Grant Thornton
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Confederation of Indian Industry

Sustainable NextGen Automotive Technologies - Imperative India

November 2017

Contents

Chairman's Message

The Indian automotive sector, given its potential contribution to GDP and employment, presents a significant opportunity to be one of the biggest growth drivers for the economy.

Several policies are being implemented by various countries to curb harmful vehicle emissions and control global warming. Such policies fuel the demand for Hybrid Electric Vehicles as these can reduce CO_2 emissions considerably. The Government of India (GoI) is also taking steps in this direction. One step in that direction is Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) in India which is a part of the National Electric Mobility Mission Plan (NEMMP) 2020, one of the most important and ambitious initiatives undertaken by the GoI that has the potential to bring about a transformational paradigm shift in the automotive and transportation industry in the country.

India's potential to create a new mobility paradigm that is shared, electric and connected could have a significant impact, domestically and globally. In today's increasingly competitive world, Indian automotive industry has to evolve fast to become a benchmark global player of manufacturing by using innovative application of technologies, newer processes, environment-friendly products and sustainable futuristic know-how. The Indian automotive sector, given its potential contribution to GDP and employment, presents a significant opportunity to be one of the biggest growth drivers for the economy.

The NextGen technological advancements are helping the automotive manufacturers offer many useful features in automobiles. Today, emphasis is on refined engines with high performance, safe design, and full compliance with latest emission norms, green fuels, connected cars/IoT, wearable devices, driver-less vehicles, fuel efficiency and so on. Indian automotive companies need to become future-ready by keeping abreast with the global changes and by faster adoption of new technological solutions.

To provide a platform for the automotive, auto component and allied sectors to discuss important aspects related to global innovative technological advancements, we are holding today, the conference on "Sustainable NextGen Automotive Technologies - Imperative India". We hope that deliberations at today's conference by the policy makers, leading automotive players, institutions, and technology experts will help the industry in aligning its efforts for adoption of environment-friendly technologies.

Shreekant Somany

Chairman,
CII - Centre of Excellence for Competitiveness for SMEs and Chairman & Managing Director, Somany Ceramics Ltd

Foreword

One of the key conference objectives is to present the developments driving the need for agility among the traditional industry players, new technology and start-up companies, government and regulators to chart out critical action points.

It gives me great pleasure to share the CII-Grant Thornton "Sustainable NextGen Automotive Technologies - Imperative India" knowledge paper. During the initial deliberations on this between conference chair Mr. CV Raman (Executive Director, Engineering, Maruti Suzuki), CII and Grant Thornton, it was decided that we focus on the sustainability imperative in the context of new automotive technologies namely Electric Vehicles (EV), Shared Mobility and Connected Cars.

One of the key conference objectives is to present the developments driving the need for agility among the traditional industry players, new technology and start-up players, and government and regulators to chart out critical action points. Recent industry updates suggest this is starting to gain momentum both, globally and in India. Volkswagen's USD 12 bn China investment in electric vehicles, Suzuki-Toyota EV Tech partnership, GoI awarding world's largest global procurement contract of 10000 EV to Tata Motors and Mahindra & Mahindra, among others, are some of the examples.

For Indian automotive industry, which is a significant contributor to India's manufacturing GDP, these developments present both, a challenge and an opportunity towards ensuring that India remains an important part of the emerging supply chain.

This study serves as a quick primer on the key imperatives driving this change, overall market context as well as technology and regulatory imperatives for the future.

Alok Verma
Partner
Grant Thornton India LLP

Executive Summary

Life in the Automotive World goes full circle with concepts like EV and shared mobility coming back into favour and becoming a critical part of global discourse. Consider the following recent announcements from some of the leading players in global automotive industry:

- General Motors is moving towards an all-Electric future with the launch of more than 20 Electric Vehicle (EV) models by 2023
- Volkswagen to invest USD 12 billion in building EVs in China
- Tesla to increase Model 3 production capacity to 500,000 by 2018
- Toyota-Suzuki sign pact to roll-out electric cars by 2020
- Uber confirms USD 10 billion deal with SoftBank and a consortium of investors

Apparently, these developments provide strong momentum to the automotive industry transformation which will put the industry on the path of a sustainable future.

EVs are not really new to the automotive world given the concept was invented in 1830s. After holding a market share of 28 per cent in early 1900s, its development was put on the back burner 1910 onwards. Things have changed drastically since then. Announcements like 'an all-Electric future in Norway effective 2025', an 'all-electric car production in India effective 2030' and 'China leading the way by already producing EVs representing 8 per cent of its overall passenger vehicle market', among others, have been covered regularly by the global media.

In the backdrop of such developments, the question that comes to mind is: Whether this change is for real given the myriad challenges related to the tectonic shift to shared mobility and connected and autonomous cars. The truth is: This shift is the result of a sustainability imperative triggered by challenges in rapid urbanisation, an ever-changing regulatory environment, multiple technological breakthroughs in battery technology, smartphone, GPS, digital technology, and most importantly, the looming threat of climate change.

So, clearly a disruption is underway wherein the OEMs, Tier-I/II players are either clearly reinventing themselves or there is a clear imperative for the same. Disruption also brings in new players who will challenge the status quo (likes of Tesla, Google, and Apple) enabled by big VC investments going into the technology disruption areas. Around USD 25 billion have already been invested in top 4 companies in shared mobility space. It will be interesting to watch how partnerships, alliances, acquisitions will unfold (and there are plenty happening every week) between auto OEMs, Tier-I players and the new technology players. While disruption is difficult to predict with naysayers commenting that EVs still barely account for 1 per cent of global automotive volumes, it's hard not to read the tea leaves of an evolving automotive future.

In India, Mahindra & Mahindra and Tata Motors have made significant EV investments while Suzuki is joining hands with Toyota on its EV strategy. Various OEMs have announced partnerships with the likes of Ola, Uber and incumbent market leaders. For example, Maruti and Hyundai are beginning to show interest in building EVs. On autonomous and connected car front though, India would probably embrace 'driver assist', and smart connected (fleet telematics) technologies given the infrastructure challenges and the fact that autonomous cars can work fully in a controlled environment only.

At this juncture, India's regulators need to do their best to address the concerns of auto companies as they embrace sustainable technologies and inch closer to the target of contributing more than 50 per cent towards country's manufacturing output. We are also looking at a different automotive future wherein electronic content might grow from 30 per cent to 50 per cent. This is an area which has traditionally not been India's auto component industry's sweet spot and will need targeted investments from the auto players.

On a positive note, with India's start-up ecosystem, industry and regulatory initiatives coming together, the country's automotive future seems bright.

Sustainability Imperative in the Auto Sector

Automotive Sector is undergoing a major transformation with mature technologies (like ICE) being challenged, consumers embracing new business models of shared mobility, and widespread realisation of keeping sustainability at the core of megacities. All of this, coupled with the changing regulatory environment, has triggered a tectonic shift in the automotive ecosystem, ushering in new players like Tesla, Google, Apple and pushing incumbents like GM, Nissan, Mahindra, among others, to up their game.

Even with the predictable nature of new product lifecycles in the auto sector where typically the next 5-year roadmap is already laid out, companies are rolling out multiple electric vehicle (EV) models in the next couple of years, making bold moves in terms of technology adoption as the government and regulators set deadlines for phasing out old technologies.

Climate Change Imperative

Since the advent of industrialisation, global warming has always been a pivotal concern for the modern world. The UN Climate Change Conference held in Paris in 2015 raised serious concerns over adverse consequences of increasing greenhouse gas (GHG) emissions. It was said that about 23 per cent of the global energy-related GHG emissions are emitted from the transport sector. Further, it is anticipated that these emissions will rise from the current levels by 20 per cent by 2030 and another 30 per cent by 2050 unless significant measures are undertaken to curb emissions.

To address this concern, it is important to curb global temperature rise to a maximum of 2 degrees celsius. This will entail changing the trajectory of the automobile industry by including a conjunction of electric vehicles, shared mobility and connected cars ecosystem. To achieve this goal, it was agreed as part of the Paris deliberations that at least 20 per cent of all vehicles will have to switch to electricity and hydrogen technologies by 2030.

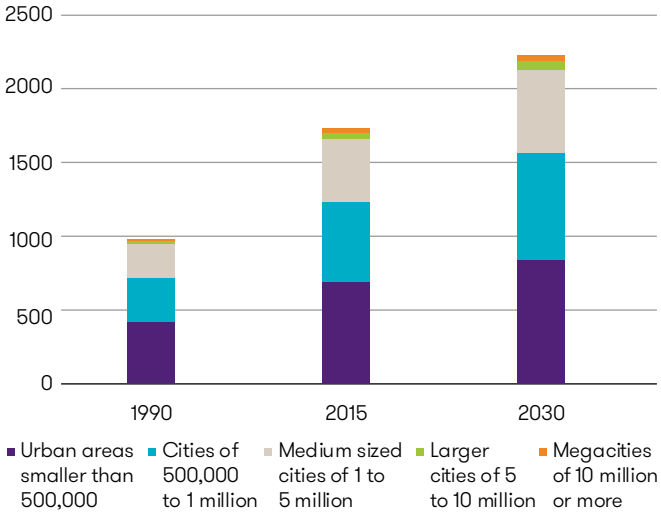
Rapid Urbanisation Imperative

Rapid Urbanisation over the last five decades has led to an increase in urban population from 34 per cent in 1960s to 54 per cent in 2016. Urban centres with 5 per cent landmass are accounting for 70 per cent energy consumption and greenhouse emissions. Mobility is the key dynamic of urbanisation and the associated infrastructure which invariably shapes the urban form-spatial imprint defined by roads, public transport systems, spaces and buildings. By 2030, there may be twice as many passenger-kilometres traveled as compared to the present situation. Yet, despite the increasing level of urban mobility worldwide, access to places, activities and services has become increasingly difficult. Owing to urban sprawl – the horizontal, low-density growth of cities over vast areas – distances between functional destinations such as workplaces, schools, hospitals, administration offices, or shopping amenities have become longer, leading to a growing dependency on private motorised transport and other car-centred mobility. City Managers in developing countries are following the same car-oriented concept used by the developed nations wherein they are trying to curb congestions by building more roads. These city managers are then getting stuck into a vicious cycle where the only way to get out is re-allocating roads for public transport.

7 Indian cities will figure in the top 40 global mega cities by 2030 with urban population greater than 10 million. Besides existing mega cities of Delhi, Mumbai and Kolkata; Ahmedabad, Bangalore, Chennai and Hyderabad will be new additions by 2030.

By 2050, India along with China and Nigeria will be adding around 37 per cent of the new urban dwellers with India adding 400 million plus alone. This increasing urban sprawl poses a threat to sustainability and needs to be addressed by urban planners as well as the Auto industry.

Global Change in Urbanisation



Source: UN: World Urbanisation Prospects Report 2014

Smart City Imperative

All mega cities are developing a smart city blueprint which would focus on sustainable living through a holistic approach involving smart mobility in addition to smart care, smart buildings, renewable energy, etc. India has embarked on a Smart Cities Mission which is an urban renewal and retrofitting programme by the GoI with a mission to develop 100 cities all over the country, making them citizen-friendly and sustainable.

Smart Cities: Constant Enabler of Smart Technology

- **Environment**
- **Government and Administration**
- **Smart Energy**
- **Education**
- **Healthcare**
- **Smart Infrastructure**
- **Transportation**

Regulatory Imperative

Ban on ICE(Internal Combustion Engine)-based cars by 2025 in Norway, National Highway Traffic Safety Administration (NHTSA) developing a framework for advanced technologies, State of California approving requests for 30 pilot projects on connected and autonomous cars, and ban on Uber in London are some of the recent regulatory initiatives taken up across the globe. All these example show that regulatory landscape is dynamic and thus automotive industry will need to align and engage with the regulatory stakeholders in a proactive manner.

Closer home in India, last year's temporary ban on sale of diesel engines with capacities higher than 2,000cc and experimentation with the odd-even rule in Delhi NCR followed by enforcement of BS IV standards and leapfrogging to BS VI norms indicate that even India is working proactively to curb emissions. This coupled with the announcement regarding India's plan to cease the sale of vehicles operating on ICE by 2030 will support the agenda of the Paris declaration. At the same time, industry will need a clear direction given the costs of transition as well as the critical contribution of the automotive industry in the overall manufacturing sector of the country. While the overall cost of ownership of electric vehicles will need to remain competitive, any lag from an infrastructure development standpoint will impede penetration of electric vehicles.

Policies for more road construction have clearly failed due to ever increasing demand from rapid motorisation. This vicious cycle shows how better infrastructure to alleviate travel demand will have positive consequences in the short term, but some months later there will be a much greater congestion than before, thus aggravating the problem. Therefore, the transition from ICE-based vehicles to electric vehicles coupled with adoption of shared mobility provide greater cost savings, use lesser energy and reduce pollution. Further, it would solve problems related to shortage of parking and infrastructure. Consequently, potential savings from reduced requirement of infrastructure in terms of cost and space could be put to other productive use.

Electric vehicles also inherently bring with them a plethora of advanced and smarter technologies. They could potentially reduce the time taken to make more intelligent and connected cars. Connected cars can communicate with other cars as well as with humans through a sophisticated digital interface. This could pave way to augment human experience with the vehicle through autonomous technologies and predictive intelligence, thereby making cars more engaging and safer. Governments across the globe may utilise this EV route to fulfill the commitments made during the Paris Agreement.

Multiple Breakthrough Technologies Imperative

We are witnessing investments from both, existing players into new technology areas and also new players like Google, Apple, Tesla, Dyson, among others entering the automotive space. While Apple's CarPlay is an attempt to own the car infotainment through its device compatibility and integration, Google is much more ambitious with its autonomous car initiative. In a short span, Tesla has already achieved leadership status in the EV space with cutting edge innovation in battery technology, OTA updates, and 300 miles EV range. Dyson, the latest new entrant into the EV space however has raised eyebrows among industry insiders who feel regulatory complexity around crash regulations alone will make it difficult for a Wiltshire-based vacuum cleaner company to achieve building a EV by 2020 on the back of electric motor technology and 400 engineers devoted to the cause. Dyson being an industry outsider could trigger an EV approach which can challenge existing industry thinking and "ways of operating" as this is something that SpaceX has achieved under Elon Musk's leadership.

These imperatives have now pushed the automotive players as well as new entrants to invest more in innovations and M&A deals. This will usher in a disruptive phase in which new players will challenge the status quo, while established automotive companies will try to retain turf with both in-house as well as acquisitive efforts.

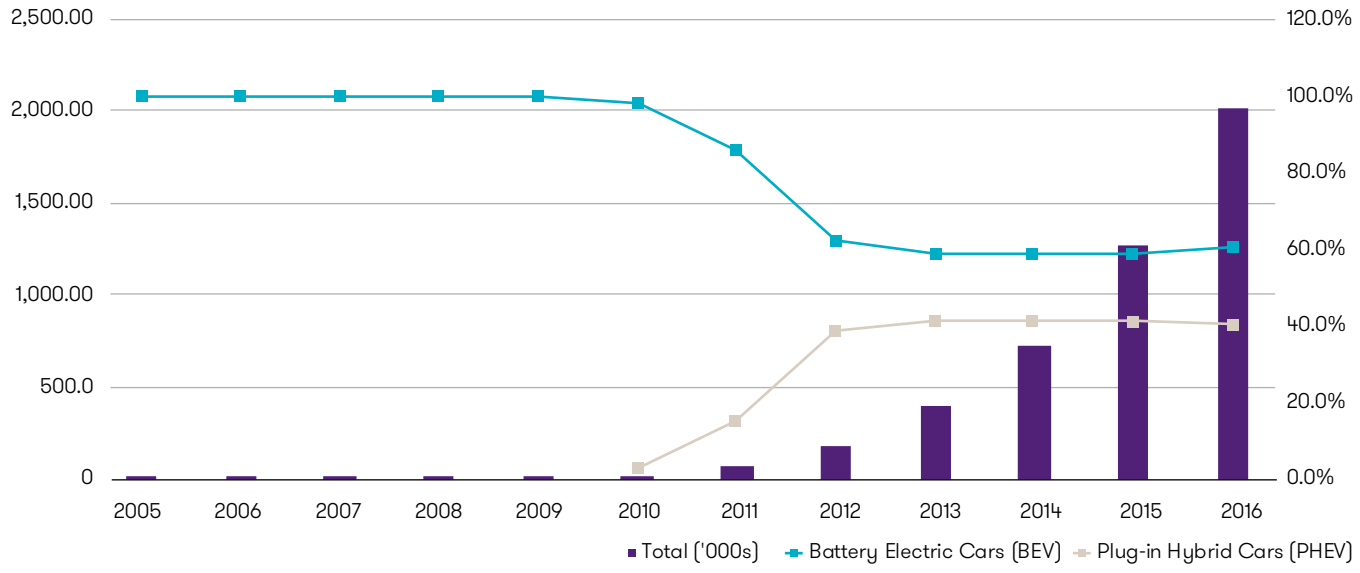
Electric Vehicles

Given the climate change, smart city imperative at both, the global and India level, EVs are promising not just as an alternative to ICE technology, but something that lends itself to many more possibilities. It's not that EV is a new concept. As Stanford University's Tony Seba points out, "when multiple breakthrough technologies come together, probability of a disruption improves exponentially". So even though EV is not a new idea given that the first EV was rolled out in 1830, it has captured the imagination of new and existing players alike indicating a widespread adoption of EVs in future. Varying estimates from industry analysts suggest that EV sales will increase from 10 million in 2017 to 15 million by 2025, making up a quarter of the global car market.

Market Perspective

EVs which constituted 28 per cent of all cars in the US in early 1900s, now constitute just 1.22 per cent of the new vehicle production in 2017. China leads in EV adoption at 32 per cent of the total market followed closely by the US at 28 per cent. In Norway, EVs constitute 5.6 per cent of the total new car market with plans to go completely electric 2025 onwards.

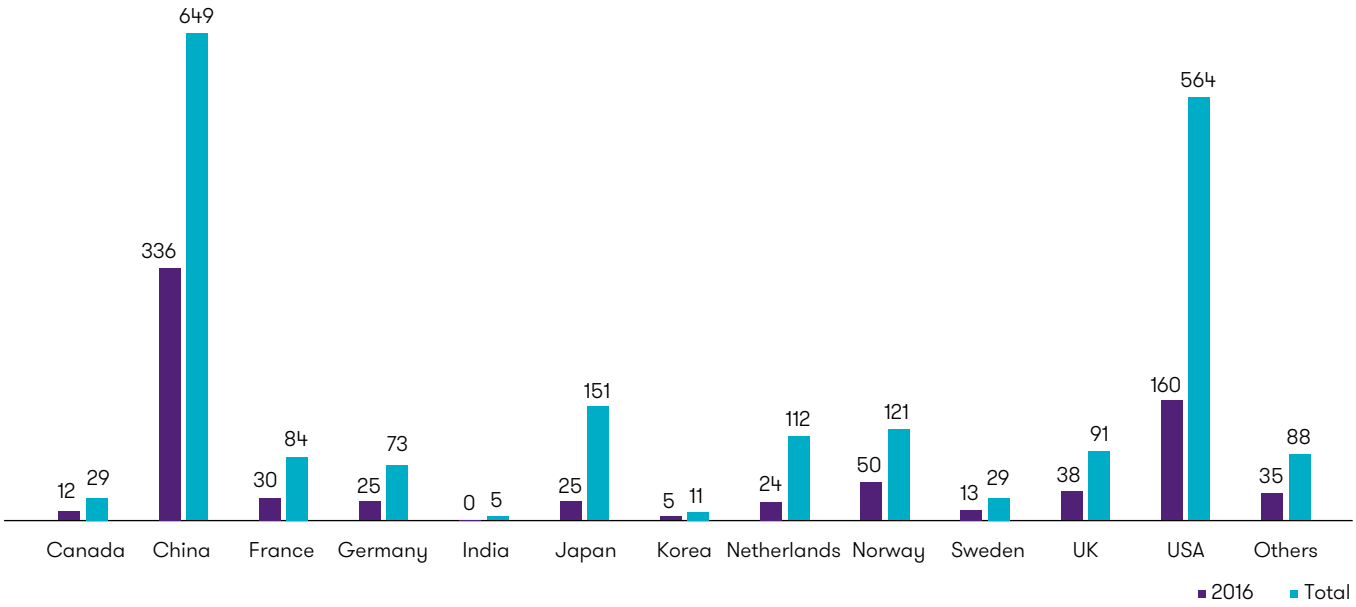
Global Plug-in Vehicle Sales & Share



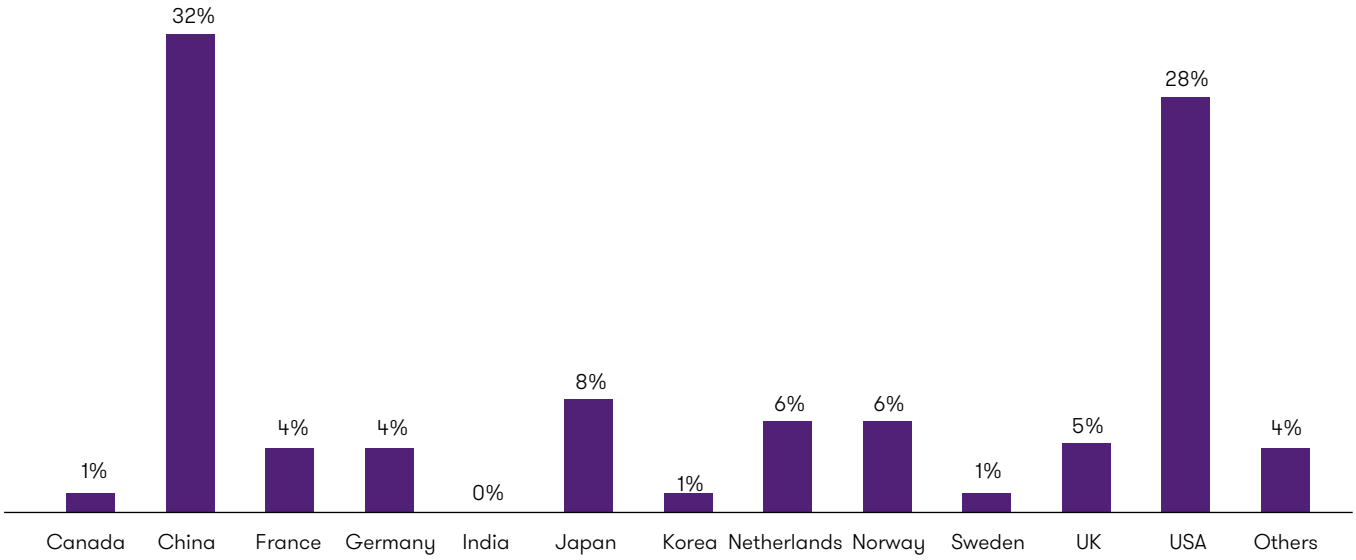
Source: Global EV Outlook 2017 - International Environmental Agency

The following charts represents the current vehicle registrations for Electric Vehicles among top auto markets globally or high EV adoption countries.

No. of Registrations '000s



Global Share



Source: Global EV Outlook 2017 - International Environmental Agency

China in terms of overall numbers has an annual run rate of 352 thousand EV demand which is double of the US, the second biggest EV market. Globally, 95 per cent of electric car sales are taking place in just 10 countries: China, the US, Japan, Canada and the six leading European countries. Overall, the European market stands at 150 thousand vehicles with Norway having a favourable policy in terms of tax breaks and exemptions to waivers on road tolls and ferry fees. This has resulted in several European nations having a greater than 1 per cent overall passenger vehicle market. Though EV sales have been picking up for the last five years, the increase in unit sales can be seen in new and old companies that are proactively integrating sustainability and technology to enhance customer experience.

Top-Selling Electric Vehicle Models

USA			Europe		
Model	**Propulsion**	**Total Sales (2016)**	**Model**	**Propulsion**	**Total Sales (2016)**
Tesla Model S	EV	29,421	Renault Zoe	EV	21,735
Chevrolet Volt	PHEV	24,739	Mitsubishi Outlander	PHEV	21,318
Tesla Model X	EV	17,129	Nissan Leaf	EV	18,827
Ford Fusion Energi	PHEV	15,938	BMW i3	EV	15,060
Nissan Leaf	EV	14,006	Volkswagen Passat GTE	EV	13,110
Ford C-max Energi	PHEV	7,957			
BMW i3	EV	7,625			

Source: GT Analysis

Tesla's great run

Currently, Tesla is leading the EV market with its innovative technology, simplistic and elegant design, and higher miles per charge. In peak condition, a Tesla car can go up to 300 miles on a single charge leaving behind its EV competitors that have only recently been able to reach 100 miles on a single charge. The latest launch of Tesla's Model 3 has garnered huge response from the customer where the pre-order count has reached roughly around half a million orders, with an average of 1,800 new orders per day. The car will not be delivered before the end of 2018. This overwhelming response from the consumers suggests that early adopters are ready to shift to EV cars from the traditional ICE-based engines even though the infrastructure readiness might lag behind.

EV: The India Story

Today, there are more than 4 lakh electric two-wheelers and few thousand electric cars on Indian roads. However, it is quite unlikely that the total vehicle sales will grow more than 5 per cent in few years. Government is starting to get its act together by releasing its first tender of 10000 Electric Vehicles through the state-run Energy Efficiency Services Limited (EESL) with Phase I being for 500 cars whereas Phase II accounting for the rest 9500 cars. The electric vehicles procured under the current tender will be used to replace petrol and diesel cars currently used by the central government and its agencies over a 3 to 4-year period. The phase I contract has been jointly awarded to Tata Motors and Mahindra. This government contract is the largest procurement anywhere in the world and will give a boost to EVs. This will also show the government's seriousness to move to its 'EV only' agenda effective 2030.

From an investment standpoint, 'EV Market Attractiveness' is defined as the degree to which - from a customer perspective - the purchase of an EV instead of a conventional vehicle is a more attractive option, in both monetary and non-monetary terms. It depends on factors that are either market-specific - typically governmental regulations and subsidies or non-market-specific such as battery range. Non-market-specific factors influence the global attractiveness of the EV market and affect all domestic markets to a similar extent. For example, battery costs, which account for up to 25 per cent of an EV's price, are predicted to fall from above USD 1,000 per kilowatt-hour in 2007 to USD 200 in 2020 (2015: USD 383). The Gigafactory, a huge production site for high-performance lithium-ion batteries, built by Tesla Motors and Panasonic, will accelerate this price development, facilitating overall market growth.

Global Market Scenario and its Implications on OEMs

Markets	Characteristics			Implications
Market Type	**Market Opportunity**	**Regulatory Support**	**Charging Infrastructure**	**Implications on OEMs**
Mature	High	High	High	• Strengthen local footprint • Invest in supply chains & distribution networks that can exploit the rising demand for EVs. • Adapt product portfolios to specific market preferences. For instance, Chinese customer preferences & government policies in particular differ from European standards which can already be observed in the market for conventional vehicles
Growth	Low	High	Low	• Make use of the dynamic conditions, driven by the strong regulatory support • Ensure agility when the markets show potential
Laggards	Low	Medium	Low	• Swiftly grab first mover advantage • Channel focus on mature & growth markets

Source: GT research

One of the biggest and strongest catalysts for EVs is the presence of monetary and non-monetary government subsidies. The latter can be seen in Norway where the government is driving the EV market with measures like nationwide access to business or free parking. Motorists in Oslo said that it saved them an hour on their daily commute to be able to use the bus lanes and have easy access to dedicated "EV only" parking lots. Another example of government support for market development can be seen in China. In order to reduce emissions, the government decided to ban conventional scooters from mega cities. In 2013, this led to sales of 9.4 million electric scooters.

In India, Niti Aayog has recently released a proposal to boost EV charging infrastructure - quick pilot that could be used to provide a structure for EV infrastructure roll-out in the Gurgaon-IGI-South Delhi-Noida corridor. This proposal for developing the pilot includes 55 locations with 135 charging stations, of which, 46 are DC quick charging stations and 89 are slower AC charging stations. This deployment would require cooperation with state governments, selected government authorities and companies as well as some private enterprises (e.g. DIAL at IGI, DLF Mall).

It is important to note that OEMs are embracing this disruption which can be understood by their immediate commitments getting translated into actual production numbers.

Announcements by key OEMs

OEM	Announcement
BMW	0.1 million electric car sales in 2017 and 15-25 per cent of the BMW group's sales by 2025
Chevrolet (GM)	30,000 annual electric car sales by 2017
Chinese OEMs	4.52 million annual electric car sales by 2020
Daimler	0.1 million annual electric car sales by 2020
Ford	13 new EV models by 2020
Honda	Two-third of the 2030 sales to be electrified vehicles (including hybrids, PHEVs, BEVs and FCEVs)
Renault- Nissan	1.5 million cumulative sales of electric cars by 2020
Tesla	0.5 million annual electric car sales by 2018 1 million annual electric car sales by 2020
Volkswagen	2-3 million annual electric car sales by 2025
Volvo	1 million cumulative electric car sales by 2025
Mahindra	Mahindra Electric aims to manufacture 60,000 electric cars by 2020 in India
Toyota	Toyota takes 5 per cent stake in Mazda to jointly develop EV vehicles
Suzuki	Suzuki and Toyota join hands on EV strategy for Indian market

Source: GT research

The Game Changers

Panasonic India Energy Solutions

Panasonic in India is one of the leading companies covering wide spectrum of energy products across electricity value chain like highly efficient HIT solar panel & Smart Eco Power Meters. It also started its Energy Storage Solutions business in FY 2012-13, primarily providing Lithium ion batteries. Currently Panasonic India is catering to various segments like Telecom BTS, Microgrids, and Data Centres and Battery as a Service (BaaS) for large number of ATMs across the country. The company gained a market share of 35-40 per cent in the last three years.

Globally, Panasonic has partnered with Tesla in building World's Largest Li-Ion Battery Factory "Gigafactory-1" with a production capacity of 35Gwh (GWh), with 1 GWh being the equivalent of generating (or consuming) 1 billion watts for one hour. This is nearly as much as the entire world's current battery production combined.

Recently, at the Gigafactory, Panasonic along with Tesla has officially started making batteries. These "high energy density" lithium-ion batteries will go into battery farms and also will be used in the Model 3, which is Tesla's upcoming USD 35,000 electric car. The new Panasonic batteries are bigger than standard 18650 cylindrical cells and hold more raw materials.

Further, to Tesla's acquisition of Solarcity, Musk renamed the solar factory as – Gigafactory 2. In partnership with the Research Foundation for the State University of New York, Panasonic will construct approximately 1.0 million-square-foot manufacturing facility capable of producing 1.0 gigawatts of solar cells annually in Buffalo, New York. Nearly, USD 300 mn investment is planned for the purpose of manufacturing 1.0 gigawatts-worth of PV cells and modules annually by 2019.

Additionally, recent acquisition of Ficosa International in 2017 accelerated Panasonic's in-roads in connected cars-related technologies. Through this deal Panasonic is aiming to reach sales of 2 trillion yen in its automotive business in FY 2018-19, and is proceeding with initiatives targeting growth in the areas of 'Comfort', 'Safety' and 'Environment'. Through this initiative, Panasonic and Ficosa will combine their respective technologies to jointly develop products such as electronic mirror systems, next-generation cockpit systems and Advanced Driver Assistance Systems (ADAS), which will facilitate business expansion in fields where future growth is anticipated.

Going forward, Panasonic India is studying the feasibility of setting up an R&D and product development team locally in India to effectively address new segments and applications, in India to further strengthen the product line-up and supply chain optimisation.

Contributed by

Aseem Goyal
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Panasonic India

Mahindra Reva

Reva, an electric car, was introduced in the Indian market by Mr. Chetan Maini in 1994 under the aegis of Reva Electric Car Company (RECC). The market for the electric cars in India was not yet ready to accept the same as a mainstream product and the company faced a hard time to manufacture and sell the product. To meet the high technology requirements of the electric car, Reva tied up with reputed vendors to provide a competent and technically sound car to the Indian consumers and launched the first version of the car in year 2001.

Initial marketing plans of the company were focused on explaining the benefits of the electric car vis-à-vis the conventional cars present in the market. Cost of education in addition to the cost of manufacturing was prohibitive in the Indian market. Target of selling 1500 cars a year turned out to be a far-reaching one and the company was able to sell only 300 cars in the first year. This compelled the company to take the car out of the market within first three years of the launch. The focus of the promoter was always on enhancing the product and the marketing was carried out with the objective of spreading information about the enhancements and the features of the car. Being a heavy capital-intensive industry and low returns, the growth of the company was limited.

In 2004, RECC tied up with a UK based firm to market its car into the European markets. The European markets were highly encouraging as the non-conventional fuel cars and especially the electric cars were given special incentives and impetus by the respective governments. The reviews for the car in these markets are found to be satisfactory and competitive against its competitors.

Since 2001 to 2010, Reva sold 3500 units, out of which 50 per cent of the sales were in the domestic market, while the rest was from the overseas market. During the early days of car marketing, the marketing research found that the company was not successful in conveying the message clearly to the potential customers.

Key challenges:

- Product was targeted at small families, old couples and female drivers with the idea of promoting small size, easy of driving and slow speed. Though Reva had a beneficial cost proposition of only Rs. 0.40 per km, it was not a cheap car. Other competitors had a strong presence and influence on the targeted audience.
- The product was not appealing to the youth of the country and they found the car to be too slow in speed, frequent charging requirements and inconvenience for long drives. These people thought the car to be way below their league.
- The car was not able to create buzz and excitement in the market despite being the first Indian car to enter in the segment.
- There were not enough variants available for the customers to choose from.

In 2010, Mahindra & Mahindra acquired a large stake in the company and aggressively took steps to promote the Reva electric car. Backed by the strong sales channel and a focused marketing group experienced in the automobile industry, the company is geared up to launch three new variants with a target of selling 30,000 units in next three years. The new management portrays the willingness to learn from the past mistakes and has brought out globally competent designs and technology with focused investments.

With advent of the Mahindra & Mahindra management and their experience in dealing with the Indian consumers for a long time, the pricing model seems to be in better hands.

“For the success of electric cars, affordability is the key. And we have learnt that the customer may not be able to pay more than 15-20 per cent premium on electric cars. Our endeavour is to offer our products within that range. The extension of subsidy through new electric vehicle policy will be the key,” said Pawan Goenka, Managing Director, Mahindra & Mahindra.

EV's impact on auto component manufacturers

Automotive is a critical industry given its overall manufacturing linkages, ability to provide employment, and ability to drive GDP growth. India which has a low contribution of 15 per cent to its GDP coming from Manufacturing relative to its South East Asian peers like China, Malaysia, Thailand etc with manufacturing to GDP contribution being upwards of 30 per cent for their respective economies. India must ensure that this number increases to 25 per cent over the next couple of decades to meet its development agenda goals. One of the key contributor to India's manufacturing GDP is its USD 93 billion automotive industry contributing 7.1 per cent to GDP and almost 49 per cent to the nation's manufacturing GDP (FY 2015-16). The Automobile Mission Plan 2016-2026 envisages creating India as one of the top three automobile manufacturing centres in the world with gross revenue of USD 300 bn by 2026. It is thus key to ensure from a policy maker's perspective that this advantage is not frittered away with the transition to Electric Vehicles from ICE perspective and is addressed within FAME framework. From an overall ecosystem standpoint, once EV volumes become significant, impact on the auto component industry could range from highly negative on Engine & Transmission components to positive in terms of wiring harnesses, batteries, sensors etc. There will also be significant gains for some players as the electronic component content increasing in car from 30 per cent in 2010 to 35 per cent by 2020 to around 50 per cent by 2030.

Impact Break-up

Category	Sub-category	Impact
Engine & Engine Components	Piston	Highly Negative
	Engine Valve	
	Carburetors	
Equipment	Radiators	
Transmission Parts	Clutch	Moderately Negative
	Gears	
	Steering Systems	Neutral
Electronics	Digital Systems	
Suspension & Braking Parts	Brake Lining	
	Leaf Springs	
	Shock Absorbers	
Body Parts	Headlights	
	Sheet Metal Parts	
	Seats	
Electrical Components	Batteries	Positive
	Wiring Harnesses	Positive

Source: GT Analysis

Technology

In contrast to a petrol or diesel fuelled car, an EV has a motor that is powered by a battery which can be charged by plugging it into an electric power source. The motor of an EV is very quiet and extremely responsive. Driving an electric car produces 80 per cent fewer CO2 emissions than a petrol car, making an EV much better for the environment provided that the battery charging happens using renewable energy.

There are two main types of EVs:

- Battery electric vehicles (BEVs): BEVs are pure electric vehicles that run on battery and can be charged using plugged in electric power point. Example: Tesla S.
- Plug-in hybrid electric vehicles (PHEVs): PHEVs have two engines, one runs on battery which can be charged using plug-in electric power point and other runs on fuel i.e. petrol or diesel. Example: Audi e-Tron

Hybrids that you can't plug-in are more fuel efficient than a comparable petrol car, but they are not electric vehicles. Their batteries are only charged by re-capturing energy when braking or from electricity generated by the engine. Toyota Prius and Honda Civic Hybrid are examples of these kinds of hybrids. In vehicles already in the market, there are more efficient intake valves designed to cut down on the consumption of fuel. New electric vehicles can go further than ever, with some able to drive as much as 300 miles on electricity alone. General purpose sensors allow engines to run cleaner and smart technology, such as tyres that alert you when they need a fill-up, allow you to make the most of your full tank.

Comparison Between Various Types of EVs

Benefits	Hybrid Electric Vehicles	Plugin Hybrid Electric Vehicles	All Electric Vehicles
Fuel Economy	**Better than similar conventional vehicle** The fuel saving of driving a Honda Civic versus a conventional Civic is about 36 per cent in the city and 11 per cent on the highway	**Better than similar HEVs and conventional vehicles** Most PHEVs achieve combined fuel economy rating higher than 90 miles per gasoline gallon equivalent	**Better than similar HEVs and conventional vehicles** Most EVs achieve fuel economy rating higher than 100 miles per gasoline gallon equivalents
Emission Reduction	**Lower emission than similar conventional vehicles** HEV emissions vary by vehicle and type of hybrid power system. HEVs are often used to offset fleet emission to meet local air quality improvement strategies and federal requirements	**Lower emissions than HEVs and similar conventional vehicles** PHEVs produce no tailpipe emission when in electric only mode. Life cycle emission depend on the sources of electricity, which vary from region to region	**Zero tailpipe emission** EVs produce no tailpipe emission. Life cycle emission depends on the sources of electricity, which varies from region to region. Emission reductions are substantial in most regions of United States
Fuel Cost Saving	**Less Expensive to run than a conventional vehicle** HEV fuel cost savings vary by vehicle model and type of hybrid power system. For many HEV models, annual fuel cost saving range from USD 400 to USD 1,000 relative to their conventional counterparts	**Less expensive to run than an HEV or conventional vehicles** In electric only mode, PHEV fuel costs can range from about USD 0.02 to USD 0.04 per mile. On gasoline only, fuel cost ranges from about USD 0.05 to USD 0.1 per mile. For conventional sedan, cost ranges from about USD 0.1 to USD 0.15 per mile	**Less expensive to run than conventional vehicles** EVs run on electricity only. Fuel cost for a typical EV range from USD 0.02 to USD 0.04 per mile
Fueling Flexibility	**Can fuel at gas station**	**Can fuel at gas stations; can charge at home, public charging stations, and some workplaces**	**Can charge at home, public charging stations, and some work places**

Source: Alternative Fuels Data Centre

Types of Batteries

Battery technology is the biggest area of innovation from an EV standpoint. Battery costs is a critical area for disruption as it currently accounts for up to 25 per cent of an EV's price which still makes it a significant barrier to profitability. This is despite steady improvements in terms of battery costs from above USD 1,000 per kilowatt-hour in 2007 to USD 200 per KWh in 2020 (2016: USD 227 per KWh). In addition to battery costs and energy storage capacity, other aspects like safety and life span are equally important. Thus, we see different OEMs putting their bets behind different battery technologies. Hopefully, there is convergence and a Gold standard technology will emerge from this initial experimentation as the technology matures.

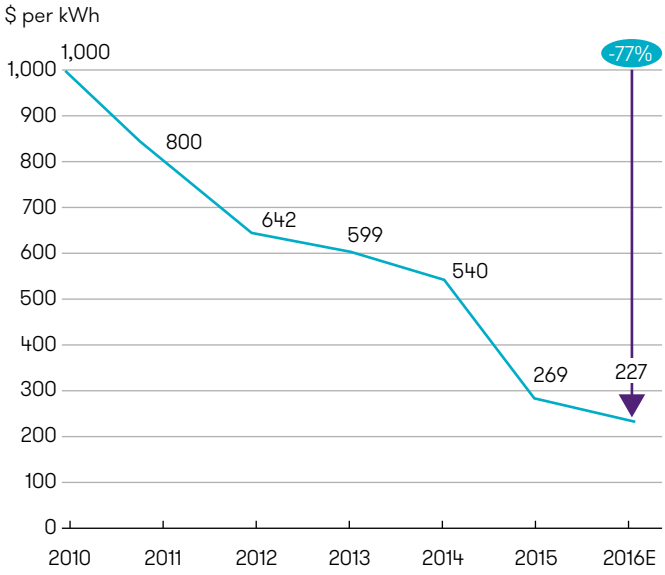
Competing battery technologies can be compared on six dimensions: Safety, lifespan (number of charge-discharge cycles), performance (peak power transmission while maintaining low temperatures), specific energy (energy density per kilogram of weight), specific power (how much power can the battery store) and cost.

Specific Energy and Specific Power: The specific energy of a battery is the energy storage capacity per kilogram of weight. Specific power describes the amount of power the battery can deliver per kilogram mass.

Safety: Safety plays the most important criterion for EV batteries as currently the general public is slowly adopting the EV's and any fire caused due to lack of safety precautions can damage the product perception.

Life Span: There are two ways of measuring battery life span: Cycle Stability and Overall Age. Cycle stability is the number of times the battery can be charged to its full capacity before degrading to 80 per cent of its output capacity.

Average battery pack price



Comparing Various Battery Technologies

			Lithium-ion		
Specifications	**Lead-Acid**	**NiMH**	**LiCo**	**LiMn**	**Li-Phosphate**
Specific energy density (wh/kg)	30-50	60-120	150-190	100-135	90-120
Cycle Life (80% discharge)	200-300	300-500	500-1,000	500-1,000	1,000-2,000
Fast charge time (hrs)	8-16	2-4	2-4	1 or less	1 or less
Maintenance Required	3 – 6 months (equalization)	60 – 90 days (discharge)	None	None	None
Safety Requirements	Thermally Stable	Thermally stable, fuses common	Protection Circuit mandatory		
OEM using battery in its EV		Ford (Fusion, Escape), Toyota (Prius), Honda (Insight), BMW (X6), Daimler (ML450), Nissan (Altima),	GM (Chevy-Volt), Ford (Escape PHEV), Chrysler (Chrysler 200C EV) , BMW (Mini E) , Mitsubishi (iMiEV), Nissan (Leaf EV) , Tesla (Roadster), Think (Think EV)		

Source: batteryuniversity.com

Battery Reuse and Recycling

If an EV battery reaches the end of its vehicle life, it may still have a useful second life, for example storing electricity from solar PV panels. Manufacturers of electric vehicles already have recycling programmes in place. Members of the automotive industry should commit to a code of practice to have suitable systems in place for the use, capture, return, refurbishment, reuse, recycling or disposal of EV and hybrid batteries with the aim of sending limited or no batteries to landfills. Lithium battery capacity degrades as the cycle number increases. Battery cycle life is measured in cycles, with an industry standard of cycles to 80 per cent capacity often used as a benchmark.

Lithium battery voltage must be prevented from exceeding this voltage because it not only ruins battery life; it can lead to battery destruction or overheating and fire in some lithium batteries. Battery management systems (BMS) are used to control charging voltage so that the max charging voltage and temperature is never exceeded. Overcharging at high voltage also leads to another limit, called calendar life. When foreign matter builds up, it prevents the flow of ions at the electrodes.

A cursory analysis of electric vehicle mileage based on 100 per cent discharge cycles yields an erroneous result because it does not consider the effect of reduced depth of discharge. With a range of over 200 miles, and an average daily mileage of about 30 miles, cycle life and mileage is extended. Daily charge defaults to 80 per cent charge, limiting maximum voltage and extending calendar life. Calendar life increases by controlling pack temperature and limiting maximum charge to a short period of time because trips are taken soon after full charge.

Lithium-ion based batteries used in the electric vehicles have a charging lifespan of around 3,000 to 4,000 full charges, during which it works in its full capacity. After that, the battery may only charge a fraction of its total capacity, but it can still be used. Such used batteries can easily power e-rickshaws, run agricultural pumps, used in solar power generation units, and keep telecom towers alive. Thus, a USD 35,000 car and a USD 50,000 public transport scale battery can help reduce fossil fuel consumption when powering the vehicle, it can then do the same in a range of use cases in industries like agriculture, telecom, urban transport, or off grid power use for many more years further down the line.

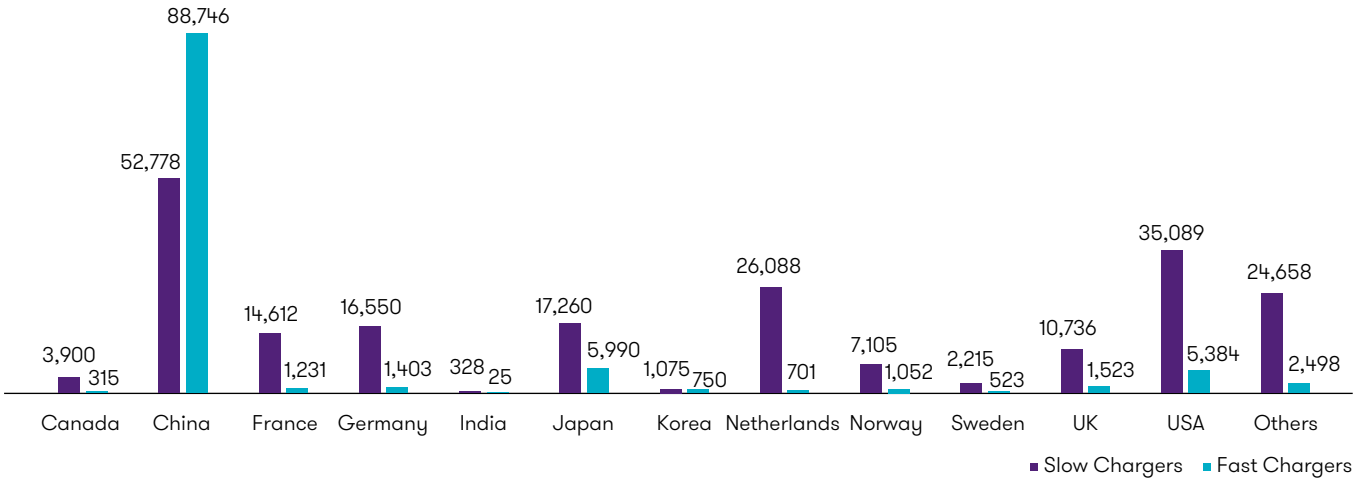
Infrastructure

Globally, as of 2015, renewable energy provided an estimated 19.3 per cent of global final energy consumption and by the end of 2016, renewables comprised an estimated 30 per cent of the world's power generating capacity and 24.5 per cent of global electricity demand. The world now adds more renewable power capacity annually than capacity from all fossil fuels combined. In 2016, renewables accounted for an estimated nearly 62 per cent of net additions to global power generating capacity, and represented far higher shares of capacity added in several countries around the world. By the end of 2016, renewables comprised an estimated 30 per cent of the world's power generating capacity, enough to supply an estimated 24.5 per cent of global electricity (up from 23.7 the year before), with hydro power providing about 16.6 per cent.

India's emission reduction commitments under the Paris agreement will lead to a sharp rise in renewable energy capacity. India aims to achieve 40 per cent of cumulative installed capacity through non-fossil fuel sources by 2030 from the current 30 per cent and also plans to grow its renewable energy capacity to 175 GW by 2022 from the current 57 GW. To build this capacity, the Indian government has to increase its capacity by almost 24 GW a year through solar power, wind power, hydroelectricity/micro hydro, biomass and biofuels. Such growth cannot be driven by a public or a private sector company alone. Strategic partnerships and knowledge sharing between the two will be of utmost importance. However, the key off-takers for most renewable projects are state-owned distribution companies, and these firms typically demonstrate weak financial profiles. This situation will pose as a key challenge for developers.

On the financing of renewable energy projects, India needs to invest close to USD 150 billion to meet its 2022 renewable energy targets. As the domestic banks are constrained in their lending to renewable projects, foreign capital and investments from Indian corporations will play an important role in achieving the goal.

No. of Chargers for EVs

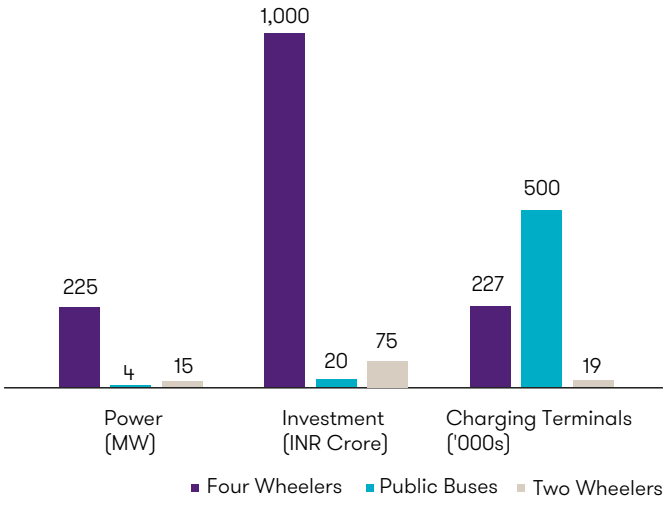


Source: GoI Industry study.

Establishing EV charging infrastructure is an essential first step towards the success of EVs in India. EV and PHEV have unique requirements unlike internal combustion vehicles. Charging infrastructure needs to be created so as to remove the anxiety and inhibitions Indian buyers face while considering an EV. Currently, India lags behind in the availability of charging infrastructure and has around 353 charging stations spread across the country out of which large number of charging stations come from the service stations of Electric Vehicles manufacturers.

In view of existing power generation and transmission scenario in India, NEMMP has provided an in-depth estimation of additional power generation infrastructure requirements, charging infrastructure requirements and the charging infrastructure that will be needed to support deeper penetration of EVs.

Infrastructure Requirement for EVs



Source: GoI Industry study.

Investment required

- **Four-wheelers:** Price per charging station is INR 2,25,000 for fast-charging, INR 36,000 for level 2/rapid charger and Rs 18,000 for level 1 charger considering the charging station efficiency to be 18 hours per day.
- **Public buses:** Price per charging station is INR 10,00,000 for fast-charging, INR 4,50,000 for level 2/rapid charger and INR 2,00,000 for level 1 charger considering the charging station efficiency to be 18 hours per day. Majority of charging is expected to occur at off-peak hours.
- **Two-wheelers:** Price per charging station is INR 2,25,000 for fast-charging and INR 36,000 for rapid charging. INR 18,000 for level 1 charging considering the charging station efficiency to be 18 hours per day.

For supporting EV demand and supply capabilities, sustainable infrastructure is indispensable. To reach the 2020 target as established by the government, investments are needed for increasing the power capacity and establishment of charging infrastructure. Based on the prediction one being the gradual growth and other being a high off-take, it is estimated that by 2020, extra power generation capacity of 150-225 MW would be required with an investment of roughly INR 750-1000 crore. If we assume requirement of 150 MW, roughly 175,000 charging stations including level 1, fast chargers and rapid chargers will be required. Depending on a higher off-take of BEV energy, requirement will be around 225MW and would necessitate roughly 227,000 charging stations that will have to be established by 2020.

Similarly, based on the two off-take scenarios, a similar investment will be required for public buses which will require an additional electricity generation of 2-4 MW and entail additional investment of INR 10-20 crore to set up 310-500 charging terminals.

For deeper penetration and sustainable development of EV industry, two and three-wheeler play a major role. India being the largest two wheeler market, infrastructural investments seem the only way forward for the same. As per the predictions an additional energy generation would be required to be increased by 10-15 MW depending on the two scenarios. Both these scenarios would need an investments of INR 50-75 crore involving 11,000-19,000 charging terminals.

Regulatory

India's regulator has taken note of deteriorating air quality in terms of alarming presence of PM 2.5, making Indian cities rank one of the worst in term of air quality and the difference in polluting potential of diesel versus petrol versus CNG. Regulators have reacted with changed ELV norms for diesel and temporarily ban on diesel above 2000 cc in Delhi as well as leapfrog from BS IV to BS VI.

While the diesel vehicles ban in Delhi NCR caused the auto OEMs losses worth INR 4,000 crore during the first eight months of the ban, the latter nationwide ban left the auto industry with INR. 20,000 crore worth of unsold inventory.

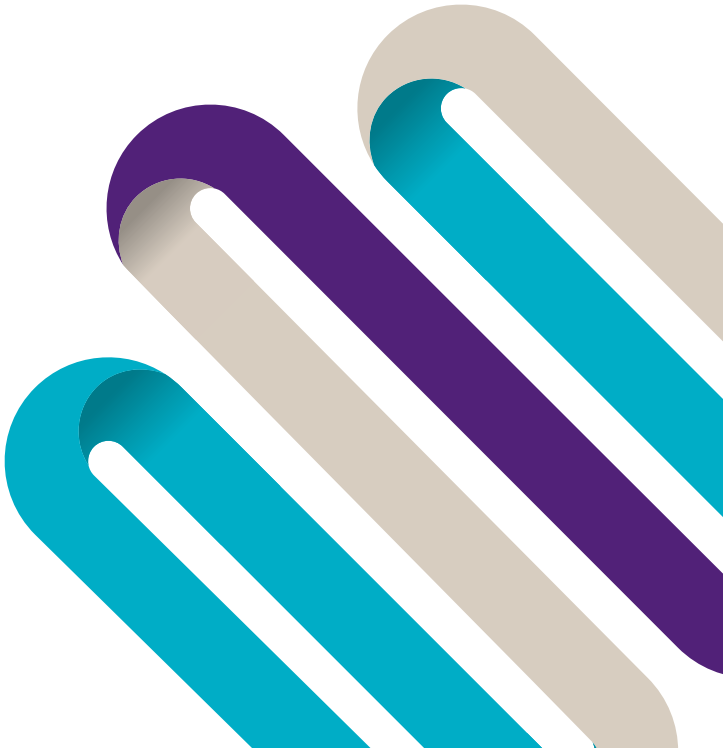
These incidents also highlighted that the Indian emission standards were quite outdated compared to global emission norms. Therefore, the Ministry of Road Transport & Highways decided to leapfrog from the current BS IV standards directly to BS VI norms, completely skipping BS V by April 2020. Although this measure was quite justified considering the current pollution levels in the country, it would require substantial upgrade of ancillary infrastructure. This drastic step unfolds two major challenges:

1 Oil refineries would be required to upgrade to supply fuel that can match BS VI standards thereby attracting upgradation costs worth INR 50,000-80,000 crore.
2 Automobile component manufacturers will need to make substantial technological advancements; especially in diesel filter technology and in optimisation of selective catalytic reduction technology.

This hasty advantage could likely pose a compromise on the quality and safety of the components as well as make the components significantly expensive. Enforcement of BS VI norms will consolidate all Indian cities under a single, unified emissions standard on an accelerated timeline. However, with these regulations set to come into effect in 2020, India will be well-placed positioned to overcome its high pollution levels.

Enforcement of BS IV standards and the leapfrogging to BS VI is likely to bring a bulk of vehicles for scrap. This would create a huge opportunity for recycle and reuse. Currently, about 85 per cent of the vehicle weight can be recycled. While doing this, the vehicle owner gets about 85 per cent of the scrap value as well as a 50 per cent rebate on the excise duty from the government while purchasing a new vehicle.

An increasing number of automakers and manufacturers have started recycling. While breaking down old vehicles, manufacturers use as much old material as possible. Not only do they recycle old cars for parts, thereby cutting down on the pollutants, emissions, and resources used to make new vehicles, they also use recycled materials in their new cars. For instance, soy might be used for padding in doors or seats. This is good for consumers since it makes the vehicle more affordable.



Global EV-related Regulatory Policies

Country	Main EV support policies in 2016, changes from 2015 and 2017
India	• Tailpipe emission standard (Bharat 3, equivalent Euro 6) • FAME Scheme (includes several components, such as demand incentives and pilot projects) • In some states, registration tax and VAT rebates or exemptions
China	• In 2016, implementation of the fourth stage of the fuel consumption standard framework • Acquisition tax and excise tax exemption (depending on engine displacement and price) • Circulation and ownership tax exemption • Possibility of local subsidies within the limit of 50 per cent of the amount granted via central subsidies • From 2017, 20 per cent reduction from 2016 subsidies with plan to adjust policies according to market response until 2020 • In seven major urban centres, exemptions from license plate access restrictions locally, access to bus lanes, exemption from access restrictions at peak times, free charging, free parking
Japan	• Tailpipe emissions standard (PNLT 2009, equivalent to Euro 6) • Battery capacity and electric range-based purchase subsidy
Netherlands	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • In 2016, exemption from registration tax for BEVs, EUR 6/gCO2/km for PHEVs. In 2017, increase of registration tax to EUR 20/gCO2/km for PHEVs • Ownership tax exemption for BEVs, 50 per cent discount for PHEVs (EUR 400 to EUR 1200 for conventional cars) • CO2/km-based taxation on the private use of a company car • EVs are considered as tax deductible investments for companies
Norway	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • Purchase tax exemption • VAT exemption for BEVs (25 per centof vehicle price before tax) • Further purchase rebates and purchase tax waivers introduced for PHEVs in 2016 • VAT exemption for leased BEVs • Circulation tax exemption • Plan to maintain BEV taxation schemes until 2020 • Waiver on road tolls and ferry fees • From 2016, leadership on free parking measures transferred from the central level to the municipal level
UK	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • CO2/km-based and zero-emission range-based purchase subsidy scheme • Tax incentives: fuel duty exemption, vehicle excise duty exemption for BEVs and discount for PHEVs, reduced taxation for company cars • Planned government spending of more than GBP 600 million to support ultra-low emission vehicle (ULEV) manufacturing and adoption
USA	• Corporate Average Fuel Economy (CAFE) standard with multipliers for EVs and alternative powertrains • Tax credit of USD 2 500 to USD 7500 to be phased out after 200 000 units per manufacturer are sold for use within the country • ZEV production mandates in place in nine states

Source: Global EV Outlook 2017 - International Environmental Agency

Implications for India

Once the government converts its current fleet of public transport buses to electric buses, it can use its infrastructure to provide public charging stations on both, the bus stations and parking lots made by the government. This will create an alternative source of revenue for public transport bodies. Similar approach can be implemented in other places such as malls and parking lots. The concept can be extended to other public spaces wherein empty spaces within an existing infrastructure like fl`yovers can be used to create charging and parking stations.

Following the recent bill announcement in UK, India can follow UK's steps to implement a bill making it mandatory to install electric car charger/s at the petrol pumps across the country. If a similar approach is to be applied in India, the number of electric charging points will increase in multiple folds as currently India has over 56,000 petrol pumps and if a single charger was to be installed at 70 per cent of these petrol pumps, India will have upwards of 39,000 charging points.

Shared Mobility

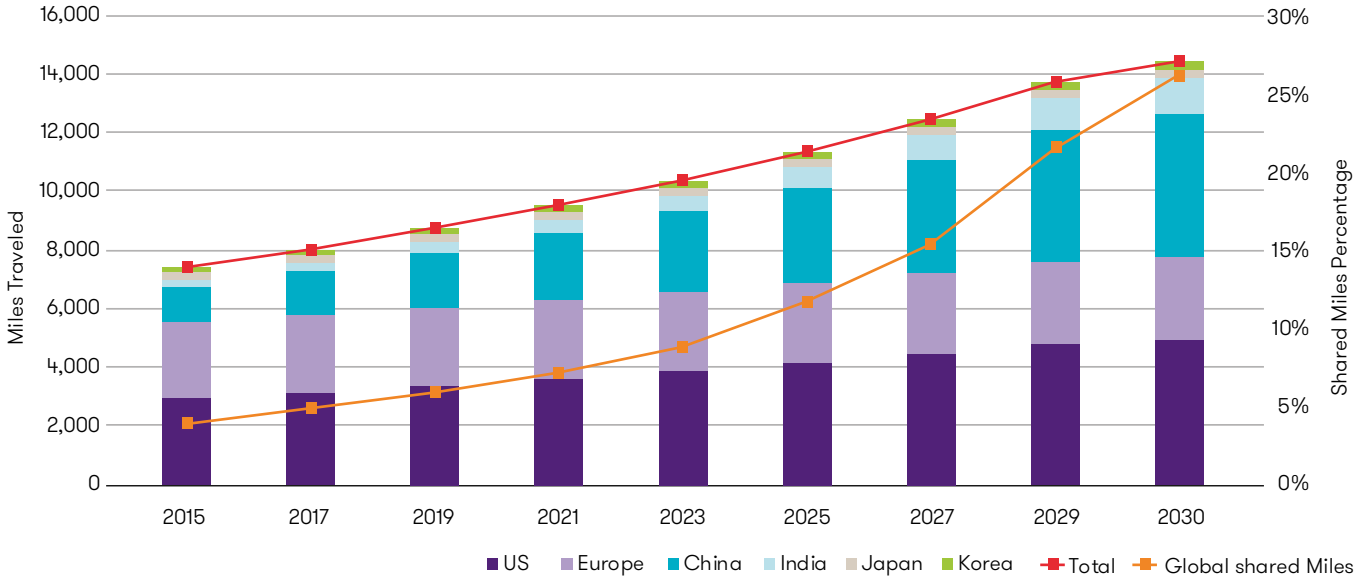
Market Perspective

Rapid urbanisation, lack of city planning and an increase in car park sizes in major cities is leading to increased congestion and commute times across mega cities worldwide. This coupled with increased social awareness, and easy-to-use platforms like Uber and Ola have made shared mobility a viable option.

Around USD 28 billion has been invested in shared mobility businesses alone including Uber, Didi Dache, Lyft and closer home Ola to develop a technology platform defined by ease of use (user experience), consumer convenience (urban consumer through initial subsidy) and driver-friendliness (with initial incentivisation).

It will be key to see how developed markets react to this disruption over medium and short term as personal mobility is central to the modern consumer needs. With shared mobility, there are early signs of this getting challenged with consumers delaying the purchase of their first cars and reduction in second car demand. There are varying estimates that a shared mobility car has the potential to reduce the new car demand by a factor of over 10-25. While Automotive OEMs will need to follow these trends as there is a downward pressure on demand, there is also a potential to earn additional revenues through new business models in terms of OEMs entering into shared mobility themselves.

Miles Traveled and Shared Miles Forecasted by Country



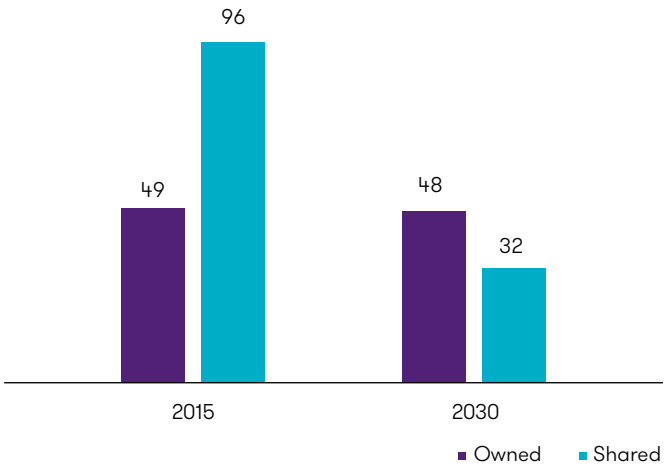
Source: Morgan Stanley

Shared cars are (taxis and cars operated by ride-sharing companies) expected to account to ~26% of the total global miles travelled in 2030 as compared to 4% in the year 2015.

There is a paradigm shift happening and the Automotive measure of **"Cars Sold"** is now starting to be replaced by **"Miles travelled"** instead. This is key as the world will actually see an increase in miles travelled from the current estimate of 10.2 bn miles to 19.6 bn miles by 2030, according to a report by Morgan Stanley. Shared mobility which currently accounts for 4 per cent of the total miles travelled could contribute around 25 per cent by 2030. These are big behavioural shifts. The Auto OEMs will need to closely follow the trends and rejig their business models. Other industries like the mobile industry saw a well-entrenched player like AT&T lose out on the mobile revolution despite having intellectual property much ahead of the others as it failed to track the changing consumer preferences.

In major metros in India, one can find students, housewives, business executives across levels embracing shared mobility as the city lends itself to such a model.

Cost per Mile: Shared vs Owned (Rs.)



Source: Morgan Stanley

According to a recent study by the International Energy Agency (IEA), passenger car ownership in India will grow by 775 per cent by 2040. At present, passenger car ownership is 20 vehicles per 1,000 inhabitants which will grow to 175 cars per 1,000 people in 2040. Therefore, along with the fleet of public buses and private vehicles, ride-sharing app platforms have been playing a major role in providing the last mile connectivity. Major ride sharing apps have been partnering with airlines to provide a more innovative and easy experience for the flight passengers by providing them with arrival services. Uber has partnered with Jet Airways to provide last mile connectivity to its passengers..

Key Developments in Shared Mobility in India

- Shared rides account for 25-30 per cent of overall trips on Ola and Uber in key cities such as Mumbai, Delhi and Bengaluru
- Uber has signed an MoU with the Haryana Government to introduce its ride-sharing services (including private vehicle ridesharing) and help the government with "smart city" development in the state
- Uber will invest INR 120 crore in Haryana
- Ola had pre-sold more than 20 million carpool rides through its Share Pass subscription
- Ola claims carpooling, launched in October 2015, has grown 500 per cent in terms of number of rides in one year

Ride-sharing and other Alternative Business Models

There are already several well-established vehicle-sharing business models catering to several customer groups.

Traditional

This business model involves around renting cars from one company, where the car is maintained by the company following an asset-heavy model. These companies can have three types of service offerings:

1 Round-trip/station-based services in which vehicles are rented and returned to the same location
2 One-way fixed point to point journeys
3 One-way free floating services in which vehicles can be rented from anywhere in a specified zone

Peer to Peer

It is the process whereby existing car owners make their vehicles available for others to rent for short periods of time. Businesses within this sector screen participants (both owners and renters) and offer a technical platform, usually in the form of a website and mobile app, that brings these parties together, manages rental bookings and collects payment. Insurance acts as key to enable the operating model/platforms.

Corporate

This model is specifically operated by companies where a dedicated fleet of vehicles is provided at the company's premises for the shared use among the its employees.

Collaborative monetisation in shared mobility space

GM-Lyft

General Motors along with Lyft, a ride sharing company based in USA, are planning to deploy thousands of self-driving electric cars in a test fleet by the beginning of 2018. This will be the largest pilot of fully autonomous vehicles before any other automaker reaches that target in 2020, the year when several companies have planned to begin building and deploying such vehicles in high volumes. Waymo, a subsidiary of Alphabet Inc., is currently testing only 60 self-driving prototypes in four states, whereas GM-Lyft initiative will have ability to create a greater knowledge bank as it gets more data to process and improve its existing self-driving capabilities. Currently, the self-driving car i.e., Bolt EV is not being sold to individual customer. GM's car sharing business Maven is likely to be involved with Lyft in developing a commercial ride sharing business around self-driving vehicles like Bolt EV.

GM-Uber

GM is also teaming up with Uber through its subsidiary Maven, a car-sharing company, to rent GM vehicles on a weekly basis in a 90-day pilot programme. The pilot phase of the project is debuting in the San Francisco bay for its residents. The rent of these cars on a per week basis would be set at USD 179 plus taxes and fees. The drivers availing this offer can use the rented car for ferrying Uber passengers or for their own personal trips. Maven seems to be branching out from just a direct-to customer car sharing model to a direct-to- businesses or a B2B offering. This development adds more versatility to Maven.

Mahindra-Ola

Cab aggregators are also vying to go into the EV space by proposing to release an electric fleet to curb its carbon foot print. Softbank Group's Chairman, earlier this year, noted that Ola will introduce a fleet of 1 million electric cars in partnerships with EV manufacturers and the government. If the company moves towards this commitment, the EV manufacturers will get a huge boost and motivation to build their presence in the EV market. Currently, Ola has partnered with Mahindra & Mahindra to release a fleet of electric cars in Nagpur, making it the first city to get electric mass mobility. Ola has deployed around 200 EVs and also partnered in the development of its EV infrastructure.

Key Indian Shared Mobility Service Providers

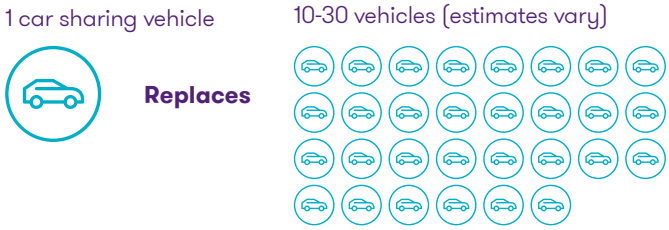
OEMs too have started investing in their own shared mobility services. For instance, General Motor, BMW and Daimler are coming with their shared mobility services such as Maven, BMWi and Car2Go, respectively. In India, as previously mentioned, OEMs such as Mahindra and Maruti are partnering with Ola. While there are multiple business models in this domain, the Indian market is largely dominated by independent service providers.

Company	Details
BlaBla Car	BlaBla Car was launched in India in Jan 2015, and successfully completed 18 million rides in 18 months
SRIDE	Launched in Nov 2014, focuses on corporate carpooling. In 2015, the company had more than 1,500 users across India.
uberPOOL	Launched in India in Sep 2015. 25 per cent of Uber users in key Indian cities use Uber Pool.
OLA SHARE	Launched in October 2015, it has grown 500 per cent in terms of number of rides in one year. More than 20 million carpool rides had been pre-sold through the Share Pass subscription.
carpool by MERU	Launched in Sep 2015, Meru Cab provides an option to passenger for sharing their rides travelling in same direction promising fixed 30 per cent discount on estimated trip fare. Company has partnered with IOCL to promote carpooling
ryde	Ibibo group launched carpooling app in Apr 2015 that offers both inter-city and intra-city rides
Quick Ride	Launched in Sep 2015. Within four month of its launch, the company had more than 4000 registered users and an average of 130 rides per day
Zify	Launched in Feb 2014, Zify offers both intra-city and inter-city ride-sharing. Recently expanded its presence to Europe.

Impact of Carpooling on Automobile Industry

Market size-related insights: Although it's difficult to predict the impact of disruption as estimates tend to vary drastically, following are industry estimates capturing the impact of carpooling on the automotive industry.

1 Car-sharing market to hit USD 16.5 bn by 2024.
2 Various industry analysts suggest that car-sharing will reduce vehicle sales by 550,000 to 650,000 vehicles worldwide by 2021.
3 Despite shift towards shared mobility, vehicle unit sales will continue to grow, but likely at a lower rate of around 2 per cent per annum.
4 The automotive revenue pool will grow and diversify with new services (shared mobility, data connectivity), potentially becoming a USD 1.5 trillion market in 2030.



0.58 - 0.84 metric tons	Reduction in green-house gas (GHG) emissions per year for one household
34% - 41%	Reduction in GHG emissions per year for one household
27% - 43%	Reduction in vehicle miles travelled (VMT) per year, considering vehicles sold and purchases postponed

While contributing towards sustainability, carpooling will have an impact on both OEMs and dealers alike. Short term impact seen in India has given boost to automobile sales as new business models like Uber and Ola are making it possible for drivers to go in for car ownership given the steady flow of income and sustainability. Long term impact on new car sales have estimated that one shared car will replace 10-30 new car sales. While this will have several inbuilt assumptions, one cannot step away from a volume impact. However, OEMs can compensate the lost profit by adding revenue from car-sharing business, whereas dealers are unlikely to do so. The current dealer environment allows limited maneuvering space to react to a changing market situation.

Impact of Shared Mobility on OEMs and Dealers

	Impact on OEM	Impact on Dealer
New Cars	• Demand increase due to shared mobility cars. • New car demand decrease for second car purchase and delayed first car purchase	• Demand for new cars decreases due to slowdown in second car purchase and delay in first new car purchase
Used Cars	• Increase in supply because of increasing usage of shared mobility	• Increase in stock of used cars • Resale value decreases due to increase in stock of used cars
After Sales	• Increase in after-sales services due to shared mobility cars	• Demand for after-sales service will be reduced due to share mobility and over the air (OTA) updates results in less work/ shop utilisation
Additional Revenue Potential	• OEM can compensate effects by investing in car-sharing business	• It is unlikely that dealers will invest in the car-sharing business

Source: GT Ananlysis

Influence of Car-sharing on Vehicle Ownership

Consumer insights: There is a lot of VC money flowing in terms of changing consumer preferences in terms of making shared mobility easy to use, enabling network effect in terms of adoption and providing initial incentives for the development of overall ecosystem. Based on the initial trends and star gazing into the future, it is estimated that:

1 About 5.8 million people worldwide share about 86,000 vehicles
2 25 per cent of all car-sharing members will sell a car after joining car-sharing
3 50 per cent of all car-sharing members stop buying cars
4 One car-sharing vehicle replaces 32 ownerships

Infrastructure

Autonomous Vehicles (AV) and shared mobility are introducing exciting possibilities for cities and have the potential to revolutionise how we use public infrastructure. As cities grow, however, more of the same dependency on the single occupancy vehicle will bring traffic to a standstill. The public and private sector must work together today to shape a future of urban mobility that contributes to goals of 'liveability', 'sustainability' and 'access to economic opportunity'.

Integration of public and private transportation can be seen between initiatives taken by ride-sharing apps in the country in partnership with public transportation, providing a last-mile connective system. In these use cases, the ride-sharing app offers quicker pickup time and attractive offers to make it feasible to choose them for covering the last mile. For example, Ola has partnered with Rapid Metro to provide a much more efficient and easy model at stations. Also, on-boarding local auto-rickshaw vendors and bike drivers have allowed its customer to move quickly thus reducing their travel time from public transport stations.

Thus, focusing on policies that alleviate the public transportation, infrastructure should become the priority of the city managers. Gradually developing the infrastructure is a must to stay out of the vicious cycle while promoting the use of public transport.

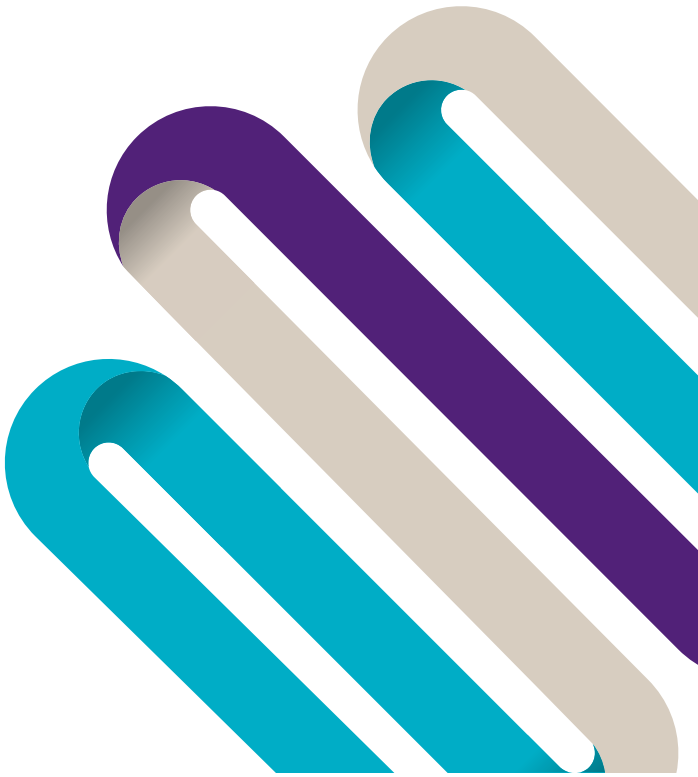
Regulatory

Regulators have to deal with the new business models and ensure that it addresses key concerns of its stakeholders. Due to issues relating to licensing customer safety and employee rights, Transport for London has banned Uber. However, Uber still operates as the matter is sub-judice. On the regulatory side, one will need to ensure driver KYC requirement is robust, and customer safety and business practices are acceptable.

1 Regulators have the additional burden of protecting user-safety and would be cautious before adopting new business models
2 Drivers of traditional taxi services demand government intervention to safeguard their interests, to prevent falling incomes and changing incentive structures.
3 Some state governments have excessive regulation for shared mobility. For instance, Maharashtra's city taxi rules require app-based taxis to adhere to a minimum limit for engine capacity and requires operators to have 30 per cent of the vehicles over 1,400 CC on its platform. Karnataka government has banned ride-sharing.

Implications for India

Roads are one of the largest public assets and were built on a much different assumption of an automotive ownership in most of the towns and cities. With shared mobility driving the future, it is anticipated that there will be a significant reduction in the number of vehicles, making these assets efficient. In the western world, implications would be on reduced demands of roads and parking lots, while in India, it would mean lesser congestion and more space for roads for a better driving experience. Rethinking the streetscape and eliminating a large number of parking lots could spur productive infrastructure development. Leveraging the opportunity with the right set of investments pumped in, it would bring opportunities for private sector to open up commercial spaces. This could also uplift the well-being of the community by restoring community spaces like gardens, pavements, bicycle lanes, etc. which have been encroached by vehicles for parking.

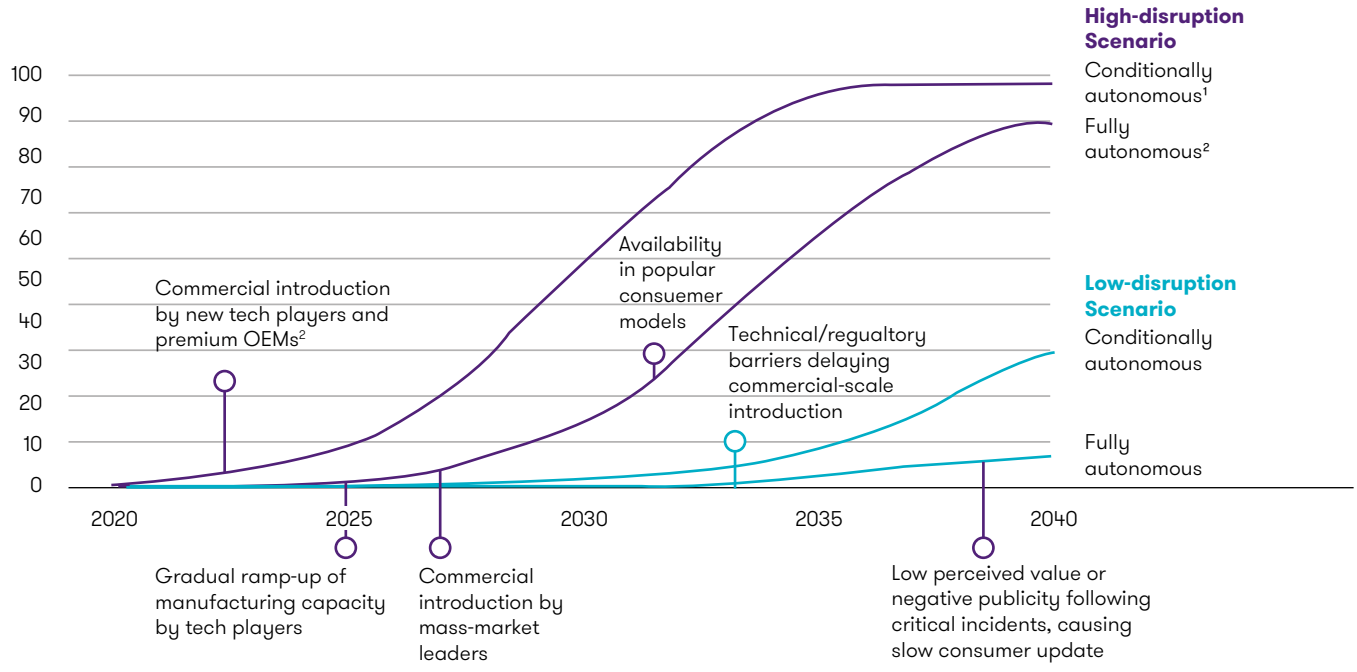


Connected Cars

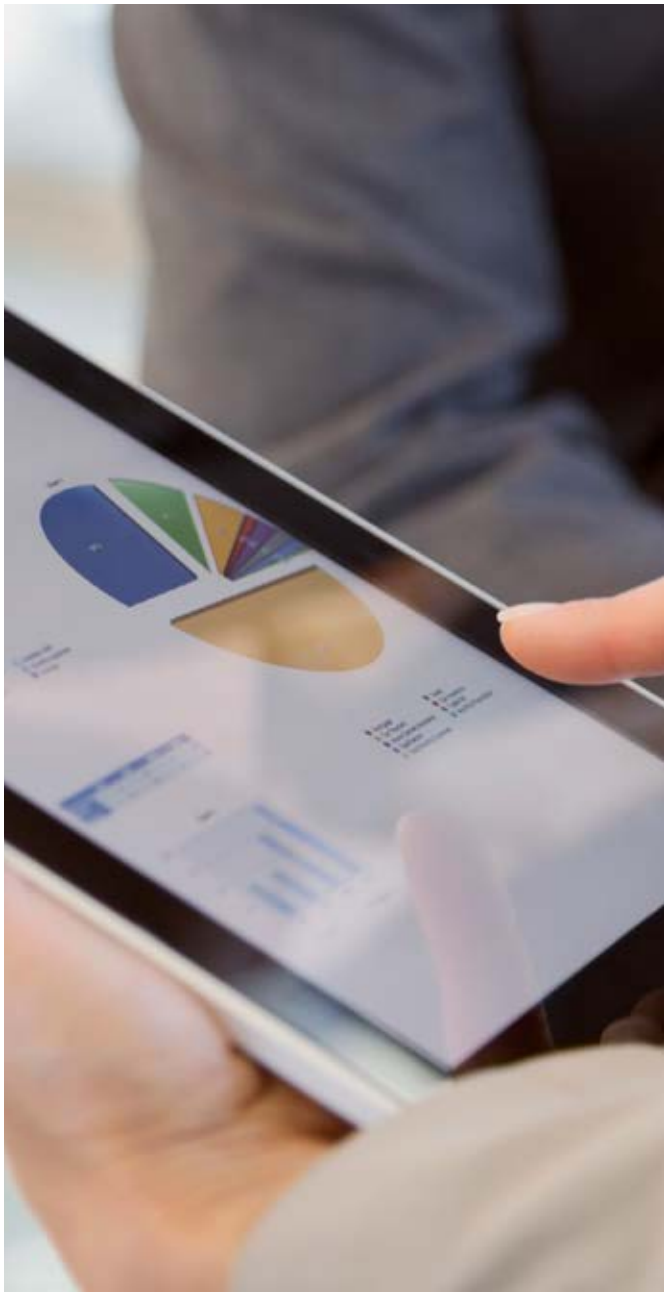
Market Perspective

What started as a journey to provide convenience for the vehicle owner, has now transformed to increase the human-vehicle engagement. For a new car owner, moving from a connected home environment where his smartphone is integrated into the home music infrastructure (e.g. Sonos, others) to his smart vehicle environment during a commute will carry the expectation of maintaining or enhancing that level of connectedness in terms of vehicle features, infotainment, etc. OEMs are now moving towards development of vehicles that can not only provide a number of features, but also get them to interact with each other as well as with the external environment and humans. The final intent would be to provide all of the current features plus a plethora of new features as an exhaustive package. The consumer touch point could either be through an embedded system in the car or an external wireless device such as smartphone, tablet or a watch. This journey will eventually enable the automobile industry to develop autonomous cars.

New Vehicle Market Share of Autonomous Vehicles, %



Source: McKinsey research



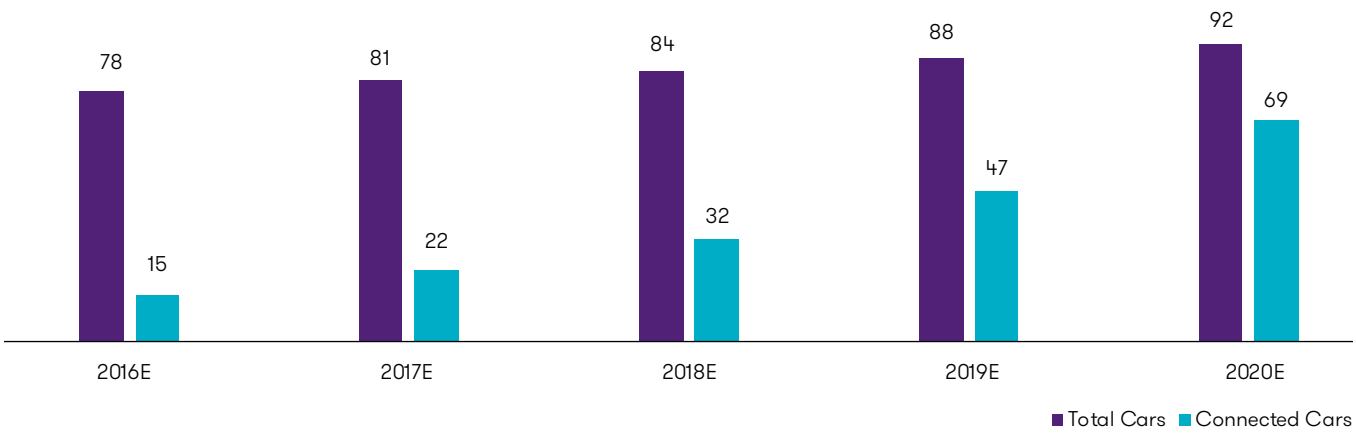
The value chain of connected cars includes a number of players ranging from automotive OEMs, drivers/consumers, insurers, equipment suppliers, software companies, IT enablers and app providers, connectivity providers (MVNOs) and the mobile network operators (MNOs) or satellite capacity offers. Regulatory bodies include the highway and traffic authorities to the data protection and telecoms regulators.

The portfolio of connected cars would include:

Key Features	Key Examples
Personalised Software Driven Experience	• Entertainment • Navigation • Communication • One-Touch Customisation
Data Analytics	• Vehicle Diagnostics • Preventive Maintenance • Real-Time Updates • Data Enabled UX
Safety & Security	• Anti-Theft • Cyber Security • Fatigue Alert • Hazard Detection
Strategic Partnerships	• Technology Partners • Car Dealers • Insurance • Advertising
Autonomous Vehicles	• Autonomous Driving • Shared Mobility • Fleet Management • Parking Management

The connected car market is anticipated to grow at a five-year CAGR of 46 per cent which will be 10 times faster compared to the overall car market. By 2020, about 75 per cent of the estimated 92 million cars shipped globally will be built with internet-connection hardware. Currently, most of the connected cars are available only from premium car makers and cost an average of USD 55,000. However, with technology advancements and increasing scale, prices are anticipated to drop significantly in near future.

Global Anticipated Shipping Volumes of Cars (in Millions)



Source: BI Intelligence

Connected car technology is now split in two approaches: first that puts the internet connection in the car and second that is dependent on a secondary device. Embedded connections don't require a phone's data plan to operate, and consumers and car makers gain access to a wider variety of features and data. Embedded connections have an upper edge since they allow auto companies to collect data on cars' performance and send updates and patches to cars remotely, avoiding recalls related to the car's software. As a consequence, most of the technology start-ups are focused on enhancing connectivity, providing diagnostic solutions, mobility management, safety and driving assistance and in-car entertainment services.

Both OEMs and Tier I alike are investing in connected cars, vehicle automation and shared mobility technologies that can be observed from a select analysis of investments made by General Motors, Toyota, Panasonic, Delphi, etc.

Key OEMs and their Investments in Shared Mobility and Connected Car Space

Companies	Investments	Area of focus
General Motors	• **GM** has been most active, investing in or purchasing more than 15 companies since 2011, either directly or through its corporate body or venture arm, GM Ventures • **GM** was the first major OEM to commit heavily to ride-hailing and automation, invested USD 500 mn in a corporate minority round to Lyft, snapping up **SideCar's** assets and also acquired **Cruise Automation** for upwards of USD 1 bn	Vehicle automation Diverse mobility
TOYOTA Volkswagen DAIMLER	• Automakers attempting to secure a foothold in ride-hailing and sharing • **Toyota** and **Volkswagen** have taken corporate minority stakes in Uber and Gett, respectively • **Daimler** is looking to assemble a European contender under its Moovel subsidiary, purchasing a majority stake in **Hailo** this July to augment its investments in **Blacklane** and the previously-acquired **myTaxi**	Shared mobility Ride hailing
Ford	• **Ford** has disclosed a pair of startup acquisitions including **SAIPS** (machine learning and computer vision) and **Chariot** (shuttle transit service) • **Ford** has participated in investments across stages, from Civil Maps' USD 6.6 mn seed round to Pivotal's USD 653M Series C to leading a USD 24 mn Series B funding in the car rental platform, Zoomcar	Smart vehicles Shared mobility
BMW TESLA	• **BMW**, through its venture arm, BMW I Ventures has invested in various companies including, but not limited to Moovit, Parkmobile, JustPark, RideCell, ZenDrive, etc • Additionally, a consortium of German manufacturers including BMW, Daimler, and Audi also purchased Nokia's **HERE mapping** unit for USD 3.2 bn • **Tesla Motors** recently acquired **SolarCity** so as to increase its competencies as an integrated clean energy company	Smart mobility

Source: CB Insights

Key Tier-I players & their Investments in Shared Mobility and Connected Car Space

Companies (Tier-I)	Investments	Area of focus
Panasonic	• Panasonic Corporation along with other co-investor has invested USD 6.5 mn in mobile-based automotive technology company Drivemode • Panasonic is planning to collaborate with Tesla on Automatic Vehicle Technology	Autonomous vehicles
DELPHI	• Delphi has invested in connected car services company Otonomo and semiconductor products company Valens	Self-driving cars
SAMSUNG	• Samsung launched USD 300m fund dedicated to autonomous driving • Invested USD 90m in Australia based TTTech which develops platform and safety software for connected cars	Autonomous driving
LG Electronics	• Volkswagen-LG Electronics to jointly develop connected car platform • LG with QUALCOMM to develop an autonomous driving technology	Autonomous driving, connected cars
HARMAN	• Harman partners with AT&T to develop a telematics platform	Connected cars

OEMs and Tier I auto component manufacturers work in alliance to develop connected cars

Source: CB Insights

Investment in Indian Auto Tech Companies

Transaction Type	Date	Target	Target	Size (USD Mn)
Acquisition	January 2017	CloudCar	Jaguar Land Rover	15
Private Placement	October 2016	Ather Energy	Hero MotoCorp	30.67
Private Placement	December 2016	GrabTaxi Holdings	Honda MotoCorp, SoftBank, Tokyo Century	750
PE Investment	December 2016	Revr	Edelweiss Private Equity	9
PE Investment	December 2016	GoMechanic	Venture Catalysts	25
PE Investment	November 2016	Connect India	Aavishkaar Venture Management	1
PE Investment	November 2016	Rivigo	Warburg Pincus	75
PE Investment	November 2016	JustRide	Justin Kan, Qasar Younis, Paul Buccheit, Susa Ventures, Kima Ventures, Axan Ventures, SCM Holdings	3
PE Investment	April 2016	Jugnoo	Paytm, Snow Leopard, Rocketship	10
PE Investment	February 2016	Zendrive	Sherpa Capital, Nyca Partners, Thomvest Ventures	13.5
PE Investment	February 2016	Xpressbees	SAIF Partners, IDG Ventures India, Vertex Ventures, Valiant Capital	12.5

Technology

Connected car technology cuts across a diverse spectrum focusing on fleet telematics, driver assistance, V2V communication and driver safety.

Fleet Telematics

Fleet telematics caught on relatively early as a hot category for auto tech start-ups. Companies like Telogis (first funded in 2009), Greenroad (which received a Series B in 2005), and Vnomics use installed hardware and more recently, sometimes, smartphones to capture data about the driving habits and fuel efficiency of truck drivers. Since trucks typically transport asset-intensive goods, businesses are highly incentivised to use products like these to improve savings and manage their inventory. Most of these installed systems transmit and organise data about fleets, provide in-vehicle coaching, and notes to drivers, and also handle billing for transport as part of a suite of offerings.

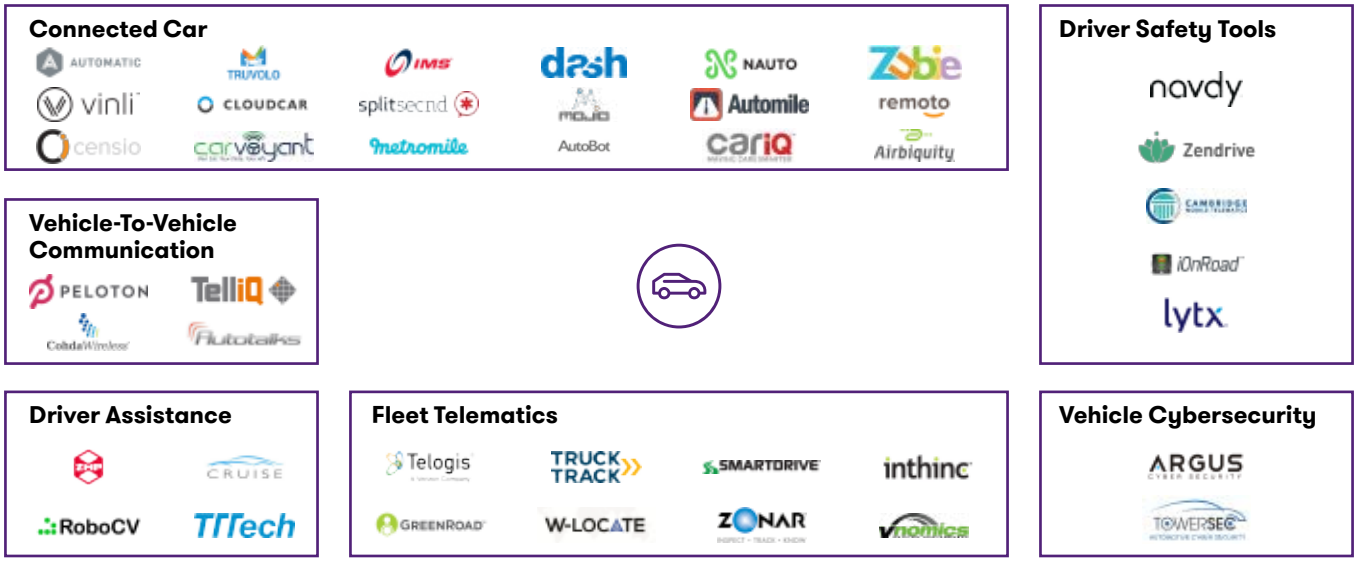
Driver Assistance/Automated Car

These companies are using networks of sensors and powerful software to provide driver-assistance features. While companies like Cruise are retrofitting older cars, Robot of Everything has an entire lab dedicated to improving the different facets of automated driving in their robocars. It's not just cars, RoboCV is working to automate warehouse vehicles, which navigate in smaller and more constrained spaces. General Motors put its stake in the ground in the realm of driving tech start-ups with its acquisition of Cruise Automation. Cruise had raised just USD 18.8 mn, but GM valued the company at over USD 1 bn.

Vehicle-to-Vehicle Communication

Vehicle-to-vehicle communication allows cars to make decisions based on their surroundings and context, including distance, speed, and directional movement of other vehicles, underpinning self-driving and safety applications, but also traffic management and driving efficiency use cases. Autotalks and Cohda Wireless market suites of hardware and software solutions for vehicle-to-vehicle communication (as well as vehicle-to-infrastructure communication). And Peloton deploys this technology primarily in trucks, which would theoretically allow self-driving trucks to travel in close "platoons," and reduce the need for constant driver control.

Auto Tech Market Map (Global)



Source : CB Insights

Vehicle Cybersecurity

Vehicle cybersecurity is a small, but emerging field. As more cars become connected to the cloud and infrastructure and other vehicles, more possible entry points will need to be protected against hackers' exploits. Argus, which has raised USD 30 mn, is a cybersecurity company specifically focused on automobiles. Towersec aims to protect not just the vehicle itself, but also any telematics and any in-vehicle infotainment as well.

Driver Safety Tools

Driver safety and collision-prevention are among the most important immediate applications auto tech is attacking. Insurance companies are particularly interested in this category. Various approaches exist: Navdy is using heads-up projections to display relevant information so that drivers don't look at their smartphones while driving; Cambridge Mobile Telematics analyses your driving habits using your smartphone, and provides coaching/analytics on how to improve; and Lytx uses dashcam technology to provide feedback based on visual cues, combined with driving habits.

Auto Tech Market Map (India)

Connected Cars

Aggregator / Rental

Vehicle Tracking / Navigation

Vehicle / Driving Analytics

Electric Vehicles

Safety / Other Solutions

Logistics Solution / Services

Source: Grant Thornton India Research

Waymo

Waymo is a subsidiary under the newly formed Alphabet which is developing self-driven cars. The cars developed by Waymo are currently offering Arizona drivers USD 20 an hour for testing. The technology is currently being tested both in Google's own prototype car and a modified Lexus SUV. The biggest question remains: How exactly will the technology be offered to the consumers? As a platform implemented on top of an existing car or a car fully developed and manufactured by Google, with the supply chain system with the likeness of other car manufacturers, another possible outcome that can be expected by Google is that they will come with fleets of autonomous cars and serve metro areas. This way drivers can order a car to their location with a few taps on their smartphone screens, similar to a cab service like Ola or Uber. With the competitive nature of Google and the fact that the company has surplus cash, it has the power to come out with all three offerings together.

Growing population has increased pressure on our environment and has led to an increase in congestion. Thus it has become imperative for the city developers to design streets to accommodate other choices of transportation, be it active (walking and biking), shared mobility or public transport.

Currently, shared mobility demands are met by ride-sharing apps that are either home-grown like Ola in India or global ride-sharing companies like Uber. Many technology companies are trying to implement autonomous shared mobility system for the purpose of creating a network of autonomous taxis. Google has been implementing its driver-less pods around the Silicon Valley for the past few years. Now, Google's efforts to create a self-driven car have been pivoted and led by Waymo. With the huge bank of autonomous data and partnership with existing auto manufacturing companies, Waymo will exploit its strengths to steer ahead of its competition.

Mahindra & Mahindra

DiGiSENSE will be available across Mahindra's breadth of mobility products from commercial and passenger vehicles to tractors and construction equipment. Its launch makes the company the first OEM in India to integrate its product line-up onto a cloud-based technology platform. The software empowers owners, fleet operators, drivers, dealers and service teams to access vital information about their vehicles, trucks, tractors or construction equipment on a real time basis from the driver's seat. It will help customers to digitally build knowledge 24X7 about the performance and location of their vehicles. Drivers can contact emergency breakdown services or pull up a route planner at the touch of a button. Fleet owners and dealers can track the location of their vehicles in real-time, while remote diagnostics and reports allow service teams to monitor the vehicle's health and productivity parameters, on a real-time basis.

DiGiSENSE will initially be available in Jeeto and Imperio in the small commercial vehicles space; Arjun Novo in the tractor space; Mahindra Blazo in the heavy commercial vehicles space; and Earthmaster in the construction equipment space. It will be available as a subscription-based service at an affordable price, DiGiSENSE will eventually be available across the entire line-up of Mahindra vehicles.

Salient Features of DiGiSENSE are as follows:

- One Solution with Multitude of Applications: Mahindra has created a unified, cloud-based technology platform for its entire mobility sector. The same platform is customised to suit different applications and different sets of customers, while providing a seamless and unified Mahindra experience. A customer owning different Mahindra vehicles will still have the same user experience with individual and unique customisations.
- Ecosystem Orchestration: Mahindra will be the first Indian OEM to have created an ecosystem of technology partners like cloud service provider, map provider, telecom network provider, hardware manufacturer and other third parties.
- Keeping Pace with the Times: "DiGiSENSE" is an open-architecture platform that will be upgraded on a periodic basis.
- Seamless Feature Upgrades: Customers will constantly be upgraded to the latest versions of DiGiSENSE over the cloud without ever needing to step into a showroom or dealership, similar to software upgrades on mobile phones.
- Redefining Service Paradigms: With DiGiSENSE, Mahindra will be taking the next step towards redefining service paradigms the digital way. It's an attempt to get closer to the customer by offering value added services directly, "then & there", and enhancing the overall customer experience.

Infrastructure

V2V/ V2G/ V2H/ V2I connectivity

Vehicular communication systems are networks in which vehicles and roadside units are the communicating nodes, providing each other with information, such as safety warnings and traffic information. They can be effective in avoiding accidents and traffic congestion. Both types of nodes are dedicated short-range communications (DSRC) devices. DSRC works in 5.9 GHz band with bandwidth of 75 MHz and approximate range of 1000 m. Vehicular communications is developed as a part of intelligent transportation systems (ITS).

Vehicle-to-Grid (V2G)

Vehicle-to-grid (V2G) describes a system in which plug-in electric vehicles, such as electric cars (BEV) and plug-in hybrids (PHEV), communicate with the power grid to sell demand response services by either returning electricity to the grid or by throttling their charging rate.

Vehicle-to-Home (V2H)

V2H capability describes the ability of the car to charge from the grid or through solar panels and be used by the homes as a source of power backup during power outage like a regular standalone power generator. V2H concept is basically a smaller implementation of the V2G concept. The concept allows V2G vehicles to provide power to help balance loads by "valley filling" (charging at night when demand is low) and "peak shaving" (sending power back to the grid when demand is high). V2G concept is being experimented under several global initiatives to evaluate viability as challenges like subjecting a car battery through several charge discharge cycles for "valley filling" and "peak shaving" concept could impact its overall performance.

Vehicle-to-Infrastructure (V2I)

In V2I communication the infrastructure plays an important role of coordinating with vehicles by gathering global and local information on traffic and road conditions to suggest or impose certain behaviours to be followed by the autonomous vehicle. Suggestions to vehicles could be broadcast to drivers via road displays or directly to vehicles via wireless connections. Looking further ahead, in some cases suggestions could be integrated into the vehicle controls and implemented semi automatically (always taking onto account the restrictions on automatic vehicle driving imposed by the Vienna Convention on Road Traffic). An advanced implementation of V2I communication can be done by implementing a vehicle to vehicle (or V2V) communication, allowing to vehicles to communicate with each other the position, speed and direction in which they are travelling to coordinate between multiple vehicles allowing for a smother flow of traffic. In V2V communication a wireless LAN network based on IEEE 802.11 on a frequency spectrum of 5.9-Ghz is used to communicate with other vehicles.

V2V communication

Implementing a charging mechanism based on inductive charging can be used between cars connected to each other. This type of charging infrastructure based on V2V communication and car data processing can allow cars to charge while moving using Mobile Energy Disseminators(MED). In this method, similar to information dissemination, special nodes, like buses (trucks), can act as energy sources to EVs that need charging, in order to increase travel time. These special nodes are referred to as MEDs. These vehicles use inductive power transfer(IPT) in order to refill the starving EVs. Buses can be used as MEDs as they follow a specific route with a predefined schedule.

Regulatory

Connected cars will be subject to a mix of laws and regulations across the globe. These will include, on the one hand, new laws and regulations specifically adopted in respect of connected cars, and on the other hand, existing, non-sector specific laws and regulations.

For example, Regulation (EU) 2015/758 of the European Parliament and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall-in-vehicle system will require all new models of cars and light vehicles to be equipped with eCall technology as of 31 March 2018. In case of a serious accident, the eCall system will automatically call the European single emergency number (112) to signal the accident along with rescue-related information such as the type of car, the time and location, the direction of driving at the moment of the accident, etc.

Once the car will be equipped with connectivity to the web for ecall purposes, it will only require a little step forward to provide not just emergency services, but also other web-based offerings.

Existing laws and regulations that will apply to connected cars include, for example, telecom regulations, automotive and road regulations, data protection and consumer protection laws. And if this was not enough, consider that the car - and its driver and passengers - often move across the borders of different countries with different legislation applying in each case.

1. Telecommunication regulations

Connected car services are offered through connectivity typically provided by a mobile and/or a satellite network operator. This makes the connected car subject to telecoms regulations in each jurisdiction where it operates. But the technological developments of connected cars do not always fit with the pre-existing telecoms regulations which were designed around a different concept of mobile connectivity. The exigencies around voice communication over a smartphone are different to the needs of M2M transmissions.

Therefore, in several countries, certain typical features of connected car business models may raise a number of issues. For example, delivering multinational connectivity through permanent roaming or the use of foreign IMSI (International Mobile Subscriber Identity, a number that is embedded in each SIM card and identifies in a unique manner the country network and the subscriber) is a pressing challenge that needs to be addressed. Furthermore, there will be a risk that players in the value chain (e.g., car manufacturers) qualify as resellers of electronic communication services, thus entering the realm of telecom regulations. In addition, it is not always clear how rules on number portability could work in a connected car environment.

2. Automotive and road regulations

While redefining the concept of cars, connected cars are still vehicles travelling on public roads. As such they must comply with type-approval requirements and technical standards which are of the essence in the automotive industry as well as in relation to road regulations. This is particularly important when it comes to rules conceived to prevent driver distraction and ensuing safety for other vehicles or pedestrians. Connected cars allow a continuous interaction between the driver and the vehicle, including the flashing of warnings on the dashboard, the screen shield or rear mirrors. It is important that these warnings be designed and presented so as to minimise distraction.

3. Privacy and data protection laws

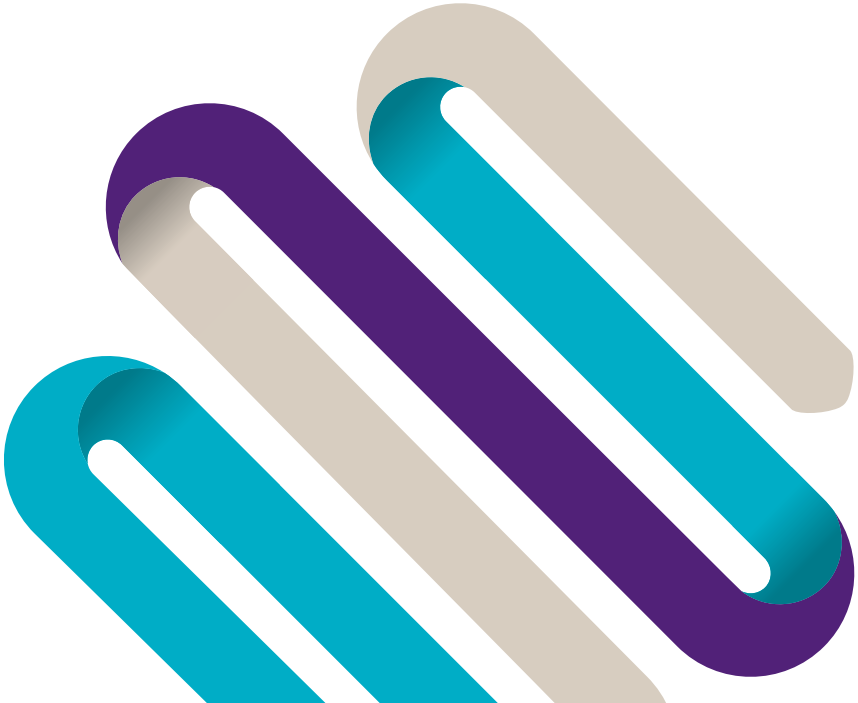
Privacy and data protection are of paramount relevance in a connected car environment. In particular, the continuous collection, processing and storage of location data will challenge core data protection principles relating to transparency, data minimisation and purpose specification, etc. Further, obtaining data subjects' consents will possibly be an issue in certain countries, especially in relation to passengers or purchasers of second-hand cars. Also, the inherent mobility of data poses security issues that various players need to address carefully in advance.

4. Consumer protection laws

Cars are typical consumer goods, and connected cars are no exception. Now, in addition to general consumer protection ramifications, specific legal issues may arise around the right of withdrawal for connected car-related distance contracts, depending on how contractual arrangements are qualified. The enjoyment of this right would in fact change depending on whether the distance contract with the consumer qualifies as a contract for the provision of a service or of digital contents. Also, in several countries there are uncertainties on whether the statutory warranty for defective products applies to digital contents downloaded via the on-board unit.

Implications for India

India will most likely be focused towards driver assistance, infotainment and vehicle efficiency among others. Keeping in mind the increased electronic content rising to almost 50 per cent by 2030, India tier I auto players should grab the opportunity to become a critical part of this emerging ecosystem. Considering the country's strength in the IT sector, India could already start to play a larger than life role in certain areas, especially in vehicle cyber security on the global arena. As the industry tries to embrace new technologies, regulators will need to have an open mind towards evaluating new paradigms such as vehicle-to-vehicles communication, fleet telematics, etc. and at the same time be agile in framing policies and work closely with the auto industry.



Appendix

Global EV Support Policies

Country	Main EV support policies in 2016, changes from 2015 and 2017
India	• Tailpipe emission standard (Bharat 3, equivalent Euro 6) • FAME Scheme (includes several components, such as demand incentives and pilot projects) • In some states, registration tax and VAT rebates or exemptions
Canada	• Fuel economy standard including EV multipliers - Passenger Automobile and Light • Truck Greenhouse Gas Emission Regulations • Waivers on fees (e.g. tolls, parking and ferries) in Ontario and Quebec • Access to HOV lanes in British Columbia, Ontario and Quebec • Provincial-based purchase incentives: British Columbia, Ontario and Quebec
China	• In 2016, implementation of the fourth stage of the fuel consumption standard framework • Acquisition tax and excise tax exemption (depending on engine displacement and price) • Circulation and ownership tax exemption • Possibility of local subsidies within the limit of 50 per cent of the amount granted via central subsidies • From 2017, 20 per cent reduction from 2016 subsidies, with the plan to adjust policies according to market response until 2020 • In seven major urban centers, exemptions from license plate access restrictions. Locally, access to bus lanes, exemption from access restrictions at peak times, free charging, free parking.
Denmark	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • Registration tax exemption until 2015 and phase out between 2016 and 2022 • (introduction of 20 per cent of full tax rate for BEVs in 2016, full tax rate applicable by 2022)IEA HEV TCP (forthcoming). Starting in 2017, battery capacity-based purchase tax rebate (USD 225/kWh with maximum 45 kWh)
France	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • CO2/km-based eco bonus-malus scheme (bonus of EUR 6300 (USD 6900) for BEVs and EUR 1000 (USD 1100) for PHEVs, up to EUR 10 000 (USD 11000) for BEVs and EUR 3500 (USD 3900) for PHEVs when returning an old diesel car) • Company car tax credits • Electricity and hydrogen tax exemption • From 2017, government fleet commitment of 50 per cent of renewals being EVs, and 20 per cent for local authorities
Germany	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • Purchase rebates of EUR 4000 (USD 4400) for BEVs and EUR 3 000 (USD 3300) for PHEVs, at the limit of 400 000 cars until 2020 or EUR 600 million (USD 674 million) • Ten-year circulation tax exemption, reduced to five years from 2021 • Tax deduction for company cars • Differentiated plates for EVs, allowing for differentiated measures • Locally, free parking, dedicated parking and access to bus lanes
Japan	• Tailpipe emissions standard (PNLT 2009, equivalent to Euro 6) • Battery capacity and electric range-based purchase subsidy
Netherlands	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • In 2016, exemption from registration tax for BEVs, EUR 6/gCO2/km for PHEVs. In 2017, increase of registration tax to EUR 20/gCO2/km for PHEVs • Ownership tax exemption for BEVs, 50 per cent discount for PHEVs (EUR 400 to EUR 1200 for conventional cars) • CO2/km-based taxation on the private use of a company car • EVs are considered as tax deductible investments for companies
Norway	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • Purchase tax exemption • VAT exemption for BEVs (25 per cent of vehicle price before tax) • Further purchase rebates and purchase tax waivers introduced for PHEVs in 2016 • VAT exemption for leased BEVs • Circulation tax exemption • Plan to maintain BEV taxation schemes until 2020 • Waiver on road tolls and ferry fees • From 2016, leadership on free parking measures transferred from the central level to the municipal level

Country	Main EV support policies in 2016, changes from 2015 and 2017
Korea	• Tailpipe emission standard CARB NMOG (equivalent to Euro 6) • Central purchase subsidies • Additional local purchase subsidies and Tax reduction • Upwards revision of 2020 target for EV deployment
Sweden	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • Between 2011 and 2015, Super Green Car Premium purchase rebate • Five-year exemption from annual circulation tax for EVs • For businesses, premium of 35% of the price difference between the purchased EV and the nearest comparable car, • For company cars, a reduction in fringe benefits value by 40 per cent compared to a similar conventional car
UK	• EU tailpipe emission standard (Euro 6 in 2016), EU fuel economy regulation • CO2/km-based and zero-emission range-based purchase subsidy scheme • Tax incentives: fuel duty exemption, vehicle excise duty exemption for BEVs and discount for PHEVs, reduced taxation for company cars • Planned government spending of more than GBP 600 million to support ultra-low emission vehicle (ULEV) manufacturing and adoption
USA	• Corporate Average Fuel Economy (CAFE) standard with multipliers for EVs and alternative powertrains • Tax credit of USD 2 500 to USD 7 500 to be phased out after 200 000 units per manufacturer are sold for use within the country • ZEV production mandates in place in 9 states

Comparison of ICE with various Battery Technologies

Aspect	Current ICE	Battery electric (BEV)	Fuel Cell (FCV)
Fuel Type	Gasoline	Electricity	Hydrogen
Number of vehicle model available	287	13	3
Average fuel economy*	23.3 mpg	105.2 mpge	58.5 mpge
Fuel Economy range*	12-50 mpg	84-119 mpge	50-67 mpge
Effective cost per mile	USD 0.1	USD 0.04	USD 0.09
Well-to-wheel GHG emissions (g/mi)	356-409	214	260-364
Well-to-wheels total petroleum usage (Btu/mi)	3791-4359	54	27-67
Driving Range (average)	418mi	110mi	289mi
Driving Range (min-max)	348-680mi	62-257mi	265-312mi
Time to refuel	~5min	20-30 min (DC Level 2) 3.5-12 hr (AC Level 2)	5 – 30 min
High Voltage	No	Yes	Yes
High Pressure	No	No	Yes
Availability of qualified mechanics	Yes	Limited	Limited
Availability of qualified emergency responder	Yes	Yes	Limited
Vehicle maintenance issues	-	Lower maintenance than gasoline; possibly battery replacement required during vehicle lifetime	Lower maintenance than gasoline; high pressure tanks may require inspection and maintenance

Note: * indicates model year 2016

Key Indian Policy Interventions

1 **National Urban Transport Policy, 2014:** This policy document was prepared by Ministry of Urban Development. It has paved the way for reforms in transportation sector and is likely to give a big boost to the sector.

2 **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** The focus of this mission is on capacity building, reform implementation, water supply, sewerage and seepage management, storm water drainage, urban transport and development of green spaces and parks. An investment of INR 50,000 crore (USD 7.5 bn) will be done by the central government over a period of five years, FY 2015-16 to FY 2019-20. One of its important components is improving urban transport.

3 **Automotive Mission Plan 2016-26 (AMP 2026):** A plan prepared by the Ministry of Heavy Industries and Public Enterprise in consultation with ACMA and SIAM. Upon its proper implementation, automotive industry will emerge as a vehicle for growth of Indian economy. It is expected to boost domestic turnover from INR 2.3 lakh crore (USD 35 bn) to INR 9.67 lakh crore (USD 145 bn), exports from INR 33,333 crore (USD 5 bn) to INR 2.3 lakh crore (USD 35 bn) and provide employment to 25 mn people. This will help the industry contribute 10 per cent to the national GDP by 2026.

4 **Smart Cities Mission:** INR 48000 crore (USD 7.2 bn) will be spent over the next five years under this Mission. Names of the smart cities will be finalised through a competition named Smart City Challenge. The first phase of challenge concluded in February 2016 and names of top 20 cities were declared for funding.

5 **Make in India:** India is a global hub of automobile manufacturing and ranks in the top 10 countries in the world. Domestic vehicle sales of Indian Automobile industry have been growing at CAGR of approximately 9.6 per cent over the period of FY05-FY15, while exports have grown at a CAGR of approximately 18.9 per cent. However, in FY13-FY15, domestic sales grew at a CAGR of just about 4.4 per cent mainly due to sluggish economy. On the contrary, the export market is showing a growth over the last few years. However, due to increasing stress on infrastructure, government is investing heavily in Urban Mass Mobility Schemes such as Mass Rapid Transport systems (MRTs)/ metro rail systems and state-of-the-art buses. Hence, manufacturing for mass mobility sector is poised to grow at a high rate in the next few years. This would also give boost to manufacturing related to auto components. Besides vehicles, infrastructure development such as roads, highways, ports, airports, waterways would also require heavy industries to manufacture in India at competitive prices.

6 **National Manufacturing Policy (NMP):** With the objective of enhancing the share of manufacturing in GDP to 25 per cent and creating 100 mn jobs over a decade, the Policy aims to achieve the intended target within the stipulated timeframe. A good percentage of jobs are likely to be created in transportation and automotive sector in coming years.

7 **Skill Development:** Currently, automotive sector provides direct and indirect employment to more than 25 mn people. As manufacturing in Transport and Automotive sector is poised to grow, there is a huge demand for skilled manpower. As per the Automotive Sector Skill Council under NSDC, there is a supply versus demand gap of incremental 35 mn people by 2022. Automotive Sector Skill Council is already working with industry and academia to bridge this gap by developing industry relevant training programmes. The transportation infrastructure development schemes would also provide scope for large-scale employment in construction sector. India has 550 mn employable youth which is a big asset for manufacturing sector. This has attracted large FDI of INR 18.67 lakh crore (USD 280 bn) during the period April 2000 to December 2012.

8 **FAME India Scheme:** On April 8, 2015, GoI announced FAME India, a scheme under the Ministry of Heavy Industries and Public Enterprises. This scheme is a part of National Electric Mobility Mission Plan (NEMMP), which aims to sell 6-7 million hybrid and electric vehicle by 2020, leading to 9,500 million litres of estimated cumulative fuel saving, 2 million tonnes reduction in pollution and GHG emissions, and 65,000 direct to 3,00,000 new indirect jobs.

9 **Voluntary Vehicle Modernisation/End of Life Policy:** In a move aimed at giving thrust to emission control measures, the Union Road Transport Minister has finalised the draft norms of 'end of life' policy which will provide at least 50 percent rebate in excise duty on new vehicles for buyers who surrender their polluting old vehicles. It will result in about 40 per cent increase in automobile production and will significantly bring down pollution.

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