS (Europe, UK and Korea), GB/T (China) and US-based electric super car maker Tesla uses its own unique form called Supercharger. The Indian government has allowed a combination of charging technologies. However, the charging infrastructure is at very nascent stage in India. There is no universal benchmark for number of electric vehicles per public charging point. Electric vehicle owners in California more frequently have access to home and workplace charging, and one public charger per 25-30 electric vehicles is typical. In Netherlands, private parking and charging are relatively rare, and one public charger per 2 to 7 electric vehicles is typical. This ratio ranges to 3-6 in major cities in China.

Exhibit 46: Indian public charging stations specifications are in line with international standards
Minimum requirements for public charging infrastructure in India

Charger Type	Charger connectors	Rated Voltage (Volts)	No. of Charging points/ No. of Connector guns (CG)
Fast	CCS (min 50 kW)	200-1000	1/1 CG
	CHAdeMO (min 50 kW)	200-1000	1/1 CG
	Type-2 AC (min 22 kW)	380-480	1/1 CG
Slow	Bharat DC-001 (15 kW)	72-200	1/1 CG
	Bharat AC- 001 (10 kW)	230	3/3 CG of 3.3 kW each

Source: Ministry of Power, Kotak Institutional Equities

Exhibit 47: Major economies are shifting towards standardized electric charging infrastructure
Minimum requirements for public charging infrastructure in the US, Europe and China

Country	Charging Standard
China	China has one nationwide EV fast charging standard. Chinese standard is known as China GB/T (initials GB stand for national standard). It was released in 2015 and is now mandatory for all new electric vehicles sold in China. Global OEMs such as Tesla, Nissan, BMW etc. have adopted the GB/T standard for their EVs sold in China. GB/T currently allows fast charging at a maximum of 237.5 kW of output (at 950V and 250A). A new GB/T will be released soon which is expected to upgrade the standard to include charging upto 900 kW for larger CVs.
United States	US has three EV charging standards for DC fast charging: (1) CHAdeMO, (2) CCS SAE Combo and (3) Tesla. (1) **CHAdeMO:** CHAdeMO was developed in 2011 and is currently used in Nissan Leaf and Mitsubishi Outlander. As of January 2019, there were over 2,900 CHAdeMO fast chargers in US. In 2016, they upgraded its standard from its initial charging rate of 70 kW to offer 150 kW. In June 2018, they introduced 400 kW charging capability using 1,000V, 400 amp-liquid cooled cables. (2) **CCS SAE Combo:** CCS SAE Combo was released in 2011. It has a plug that contains both AC charging (at upto 43 kW) and DC charging. JLR, Volkswagen, GM, BMW, Daimler, Ford, FCA and Hyunadi supports CCS. CCS fast chargers allow charging at around 50 kW with fast charging capability of 350 kW which could compelete charge in less than 10 mins. (3) **Tesla:** Tesla launched its own propietary supercharger network in September 2012. It typically operates at 480 Volts and offer charging at maximum 120 kW. As of January 2019, Tesla had 595 supercharger stations in the US.
Europe	EU has wide range of standards for charging speed, capacity and modes. In EU, five types of connector types are used which includes (1) Type 1/ Yazaki (SAE J1772), (2) Type 2 (IEC 62196-2), (3) Combined Charging system (CCS), (4) Type 4/CHAdeMO and (5) Tesla supercharger. Charging rate can vary from 22 kW to 175 kW (heavy duty vehicles there are chargers which delivers 450 kW of power). In EU, there are four charging modes which includes (1) Model 1 means charging at regualar 230 volts socket, (2) Mode 2 entails charging through a cable with an In-Cable Control Box (ICCB) with 230 Votls socket, (3) Mode 3 charging capacity is determined by communication between charging station and vehicle and (4) Mode 4 is DC-charging and is mainly being applied for fast-charging.

Source: Government, Inside EVs, Kotak Institutional Equities

Performance of electric vehicles currently is inferior to petrol/diesel vehicles in India

If we compare the current electric vehicles, which are selling in India versus ICE vehicles, the performance of electric vehicles is significantly inferior to ICE vehicles as Indian OEMs are struggling to give high performance vehicles at low price points. In two-wheeler segment, high-end electric scooters and motorcycles are significantly expensive than petrol scooters while the lower-end electric vehicles (with 1.5 kW-hr lithium ion battery) is cheaper than petrol scooters but it gives a range of 40 kms with top speed of 45 kms. Similarly in passenger car segment, Mahindra e-20 performance is below par versus petrol hatchbacks in the Indian market. Electric vehicles in the market struggle with very low range, take a long time to charge as they don't have DC chargers and inverters and have very low power.

Hence, the consumers are not very excited to buy the current electric vehicles, which are available in the market. We believe that OEMs will need to focus on high performance electric vehicles to increase adoption of electric vehicles, which will be costly. Hence, we expect a gradual shift to electric vehicles in India.

Exhibit 48: Ather S340 has a mileage of 45- 60 km per charge with a peak power of 4 kW
Comparison of the features of an electric scooter with that of a gasoline scooter, April 2019

	Ather Energy e-scooter (S340)	Honda Activa
Cost to consumer (Rs)	113,230	79,327
Engine		
Power	2.8 kW (4 kW Peak)	5.91 kW @ 7000 rpm
Torque	20 Nm	8.94 Nm @ 5500 rpm
Brakes		
Brakes front	Disc	Drum
Brakes rear	Disc	Drum
Performance		
Mileage	45 - 60 km/charge	60 Kmpl
Top speed (Km/h)	70	83
0-40 kmph (sec)	5.1	N/A
Suspension		
Suspension-front	Telescopic fork	Spring loaded hydraulic type
Suspension-rear	Symmetrically mounted progressive mono-shock	Spring loaded hydraulic type
Tyres		
Tyre size (Front)	90/90-12	90/100-10
Tyre size (Rear)	90/90-12	90/100-10
Wheel size (inch)	12	10
Dimensions		
Length*Width*Height (mm)	1800*700*1250	1795*705*1115
Ground clearance (mm)	160	165
Kerb weight (kg)	118	103
Battery features		
Battery installed capacity	2.71 kWh	NA
Battery usable capacity	1.92 kWh	NA
Charging time (mins)	160	NA
Fast charging time	up to 80% at 1 km/min	NA
Other key features		
Starting	Self Start Only	Kick and Self Start
Speedometer	Digital	Analogue
Standard warranty (Years)	2	2
Standard warranty (km)	30,000	24,000
Battery warranty (Years)	3	NA
Battery warranty (km)	unlimited	NA

Source: Company, Kotak Institutional Equities

Exhibit 49: Mileage, power and top speed of electric cars is significantly lower than petrol/diesel cars
Comparison of the features of an electric car with that of a gasoline car, April 2019

	Mahindra E2O plus P6 variant	Maruti Swift Vxi
Cost to consumer (Rs)	1,395,547	700,074
Engine		
Power	19 KW @3500 rpm	61 KW @6000rpm
Torque	70Nm@1050rpm	113Nm@4200rpm
Brakes		
Brakes front	Disc	Disc
Brakes rear	Drum	Drum
Performance		
Mileage	110 km/ charge	22 kmpl
Top speed (Km/h)	80	165
0-40 km/h (sec)	6.3	NA
0-60 km/h (sec)	14.1	5.5
Suspension		
Suspension-front	Macpherson strut	Macpherson strut
Suspension-rear	Twin pivot with coaxial spring	Torsion beam
Tyres		
Tyre size (Front)	165/60 R14	165/80 R14
Tyre size (Rear)	165/60 R14	165/80 R14
Wheel size (inch)	14	14
Dimensions		
Length*Width*Height (mm)	3590*1575*1585	3840*1735*1530
Ground clearance (mm)	170	163
Kerb weight (kg)	940	860
Battery features		
Battery capacity	11 Kwhr	NA
Charging time	6 hours	NA
Battery weight	84 kg	NA
Other key features		
Lighting	Projector headlights,LED tail lamps	No
Airbags	No	Driver and passenger
Anti-lock Braking System (ABS)	No	Yes
Standard warranty (Years)	3	No
Standard warranty (km)	60,000	No
Battery warranty (Years)	3	NA
Battery warranty (km)	60,000	NA

Source: Company, Kotak Institutional Equities

Exhibit 50: E-rickshaw has a mileage of 130 km/charge with charging time of 230 minutes (full charge)

Comparison of the features of an electric rickshaw with that of a CNG rickshaw, April 2019

	Mahindra Treo SFT	Bajaj RE CNG
Cost to consumer (Rs)	275,053	234,681
Engine		
Power	5.4 kW (Peak)	7.5 KW at 5000 rpm
Torque	30 Nm (Peak)	14.9Nm at 3500 rpm
Brakes		
Brakes front	Hydraulic	Hydraulic expanding friction shoe type
Brakes rear	Hydraulic	Hydraulic expanding friction shoe type
Performance		
Mileage	130 km/ charge	NA
Top speed (Km/h)	45	NA
Suspension		
Suspension-front	Helical spring, dampener and hydraulic shock absorber	Double acting hydraulic shock absorber
Suspension-rear	Rigid axle, leaf spring & shock absorber	Double acting hydraulic shock absorber
Dimensions		
Length*Width*Height (mm)	2746 * 1350 * 1750	2635*1300*1710
Ground clearance (mm)	140	200
Kerb weight (kg)	340	337
Battery features		
Battery capacity	7.37 kWh	NA
Battery type	Lithium-ion, 48V	NA
Charging time (min)	230	NA
Other key features		
Seating capacity	D+3 seater	D+3 seater
Standard warranty (Years)	3	NA
Standard warranty (km)	50,000	NA
Battery warranty (Years)	3	NA
Battery warranty (km)	50,000	NA

Source: Company, Kotak Institutional Equities

Exhibit 51: BYD K7 has a mileage of up to 200 km per charge with charging time of 2-3 hours
Comparison of the features of an electric bus with that of a diesel bus, April 2019

	Goldstone-BYD K7 bus	Volvo 8400 (diesel)
Cost to consumer (Rs)	12,188,000	8,117,920
Engine		
Power	180 kW	243 kW@2200 rpm
Torque	800 Nm	1200 Nm @1200-1600 rpm
Brakes		
Brakes front	Disk brake with ABS	Disc brake with Volvo EBS
Brakes rear	Disk brake with ABS	Disc brake with Volvo EBS
Performance		
Mileage	Up to 200 km/ charge	2.7 to 3 kmpl
Top speed (Km/h)	70 (with speed limiting device)	80
0-30 km/h (sec)	< 10.5	NA
Suspension		
Suspension-front	Electronically controlled air suspension	Electronically controlled air suspension
Suspension-rear	Electronically controlled air suspension	Electronically controlled air suspension
Tyres		
Tyre size (Front)	255/70 R22.5	295/ 80 R 22.5
Tyre size (Rear)	255/70 R22.5	295/ 80 R 22.5
Wheel size (inch)	22.5	22.5
Dimensions		
Length*Width*Height (mm)	8600*2465*2930	12000*2510*3200
Kerb weight (kg)	9,500	10,600
Battery features		
Battery capacity	195.6 kWh	NA
Battery type	Li-ion Phosphate Battery	NA
Charging time	2-3 Hours	NA
Battery weight	30 kg	NA
Other key features		
Seating capacity	D+31 seats	D+32 seats (+1 wheel chair space)
CCTV surveillance	Yes	Yes
Real time tracking	Yes	Yes
Passenger information safety	Yes	Yes

Source: Company, Kotak Institutional Equities

WHO ARE THE BENEFICIARIES IN INDIA AND WHO ARE MOST IMPACTED?

Increase in adoption of electric vehicles in India will be (1) margin dilutive for OEMs initially due to higher overhead costs and (2) negative for 'traditional' automotive component suppliers due to lack of an engine and reduction in transmission content in EVs (60% of vehicle cost in ICE). Also, we note that EVs have much lesser moving parts and require much lower maintenance costs, therefore, spare revenues of OEMs and aftermarket revenues of ancillaries will be negatively impacted—however, the effect of this will be visible only after FY2030 as population of ICE vehicles will still increase from current levels over the next 10 years. Beneficiaries from adoption of EVs will be lithium-ion battery manufacturers, supplier of electronic components and manufacturers of EV chargers—none of the major listed names are currently present in India in these categories.

Shift to electric vehicles will be negative for profitability of OEMs initially

Profitability in electric vehicles will likely be negative in the initial few years due to (1) lack of economies of scale at both suppliers (leading to lower gross margin) and at OEM level and (2) potentially aggressive pricing by OEMs to increase adoption levels of EVs. We analyse the financials of Tesla Inc. (and compare with BMW), the only major pure electric vehicle manufacturer globally to better understand the profitability in EVs, particularly the impact of scale on margins (refer to Exhibit 52-53 below).

- In CY2018, EBITDA margin of Tesla was 7% while EBIT margin was negative 1.8%—a significant improvement compared to steep losses incurred by the company in CY2015. However, the profitability of Tesla is still below that of leading premium car manufacturers globally (EBIT margin of BMW, Mercedes and Audi range 6-10%). The lower profitability of Tesla versus BMW is largely due to higher other expenses to sales (reflects lower scale benefits at OEM level), even though there is not much difference between the gross margin of both the companies despite much lower scale of Tesla (note that both the companies are not directly comparable as Tesla is a more premium player with higher ASPs and the company owns its distribution network, which leads to higher gross margin and higher other expenses).

- For Tesla, gross margin improved steadily over CY2013-16 period led by reduction in lithium-ion battery prices as discussed in sections above and economies of scale benefits (at supplier level); gross margin has come down in CY2018 due to ramp-up of Model 3 volumes where margins would be lower than Model S and X. We note that Tesla's gross margin would likely be higher than comparable EV models of other OEMs due to the fact that Tesla has fully-owned distribution operations and lack of discounting/strong pricing power in the market. This also implies Tesla would have higher distribution costs in SG&A.

- With improvement in scale (revenues up almost 5X over CY2015-18), Tesla's R&D expenses to sales and other expenses to sales have come down significantly—down to around 20% of revenues in CY2018 from around 40% of revenues in CY2015. Having said that, these expenses as % of sales is still much higher than a bigger premium car manufacturer such as BMW. This is the primary reason for difference in EBITDA margin between BMW and Tesla. If Tesla is able to double its volumes to around 500,000 units and revenues to around US$40-42 bn and R&D and other expenses increases by only 50%, then Tesla's EBITDA margin can improve to around 12%, which would be comparable to that of BMW.

- Due to lower scale and in-house manufacturing of batteries (leading to higher gross block), depreciation as percentage of revenues is much higher compared to that of BMW (~9% of sales for Tesla versus 5-5.5% of sales for BMW). This leads to a much lower EBIT margin for Tesla (EBIT loss currently) compared to that of BMW. All this implies that for Tesla to reach an EBIT margin of 8-9%, apart from operating leverage benefits, the company needs to improve gross margin further as well (this can happen if Tesla can retain part of the benefit of potential decline in lithium-ion battery prices).

Exhibit 52: Tesla's profitability has improved over past three years due to operating leverage benefits
Income statement of Tesla, calendar year-ends, 2012-18 (US$ mn)

	2012	2013	2014	2015	2016	2017	2018
Model S	2,650	22,581	31,609	50,446	50,931	51,000	50,000
Model X	—	—	—	774	33,069	50,420	49,394
Model 3	—	—	—	—	—	1,764	145,846
Total volumes	**2,650**	**22,581**	**31,609**	**51,220**	**84,000**	**103,184**	**245,240**
ASPs	145,547	88,473	90,937	66,998	66,536	82,714	71,895
Automotive revenues	386	1,998	2,874	3,432	5,589	8,535	17,632
Automotive leasing	—	—	133	309	762	1,107	883
Services and others	28	16	187	291	468	1,001	1,391
Energy storage	—	—	4	14	181	1,116	1,555
Total revenues	**413**	**2,013**	**3,198**	**4,046**	**7,000**	**11,759**	**21,461**
Cost of goods sold	(354)	(1,451)	(2,085)	(2,700)	(4,454)	(7,900)	(15,518)
R&D expense	(274)	(232)	(465)	(718)	(834)	(1,378)	(1,460)
SG&A expense	(150)	(286)	(604)	(922)	(1,432)	(2,477)	(2,970)
Total expenses	(779)	(1,969)	(3,153)	(4,340)	(6,720)	(11,755)	(19,948)
EBITDA	**(365)**	**45**	**45**	**(294)**	**280**	**4**	**1,513**
Other income	(2)	23	3	(40)	120	(106)	46
Depreciation	(29)	(106)	(232)	(423)	(947)	(1,636)	(1,901)
Interest expense	(0)	(33)	(101)	(119)	(199)	(471)	(663)
PBT	(396)	(71)	(285)	(876)	(746)	(2,209)	(1,005)
Tax expense	—	3	9	13	27	32	58
Minopríty interest	—	—	—	—	—	(279)	(86)
PAT	**(396)**	**(74)**	**(294)**	**(889)**	**(773)**	**(1,961)**	**(976)**
Ratios							
RM to sales (%)	85.7	72.1	65.2	66.7	63.6	67.2	72.3
R&D exp to sales (%)	66.3	11.5	14.5	17.7	11.9	11.7	6.8
SGA expense to sales (%)	36.4	14.2	18.9	22.8	20.5	21.1	13.8
EBITDA margin (%)	**(88.4)**	**2.2**	**1.4**	**(7.3)**	**4.0**	**0.0**	**7.0**
EBIT margin (%)	**(95.4)**	**(3.0)**	**(5.8)**	**(17.7)**	**(9.5)**	**(13.9)**	**(1.8)**

Source: Company, Kotak Institutional Equities

Exhibit 53: BMW profitability has declined in the past eight years
Income statement of BMW's automotive, calendar year-ends, 2012-18 (US$ mn)

	2012	2013	2014	2015	2016	2017	2018
Total volumes	**1,845,186**	**1,963,798**	**2,117,965**	**2,247,485**	**2,367,600**	**2,463,500**	**2,490,700**
ASPs	38,049	35,966	35,493	38,059	36,503	34,805	34,467
Total Revenues	**70,208**	**70,630**	**75,173**	**85,536**	**86,424**	**85,742**	**85,846**
Cost of goods sold	(48,853)	(49,997)	(52,856)	(61,551)	(61,803)	(59,783)	(61,616)
R&D expense	(3,993)	(4,117)	(4,135)	(4,271)	(4,294)	(4,920)	(5,320)
SG&A expense	(6,757)	(6,942)	(7,457)	(7,990)	(8,372)	(9,127)	(8,556)
Total expenses	(59,603)	(61,056)	(64,448)	(73,812)	(74,469)	(73,830)	(75,492)
EBITDA	**10,605**	**9,574**	**10,725**	**11,724**	**11,955**	**11,912**	**10,354**
Other income	1,297	1,442	1,735	1,534	1,317	1,739	2,009
Depreciation	(3,679)	(3,657)	(4,230)	(4,577)	(4,876)	(4,699)	(4,982)
Interest expense	(1,053)	(797)	(1,344)	(1,158)	(480)	(235)	(404)
PBT	7,170	6,562	6,886	7,523	7,916	8,717	6,977
Tax expense	2,453	2,153	2,365	2,376	2,475	3,418	1,853
PAT	**4,717**	**4,409**	**4,521**	**5,147**	**5,441**	**5,299**	**5,124**
Ratios							
RM to sales (%)	69.6	70.8	70.3	72.0	71.5	69.7	71.8
R&D exp to sales (%)	5.7	5.8	5.5	5.0	5.0	5.7	6.2
SGA expense to sales (%)	9.6	9.8	9.9	9.3	9.7	10.6	10.0
EBITDA margin (%)	**15.1**	**13.6**	**14.3**	**13.7**	**13.8**	**13.9**	**12.1**
EBIT margin (%)	**9.9**	**8.4**	**8.6**	**8.4**	**8.2**	**8.4**	**6.3**

Source: Company, Kotak Institutional Equities

In India, the profitability of two electric vehicle manufacturers—Mahindra Electric and Hero Electric is weak with steep EBITDA losses due to lack of scale in India (refer to Exhibits 54 and 55 for details) and lower level of localization (most of the components are imported).

We believe that in India, the increase in adoption of EVs in the two-wheeler segment will be driven by existing large OEMs—Bajaj Auto, Hero MotoCorp, Honda Motorcycles and TVS Motor as these companies have manufacturing capabilities, ability to work on such higher scale and balance sheet strength to incur higher capex and sustain losses in initial years. As per news reports and management commentary, Bajaj Auto and TVS will launch electric vehicle models in FY2020 itself while we expect other OEMs to launch electric scooters from FY2021. As highlighted in sections above, economics of owning an electric scooter versus ICE will improve significantly post FY2021 as cost of manufacturing electric scooter will come down (due to reduction in battery prices) while cost of an ICE will increase post implementation of BS-VI norms. As electric two-wheeler market will largely be controlled by existing OEMs only, we expect profitability on electric vehicle sales to converge towards current profitability over a period of time with increase in scale and reduction in costs. Also note that capex intensity for an OEM is much lower in an electric vehicle compared to an ICE (limited number of components and higher outsourcing), so at similar margin levels (ICE and EV), RoCEs will be higher in an EV compared to that of ICE.

Having said that, (1) profitability from sale of spare parts will be at risk for OEMs as EVs have much lesser moving parts and require much lower maintenance costs and (2) profitability will also be impacted due to decline in residual value of ICE vehicles, which can put pressure on pricing of ICE vehicles. We note that spares account for 8-10% of revenues for two-wheeler OEMs and given higher profitability in this segment (assuming 25% EBITDA margin), accounts for 10-34% of overall EBITDA of OEMs (refer to Exhibits 57-58). However, note that the effect of this will be visible only after FY2030 as sales of ICE vehicles will continue to grow till FY2030, as per our estimates.

Further, in terms of impact on auto ancillaries, shift towards EVs would be negative for 'traditional' automotive component suppliers due to lack of an engine and reduction in transmission content in EVs (60% of vehicle cost in ICE). Tire manufacturers, companies with presence in interior and exterior parts such as bumpers, door panel, instrument panel, seats, rear-view mirrors, etc. won't be much impacted by the shift towards electric vehicles (refer to Exhibit 59 for details).

Exhibit 54: Mahindra Electric: strong revenue growth but EBITDA loss due to lack of scale
Financial summary of Mahindra Electric Mobility Solutions, March fiscal year-ends, 2015-18 (₹ mn)

	2015	2016	2017	2018
Income statement				
Gross sales	370	655	1,173	1,261
Exide duty	—	51	68	14
Net sales	**370**	**604**	**1,105**	**1,246**
Cost of materials consumed	322	524	901	833
Staff cost	292	302	440	606
Other expenses	316	404	490	681
EBITDA	**(560)**	**(625)**	**(727)**	**(873)**
Depreciation	329	262	409	441
EBIT	**(889)**	**(887)**	**(1,135)**	**(1,314)**
Other income	14	23	23	33
Interest expense	66	46	19	10
Profit before tax	**(941)**	**(910)**	**(1,132)**	**(1,290)**
Tax expenses	—	—	—	—
Net income	**(941)**	**(910)**	**(1,132)**	**(1,290)**
Balance sheet (Rs mn)				
Equity	344	1,750	2,285	2,359
Total Borrowings	1,071	203	123	105
Other non-current liabilities	134	131	113	81
Current liabilities	607	651	787	830
Total liabilities	**2,156**	**2,735**	**3,307**	**3,375**
Net fixed assets	1,528	1,689	1,935	1,813
Long-term investments & receivables	170	217	91	198
Cash & cash equivalents	57	127	62	56
Other current assets	401	702	1,218	1,308
Total assets	**2,156**	**2,735**	**3,307**	**3,375**
Capital employed	1,358	1,825	2,345	2,408
Free cash flow				
Operating cash flow excl. working capital	(541)	(587)	(661)	(794)
Working capital changes	51	(201)	(405)	(127)
Capital expenditure	(455)	(496)	(546)	(370)
Free cash flow	**(945)**	**(1,284)**	**(1,612)**	**(1,292)**
Ratios				
Gross margin (%)	13.0	13.3	18.4	33.2
Employee cost to sales (%)	79.0	49.9	39.8	48.6
Other expenses to sales (%)	85.4	66.8	44.4	54.6
EBITDA margin (%)	(151.5)	(103.5)	(65.8)	(70.0)
EBIT margin (%)	**(240.5)**	**(146.8)**	**(102.8)**	**(105.4)**

Source: Company, Kotak Institutional Equities

Exhibit 55: Hero Electric: strong revenue growth but still making losses
Financial summary of Hero Electric, March fiscal year-ends, 2015-18 (₹ mn)

	2015	2016	2017	2018
Income statement				
Net sales	**285**	**575**	**563**	**1,134**
Operating expenses	367	577	810	1,239
EBITDA	**(82)**	**(2)**	**(246)**	**(105)**
Depreciation	5	6	6	6
EBIT	**(87)**	**(8)**	**(252)**	**(111)**
Other income	—	—	109	95
Interest expense	—	1	2	9
Profit before tax	**(87)**	**(9)**	**(145)**	**(24)**
Tax expenses	(15)	(11)	(45)	21
Net income	**(72)**	**2**	**(100)**	**(45)**
Balance sheet (Rs mn)				
Equity	471	473	373	328
Total Borrowings	1,040	1,363	1,576	1,639
Other non-current liabilities	32	40	49	67
Current liabilities	41	210	134	539
Total liabilities	**1,585**	**2,087**	**2,132**	**2,574**
Net fixed assets	76	76	80	80
Long-term investments & receivables	1,074	1,375	1,525	1,593
Cash & cash equivalents	7	23	34	60
Other current assets	427	613	492	841
Total assets	**1,585**	**2,087**	**2,132**	**2,574**
Capital employed	1,504	1,814	1,915	1,907
Free cash flow				
Operating cash flow excl. working capital	(217)	24	(216)	(85)
Working capital changes	181	44	(193)	(11)
Capital expenditure	(1)	(50)	(9)	(6)
Free cash flow	**(36)**	**18**	**(418)**	**(102)**
Ratios				
EBITDA margin (%)	(28.8)	(0.4)	(43.7)	(9.3)
EBIT margin (%)	**(30.5)**	**(1.3)**	**(44.7)**	**(9.8)**
PAT margin (%)	(25.1)	0.3	(17.8)	(4.0)

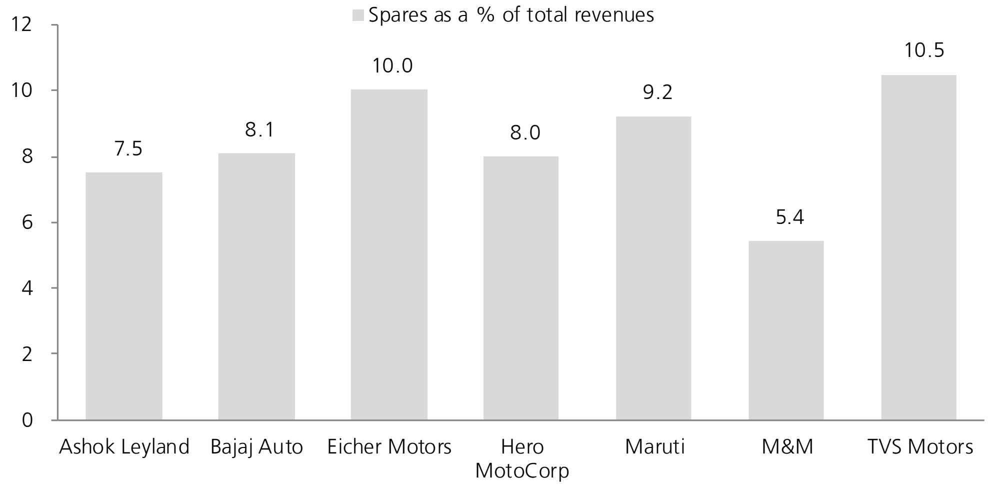
Source: Company, Kotak Institutional Equities

Exhibit 56: Hero Electric has market share of 57% in electric two-wheeler space in FY2018
Company wise electric two-wheeler sales, March fiscal year-ends, 2017-18 (units)

	2017	2018
Electric 2-wheelers sales		
Hero Electric	13,815	31,000
Ampere	6,000	15,000
Others	3,210	8,800
Total	**23,025**	**54,800**
Electric two-wheelers market share (%)		
Hero Electric	60.0	56.6
Ampere	26.1	27.4
Others	13.9	16.1
Total	**100.0**	**100.0**

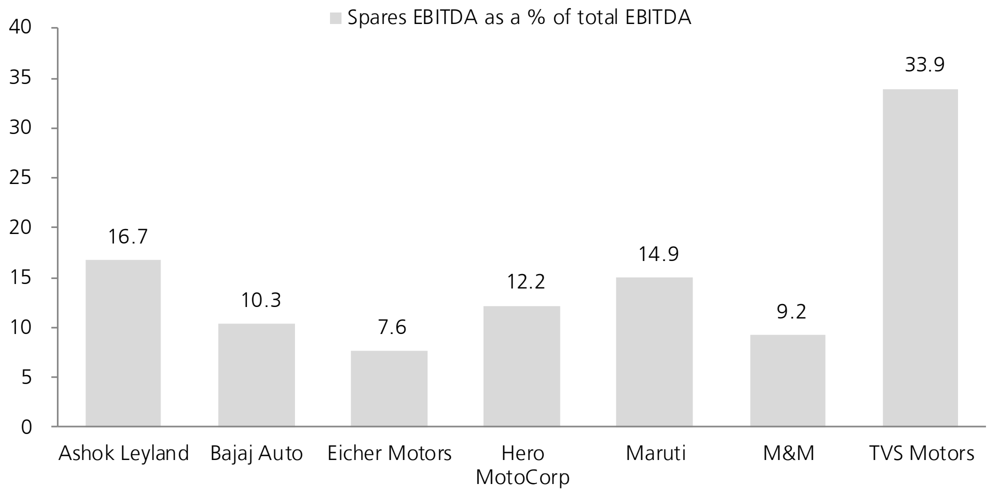
Source: Company, Kotak Institutional Equities estimates

Exhibit 57: Spares account for 5-10% of overall revenues or Indian OEMs
Spare revenues as % of total revenues of Indian OEMs, March fiscal year-end, 2018 (%)



Source: Company, Kotak Institutional Equities estimates

Exhibit 58: Spares account for 8-34% of overall EBITDA of Indian OEMs; highest for TVS
Spare EBITDA as % of total EBITDA (assuming 25% EBITDA margin), March fiscal year-end, 2018 (%)



Source: Company, Kotak Institutional Equities estimates

Exhibit 59: Engine and transmission component manufacturers will be negatively impacted as market shifts to EVs
Details on different automotive components, key players and impact of increased adoption of EVs

Component	Key players	Impact from EVs
Battery	Amara Raja Batteries, Exide Industries, Tudor India, Amco	Content will increase in EVs but competition will also likely increase
Engine & engine parts		Extremely negative as content will decline to almost zero
Pistons	Goetze, Shriram Pistons & Rings, India Pistons, Bharat Forge, Sunbeam Auto	
Cylinder blocks and heads	Amtek Auto, Jaya Hind Industries, Rico Auto, Endurance, Federal Mogul Goetze	
Crankshafts	Amtek Auto, Bharat Forge, Nelcast, Mahindra CIE	
Engine valves	Rane Engine Valves and Shriram Pistons & Rings	
Carburettors	Ucal Fuel Systems, Spaco Carburettors	
Fuel-injection systems	Bosch, Delphi, Ucal Fuel Systems, Magetti Marelli	
Exteriror and interior components		Neutral to positive; LED penetraion might increase and these components might become differentiating factors
Lighting	Lumax, Varroc, Autolite and Phoenix Lamps	
Dashboards	Premiere Instruments & Controls	
Sheet-metal parts	Jay Bharat Maruti, Omax Auto and JBM Tools	
Bumpers, door panels, etc.	Motherson Sumi, Plastic Omnium, etc.	
Rear-view mirrors	Motherson Sumi, Magna, Gentex, etc.	
Suspension & brake parts		Neutral; no mjaor change in content expected under EV
Brake systems	Brakes India, Kalyani Brakes, Wabco India and Automotive Axles	
Brake linings	Rane Brake Lining, Sundaram Brake Lining, Hindustan Composites and Allied Nippon	
Leaf springs	Jamna Auto and Jai Parabolic	
Shock absorbers	Gabriel India, Delphi and Munjal Showa	
Transmission & steering parts		Negative as content will come down significantly except for steering systems
Steering systems	JTEKT India, Rane NSK and Rane TRW Systems	
Gears	Bharat Gears, Gajra Bevel Gears, Eicher, Graziano Trasmissioni and SIAP Gears India	
Clutch	Clutch Auto, Ceekay Daikin, Amalgamations Repco, Luk Clutches	
Driveshafts	GKN Driveshafts, Delphi and Sona Koyo Steering Systems	
Tyres	Apollo Tyres, Michelin, Bridgestone, JK Tyre, MRF and Ceat	Neutral to positive; replacement life of tyres would come down due to higher vehicle kerb weight
Wiring harnesses & plastic parts	Motherson Sumi Systems, Yazaki India, Suprajit Engineering, etc.	Neutral to negative depends on vehicle design; wiring harness content is lower in recently-lauchned EV models globally

Source: Companies, Kotak Institutional Equities

APPENDIX 1: GLOBAL COMPANIES ARE INVESTING HEAVILY IN ELECTRIC TECHNOLOGY

Global auto companies are increasing their commitment towards plug-in hybrid vehicles and electric vehicles. Volkswagen group is the most aggressive and has committed EUR30 bn investment towards developing electric vehicles and plans to launch 70 new electric vehicles by CY2028. Tighter regulations on automotive emissions and countries commitment to reduce CO2 emissions are driving the shift towards electric vehicles.

China, Europe and the US are focussed on increasing adoption of electric vehicles. Three policies that are helping the push to electric vehicles are—(1) China's new energy vehicle system, (2) European Union vehicle CO2 targets in CY2021 and (3) CAFÉ norms in the US. Most of the automotive companies have made significant commitments to electric vehicles as they see little future of ICE vehicles. Volkswagen group is the most aggressive and has committed EUR30 bn investment towards developing electric vehicles and plans to launch 70 new electric vehicles by CY2028. Daimler has also indicated that 50% of its cars globally will be electric (including plug-in hybrid) by CY2030, while BMW will have 12 electric models by CY2021. We believe China and Europe will be faster than the US to shift towards electric because governments in these geographies are supporting electric vehicles through incentives and developing charging infrastructure and have very stringent policies on emission reduction.

Exhibit 60: Major global OEMs are increasingly shifting their focus on electric vehicles
EV guidance and strategies by OEMs

OEMs	Volumes	Models	Other
Volkswagen group	22 mn electric vehicles in next 10 years	70 new electric models by CY2028	1) €30 bn investment for electrifying the vehicle portfolio 2) To reduce CO2 footprint of the vehicle fleet by 2025 as compared to 2015
BMW group	More than 500,000 electric vehicles on road by the end of CY2019	By CY2021, BMW Group will have five all-electric models: the BMW i3, the MINI Electric, the BMW iX3, the BMW i4 and the BMW iNEXT. By CY2025, that number is set to grow to at least twelve models.	1) To establish new battery research facility to advance battery performance 2) BMW and Porsche have tied up together to build an EV charger prototype which is supposed to be three times faster than Tesla's supercharger 3) BMW has signed a €4bn contract with Contemporary Amperex Technology Co. Limited (CATL) to supply battery cells from a brand new factory in Erfurt
Daimler group	More than 50% of its car sales will be full EV or plug-in hybrid by CY2030.	Plans for more than ten different all-electric vehicles by CY2022. Plans to have total of 130 electrified variant by CY2022	1) Targets to become carbon neutral by 2050 including its factories, offices and cars 2) Announced over $150 bn in investments to achieve collective production targets of more than 13 mn EVs annually around 2025
Honda group	Two-thirds of European sales will be "electrified" vehicles by CY2030		
Toyota group	15% of its car sales will be full EV or plug-in hybrid in CY2019. Aim to sales 5.5 mn battery EV by 2030	Plans to bring more than 10 EVs to market in the next six years	1) Toyota and Panasonic are creating a joint venture to develop and produce high-capacity EV batteries 2) Plans to produce 400,000 green vehicles in China by CY2022
GM group		Plans to produce 20 new electric cars by CY2023	
Ford group		16 new, pure electric cars in the next three years	1) $11 bn investment to produce 16 fully electric vehicles by 2022
Hyundai-Kia group		Hyundai Motor Group is planning to deploy 44 eco-friendly models by year CY2025, including 23 electric vehicles	1) Hyundai Motor Company and Kia Motors jointly invested €80 mn in Rimac Automobili
Tesla	Produce 1 mn fully electric vehicles by CY2020–2021		
Renault-Nissan-Mitsubishi	Targeting sales of more than 14 mn units a year by the end of CY2022.	12 new BEVs by CY2022	
BAIC	To produce 500,000 new-energy vehicles by CY2022. To sell 220,000 electric cars in CY2019		1) Plans to invest 10 bn yuan over the next three years 2)BAIC BJEV and Magna International Autolaunch Ireland Ltd. formed a joint venture that focuses on manufacturing premium all-electric passenger vehicles (PVs)
BYD	Targeting sales of more than 14 mn units a year by the end of CY2022.	Three sedan models and two SUV models under 'e' series in CY2019	
Geely		Plans 10 EVs By 2025	

Source: Company, Kotak Institutional Equities

APPENDIX 2: DOMESTIC EV COMPANY PROFILES

Hero Electric

Hero Electric is a pioneer and market leader in the Indian electric two-wheeler industry. It has been the frontrunner for electric mobility in India for the past 10 years. The company offers an ecological two-wheeler solution to the consumers, which above all gives excellent value for money. The company has of endeavor of making the country greener and to be the best in 'Zero Pollution' transportation in the country through its wide range of electric vehicles. The company is currently present in 25+ states with over 600+ dealers.

Exhibit 61: Hero Electric launched its first lithium ion e-scooter in FY2016-17
Journey of Hero Electric

Source: Company, Kotak Institutional Equities

Ather Energy

Ather Energy is an Indian electric vehicle company founded by Tarun Mehta and Swapnil Jain in 2013. It manufactures two electric scooter models: the 340 (price: ₹110,647) and 450 (price: ₹122,647). It has also established electric vehicle charging infrastructure AtherGrid. The company has announced an online-only purchase model for selling the product with doorstep service. It set up its manufacturing unit in Whitefield, Bangalore which commenced production in 2018 with capacity of 600 vehicles per week. Ather has set up its own charging network, dubbed Ather Grid, in Bangalore & Chennai. These DC-fast-charging stations use Ather's proprietary charging method and connector to charge the Ather scooters at a rate of 1 km/min. Tiger Global Management, Sachin Bansal and Hero MotoCorp are the top three investors in Ather Energy.

Okinawa Autotech

Okinawa Autotech is a 100% Indian electric two-wheeler manufacturing company that was established in 2015 with a mission to create two-wheelers that can drive present towards a sustainable future. The company is founded by Jeetender Sharma and Rupali Sharma, Okinawa's headquarter is located in JMD Megapolis, Gurugram, while the manufacturing facility is located in Bhiwadi, Rajasthan. The company currently manufactures six e-scooters mainly Praise, I-Praise, Ridge, Ridge+, Ridge 360 and Raise. The company has invested ₹340 mn for setting up the manufacturing facility in Rajasthan and will invest another ₹2,700 mn over FY2018-21 to expand its domestic operations and invest in R&D capabilities. The company will also invest ₹2,000 mn to set up a new manufacturing plant with an annual capacity of 1 mn units, preparing to meet increased demand following the implementation of FAME II scheme. The new plant at Alwar in Rajasthan is being set up with 0.5 mn units per annum capacity and will be ready by the end of this fiscal to add to the existing volume of 90,000 units a year. The company is also ramping up its sales network across India and has a total of 500 dealers as on March 31, 2019.

Ampere Vehicles

The company was started in 2008 to revolutionize electric vehicles in India to provide 'Affordable Personal Mobility' solutions. The company has come a long way in design, development, manufacturing and marketing of battery-operated electric cycles, two wheelers, three wheelers and custom built vehicle. The company has three series in e-scooter segment mainly Reo series, V48 series and Magnus series. The company produces vehicles powered by both lead-acid and lithium-ion batteries, has a capacity to make 60,000 units annually. Utilization is currently around 40% as it sells about 2,000-2,500 units a month through 102 dealers. It is adding 8-10 dealers every month. In August 2018, Greaves Cotton had entered a definitive agreement to acquire majority stake of 67% Ampere Vehicles for ₹770 mn. In the first phase, Greaves will acquire 67% of the company. Following this, Greaves Cotton may acquire another 13% in a span of three years at its discretion for ₹755 mn, valuing the total deal at ₹1.15 bn.

Mahindra Electric Mobility

Mahindra Electric Mobility is the pioneer of electric vehicle technology in the country. The company has a wide variety of electric vehicles under the brand—Mahindra Electric (+ME). In order to promote the growth of Electric Vehicles (EV) in the country, Mahindra & Mahindra (a part of the US$19 bn Mahindra Group) sought the opportunity to combine their years of car manufacturing expertise with the country's leading EV manufacturer—Reva Electric Car Company (founded in 1994) and renamed it to Mahindra Reva Electric Vehicles. In 2016, the company again got renamed to Mahindra Electric Mobility. The company has products in personal and commercial segments and is designed to support the new paradigm of shared, electric and connected mobility. Product portfolio comprises e20 plus and eVerito in the passenger car segment, eSupro in the van segment and eAlpna Mini and Treo in the three-wheeler segment. The company will invest US$130-140 mn over the next three years for the expansion of its Bengaluru plant, a new R&D center for EVs and setting up of a battery manufacturing facility in Chakan, Maharashtra.

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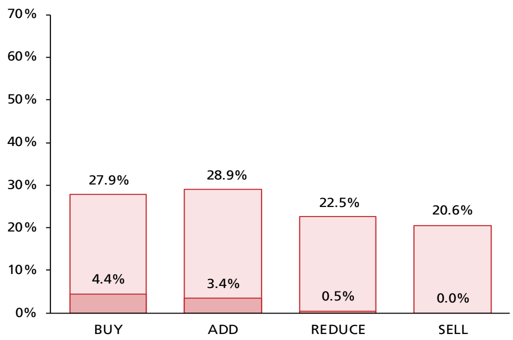

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Source: Kotak Institutional Equities

As of March 31, 2019

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