

# The future of mobility in India: Challenges & opportunities for the auto component industry

Prepared for the 57<sup>th</sup> annual conference organized by the  
Automotive Component Manufacturers Association of India (ACMA)

September 2017

**Authored by:**

Rajat Dhawan  
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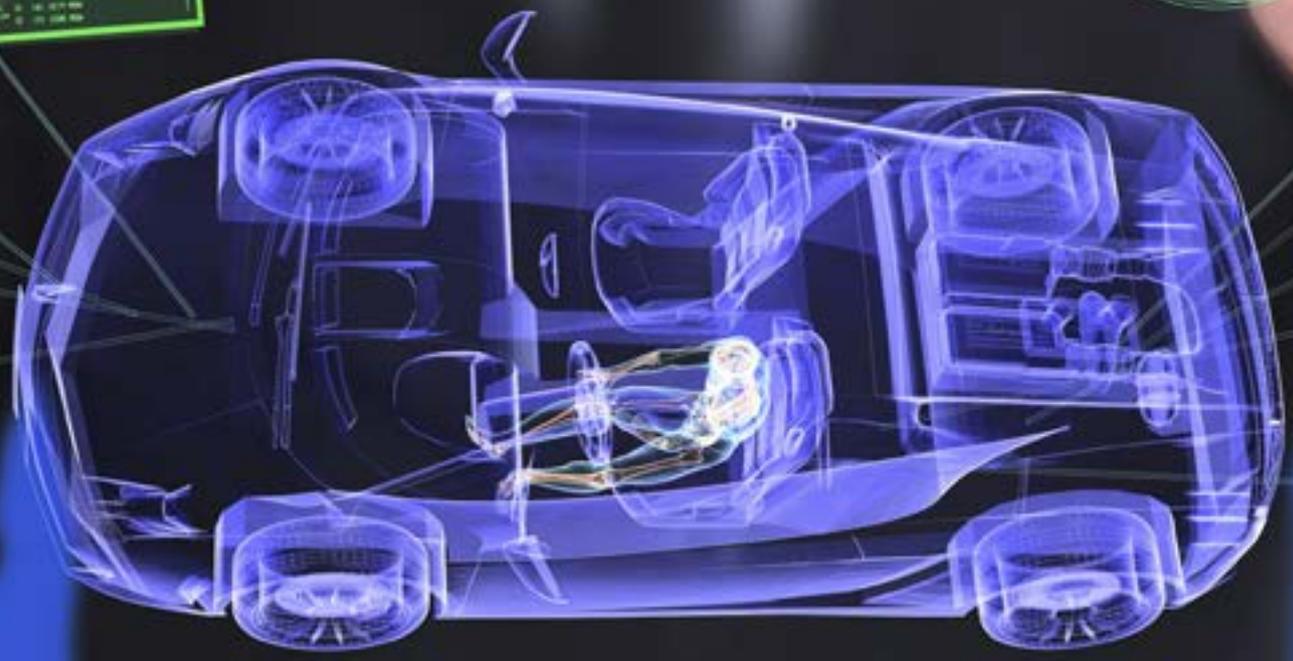
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 Date of Birth: [REDACTED]  
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# Contents

Acknowledgements	vii
Executive summary	viii
E-mobility is here and now	1
Drivers of EV adoption	7
The way forward for e-mobility in India	17



# Acknowledgements

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# Executive summary

The global automotive industry is on the verge of disruption. Digitization, increasing automation and new business models have revolutionized other industries, and the automotive industry will be no exception to such a revolution. The Indian automotive industry has started to experience the effects of this global disruption. How prepared are automotive stakeholders for this disruption? And how can they ride this change to expand into newer areas?

This report outlines the importance and imminence of the disruption, the drivers of electric vehicle penetration and the implications for all stakeholders, especially auto component manufacturers. Acknowledging the upcoming disruption and reinventing the business accordingly is the key to managing the changes that lie ahead.

## E-mobility is here and now

Four technology-driven trends—electrification, shared mobility, connectivity and autonomous driving—are leading the automotive industry to this disruption. These trends will shift markets and revenue pools, change mobility behaviour and build new avenues for competition and cooperation. Globally, revenue pools from conventional sources such as one-time vehicle sales and aftermarket sales could continue to grow at their current pace (low single-digit growth depending on geography). The real growth ahead lies in services, which are poised to grow by an average of up to 40 percent per annum globally.

Electrification—an attractive solution to growing levels of vehicle pollution in metropolises—is of particular importance to India today. The automotive industry is already feeling the effects of electrification or e-mobility, both globally and in India. By 2030, electrification could lead to electric vehicles (EVs including Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles and Hybrid Electric Vehicles) holding a substantial share (up to 50 percent of new vehicle sales in a breakthrough scenario) of the global automobile sector<sup>1</sup>. If India sees a similar momentum, it will significantly impact manufacturers across the automotive value chain.

## Drivers of electric vehicle adoption

Earlier in 2017, former Power Minister Piyush Goyal announced the aspiration to not sell a single petrol or diesel car in the country by 2030<sup>2</sup>. While global EV sales remain low, examples from other countries indicate that four factors—a mix of push and pull—could determine the pace of EV penetration in India:

- **Regulations and incentives:** Many countries have promoted e-mobility through a range of incentives, but these alone did not drive EV penetration. A supportive ecosystem that also establishes strict regulations on carbon emissions and regulations driven by strategic intent (e.g., reduce current account deficit and geographic dependence driven by crude oil) indirectly prompts the higher adoption of EVs.
- **Technology:** As a large component of the overall EV costs, high battery prices impact manufacturing and sales. Improved technology can reduce battery costs, increase

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1 McKinsey Sustainable Mobility Initiative; The International Council on Clean Transportation (ICCT)

2 <http://www.livemint.com/Industry/JvyUPmrumUS832KL5BKzhN/India-eyes-allelectric-car-fleet-by-2030-says-Piyush-Goyal.html>

efficiency and improve driving range, making EVs more accessible and attractive to potential customers.

- **Infrastructure:** Easy and affordable access to charging infrastructure—both standard AC charging as well as rapid DC charging—is a key to meeting customer needs.
- **Customer demand:** Participants in two industry roundtables organized by the McKinsey Center for Future Mobility in Delhi and Chennai cited high upfront acquisition cost as the top deterrent to EV penetration<sup>3</sup>. Creating a pull among customers by creating an economical cost proposition will be crucial in encouraging customers to invest in EVs.

### The way forward for e-mobility in India

Besides the end-users or customers, three key stakeholders could play an integral role in India's transition towards EVs.

**The government:** By defining the regulations on emissions and fuel efficiency, clarifying aspirations, strategic intent and direction, exploring incentives and subsidies, it can support EV adoption and focus on developing a supportive ecosystem.

**The power, fuel and charging infrastructure companies:** By laying down a foundation of support, innovating on business models (e.g., leasing of batteries, swapping infrastructure, deploying fast chargers), making the economics of (fast) charging infrastructure work, providing stable power supply and grid stability, they can enable easy and rapid charging and drive EV adoption.

**The automotive industry:** By changing the product and component mix bringing EV components and vehicles to life, building the right talent pool and skill set, improving the performance of batteries and electric vehicles and building scale, the industry can drive the EV disruption in India.



E-mobility has arrived. The automotive industry could benefit by viewing it not as a threat, but an opportunity. An action-oriented perspective, acknowledging the shift, exploring expansion into uncharted territory and reinventing the way companies manage revenue and profit pools would help industry players be a part of the success story of e-mobility in India.

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<sup>3</sup> Industry roundtables organized by the McKinsey Center for Future Mobility for automotive industry experts and executives in August 2017



# E-mobility is here and now

The global automotive industry is on the verge of disruption due to the outcomes of four key technology driven trends—electrification, shared mobility, connectivity, and, autonomous driving. Stricter emission regulations, lower battery costs, more widely available fast charging infrastructure, increasing consumer acceptance and better total cost of ownership (TCO) will create new and strong momentum for the adoption of EVs in the near future<sup>4</sup>.

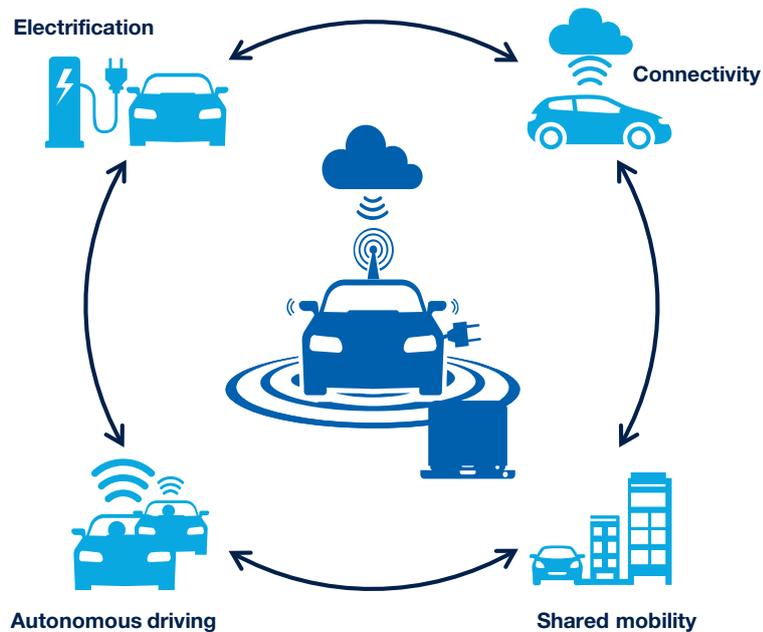
A group of global automotive experts indicated that this disruption could significantly affect the automotive value chain—75 percent believe that new technological players in the industry might acquire a considerable share of revenues and profits from traditional businesses by 2030; 88 percent agree that some OEMs or suppliers may even cease to exist by that time due to the arrival of EVs<sup>5</sup>. Of the various disruptive trends, electrification in particular is likely to have the most deep-rooted and immediate impact on the automotive industry. However, it is not the only trend transforming the industry worldwide.

## Disruptive trends in the global automotive industry

Four technology-driven trends are disrupting the global automotive industry. These will reinforce each other to effect a shift in markets and revenue pools, change mobility behaviour and build new avenues for competition and cooperation (Exhibit 1):

Exhibit 1

### Four technology-driven trends are disrupting the automotive industry globally



SOURCE: McKinsey Center for Future Mobility

4 *Disruptive trends that will transform the auto industry*, Paul Gao, Hans-Werner Kaas, Detlev Mohr and Dominik Wee, McKinsey & Company, January 2016: <http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/disruptive-trends-that-will-transform-the-auto-industry>

5 Findings from McKinsey expert and executive interviews in 2015 (n=30)

- **Electrification:** In 2030, the share of EVs<sup>6</sup> could range from 40 to 50 percent of new vehicle sales<sup>7</sup>. Adoption rates could be the highest in developed, dense cities with strict emission regulations and higher consumer incentives (tax breaks, special parking and driving privileges, discounted electricity, etc.). Penetration may be slower in small towns and rural areas with less charging infrastructure and a higher dependence on driving range. Continuous improvements in battery and charging technology could minimize such local differences, and EVs are expected to gain more market share from conventional vehicles<sup>8</sup>.
- **Shared mobility:** Mobility options like car-sharing, bike-sharing, ride-sharing (carpooling and vanpooling) and on-demand ride services<sup>9</sup> are gaining significant traction in metropolises. Shared mobility offers easy, on-demand availability, the flexibility to choose vehicle type as per need and freedom from parking hassles. It also cuts down costs related to car ownership, such as maintenance, service and insurance. In the US, the percentage of vehicle miles travelled in ridesharing cars stood at 1 percent in 2016<sup>10</sup>.
- **Connectivity:** Automotive connectivity comprises four relevant functional groups— in-car content and services (e.g., navigation or entertainment), vehicle relationship management (e.g., remote diagnostics), insurance (e.g., telematics-based insurance solutions) and driving assistance (e.g., semi-autonomous driving features)<sup>11</sup>. The market for fully or partially integrated in-car infotainment systems could grow from 18 million units in 2015 to 50 million by 2025<sup>12</sup> given the convenience offered by such systems.
- **Autonomous driving:** Various global automakers and technology companies are pursuing and investing in the creation of autonomous-driving vehicles. Traditional vehicle manufacturers, too, are already taking a slightly different track in their development processes, working independently and with leading suppliers to develop and begin implementing technologies that augment driver behaviour. OEMs across the world are doing this by adding incremental autonomous functions as driving technology and infrastructure improve over time. If autonomous driving takes off in a big way, with supportive regulations, up to 15 percent of all new vehicles sold globally in 2030 could be fully autonomous<sup>13</sup>. In India, however, the government is currently cautious of self- or autonomous-driving cars due to concerns that these may hurt employment opportunities<sup>14</sup>. A change in the government's position in the future may shift the relevance of this global trend for India.

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6 Includes BEVs, PHEVs, FCEVs and HEVs, across US, EU and China; does not include mild hybrids

7 McKinsey Sustainability Mobility Initiative, The International Council on Clean Transportation (ICCT)

8 *Automotive revolution—perspective towards 2030*, McKinsey & Company, January 2016

9 *Shared Mobility: Definitions, Industry Developments, and Early Understanding*, Susan Shaheen, Nelson Chan, Apaar Bansal and Adam Cohen, November 3, 2015, Innovative Mobility: <http://innovativemobility.org/?project=shared-mobility-definitions-industry-developments-and-early-understanding>

10 *Cracks in the ridesharing market—and how to fill them*, Russell Hensley, Asutosh Padhi and Jeff Salazar, McKinsey Quarterly, July 2017: <http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/cracks-in-the-ridesharing-market-and-how-to-fill-them>

11 *Connected car, automotive value chain unbound*, Andreas Habeck, Martin Hehensteiger, Julian Hölz, Matthias Kässer, John Newman and Dominik Wee, McKinsey and Company, October 2014

12 *Performance and disruption—A perspective on the automotive supplier landscape and major technology trends*, Dirk Breitschwerdt, Andreas Cornet, Lukas Michor, Nicolai Müller and Lionel Salmon, McKinsey and Company, March 2016

13 McKinsey Centre for Future Mobility

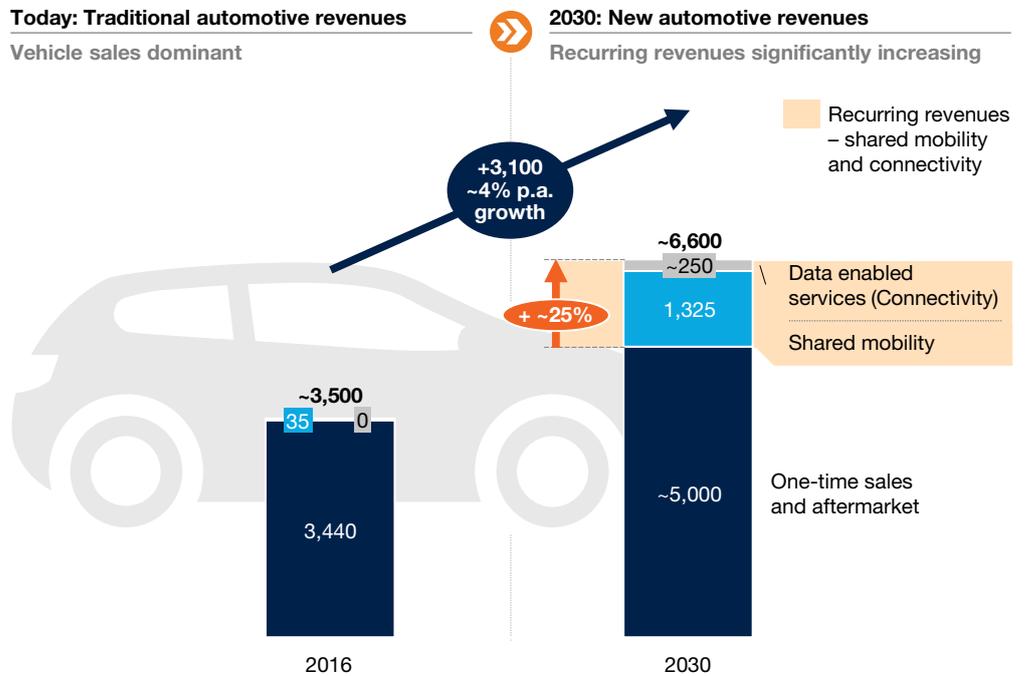
14 <http://timesofindia.indiatimes.com/auto/cars/government-wont-allow-driverless-cars-on-indian-roads-nitin-gadkari/articleshow/59741458.cms>

While global revenue pools from conventional sources such as one-time vehicle sales and aftermarket sales may continue to grow at their current pace (low single-digit growth depending on geography), the real growth ahead lies in services, which, for passenger vehicles, are expected to grow by an average of up to 40 percent per annum globally (Exhibit 2).

Exhibit 2

### Globally, light vehicle revenue pools could almost double by 2030 and may also be more diversified with services contributing potentially 25% of the revenue pool

US\$ billion



SOURCE: McKinsey Center for Future Mobility

In India, the transformation story of the automotive industry is likely to be most heavily driven by electrification and shared mobility, followed by connectivity and autonomous driving.

### The impact of electrification on India's automotive industry

With increasing urbanization come environmental challenges due to high levels of vehicle emissions. To combat this, governments across the world have announced regulations on emissions and efficiency that are expected to become stringent with time. In the case of India, crude oil imports account for a significant portion of the current account deficit and also create dependence on certain global regions to meet fuel needs of the country<sup>15</sup>.

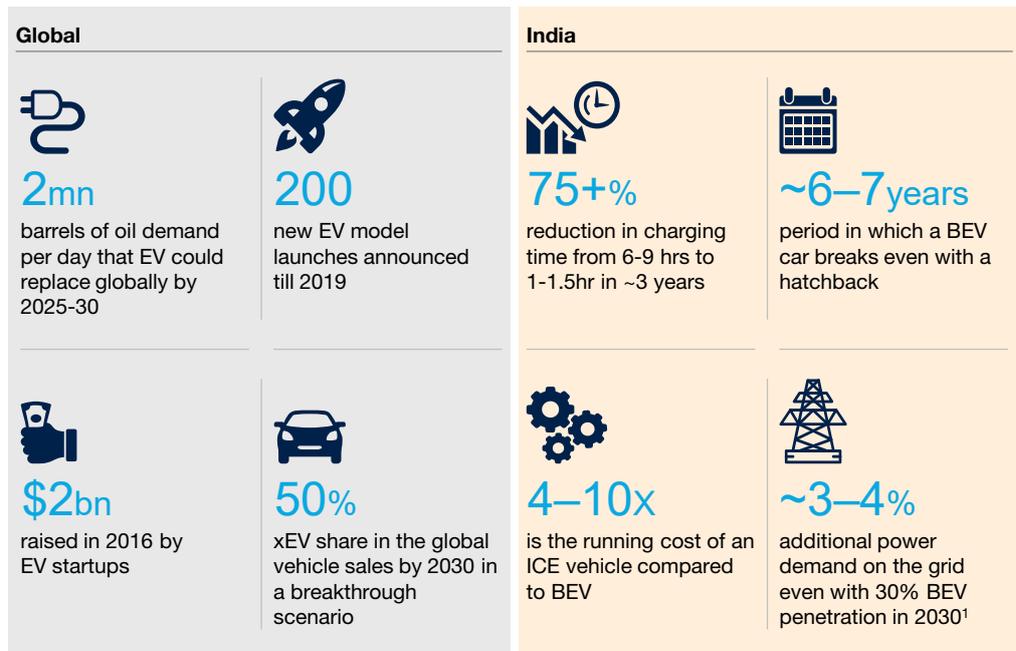
15 <http://economictimes.indiatimes.com/news/economy/finance/indias-current-account-deficit-to-touch-30-billion-in-2018/articleshow/57554193.cms>

Electrification emerges, therefore, as an increasingly attractive avenue of exploration, and e-mobility, or the “electrification of the automotive powertrain”<sup>16</sup> in the form of xEVs (e.g., battery-powered electric vehicles, hybrid electric vehicles, plug-in hybrid electric vehicles) could be the way forward. As per a NITI Aayog report, India could save 64 percent of energy demand for road transport and 37 percent of carbon emissions by 2030 by pursuing a shared, electric and connected mobility future<sup>17</sup>.

The automotive industry is already feeling the effects of electrification or e-mobility, both globally and in India (Exhibit 3).

Exhibit 3

### E-mobility is already shaping and will continue to shape the automotive industry in India and around the world



1 Based on current installed capacity

SOURCE: Analyst reports; Press search; McKinsey & Co. analysis

The transition to EVs could be very quick in India. As seen in developed economies like the US and Germany, around 30 to 45 percent of vehicle buyers already consider EV as an option while choosing a car<sup>18</sup>. By 2030, xEVs could hold a substantial share—up to 50 percent in breakthrough scenarios—of passenger vehicle sales in major global geographies<sup>19</sup> (Exhibit 4).

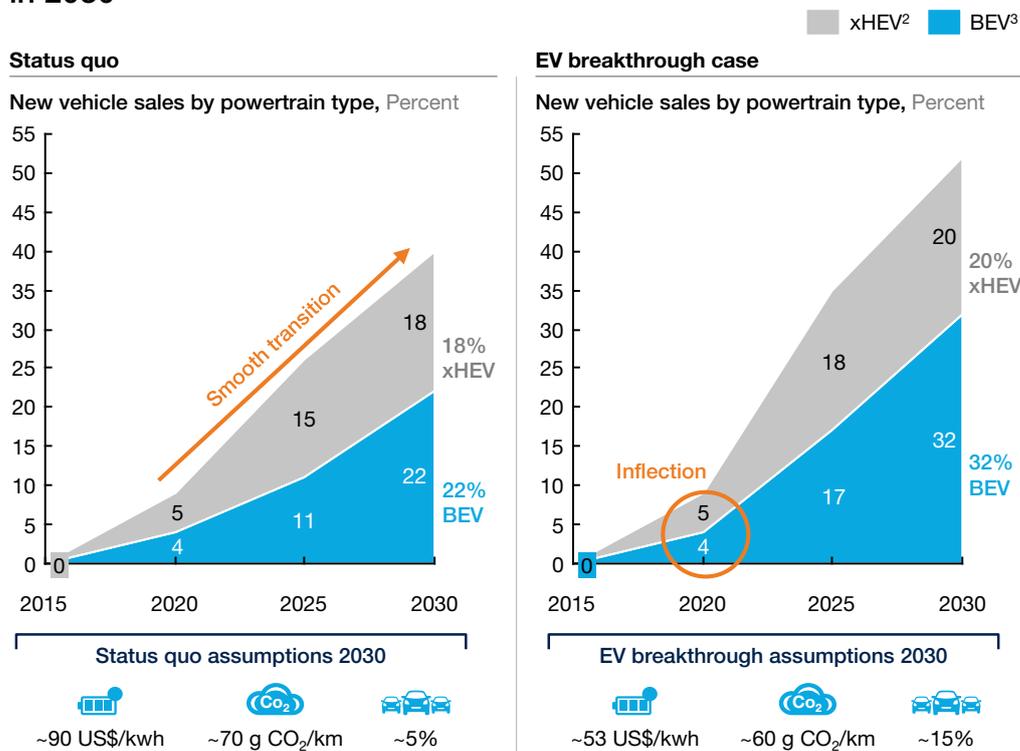
16 *EVolution—Electric vehicles in Europe: Gearing up for a new phase?*, Amsterdam Roundtable Foundation and McKinsey & Company, April 2014

17 [http://niti.gov.in/writereaddata/files/document\\_publication/RMI\\_India\\_Report\\_web.pdf](http://niti.gov.in/writereaddata/files/document_publication/RMI_India_Report_web.pdf)

18 *Automotive revolution—perspective towards 2030*, Advanced Industries, McKinsey and Company, January 2016

19 McKinsey Sustainable Mobility Initiative and International Council on Clean Transportation; estimates include US, EU and China

## EV scenarios for passenger vehicles – between 40-50% xEVs in 2030<sup>1</sup>



<sup>1</sup> Includes Europe, USA, China

<sup>2</sup> xHEV includes full hybrid electric vehicles and plug-in hybrid electric vehicles

<sup>3</sup> Battery electric vehicle

SOURCE: McKinsey Sustainable Mobility Initiative; International Council on Clean Transportation (ICCT)

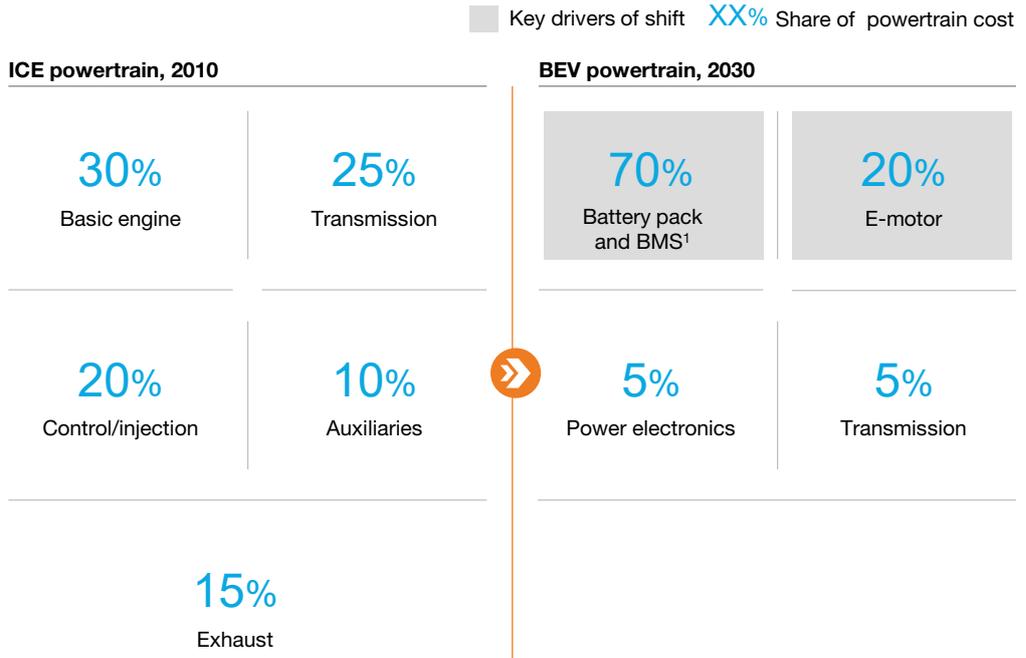
This trend could impact the automotive industry in different ways. It could cause overlaps in the value chain, affect the cost structure and render a few components obsolete. For example, electrification will gradually drive down demand for core value components like engines and transmission. This might push OEMs and suppliers to explore options beyond their traditional means of value addition. Uncharted areas like e-motors and battery services or packaging will emerge as more relevant and attractive. This could create an overlap between OEMs and suppliers, making it important for them to identify a collaborative model.

Automotive companies could benefit from seeing electrification as an opportunity to venture into newer areas of value addition (Exhibit 5).

Exhibit 5

## With electrification, the automotive industry landscape is changing – powertrain example

Share of powertrain cost



<sup>1</sup> Battery management system

SOURCE: McKinsey Center for Future Mobility

E-mobility is here to stay, and will play out in different ways across the world and India. The one certainty is that it will impact automotive component manufacturers as it gains traction in India.

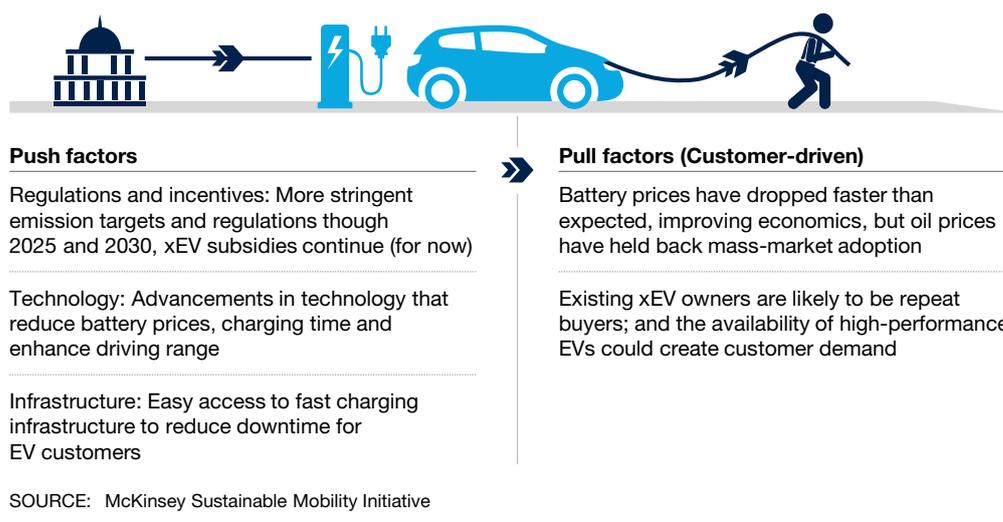
# Drivers of EV adoption

While global EV sales presently form less than 1 percent of new car purchases<sup>20</sup>, this may soon change, with a mix of push and pull factors creating a self-sustainable cycle of EV growth over the next few years.

Earlier in 2017, former Power Minister Piyush Goyal announced the aspiration to not sell a single petrol or diesel car in the country by 2030<sup>21</sup>. With such a thrust, both the push and pull factors of EV adoption could shape the e-mobility landscape in India (Exhibit 6). Globally, governments are working with the private sector to build EV infrastructure for sustainable growth. These efforts may boost EV sales and demand and facilitate investment in research and development, possibly reducing the cost of critical components like batteries due to growing scale. These indirect gains could generate customer “pull” to further enhance sales.

Exhibit 6

## EV adoption is characterized by a mix of push and pull factors



## Regulations and incentives

Many countries have tried to promote e-mobility through multiple initiatives, generating a push through stringent regulations and lucrative consumer tax incentives for using EVs. These combine to create a supportive ecosystem that fosters EV adoption (Exhibit 7). However, monetary incentives alone cannot drive EV penetration. For example, West Virginia in the US offers the most monetary incentives for EVs, but has seen low EV adoption. California, on the other hand, offers fewer monetary incentives, but has the highest penetration, thanks to the government’s investment in providing robust EV infrastructure, parking benefits and workplace charging facilities<sup>22</sup>.

20 *Evolution—Electric vehicles in Europe: Gearing up for a new phase?*, Amsterdam Roundtable Foundation and McKinsey and Company, April 2014

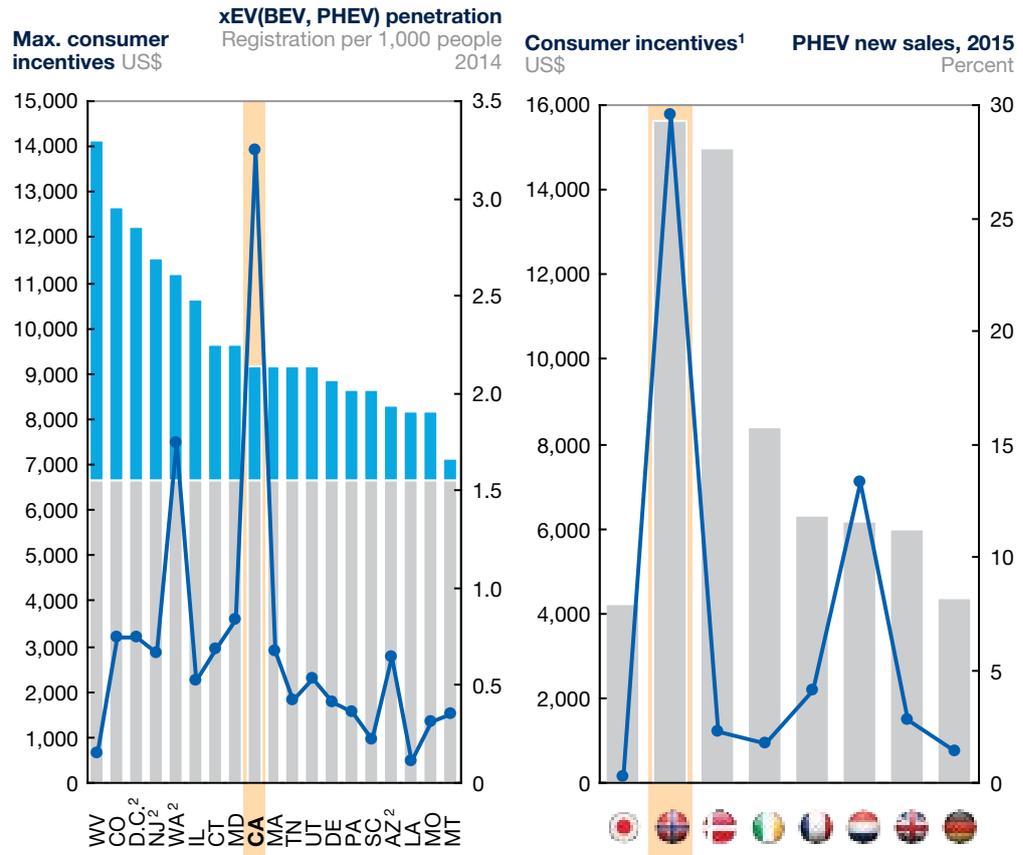
21 <http://www.livemint.com/Industry/JvyUPmrumUS832KL5BKzhN/India-eyes-allelectric-car-fleet-by-2030-says-Piyush-Goyal.html>

22 *California dominates US electric car sales—30 California cities show why*, James Ayre, September 25, 2016, Clean Technica, <https://cleantechnica.com/2016/09/25/icct-analysis-ev-market-development-californian-cities/>

## Monetary incentives alone have not been enough to drive EV penetration in the US and Europe

—● xEV penetration      ■ State incentives      ■ National incentives

**Consumer incentives and passenger electric vehicle penetration by US state**      **Japan and Europe consumer incentives<sup>1</sup>**

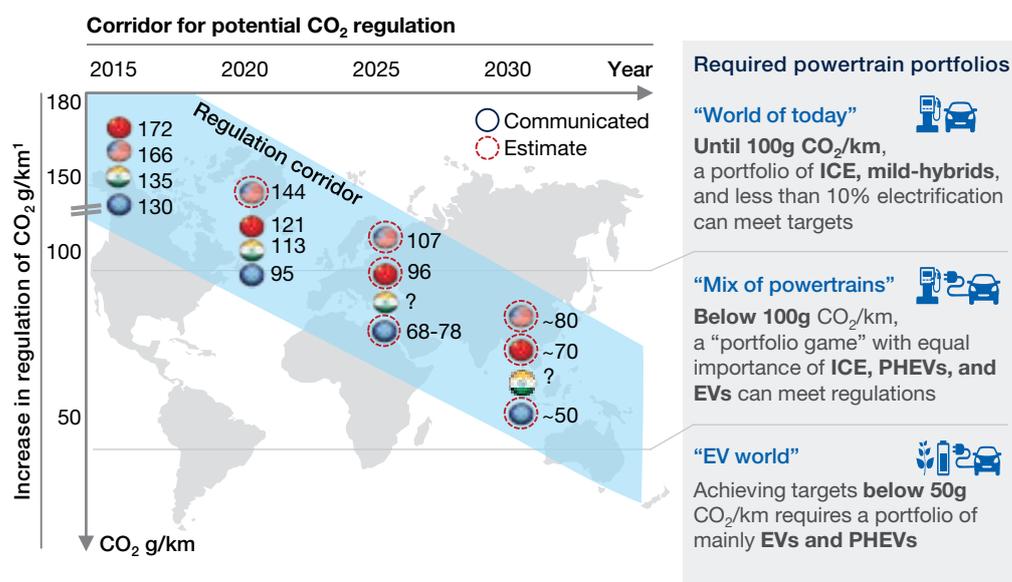


<sup>1</sup> In some European countries, up to 45% of the benefit is paid out as an annual tax break over 6 years  
<sup>2</sup> No cap of consumer incentives in these states; maximum consumer incentives are calculated using Tesla Model S

SOURCE: Plug-in American; US Department of Energy; McKinsey Sustainable Mobility Initiative; Ministry of Land, Infrastructure, Transport and Tourism, Japan; Marklines; EV volumes

Stringent government regulations on emissions could provide a big push towards EV penetration (Exhibit 8). Worldwide, the industry is gearing up to meet lower CO<sub>2</sub> emission targets over the next decade, especially through the use of alternate powertrains. In addition, India has a huge push on reducing the current account deficit by cutting down on oil imports that contribute significantly to the deficit. They also create dependence on other countries. While greater EV penetration will create dependence on new commodities and component imports, EVs could help manage current account deficit and reduce India's dependence on oil-rich countries.

## Emission regulations are a key factor for EV penetration and could trigger the shift to an EV-dominated world



- In most developed countries, the governments only mandate emission regulations and fuel efficiency standards
- The choice of technology to meet these targets is left to the industry players

1 To ensure comparability, CO<sub>2</sub> figures are cycle-adjusted and normed to New European Driving Cycle

SOURCE: McKinsey Sustainable Mobility Initiative; International Council on Clean Transportation (ICCT)

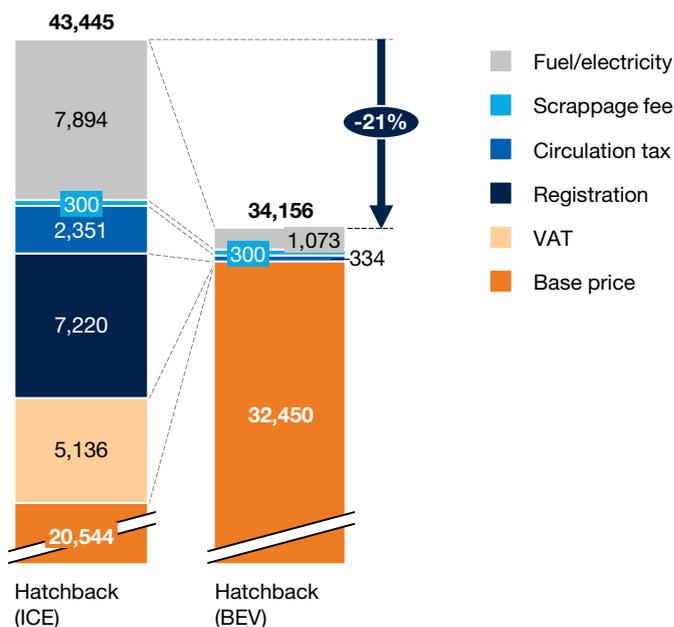
The market leader in EV adoption, Norway has implemented a mix of initiatives to promote e-mobility (Exhibit 9):

- **Lower tax:** EVs are subject to reduced circulation or road tax, and are exempt from VAT and other charges like registration fees. Moreover, tax on company EV cars is 50 percent lower than for traditional cars<sup>23</sup>. Annual motor vehicle tax/road tax is lower too.
- **Free parking:** Municipality-owned parking lots offer free parking for EVs.
- **Free or discounted road tolls and ferry costs:** EV owners can use most toll roads and ferry connections for free. They may have to pay a fee in the future, but rates could still be discounted.
- **Special transport lanes:** EVs enjoy access to dedicated, fast-moving lanes for public transport.
- **Free battery-charging points:** An increasing number of publicly-funded charging stations allow EV users to charge their cars for free.

23 <https://cleantechnica.com/2017/09/02/electric-car-incentives-norway-uk-france-germany-netherlands-belgium/> and <http://elbil.no/english/norwegian-ev-policy/>

## The market leader in EVs, Norway offers EV users tax exemptions and other privileges that save costs

TCO<sup>1</sup> BEV vs ICE in Norway, US\$, 2016



The Norwegian government's policies are "constructed to make the least polluting cars the most attractive. People aren't so green that they want to pay a lot extra to buy an electric"

– Christina Bu, ELBIL Secretary-General

1 TCO based on 6-year ownership; 15,000 km mileage per year; premium unleaded gasoline (95 RON)

SOURCE: Ministry of Transportation and Communications, Norway; Press search; McKinsey Sustainable Mobility Initiative

### Technology

Enhancements to EV technology could help improve battery prices, charging time and driving range, all changes that will encourage the faster adoption of EVs.

As a large component of the overall EV costs, high battery prices impact manufacturing and sales. Between 2011 and 2016, global battery pack prices dropped sharply from approximately USD 800 per kWh to USD 227 per kWh (Exhibit 10). This also led to higher battery-operated EV (BEV) and PHEV sales, especially in Europe and China<sup>24</sup>. The US Department of Energy expects battery prices to continue falling, and to be around USD 140 per kWh by 2022<sup>25</sup>.

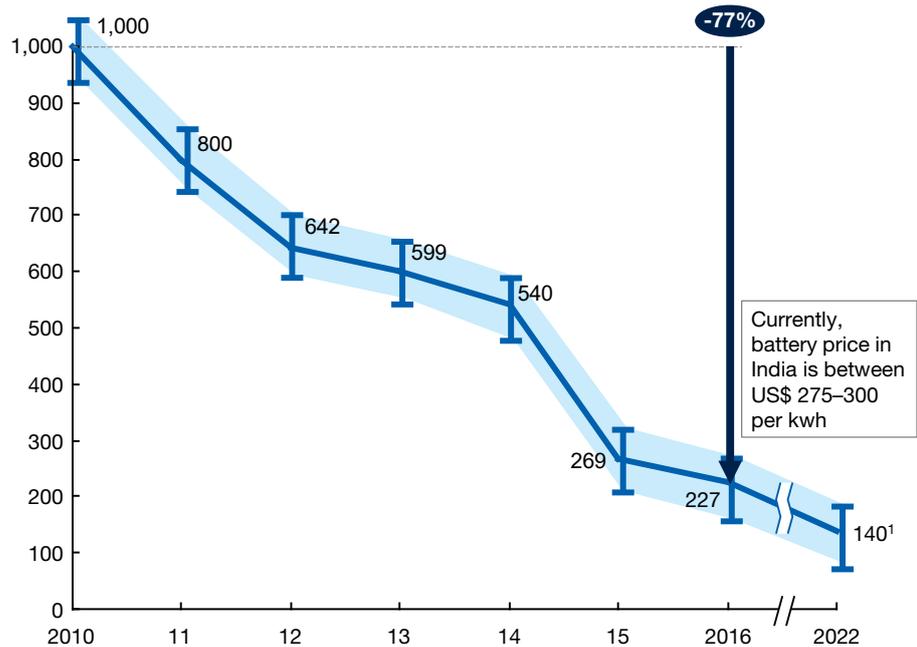
24 IHS, Bloomberg, New Energy Finance

25 <https://www.iea.org/publications/freepublications/publication/GlobalEVO Outlook2017.pdf>

Exhibit 10

## A large component of the cost structure, battery prices have rapidly fallen and could continue to drop

**Weighted average battery pack price and indicative ranges (US)**  
US\$ per kWh



<sup>1</sup> US Department of Energy target in 2022

SOURCE: IHS, Bloomberg New Energy Finance; IEA report on Global EV Outlook 2017; McKinsey Sustainable Mobility Initiative

Battery prices in India currently follow global price trends; several drivers could reduce global costs further, by as much as 50 percent between 2016 and 2021 (Exhibit 11):

- **Growing demand:** Global output demand is expected to be more than 4 TWH in 2025<sup>26</sup>. Growing scale could push down battery costs. The current average capacity utilization of manufacturers and upstream suppliers is less than 50 percent<sup>27</sup>. As battery manufacturers start exploring high volume sourcing of critical components, they could achieve economies of scale sooner rather than later, resulting in lower battery costs.
- **Technological improvements:** Advancements in cathode material and anode technology could improve energy density, prolonging battery life. Improved battery efficiency may also encourage EV adoption, eventually reducing costs.
- **Market dynamics:** Several factors will come into play as industry competition intensifies—cost-competitiveness between players, the search for cheaper raw material, new entrants with niche expertise like non-lithium battery technology, and

<sup>26</sup> Expert interviews, McKinsey analysis

<sup>27</sup> Analyst reports

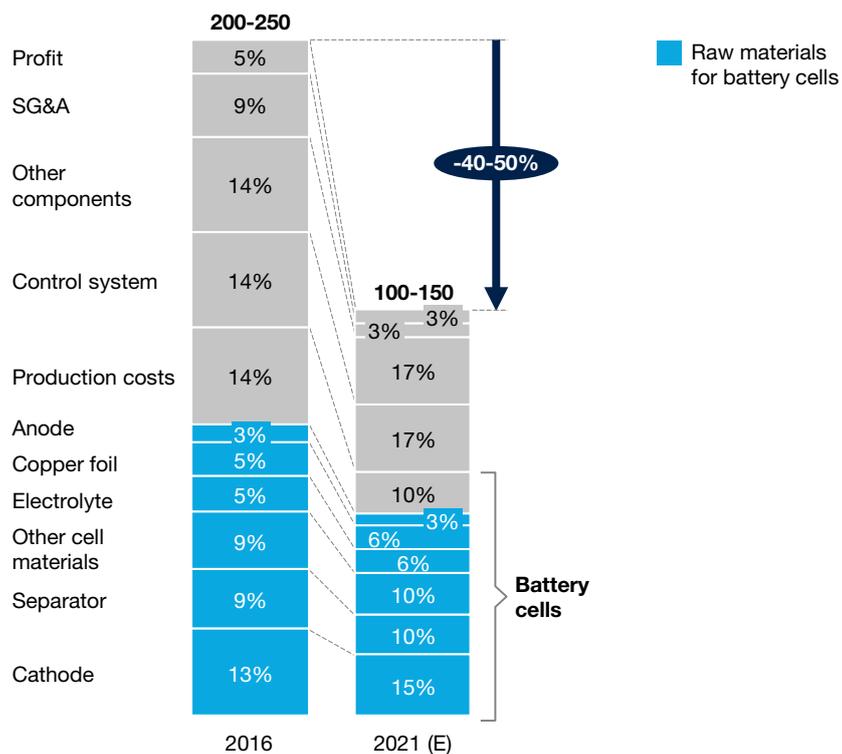
indigenization of technology. All of these could reduce manufacturing costs, lowering battery prices in turn.

- Picking up on the promising future of EVs, the private sector is also exploring opportunities in developing battery technology. In 2017, three multinational companies have announced a joint venture to manufacture lithium-ion batteries for EVs in India with an initial investment of INR 1,200 cr.

Exhibit 11

### Battery prices are expected to fall due to scale effects, technological advances and indigenization

Price breakdown for lithium-ion battery packs  
US\$/kWh



SOURCE: Analyst reports; Expert interviews; McKinsey Center for Future Mobility

Improved charging time will also make EVs more attractive. An Indian automobile manufacturer has already cut down the charging time of its EVs by 75 percent—in three years, the charging time fell from six to nine hours earlier to barely 75 to 90 minutes. However, this is still high for commercial end use applications. The automotive industry has already seen technology evolve from AC slow chargers to DC fast and ultra-fast chargers today.

Current EV models, particularly BEVs, lack the driving range of gasoline cars, and need to be plugged in to charge more frequently. Range expectation also depends heavily on vehicle end use which is mostly correlated with the vehicle segment. In the case of passenger cars,

the average driving range is expected to go up from a current estimate of 300 km to about 500 km within 10 years<sup>28</sup>.

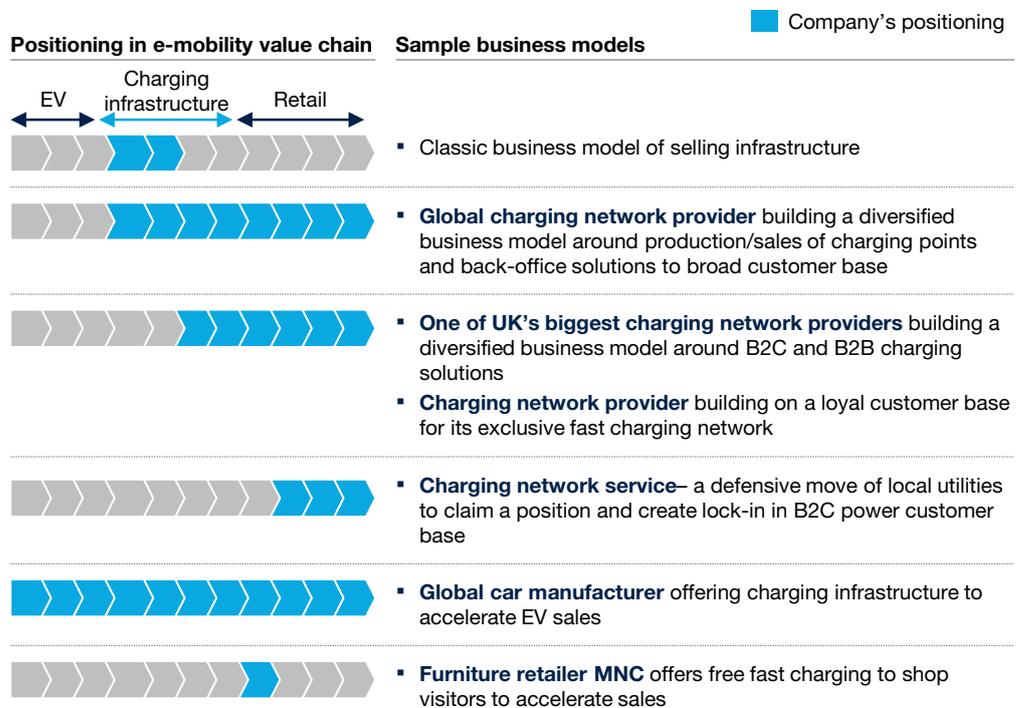
## Infrastructure

Three key factors—cell energy density, charging speed and swappable battery infrastructure—determine the availability and quality of the fast-charging infrastructure needed. Each of these factors is evolving by the day. The availability of charging infrastructure will be a crucial factor in reducing downtime for EV customers. Recognizing this concern, China is focusing heavily on EV infrastructure—it will be building around 12,000 centralized charging or battery swap stations and nearly 5 million scattered charging poles by 2020 to meet the charging demand of 5 million EVs—effectively aiming for one charging point per car<sup>29</sup>.

Most markets worldwide have been unable to grow infrastructure to keep up with their EV aspirations. To fill this gap, different business models are evolving worldwide across the automotive value chain<sup>30</sup> (Exhibit 12).

Exhibit 12

## Different business models are evolving across the value chain



SOURCE: McKinsey Sustainable Mobility Initiative

28 IHS Automotive, press coverage, OEM announcements

29 *China EV charging station and charging pile market report 2017–2020*, March 22, 2017, PR Newswire, <http://www.prnewswire.com/news-releases/china-ev-charging-station-and-charging-pile-market-report-2017-2020-300428154.html>

30 Expert interviews, press search

Car companies in some countries are themselves investing in setting up fast-charging stations and providing free charging options for customers. Besides OEMs, oil and gas companies, too, have started to offer charging infrastructure to keep customers coming to their petrol stations. Owners of facilities accessible from public roads—restaurants, parking garages and shopping malls—are doing the same to generate additional revenue<sup>31</sup>.

## Customer demand

The automotive industry in India caters to many varied segments of end customers across two wheelers, three wheelers, passenger cars, off-road and commercial vehicle segments. Moreover, there are differences based on end use as a private or public vehicle. Participants at recent industry roundtables<sup>32</sup> organized by the McKinsey Center for Future Mobility indicate that vehicle segments like buses, three wheelers, scooters and small commercial vehicles will see faster xEV penetration. These will be followed by passenger cars (taxi will likely see faster adoption than privately owned vehicles) while medium and heavy commercial vehicles will be the slowest to move to electric powertrains.

These roundtables also indicated that high upfront acquisition cost and limited availability of chargers were the two biggest deterrents to greater xEV adoption. The economics of TCO, including resale value, play a huge role as well. Our analysis shows that while e-scooters are more economical than traditional ICE scooters at purchase, when it is time to replace the battery in the fifth year, they no longer seem so economical. EVs in the passenger car segment have a significant premium over directly comparable ICE vehicles, and break even on TCO in about six to seven years<sup>33</sup>.

For passenger cars in particular, taking various factors into account, three horizons of EV purchasers emerge<sup>34</sup>:

- The first horizon has “high-end buyers” who expect luxury and new technology, “risk-averse green technology adopters” and “second-vehicle budget buyers”. These purchasers may be early EV adopters.
- In the second horizon, as the TCO of EVs improves, “in-town mobility seekers” and “mass premium seekers” who are moving up the segment may join the EV group.
- In the third horizon, young families seeking practical transport solutions with modern technology, features and style may buy EVs. They could be persuaded by the improved TCO and technology of EVs, which by then could be at par with ICE cars, if not better.

At a vehicle-segment level for passenger four-wheelers, an analysis of customer buying preferences revealed that customers for Segment B (hatchbacks and entry-level sedans) valued a broader set of factors beyond mere cost, unlike Segment A (entry-level mini-hatchbacks). Segment B customers may therefore be closer to considering EVs while making the next purchase (Exhibit 13).

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31 Expert interviews, press search

32 Industry roundtables organized by the McKinsey Center for Future Mobility for automotive industry experts and executives in August 2017

33 Expert interviews, McKinsey analysis

34 Expert interviews, McKinsey analysis

## Customer analysis suggests that Segment B customers have a higher likelihood of considering electric cars compared to Segment A

### Relative importance of different buying factors<sup>1</sup>

Statement <sup>2</sup>	Segment A n=516	Likely impact of xEV	Statement <sup>2</sup>	Segment B n=983	Likely impact of xEV
1 Fits within my budget	100	↓	1 Is the company I trust the most	100	↔
2 Has the best after-sales support	59	↔	2 Has most attractive styling	98	↑
3 Is a company I trust the most	58	↔	3 Offers the best handling and driving pleasure	95	↑
4 Has the highest fuel mileage	48	↑	4 Fits within my budget	91	↓
5 Has most attractive styling	45	↑	5 Has most roomy and comfortable interior space	88	↔
6 Has the best maintenance record	43	↑	6 Is a car that makes me feel respected	88	↑
7 Is a car that makes me feel like a smart/savvy consumer	41	↑	7 Is a car that makes me feel like a smart/savvy consumer	86	↑
8 Has most roomy and comfortable Interior space	41	↔	8 Has the most superior speed	85	↑

1 Indexed to 100; Relative importance of various attributes, rated by customers on a scale of 1-6 for purchased car vs. the 2<sup>nd</sup> best car considered; survey question: Pick the model you bought or are intending to buy and the model which was second in your consideration set. Now rank both on a scale of 1-6 (with 6 being the highest) for each of the statements

2 Showing only top 8 out of the 18 KBF statements respondents were asked to rate against

SOURCE: Primary research conducted through a survey agency (2015–16), interviewing 1400 car owners across segment A and segment B (70%) and intenders (30%). The survey covered 14 cities representing around 35 percent of India's passenger car market demand today; McKinsey & Co. analysis

Regulatory support and technology advancements could gradually lead to better TCO economics for EV customers. EVs are also expected to offer better and varied features as more players enter the Indian automotive industry, boosting EV adoption further in the coming years.



# The way forward for e-mobility in India

Beyond end customers, three key stakeholders could play an integral role in the EV transition in India—government, infrastructure (power, oil and gas) and automotive industry players (OEMs, auto component manufacturers and battery-makers). As an integral part of this ecosystem, auto component manufacturers can influence its evolution, which in turn could shape the road ahead for them.

## The government

The government could play a vital role in driving EV penetration. Given that electrification could help meet emission targets and reduce dependence on crude oil imports, EVs have become a part of mission documents for many governments globally. Any country determined to support EV adoption should focus on developing a supportive ecosystem, much like Norway has done. The Indian government in particular could focus on three areas:

- **Environmental targets and strategic intent:** The Indian government's current CO<sub>2</sub> emission target (based on the Paris Climate Treaty) is to maintain 113 g/km by 2021; the average fuel efficiency target, in line with the Corporate Average Fuel Consumption (CAFC) standard, is 22 km/litre by 2022<sup>35</sup>. The government also has a long-term strategic focus on reducing crude oil imports and the implied dependence on certain trade partners.

A consistent and stable government policy on emission regulations and well defined strategic targets on crude oil substitution could offer much needed long-term clarity to the automotive industry, enabling companies to plan pipelines in advance. The government could also set up committees to provide guidance as and when industry stakeholders need any support to achieve their targets.

As it drives EV penetration through policy and long term direction, the government could also define its level of participation in the means employed to meet the policies and targets. Globally, most governments define regulations and targets that are technology agnostic, and the industry chooses a portfolio of technologies to ensure compliance.

- **Incentives and subsidies:** Currently, the TCO economics of EVs do not work for either the customer or the charging infrastructure providers. The government might need to drive adoption, as seen in the case of Norway, through a variety of avenues like upfront or recurring incentives, tax breaks, funding for infrastructure and innovation, support for technology localization and skill development. The Indian government launched the FAME (Faster Adoption and Manufacturing of [Hybrid and] Electric Vehicles) India scheme in April 2015 to support the development of the hybrid and EV market and manufacturing ecosystem through subsidies. Of the total Phase 1 allocation in FAME, only around 25 percent has been used by August 2017<sup>36</sup>. FAME also underwent changes midway—the NITI Aayog took it over from the Department of Heavy Industries and mild hybrids were removed from the scheme's coverage list<sup>37</sup>.

35 [http://www.theicct.org/sites/default/files/publications/ICCTupdate\\_EU-95gram\\_jan2014.pdf](http://www.theicct.org/sites/default/files/publications/ICCTupdate_EU-95gram_jan2014.pdf)

36 <http://www.fame-india.gov.in> (accessed on 5<sup>th</sup> September 2017)

37 <http://timesofindia.indiatimes.com/auto/miscellaneous/subsidy-for-mild-hybrid-vehicles-under-fame-scheme-removed/articleshow/57982359.cms>

As public policy influences the automotive sector, all key stakeholders within the government could work towards a unified, transparent and predictable decision-making system. A comprehensive set of EV guidelines could help the government to meet its aspirations and milestones for emissions and efficiency. In addition, an exhaustive list of parameters for product inclusion or exclusion from the FAME scheme could help automotive companies in deciding their product pipelines and improve the utilization rate of funds offered under the FAME scheme. A clear mandate and goal for each department within key ministries could help to make the EV policy more predictable and improve its coordination with schemes like Make in India.

- **Long-term direction:** Setting long-term EV aspirations could help the government ensure sustainable penetration and define a roadmap for the industry while giving the industry enough time to prepare and act. For example, India's current EV-adoption commitment to the Clean Energy Ministerial (CEM) aims at 30 percent new sales of electric passenger cars, light commercial vans, buses and trucks (including BEVs, HEVs, PHEVs, and fuel-cell vehicles or FCEVs) by 2030<sup>38</sup>. To achieve this long-term goal, the government could also set short-term milestones to track progress and take corrective action if required.

The government could consider working with industry associations to define a technology-agnostic roadmap to chart the route ahead for automotive stakeholders in the industry.

The government could also encourage greater collaboration between public and private players to ensure long-term buy-in from all automotive stakeholders. Some collaborations are already underway—as seen in the case of the Automotive Research Association of India (ARAI), the Indian Space Research Organization (ISRO), and Bharat Heavy Electricals Limited (BHEL) working together on a project to explore the applications of lithium-ion battery technology for surface transport vehicles<sup>39</sup>.

## Infrastructure—Power, Oil & Gas, and charging

Infrastructure companies that can drive EV penetration include oil and gas companies, power companies, charging equipment manufacturers, swappable battery infrastructure providers and electric mobility solution providers.

Companies in India that have the potential to develop EV infrastructure could work on three focus areas:

- **Alternate business models:** Globally, EVs could displace a demand of 2 million barrels of oil per day between 2025 and 2030<sup>40</sup>. While oil marketing companies (OMCs) could see this as a threat, they could also see it as an opportunity to expand into different

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38 *New CEM campaign aims for goal of 30% new electric vehicle sales by 2030*, June 08, 2017, International Energy Agency, <https://www.iea.org/newsroom/news/2017/june/new-цем-campaign-aims-for-goal-of-30-new-electric-vehicle-sales-by-2030.html>

39 *ARAI-ISRO team up for using space tech for surface transport*, Press Trust of India, January 19, 2017, ET Auto, <http://auto.economicstimes.indiatimes.com/news/industry/arai-isro-team-up-for-using-space-tech-for-surface-transport/56657714> and *ISRO, BHEL tie-up for lithium-ion batteries to have buyback agreements*, Mamuni Das, April 17, 2017, The Hindu Business Line, <http://www.thehindubusinessline.com/companies/isro-bhel-lithium-ion-batteries/article9644713.ece>

40 Data compiled by Bloomberg

business areas. For example, a notable energy producer and provider bought a battery manufacturer to expand its renewable energies business. Opting for alternate asset utilization has led some major oil companies to offer EV charging infrastructure at their oil pumps.

Similarly, companies in India that can offer EV infrastructure—especially OMCs, power generation and transmission companies and OEMs—could start evaluating alternate monetization models to compensate for the loss of conventional revenues. Some OEMs are working with e-hailing companies to design a business case in which the revenue pool can include services like charging infrastructure. A cab company recently tied up with various OEMs to offer a range of e-mobility solutions like e-taxis, e-buses, e-rickshaws and autos. Some OEMs are also providing charging solutions to monetize services. Transmission and distribution (T&D) asset companies could monetize their capacity by offering charging services for EVs.

- **Power generation and grids:** Even with approximately 30 percent penetration across two-wheelers and four-wheelers in India by 2030, EVs may need only 3 to 4 percent of today's power generation capacity. Along with energy companies, the government, too, could help to identify any real concerns emerging from additional requirements on existing grids. For instance, short-range vehicles like personal cars could predominantly be charged at home, which will require a stable and reliable power supply. Proactive analysis and planning could help prevent issues with the network infrastructure.
- **Charging infrastructure:** A 2016 survey in China showed that BEV and PHEV sales tripled over the last five years largely due to substantial government investments in improved EV charging infrastructure<sup>41</sup>. A robust charging infrastructure could be the key to ramping up EV sales in India. In 2016, India had fewer than 500 EV charging stations spanning major metropolitan cities like Delhi, Mumbai, Bengaluru and Kolkata<sup>42</sup>. But by 2030, a city like Delhi could require around 300,000 fast chargers, presuming 30 percent EV penetration into an estimated car parc of 10 million. Around 12 percent of these would be taxis—the primary users of fast chargers. Meeting this infrastructure need could call for an investment of around USD 1 billion to 1.5 billion<sup>43</sup>. However, the current TCO economics in India are not profitable for a fast charging infrastructure provider. In addition to the standard business costs like investments in fixed assets and operating costs, the continuous evolution in battery cost, driving range, charging technology, charger costs drive economics of the fast charging infrastructure business. Taking the various factors into account, our analysis suggests that it may be difficult for fast chargers in India to be economically viable before 2025.

To write a success story like that of China, India needs to ask itself how it can expand its charging network exponentially in the next 10 years. Work has just started to achieve this goal—as per reports, Delhi could have 1,000 EV charging stations in the next four to five years<sup>44</sup>.

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41 McKinsey Sustainable Mobility Initiative—2016 Electrified Vehicle Consumer Surveys

42 Press search, Sustainability Mobility: xEV India Market Deep-dive

43 Expert interviews, SIAM and IndiaStat (vehicle registration data), McKinsey analysis

44 *Tata Power-DDL plans to set up 1000 electric charging stations*, Press Trust of India, March 09, 2017, The Economic Times, <http://economictimes.indiatimes.com/industry/energy/power/tata-power-ddl-plans-to-set-up-1000-electric-charging-stations/articleshow/57556032.cms>

## Automotive industry players

As e-mobility penetrates worldwide, the cost structure of vehicles is likely to change. The market for ICE components like engine and transmission could shrink gradually while key components and systems related to EV motors and battery, charging technology, power electronics and EV software could see significant growth.

With evolving technology across key components, companies have enough room to expand their play. At the same time, new players are also entering the EV space—a possible cause for concern among traditional manufacturers unless they prepare for this disruption.

Automotive players in India could expand their play in these times of disruption through the following focus areas:

- **Change the mix in the ecosystem:** The entry of EVs in the automotive landscape could change the balance of the industry. OEMs and suppliers may need to start competing for new sources of value addition to maintain their profit pools. Many unconventional partnerships are emerging, such as the foray of global tier-1 auto suppliers into the EV battery business via joint ventures with cell makers. Many EV startups have also mushroomed in the recent past, inspired to replicate the success of a few players.

OEMs and component players in India need to figure out opportunities to protect and expand their market share. There are early signs of resilience across segments—a leading two-wheeler manufacturer has invested in a start-up to manufacture affordable electric two-wheelers. A hardware startup has developed a premium scooter that uses an in-house lithium-ion battery and can charge to 80 percent in under an hour. Similar innovations are needed across the EV ecosystem.

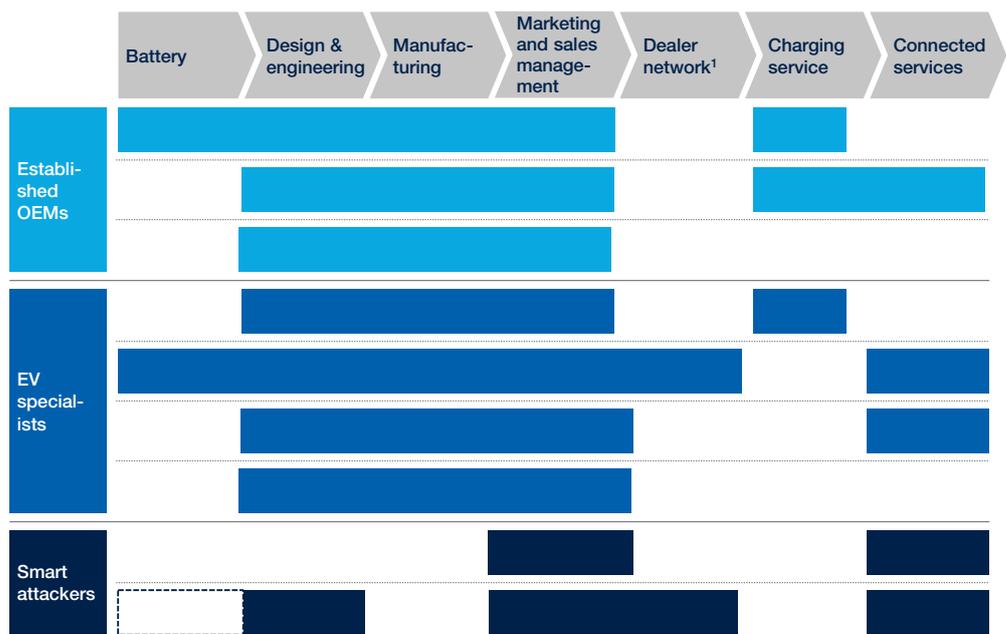
As an example, in China, incumbents and new attackers are expanding their play across the EV supply chain—from developing batteries to offering services like charging. Interestingly, the established players and EV specialists are trying to develop a presence across most parts of the value chain, while emerging players are selective about their role—venturing into areas like design and engineering, marketing and sales, distribution and charging services (Exhibit 14).

- **Build new competencies:** As EVs take off in India, most automotive players may need greater access to new technical talent not only in software and power electronics but also across commercial and supply chain functions. In addition, there could be a need to build new technology assets like testing facilities, rapid prototyping, and product/UI design capabilities. Automotive players in India need to assess such needs and find ways to build EV competencies in their existing talent pool or acquire from outside.
- **Improve performance:** This could include reducing battery cost and charging time, and increasing EV driving range. Globally, battery prices are dropping due to technology and scale improvements—this could affect battery prices in India as well. Additionally, automotive players in India could explore ways to make charging as convenient as refuelling. Battery swapping could be a solution, especially for public transport vehicles like buses and three-wheelers, where product standardization is easier (subject to charging time, ease of swapping, scheduling and routing of vehicles).

- Build scale:** Battery and EV component manufacturers in India need to figure out strategies to develop scale and to make local manufacturing feasible. Leading battery manufacturers have a different point of view on scale. According to one estimate, approximately 3 GWh of cell production facility is needed to gain economies of scale in battery cell production. Another global battery manufacturer puts the figure at a minimum of 10 GWh. Going with the conservative estimate of 10 GWh, approximately 200,000 to 500,000 four wheelers (10-20 kWh) and 1.5 million to 2 million two wheelers (3 kWh) sold in a year need to be electric to create the required scale. This seems achievable even excluding the replacement battery demand.

Exhibit 14

### Automotive companies in China are expanding their play across the EV value chain to safeguard their revenue and profit pools



<sup>1</sup> If the OEM intends to fully own its dealer network

SOURCE: Press search; Expert interviews; McKinsey & Co. analysis

## The road ahead for auto component manufacturers

There is no denying that e-mobility is here and now, and that its growth could impact auto component manufacturers in India in a big way. It is imperative for auto component manufacturers to start preparing for the ensuing disruption. They could consider a three-step roadmap to smoothly transition into the EV way:

- **Acknowledge and move fast:** While three-wheelers and buses are expected to be electrified in the first wave, the second wave will see scooters, taxis and small and light commercial vehicles going the EV way. This will eventually be followed by private cars and other vehicle segments. As a result, there could be a gradual transition away from ICE vehicles across various segments giving auto component suppliers some time to transition to a different product mix. However, as the supply–demand balance shifts, auto component manufacturers need to brace for significantly lean operations in ICE vehicle components.
- **Re-invent the business, including collaborating with OEMs/other manufacturers across the global industry:** It might be a big challenge for an individual player to take control of the EV market. Auto component manufacturers could benefit by collaborating among themselves and with OEMs to chart out their EV path, and accordingly define individual strategies. It might be timely to get started on this, as the prudent players have already started forming partnerships. As automotive players in India seek the best business model, it is important to remember that models that have worked in the past and in other geographies may not necessarily be the best solution for markets in India.
- **Build the right assets and skills to serve the needs of the new age industry:** Auto component manufacturers could need access to new assets (e.g., new prototyping and testing facilities) and skills (across diverse functions like engineering, sourcing, marketing, investments/M&A) in order to thrive in the new ecosystem. It is imperative that they think about it and chart out detailed plans to build or acquire such assets and skills.



The move to e-mobility is inevitable. It brings with it challenges and opportunities for the automotive industry and the broader ecosystem to capitalize on new technologies, and, in the process, reap substantial economic benefits and reduce dependence on fossil fuels. Concerted efforts by key stakeholders can help EVs become a self-sustaining and profitable market in the near-term future.

# Notes

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