Electrifying India: building blocks for a sustainable EV ecosystem

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ASSOCHAM INDIA

EY
Building a better working world
Electric Vehicles (EVs) have witnessed an unprecedented global interest in recent times, emerging as one of the most promising alternate powertrain technologies with zero tailpipe emissions and long term economic viability. India, too, is actively considering EVs to reduce India’s excessive dependence on oil imports and curb pollution levels. In addition, the country is also looking at EVs as a stepping stone in designing an intelligent transport infrastructure in India. Electrification of mobility is still in nascent stages in India but significant growth momentum is expected over the medium term. The growth, however, is dependent on multiple factors such as technology development, demand creation, price differentials, charging infrastructure and ease of charging for unhindered transportation.

Government’s new guidelines around allowing resale of electricity for vehicle charging services is expected to give more clarity to private developers which were being disincentivize in the past from setting up charging infrastructure. This development provides a level playing field for public undertaking, private players, Discoms, manufacturers as they can partner or compete in the EV charging space.

This knowledge report on electric mobility is designed to provide a deep insight on the current state of the EV mission in India and through this platform the readers shall be able to draw key learnings for the adoption of EVs.

We at ASSOCHAM will continue to provide a conducive platform for exchange of ideas and technical knowhow and promote business interactions and interaction with the policy makers. I sincerely thank EY, our knowledge partners, for their efforts in preparing this paper. We hope these will merit the kind consideration of policymakers.

D.S. Rawat
Secretary General, ASSOCHAM
The global automotive industry is at the cusp of a paradigm shift from internal combustion engine vehicles to zero emission vehicles. This is primarily due to the stringent regulatory interventions by governments worldwide in response to increasing greenhouse gas emissions and depleting air quality. India, too, is actively exploring cost-effective and viable solutions to the problem of poor air quality in a number of its cities. Furthermore, India is also focusing on reducing its excessive dependence on oil imports. The country has announced a significant shift to an all-electric public fleet by 2030, necessitating attention and action by players across sectors including automobile, power and utilities, oil and gas, etc.

The transition to EVs would present challenges for the incumbents, while, at the same time, offering a tremendous opportunity for those who undertake the requisite investments and start planning for the shift. Given the scale of the Indian automotive market, any significant proportion of vehicle electrification by 2030 is likely to present a multi-billion dollar opportunity. Market players across sectors will find it difficult to ignore this as they risk losing out to competitors both from within the industry as well as new entrants from other sectors.

In light of the above scenario, we have arrived at the following considerations for the industry participants that could help them gain ground in the emerging mobility landscape:

- Develop and operationalize a future-of-mobility strategy to position the business in the evolving market landscape.
- Consider alternate business models that decouple ownership (vehicle, battery) and accessibility.
- Explore niche markets and use cases that are more amenable to EV adoption.
- Challenge the type of innovation portfolio required – optimize “how to win vs. where to play”.
- Collaborate across traditional industry boundaries to create a competitive ecosystem.
- Work closely with “city as a customer” – to deliver exceptional consumer experience.
- Collaborate closely with policymakers on pilot programs to demonstrate viability.

The EV ecosystem is an interplay of several sectors and stakeholders. Thus, it is imperative for these stakeholders to come together to drive EV adoption. In a similar way, the government needs to consider the holistic EV ecosystem while developing the regulatory agenda.
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The Indian EV market is at a nascent stage with EVs forming less than 1% of overall vehicle sales. The market is now seeing a renewed interest and engagement on the back of government’s plan to achieve significant electrification by 2030. The transition to EVs is necessary for the Indian automotive industry to continue to retain its foothold and gain additional ground as the world shifts its axis towards EVs.
1.1 Indian EV market and key trends

India has emerged as one of the key automotive markets globally with a dominant position across several vehicle segments. The country is actively exploring cost-effective and viable solutions to the problem of poor air quality in a number of its cities as well as reducing its excessive dependence on oil imports.

The EV industry is at a nascent stage in India and is dominated by e-rickshaws and two-wheelers (2Ws). However, the market has the potential to grow significantly in the coming years. A varied pace of electrification is expected across different vehicle segments driven by specific user groups in India. The growth will depend on multiple factors that will be crucial in making the market ready for electrification of mobility in India.

A brief summary is provided below:

![Figure 3: Segment analysis](source: EY analysis, IEA)

For more details, please refer to EY’s thought leadership report titled “Standing up India’s EV ecosystem - who will drive the charge?”

### Factors driving electric mobility

<table>
<thead>
<tr>
<th>Route predictability</th>
<th>Vehicle utilization</th>
<th>Price differential</th>
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<td>Bus (intra city)</td>
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<td>SCV</td>
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<td>M&amp;HCV</td>
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3W: Three-wheeler; CV: Commercial vehicle; SCV: Small commercial vehicle; LCV: Light commercial vehicle.

- **Favorable**
- **Neutral**
- **Unfavorable**
2-Wheelers (2Ws) are expected to be one of the early adopters of electrification. High vehicle utilization and easy home or workplace charging would drive the uptake in the commercial 2W segment.

2Ws is the largest segment of the Indian automotive industry representing ~80% of Indian automotive sales in FY17 (17.6 million units). Owing to the vastness of this segment, it has a huge potential to promote emission-free mobility in the country.

The e2W segment has already demonstrated its potential in 2011-12, when e2Ws clocked sales of 90,000 units. However, the sales saw a dip in the following years with a withdrawal of subsidies by the Ministry of New & Renewable Energy (MNRE), with sales of only 25,000 units in 2016. However, development of an end-to-end ecosystem (right from in-house manufacturing to setting up the charging infrastructure) by emerging start-ups is likely to accelerate the adoption of e2Ws.

The following aspects would help drive e-mobility in this segment:
- Over 2 million petrol-run 2Ws with a long daily run engaged in courier services
- Intra-city travels (maximum of around 100–150 km a day)
- Ease of charging: Can be easily charged on a standard residential/workplace plug point
India has emerged as one of the biggest 3W markets, with total sales of 0.6 million units in FY17. 3Ws are widely used in India as an affordable means of public and goods transportation over short to medium distances. The segment is also witnessing an influx of e-rickshaws, with some estimates putting their numbers around 1 million.

**3-Wheelers (3Ws)** Given the head start of the e-rickshaw segment, a mild push by the Government could drive a nation-wide adoption.

Considering the lack of essential public transport for last-mile connectivity, e-rickshaws could play a critical role while giving the necessary boost to vehicle electrification in the country. However, there is a need for significant steps to ensure their expansion:

- Make safety and prototype tests mandatory
- Integrate e-rickshaws in city-based mobility plans
- Define area of operation; ascertain limit to the maximum number of e-rickshaws per zone; provide designated parking places as well as charging facilities
- Relax the rate of interest on loans from various financial institutions

**Source:** SIAM, SMEV, EY analysis.

For more details, please refer to EY’s thought leadership report titled “Standing up India’s EV ecosystem - who will drive the charge?”
India is the fifth largest car market in the world with over 3.0 million cars sold in FY17. The market offers a significant growth potential given the car density stands at 34 cars per 1,000 individuals.

Electric car sales have so far been very low on account of multiple challenges such as high cost, range anxiety, lack of EV models, etc. The acceptance of EVs will depend on multiple drivers such as range, cost and charging infrastructure and will also vary for different applications / use cases:

- Corporate fleets, which have a defined route and operations in a limited geography, will be the first ones to adopt
- Government fleet is already one of the areas where EVs are being deployed through the ongoing procurement of 20,000 EVs by Energy Efficiency Services Limited (EESL). These tenders will help provide some scale to EVs and improve the confidence toward the adoption of EVs
- Cab aggregators/fleets are likely to be more willing to adopt EVs as the low running cost of vehicles is one of the major influencers in purchase decisions
- Private consumers are likely to be the last in line to adopt EVs, given the concerns around range, high acquisition cost and lack of awareness

Car sharing and a shift from vehicle ownership to access are likely to significantly push EV penetration, as utilization of a shared vehicle is estimated at 25%-30% as compared to only 4%-5% of a private use vehicle.
**CVs: Electrification of buses allows for an opportunity to showcase a plausible deployment of EVs in the Indian context**

The intra-city bus segment is more market-ready than others because of shorter trip length, route predictability and ease of charging at bus depots. India is already witnessing a few e-bus pilots by state-run transport units (SRTUs) – Navi Mumbai, Himachal Pradesh and Bengaluru – with a few more in the pipeline – Chandigarh, Telangana and Gurgaon.

- The Government is exploring ways to address one of the biggest hurdles – the high cost of e-buses (due to larger batteries). It is developing a plan to work with automakers to reduce the battery size of intra-city buses from 300 KWh to 50 KWh.
- For a large-scale sustainable rollout of fleets of e-buses, there is a need to formulate a city-based approach by running a pilot in smart cities, installing charging points at major bus depots and rolling out pilots of fast charging and battery swapping stations.
- In a welcome move, several state governments have rolled out e-bus tenders in 10 cities. The initiatives should help the market achieve some scale while also increase consumer confidence in EVs.
- In the CV - goods carrier segment, we believe there are niche user groups/applications within the SCV and LCV segments that could see early adoption. Some of the potential applications include postal delivery vans and urban delivery vans/trucks. These vehicles have low average daily run and some route predictability, which can be served by current/upcoming product offerings.
- On the other hand, the electrification of M&HCVs is likely to be further out as the current range does not meet the requirement of average daily run of these vehicles. Additionally, the nature of their operations is also inter-city, which necessitates a widespread network of charging infrastructure on main highways which, currently, is not in place.

Source: SIAM, SMEV, EY analysis

For more details, please refer to EY’s thought leadership report titled “Standing up India’s EV ecosystem - who will drive the charge?”
1.2 Central-level policy frameworks on EV adoption in India

Under the National Electric Mobility Mission Plan 2020 (NEMMP), scheme, a total estimated subsidy worth INR 14,000 crore is planned to be invested in creating infrastructure and promoting the use of environment-friendly electric vehicles.

In 2015, the Government of India launched Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) scheme for a two-year period at an approved outlay of INR 795 crore, with a focus on technology development, demand creation, pilot projects and charging infrastructure. The scheme has been extended till September 2018 or till the time an inter-ministerial consensus on funding for the FAME- II scheme is reached.

Under FAME-II, the government is planning to extend financial support of INR 8,730 crore for five years. The focus area of the scheme is likely to be the electrification of public transport by rolling out a number of electric buses, electric 3Ws and electric shared cabs for multi-modal public transport. The fund support includes INR 2,500 crore for buses, INR 1,000 crore for four-wheelers, INR 600 crore for two wheelers (with maximum speed greater than 25 km) and INR 750 crore for high speed three-wheelers.

The Central Government has taken several fiscal measures to drive EV adoption in the country. Under FAME-II, the government plans to provide long-term tax holidays for domestic manufacturing and levy high custom duties on equipment imports. The proposal of mandatory sourcing of 50% domestic components, 60% in the second year and 70% in the third year is also likely to provide a boost to the ‘Make in India’ program.

Lower rates of GST for EVs has also been implemented by the Government as it is expected to help electric mobility gain momentum:
- Pure EVs have been kept in the 12% tax slab under GST
- Manufacturing of EV batteries and other EV components have been kept under the GST bracket of 28%
- Hybrid vehicles have been kept in the same category as luxury cars and will be taxed at the peak rate of 28% plus a cess of 15%

The Government backed Energy Efficiency Services Ltd (EESL) has issued tenders for 20,000 EVs to be deployed across the country for government use.

The government, in a recent move, has approved distinctive green license plates for electric vehicles in order to encourage people to use them. The purpose behind distinctive number plates is their easy identification for proposed benefits such as concessional toll, preferential treatment for parking and free entry in congested zones. The government is also planning a few other measures such as allowing youth in the age bracket of 16-18 years to drive electric scooters, mandating taxi aggregators to have a certain percentage of e-vehicle fleet and bringing down the GST on batteries to 12% from 28%.

There is an ongoing debate across various ministries on the taxation policy for EVs i.e. whether just pure EVs be kept in a lower GST slab or an emissions based taxation is followed. We believe, clear policy guidelines are essential for the EV market to take-off, given the huge capital investments involved.

We recommend a focus on both fiscal and non-fiscal incentives in the short run and, in order to make the ecosystem self-sustaining, a shift to only non-fiscal benefits in the long-run.

For more details, please refer to EY’s thought leadership report titled “Standing up India’s EV ecosystem - who will drive the charge?”
1.3 State-level policy frameworks on EV adoption in India

Along with the Central Government, various state governments have also started developing their EV and charging infrastructure policies. These states are looking to take advantage of the opportunities presented by the upcoming transition to EVs. States such as Andhra Pradesh, Karnataka, Maharashtra, Telangana and Uttar Pradesh are the first movers, coming up with their own policies to promote the EV ecosystem while electric bus tenders have also been released by several state governments across 10 cities.

**Andhra Pradesh**

The state government is looking to put in place an electric-mobility policy and is seeking to attract investments of INR 30,000 crore in the EV industry by providing capital subsidies to automakers and charging-equipment manufacturers.

As a part of the EV drive, the Andhra Pradesh Government and Energy Efficiency Services Ltd (EESL) have inked an agreement to invest INR 10,500 crore over the next five years to deploy about one lakh EVs in the state. Andhra Pradesh, in its proposed policy is looking at waiving off registration and road tax on the sale of EVs. In addition, the Government plans to impose additional taxes on petrol and diesel vehicles and introduce promotional schemes for women and consumers for 2W purchases.

In order to invite investments into the charging infrastructure, the Government has proposed to provide capital subsidy and SGST exemptions for charging infrastructure installations. They also have a plan in place to provide land at concessional rates to charging stations and battery swapping kiosks and are looking to make it mandatory for bus terminals, bus stops, government offices and public parking to have charging stations.

**Karnataka**

With the aim of becoming the EV capital of India, Karnataka government approved the state's Electric Vehicle and Energy Storage Policy 2017. The new policy aims to attract investments worth INR 31,000 crore and create around 55,000 employment opportunities.

The State Government is looking to set up new EV manufacturing zones, set up charging stations in public and private spaces including airports, railway stations, metro stations, and encourage start-ups to develop business models focused on supporting economic applications for EVs. According to the policy document, the Karnataka Government plans to do the following:

1. Come out with standards for battery, charging infrastructure and swapping mechanism to help build interoperable network where different OEMs can participate
2. Provide land on long-lease basis for setting up of EV fast-charging stations and battery swapping infrastructure
3. Electricity Supply Corporations of Karnataka to bring amendments to their policies and allow resale of power to encourage setting up of charging stations
4. Introduce lease/pay-per-use business models with battery-swapping station network in partnership with private players
5. Facilitate the deployment of used EV batteries for solar application, and provide battery disposal infrastructure in PPP
In the first phase, the policy will be implemented in six cities: Mumbai, Pune, Nagpur, Thane, Aurangabad and Nasik. The salient features of the policy are as follows:

1. A subsidy of 15 per cent of the total cost of the EV will be given to the buyer. However, this will be limited to only the first 1 lakh EVs that are registered in the state. To further bring down EV prices the government has also exempted them from road tax and registration fees.

2. EV manufacturers are now allowed to set up charging stations at existing petrol pumps (subject to safety clearance), and the first 250 charging stations to set up will get a subsidy of 25 per cent from the state government.

3. To make charging the EVs cheap the charging stations will get electricity at a tariff that is on par with residential electricity rates.

Source: EY analysis
Enabling ecosystem for electric mobility in India
Technology advances have blurred the line between multiple sectors/stakeholders operating in an EV ecosystem. Electric mobility is increasingly augmented and interconnected by technologies, where both power and information flow in both directions across vehicle and information systems.

While EV solutions will vary from market to market – with multiple solutions most likely to drive new customer relationships and service opportunities – a number of new players from multiple sectors are entering the EV value chain, such as equipment manufacturers, software, and networking and consumer electronics companies.

For the scope of this publication, we are focusing on the following three major themes:

- Charging infrastructure
- EV components manufacturing
- Technology and telematics

In chapter 3, 4, and 5 we will discuss in details on the above themes around the recent developments, major challenges and impact of EV adoption on the system as a whole.
Charging infrastructure in India

One of the major barriers to the adoption of EVs is range anxiety. Globally, the proliferation of EVs has taken place with several incentive mechanisms and federal policies such as subsidies, tax breaks and fee bates. But apart from a strong mandate from governments, it is evident that a thriving network of charging infrastructure plays a pivotal role in the proliferation of EVs.
A blossoming EV market is accompanied by a world record number of electric vehicle supply equipment (EVSE) installations, also known as EV charging points. In 2016, the total installed publically accessible chargers grew to 322,265, an increase of 72.2% from 2015. With more than 80,000 installations last year, China has become the global leader in installed charging stations.

The growth dependency of EV adoption and charging stations is often described as the chicken and egg problem, i.e., the need for ample EV penetration as a prerequisite for EV charging infrastructure deployment vs. the need for abundant EV charging infrastructure as a prerequisite for EV adoption.

However, recent studies confirm that availability and accessibility of reliable public charging infrastructure must precede dense EV penetration. In the absence of a robust charging infrastructure, EV fleet growth will also be difficult to sustain, as can be seen in the example of California. The region of California leads the US EV adoption, with 269,000 vehicles sold from 2011-16, representing nearly 48% of total EV sales across the US. However, charging infrastructure has not kept pace with the EV growth, with only 12,000 public chargers available in California.

Source: EY Analysis, IEA
Note: “Others” include Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Lichtenstein, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Switzerland and Turkey. Countries with battery swapping pilot/programs include US (Tesla), China, Israel (Better Place) and Taiwan (Gogoro).
3.1 Current penetration of charging stations and proposed pilots

We are already witnessing a divergence of business models for operators of charging infrastructure aimed at the users of private EVs. As of now, India has about 222 charging stations (353 charger units). Recently, EESL floated a tender for 4,500 chargers for installation in Delhi NCR. However, many installations are taking place in the country at a pilot level, offering free charging services to consumers:

**Automobile/fleet aggregators**
- A leading EV manufacturer in India has entered into an agreement with chain of malls to set up charging points and is investing in setting up charging stations at the Bangalore airport
- A leading car aggregator has set up a network of 10 fast chargers (initially) across three strategic locations as part of a pilot

**Utilities**
- One of India’s largest private sector power company is investing INR 600 crores to set up 1,000 charging stations in Delhi, including free stations. It is setting up charging points at Mumbai at a regulated tariff of electricity
- A large European player has set up a charging station at NBCC’s premises and plans to set up about 150 charging stations along with cloud-based solutions and payment gateways
- EESL is facilitating the installation of 2,500 chargers to cater to 10,000 e-Cars being procured for government

**Oil and gas**
- Multiple oil companies are setting up EV charging stations at their petrol pumps
- India’s first ever fast DC charging station was setup in Nagpur at a company owned and operated outlet of India’s largest oil company

**Heavy industries**
- DHI has expressed interest for city administration to avail subsidy of INR 120 crore for 11 cities, of which INR 15 crore shall be provided for installation of charging infrastructure and the rest for the procurement of EVs

Source: Interviews with industry executives, EY analysis.

Over the last year, the Indian Government has held extensive discussions with many companies, both domestic and foreign, for setting up a charging infrastructure. EESL has floated a tender of 2,000 electric vehicle chargers for the second phase of its EV programme and is looking to float additional tenders during the course of the year.

Despite the progress, the lack of standardization remains a key challenge. Going forward, in order to meet the rising demand of charging stations the Government will have to quickly facilitate standardization of charging infrastructure and incentivize R&D for advanced charging technologies.
### 3.2 Current charging policy, standards and expected developments

The charging infrastructure is being developed in the country keeping in mind the following criteria:

- Affordable on-board and off-board chargers
- Affordable cost per KWh (efficiency) for end users
- Minimum support and investments from the Government in the form of subsidy
- Development of open standards that can be adopted by manufacturers

#### In order to achieve the EV target, policy interventions are inevitable for facilitating the growth of the ecosystem, of which charging infrastructure is a vital component

The April 2018 ruling on the non-requirement of separate distribution licence for setting up charging stations for electric vehicles, provides a big boost to ambitious EV plans. The charging of battery of an electric vehicle by a charging station involves a service requirement and not an activity of transmission, distribution or trading of electricity, which would require a license under the 2003 Electricity Act. This development is expected to create a level playing field as public undertaking, private players, Discoms, manufacturers can partner or compete to capture the opportunity.

In addition, provisions related to standardization for widespread charging infrastructure deployment will play a crucial role in widespread deployment.

##### Solutions that need to be developed for India:

- Specifications of the AC and DC chargers must cater to open standards
- Standardized communication and billing standards are required
- There must be energy consumption monitoring, control, metering and storage specifications

In order to develop a robust information exchange system, communication and billing are major concerns for which standards and mechanisms need to be developed.

##### Standardization of communication protocols for data exchange:

- Communications between EV and charging stations/EV supply equipment (EVSE)
- Communications between EVSE and central management system (CMS)
- Grouping of stakeholders such as manufacturers of vehicle, charging stations and batteries as per the functional requirements for the development of a standard communication protocol

#### Current technology landscape for AC chargers:

<table>
<thead>
<tr>
<th>AC charging infrastructure available in India</th>
<th>Hardware requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public charging EVSEs 230 V, 15 A</td>
<td>IEC 60309* industrial socket with an optional energy meter and RFID prepaid card reader for payment, authentication, monitoring and control</td>
</tr>
<tr>
<td>AC fast charging: 3 phase, 415 V, 63A</td>
<td>IEC 61851 Type 2 socket</td>
</tr>
</tbody>
</table>

#### Current technology landscape for DC chargers

- **Globally**
  - Japan: CHAdeMO
  - China: GB/T 20234
  - Europe: EN 62196-3
  - US: SAE J1772 Combo

- **India**
  - Prevalence of BEVs with lower voltage (48-72 V) drivetrains and high currents
  - A large number of xEVs with higher voltage and lower current systems in the market

DC fast charging standards may be split based on voltage (e.g., less than 100VDC and greater than 100V) in order to facilitate safety requirements and interoperability between vehicles and charging stations.
3.3 EV charging investment models and strategies

As the EV penetration picks up, there will be an ever-increasing requirement to have a wide charging infrastructure. While home charging would continue to be the preferred mode for EV charging in the next few years, increasing focus will have to shift toward building public charging infrastructure. Destination chargers (e.g., workplace charging) and parking spaces (with charging ports) will have to be created, as vehicles remain parked there for longer durations and can serve a large base.

Implementing an appropriate EV charging infrastructure does not necessarily mean mandating an outlet at every street corner. It means creating a profitable industry where the economics are profitable and self-sustaining to justify the investment as the market develops. This will depend on understanding the EV charging value chain and developing innovative business models. In the entire value chain, distinct business activities are grouped to develop five potential business strategy variants for different spheres of operations.

**Figure 6: EV charging business models**

<table>
<thead>
<tr>
<th>Business strategy</th>
<th>The builder</th>
<th>The maintenance installer</th>
<th>The broker-operator</th>
<th>The grid master</th>
<th>The guardian</th>
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</thead>
<tbody>
<tr>
<td><strong>Charging infrastructure sphere</strong></td>
<td>Branded/unbranded station manufacturer</td>
<td>Installation and maintenance services</td>
<td>Smart grid and smart charging interface</td>
<td>Metering and billing capability</td>
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<td></td>
<td>Charging Station retailing</td>
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<td><strong>OEM sphere</strong></td>
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<td>In-vehicle charging info – telematics</td>
<td>Mobile/Web portal</td>
<td>Network software</td>
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<td><strong>Utility sphere</strong></td>
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<td>Smart grid management</td>
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<td><strong>Customer sphere</strong></td>
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<td></td>
<td></td>
<td>Vehicle purchase, operations</td>
<td>Battery re-cycling</td>
</tr>
</tbody>
</table>

*Source: EY analysis*
India suffers on the infrastructure front and mobility solutions are not that fluid, which stalls the growth of charging infrastructure. This directly increases the issue of range anxiety multifold and has a direct impact on the EV adoption. The required need at this point in time is the presence of related support industry and infrastructure as it will help the charging infrastructure thrive.

The Government of India is trying to create an investor-friendly environment to push the adoption of EVs, creation of EV charging infrastructure and launch of various schemes to promote EVs. We expect the Government to take active measures to streamline regulatory challenges and provide further policy impetus to drive uptake of EVs.

### 3.4 Outlook for EV charging infrastructure in India

EVs and the EV ecosystem is still evolving in the Indian context, with home charging emerging as the primary option mainly due to the lack of public charging facilities. We expect the share of public charging to grow; however, home charging would still continue to be the dominant source with a share of nearly 70% in 2030. Overall, the charging models are expected to vary by vehicle category. Both short-term and medium-term overviews of this are given in the table below.

### Figure 7: EV charging short term and medium term growth plan

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<th>Category</th>
<th>Segment</th>
<th>Short term (2018-19)</th>
<th>Medium term (2020-22)</th>
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<tbody>
<tr>
<td>3Ws (e-rickshaw and e-auto)</td>
<td>Fleet</td>
<td><img src="image" alt="Personalized charging" /></td>
<td><img src="image" alt="Public charging" /></td>
</tr>
<tr>
<td>e-Buses</td>
<td>Fleet</td>
<td><img src="image" alt="Personalized charging" /></td>
<td><img src="image" alt="Public charging" /></td>
</tr>
<tr>
<td>Cars (4-wheelers)</td>
<td>Private</td>
<td><img src="image" alt="Battery swapping" /></td>
<td><img src="image" alt="Battery swapping" /></td>
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<tr>
<td></td>
<td>Fleet</td>
<td><img src="image" alt="Battery swapping" /></td>
<td><img src="image" alt="Battery swapping" /></td>
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<tr>
<td>2W</td>
<td>Private</td>
<td><img src="image" alt="Battery swapping" /></td>
<td><img src="image" alt="Battery swapping" /></td>
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<tr>
<td></td>
<td>Fleet</td>
<td><img src="image" alt="Battery swapping" /></td>
<td><img src="image" alt="Battery swapping" /></td>
</tr>
</tbody>
</table>

Source: EY analysis
3.5 Impact of EV charging on the power and utilities value chain

Growing EV penetration is likely to have a varied impact on different players in the power and utilities value chain. An EV with a daily commuting distance of 30-40 km will need an energy of 6-8 KWh, which is equivalent to daily power needs of a small household. Hence, adding one more EV in the neighborhood will create a similar impact on the local electricity network as of one more household metering point. This has presented with unique challenges for electrical utilities, where the shift from fuel to electricity requires an increase in electrical production, and resolve the problem of clustered charging, which can create a localized problem for the grid. The risk of overloading local transformers is particularly high during peak hours, when all EV owners in the neighborhood decide to recharge them at the same time. Utilities across the globe are looking to modify customers’ demand by offering EV owners discounted rates for charging their vehicles during off-peak hours.

Managed charging, also known as smart or intelligent charging, entails a combination of infrastructure and communication signals sent directly to a vehicle or via a charger to influence the driver’s decision on when to charge the car. The leading US utilities are running a pilot featuring special rates encouraging electric car drivers to charge their vehicles when the electricity supply is abundant and the prices are low.

Despite all the above challenges, if handled correctly, EV provides an impactful and beneficial cross-cutting opportunity for power sector stakeholders and can enable transformation to a green and efficient power sector in India. Arrival of electric mobility is expected to help the P&U sector realize net cost and revenue benefits from both the demand and the supply side. A summary of these benefits is tabulated below.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Net Revenue Benefit</th>
<th>Net Cost Benefit</th>
</tr>
</thead>
</table>
| Supply-side (power utilities) | - EVs and charging infrastructure could present substitute demand for distribution utilities, reduce cross subsidization losses to utilities and bring in additional revenue  
- As a new source of revenues, utilities can diversify into EV charging infrastructure and related services of developing, operating and maintenance | - Setting up charging stations require power supply infrastructure (including transformers and substations) to cater to large amount of electricity required in these stations – discoms already possess required power infrastructure  
- Advancements in Vehicle to grid technologies can provide discoms a cost effective method for grid balancing  
- As the entire distribution grid and customer interface becomes smarter with EV deployment, the T&C losses for the utility will reduce and overall systemic efficiency will improve |
| Demand-side (utility consumers) | - Second life for repurposed EV batteries and vehicle to grid can lead to revenue generation through net metering for customers  
- Setting up of captive and public charging infrastructure, and exploring innovative business models, under the facilitative regulatory environment could spur revenue generation opportunities for the consumers | - With high demand for batteries, integrated battery supply chains and markets for ancillary services will develop, leading to reduced storage cost for customers  
- A possible integration of EV charging, distributed renewable generation and peer-peer transactions through blockchain technology could lead to energy independence for utility customers  
- As investments in storage technologies increase and its costs reduce, increased usage of storage in public EV charging infrastructure can lead to better business viability as it will negate the need of signing up for fixed demand charges |
3.5.1 EVs to provide a boost to India government’s power sector goals

The power and utilities sector in India is undergoing rapid transformational developments — reducing dependence on imported coal, rising energy independence with renewables, reducing plant load factors (PLFs) and national grid integration to name a few.

Increasing adoption of EVs across India will be instrumental in transforming the country’s power sector. The surge in electricity demand from EVs will help recover the slow demand growth in India. By 2020, the overall electricity demand from EVs is projected to be around 79.9 GWh and is expected to reach 69.6 TWh by 2030. The overall EV demand is expected to help utilities earn an estimated US$11 billion (INR700 billion) in revenue by 2030. The impacts of high EV adoption are expected to start showing positive results within 5-7 years in the power sector, while a few developments will take a bit longer to have a meaningful impact.

Upgrading infrastructure: The Government’s stance on aggressively pushing EVs raised the need for an improved charging and T&D infrastructure, which will help DISCOMs improve operational efficiencies.

New source of revenues for DISCOMS: Higher electricity consumption due to demand from EVs would help bridge the regulatory assets on the balance sheets of DISCOMs in the long term.

Also, DISCOMs are diversifying into EV charging infrastructure to seek a new source of revenues.

Connecting charging with renewables: EV charging can enable optimal utilization of renewable energy by shifting the charging load to day time instead of night. Solar power-based charging stations could play a significant role to achieve this.

EVs can act as a mass distributed medium of storage to level the load curve and provide sufficient evacuation of renewable energy power.

Reducing grid energy storage cost: High demand for batteries will lead to the development of integrated battery supply chains, which are bound to considerably lower the costs of storage.

Lower storage costs will in turn help lower landed renewable energy costs and make its evacuation more efficient.

Achieving carbon emission reduction targets: By 2030, EVs are expected to reduce emissions by 40-50%, compared to ICE vehicles in an aggressive renewable energy scenario. However, even if the grid continues to be coal heavy, emissions are likely to reduce by 20%-30%
3.5.2 Challenges currently faced by power distribution companies in providing efficient charging facilities

**Poor financial health of DISCOMs:** For many decades, DISCOMs were supplying electricity at tariffs far below cost, accumulating massive losses and mounting debts over the years. This led to the launch of UDAY Scheme in 2015, when DISCOMs reported an annual loss of INR600 billion and total accumulated debt of INR3.96 trillion. Despite an improvement over the last two years, annual losses still stand at ~INR400 billion, which can continue to restrain DISCOMs from taking any new investment decisions.

**Stressed distribution networks:** Many parts of India are still facing power shortage, with 16 states and 2 union territories (UTs) reporting electricity deficits in FY17. Northern, Eastern and Northeastern regions have stressed electricity networks. Increasing adoption of EVs is expected to boost electricity demand, which may put additional strain on the electricity networks and lead to more load shedding and power outages, especially in regions that are already facing deficits.

**Lack of regulations for charging services:** The Government is in discussion to standardize charging infrastructure development in India. Many norms are proposed to standardize the market, but they are still in the planning stage. Additionally, EV charging tariffs are regulated at some locations, while tariffs are not fixed at other locations. There is a growing need for a national regulated rate that can be applicable to all charging stations across India.

Despite these challenges, DISCOMs are entering the EV charging space:

One of India’s largest private sector power company is among the few distribution companies that are exploring this space and have aggressive plans for expansion:

- Announced plans to invest INR6 billion to upgrade its power transmission network and install 1,000 charging stations across Delhi
- Installed its first charging facility in Mumbai in August 2017 and in talks to install more stations in the city
- Launched two free charging stations for electric 2Ws in North and North West Delhi
The success of India’s EV mission depends on the development and proliferation of the domestic manufacturing ecosystem. However, the absence of an EV supply chain in the country demands an urgent investment in domestic R&D and local manufacturing capabilities.
4.1 Current EV supply chain scenario

The transformation from ICE vehicles to EVs has significant implications for the existing automotive industry supply chain. The growth of EVs will lead to profound changes in the automotive value chain, including technology, manufacturing systems, ownership models, distribution and aftermarket support. An EV is relatively simpler to build with only 20 moving parts against ~2,000 in an ICE vehicle. This would have a significant impact on the incumbent automakers while also disrupting the supplier ecosystem on the back of a major decrease in the addressable market for vehicle repairs/service and would require them to build new capabilities.

From the perspective of component suppliers, large automotive suppliers are likely to adapt to the dramatic changes; however, small players could be hit the hardest by this disruption. The existing suppliers will not only have to deal with the transition but also face severe competition from the new entrants in the industry such as technology companies and battery producers.

OEMs likely to lose some control in the EV value chain: EVs are less complex to manufacture as compared to ICE vehicles with far fewer moving components and the battery constituting around 50% of the value of the vehicle. This would result in a dilution of control for the OEMs.

Significant changes in component manufacturers’ portfolios: Existing powertrain-related suppliers would lose market share, in an all-EV scenario, while new opportunities would emerge in EV parts such as battery, motors, controllers and microprocessors.

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**Figure 11: Impact on major auto-components**

Source: EY analysis
The changes in the manufacturing supply chain will have long-term implications on market leaders and component manufacturers:

► OEMs need to reinvent their business to focus on building relationships with battery and electric/electronics component suppliers and also explore opportunities for in-house battery manufacturing
► Given the ease of manufacturing of EVs combined with a larger trend of increased vehicle sharing, there is a risk of vehicles getting commoditized and thus an increased focus on OEM brand differentiation would be required
► Component manufacturers need to re-align their product portfolios as the industry transitions to EVs
► Given EVs are a cross-sector play, new sources of value creation will need to be discovered and the pecking order of the industry participants will get redrawn

There is a need for a long-term supply-side incentives that attract desired investments required for EV deployment.

Figure 12: Incentive support to ancillary manufacturers

<table>
<thead>
<tr>
<th>Medium term: 2018-22</th>
<th>Long term: 2022 onward</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>Provide incentives on EV R&amp;D investments and development costs</td>
<td>Incentivize development of local technology</td>
</tr>
<tr>
<td>03</td>
<td>04</td>
</tr>
<tr>
<td>Continue reduced GST / taxation incentives for EVs till 2030, components, batteries should also be included</td>
<td>Explore provision of tradeable carbon credits to OEMs</td>
</tr>
</tbody>
</table>

Source: EY analysis, For more details, please refer to EY’s thought leadership report titled “Standing up India’s EV ecosystem - who will drive the charge?”
4.2 Battery storage technology

4.2.1 New emerging battery technology and global best practices

As EVs gain traction, there is an increased focus on finding and adopting an optimal battery solution that provides the highest energy density for maximum range. Lithium-ion batteries are currently used in most of today’s electric cars, and it is likely that they will remain dominant in the coming future.

The growth in the production capacity is likely to be led by China, with 62% of the Li-ion mass production set to be in China by 2020. EVs are likely to account for around 40% of the total battery production (in GWh) in 2020, and the requirement is expected to further grow up to almost 60% by 2024. According to BNEF, the annual demand for Li-ion batteries from EVs is expected to reach around 1,293 GWh in 2030, representing an annual growth of 32.49% from the 2015 levels.

Researchers are also working on “beyond lithium” projects, and are looking at other technologies that are more efficient in terms of energy density and can replace Li-ion in the long run.

1. **Solid-state** batteries are getting significant attention as they can operate at super capacitor levels to completely charge or discharge in just minutes. Their construction provides several advantages: no electrolyte leaks or fires, extended lifetime, decreased need for bulky and expensive cooling mechanisms and the ability to operate in an extended temperature range between -30°C and 100°C.

2. **Lithium-air batteries** offer far greater energy density - maybe as much as 10 times more. As cathode typically makes up most of the weight in a battery, having one made of air is a major advantage. However, these batteries suffer from poor cycle life and cyclability issues.

Toyota has been focusing on solid-state and Li-air batteries and is reportedly planning to begin releasing plug-in EV utilizing solid-state battery tech in early 2020. Another automotive giant BMW has announced to partner with Solid Power to develop solid-state batteries for use in BMW’s future EV models and is targeting to field solid-state batteries in commercial vehicles within 5-10 years.
4.2.2 Locked smart (LS) batteries

There is a need to distinguish Li-ion batteries in EVs from the ones used for other applications, so that different tax and regulation treatment can be provided if needed. LS batteries are batteries designed to be used with EVs and cannot be used for any other applications. This is especially important when the battery is leased/sold separately from the vehicle.

LS batteries are specially designed smart lithium batteries built to power authorized EVs only. They work with a highly secured encryption algorithm that exchanges a unique key during each use to ensure they are used only by authorized EVs (and no other applications) and authorized charging and swapping stations.

- They cannot be charged except at the authorized charging and swapping stations.
- They cannot be discharged except in the authorized vehicle.

These batteries are programmed with a unique encrypted key to be used for authenticating the specific vehicle and the chargers where such batteries will be charged. These keys are generated in such a manner that they cannot be changed except by authorized personnel. When LS batteries are used by a charging-cum swapping operator, a discharged LS battery can be swapped with another charged locked smart battery. The new swapped LS battery shall be specifically authorized again at the time of swapping to be usable with that specific vehicle only. The returned discharge battery shall go for charging to the bulk charging station.

4.2.3 Battery manufacturing in India

In order to achieve significant electrification of automobiles by 2030 and beyond, India needs a robust and competitive battery manufacturing supply chain. As per a report by NITI Aayog and Rocky Mountain Institute, India would require to set up a minimum of 20 Gigafactories to produce batteries at an investment of US$100 billion for meeting India’s EV targets.

However, lack of clear long-term policies, technology uncertainty, low mineral reserves and absence of major EV battery producers are preventing investments in battery storage technologies in India. As EVs gain traction in India, OEMs are looking to secure access to Li-ion reserves and R&D capabilities to manufacture batteries indigenously. Going forward, a number of foreign collaborations, partnerships and consortiums between OEMs, battery producers and suppliers could be expected.

While the policy and regulatory framework for battery storage system does not exist at the Central Government level; however, State Governments of Uttar Pradesh, Karnataka and Telangana have, in particular, proposed some policies for battery storage in their EV policy draft.

<table>
<thead>
<tr>
<th>Karnataka</th>
<th>Telangana</th>
<th>Uttar Pradesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>The State targets to set up 5 GWh of EV battery manufacturing capacity. It plans to offer special package of incentives for ultra mega and super mega Li-ion battery manufacturers catering exclusively for EVs and the EV charging or swapping infrastructure.</td>
<td>The State targets to develop an automotive electronics park and will offer special status and incentives to units manufacturing batteries cells/packs for EVs.</td>
<td>The state government plans to offer special incentives and concessions to attract investments in EV battery manufacturing and assembly</td>
</tr>
<tr>
<td>It aims to facilitate the deployment of used EV batteries for solar application, and will provide battery disposal infrastructure in the PPP model.</td>
<td>The Government will provide capital subsidy of 35% (cap of INR10 million) and 25% (cap of INR100 million) for the first 10 companies involved in batteries cells/packs for EVs manufacturing.</td>
<td>It targets to create a capacity of 2000MWh for manufacturing or assembling of EV battery in the state, thereby creating 10,000 job opportunities over time</td>
</tr>
<tr>
<td>It will offer investment subsidy of 20% of the value of fixed assets (VFA) (maximum INR200 million per project) for the first two units in the state.</td>
<td>Battery manufacturing/assembly units will be extended a rebate of 50% of the cost (upper limit of the rebate at INR1.5 million per acre) to the first 10 units.</td>
<td>Plans to set-up EV Skill centres will be set-up in collaboration with the industry to offer courses on electric mobility, repair and maintenance, battery manufacturing and maintenance</td>
</tr>
</tbody>
</table>

Source: State Government websites of Karnataka and Telangana
4.2.4 Battery recycling and disposal: Repurposed EV batteries

EV batteries have a shelf life of less than 10 years and after 8-10 years of usage, they are not considered fully functional to power an EV. However, studies have proven that 70%-80% of the initial battery capacity can be retained and batteries may function for up to 25 years. Such an EV battery can serve the purpose of utility/home storage, reducing overall cost without seriously compromising the storage capacity or quality. A potential cumulative capacity availability of “second use” batteries is expected to be around 1,000 GWh by 2030, at a repurpose rate of 80% and at a replacement timescale of 7 years.

Several global automakers are establishing storage arrays with repurposed EV batteries for remote facilities and data centers, combined with renewable capacity to provide power equivalent to baseload supply.

At present, India does not have any policy framework or mechanism for the battery recycling and second use market. However, in order to achieve its electrified mobility target, reclaiming the materials from old Li-ion batteries in a certified and sustainable manner should be a huge priority of the Government of India. The Government should focus on the following:

► Using an environmentally friendly method of recycling involves significant investments in infrastructure and technology, and the Government should develop a detailed incentive framework such as investment subsidy for setting up plants, tax holiday and income tax deduction for R&D

► The battery recycling market should be organized, where all vehicle suppliers should take back used Li-ion batteries and enable second-use of these batteries before giving them to a suitably certified recycling organization for disposal
Technology landscape in the EV ecosystem
Many new emerging technologies could play a supportive role in making the entire EV charging value chain more efficient and profitable. A number of disruptive startups with new models are expected to come up in these areas.

**Digital payments and blockchain**
- There is a need to provide a hassle-free payment mechanism, where users will be directly billed using their vehicle’s unique identification number, with transactions being secured through a blockchain layer.
- Share&Charge, a decentralized marketplace that connects EV owners with private and public charging stations, has released its mobile app enabling digital payments secured using an Ethereum blockchain.

**Data analytics**
- Data analytics is likely to be a great enabler of improvements in charging services. The analysis based on data sets can be used for anomaly detection and preventive maintenance by helping estimate the present energy consumption and future demand, load on grid during peak demand and recharge pattern.
- A US-based charging station operator, provides data around charging patterns, charging times, sessions lengths, idle time etc., which can be analyzed using various data analytics tools.

**Solar-based charging stations**
- As India plans to reduce its dependence on oil imports, it is shifting its focus toward solar PV. Using solar-based charging stations for EV will help optimally utilize renewable energy by shifting the charging load to different times of the day depending on overall demand. This would help take off additional load from the grid and ensure energy security apart from being the cleanest fuel.
- A Taiwan based e-scooter manufacturing company has come up with a new initiative where the swapping stations run on solar power.

**Vehicle-to-grid (V2G) charging**
- Integrating EV with the grid can provide various benefits as it would provide additional storage device to make the grid more resilient and could also serve as a load-balancing device.
- A Japanese automobile manufacturer in collaboration with an Italian utility has announced a V2G trial with 100 V2G units.
- A Netherlands-based utility has announced a pilot with a charging solutions provider to explore whether EVs can provide reserve capacity without disturbing the European grid frequency.
5.2 Telematics: A key enabler for EVs

Telematics could play an important role in providing a boost to EVs by providing an anxiety-free EV ownership experience for drivers as well as smartly managing charge of the vehicle. It could support a new generation of intelligent transport solutions by embedding intelligence into vehicles using sensors and chips and help improve communication between different stakeholders (automakers, dealers, mobility providers, power and utility players, technology companies, etc.).

The global telematics market is estimated to grow at a CAGR of 28% between 2017 and 2022 to reach a revenue of more than USD 230 billion by 2022 with more than 100 million new cars having some form of connectivity.

From an India perspective, the growing population of smartphone and falling data costs have resulted in an ever-connected consumer. India now represents second biggest internet user base in the world with around three fourths of users accessing internet through mobile phones. The telematics market in India is still at a nascent stage (at the initial stages of Telematics 3.0), however, multiple connectivity options, changing consumer preferences and low cost data are providing momentum to the market with OEMs introducing new features leveraging connectivity.

Embedding telematics into EVs can enable:

- Lower range anxiety: Telematics solutions can provide the driver with information about the state of charge, the distance that can be covered with the charge remaining, the location of the next charging station, the distance and directions to reach that station, and the availability and booking of that charging station.

- Managing the charge of the vehicle: Telematics solutions can facilitate (1) smart charging capability to manage the power used by EVs, such as adjustments in charging based on load, (2) vehicle to grid charging, (3) time of charging (users can charge during off-peak hours when rates are the lowest) and 4) notification to owners when the charging stops or is unplugged.

420 million: Number of estimated mobile internet users in India in June 2017, up from 389 million in 2016

The Indian market is already seeing a growing use of telematics involving multiple services such as navigation, safety and security services (emergency and breakdown calls), fleet/asset management, insurance telematics, etc. We believe that telematics based services are likely to become standard offerings as part of the overall EV package and, in the medium to long run, the focus will increasingly shift toward EV to grid interaction, more sophisticated infotainment solutions, such as live traffic, weather, streaming content and cloud-based applications.

Sources: Internet and Mobile Association of India, Netscribes, Statista, SBD, EY analysis

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Evolution of automotive telematics

<table>
<thead>
<tr>
<th>Telematics 1.0</th>
<th>Hands-free calling and screen-based navigation</th>
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<tbody>
<tr>
<td>Telematics 2.0</td>
<td>Portable navigation and satellite radio</td>
</tr>
<tr>
<td>Telematics 3.0</td>
<td>Introduction of comprehensive connectivity to the vehicle</td>
</tr>
<tr>
<td>Telematics 4.0</td>
<td>Seamless integration of mobility and the web – the biggest opportunity yet</td>
</tr>
</tbody>
</table>

Major Stakeholders: Telematics is about cooperation between different stakeholders and developing an integrated product offering

| Automotive Industry | Government | Telematics service providers | Insurance Sector |
| IT Industry         | Telecom Sector | Power and Utilities | BPO & Others |

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Electric mobility in India: Leveraging collaboration and nascency
Bringing it all together toward smart and sustainable mobility

The combination of disruptive trends such as sharing economy, vehicle electrification and connected car are likely to transform the Indian automotive industry and present an unimagined mobility experience.
Evolving demographics, urbanization, digitization and collaborative consumption are likely to disrupt the mobility ecosystem. The future urban mobility network will involve vehicles with connectivity and digital technologies enabling the provision of customizable mobility packages, and stakeholders will compete for a share of customers’ mobility spend.

In line with what we are witnessing globally, the Indian market is also witnessing proliferation of technology-driven mobility service providers, as the consumer is being drawn towards the idea of “access” from “ownership”. The Indian market has witnessed a growth in shared mobility as a result of evolving demographics, rising disposable income and confluence of smartphones and internet penetration, which could help bring in the new age of mobility.

- **31%** of people were residing in Indian Urban areas in 2011, set to go up to **40% & 58%** in 2030 & 2050 respectively
- **10%** of miles driven in 2015 estimated to be shared, the number could reach **25%** by 2030
- **30%** of cars in India estimated to be bought as second cars in the household, one of the segments worst hit by car sharing
- **3.5x** Faster replacement rates of a shared vehicle as compared to a private vehicle, which will support vehicle sales to some extent


Driven by rising real incomes and low penetration rates (in both car ownership and per capita miles travelled), the Indian mobility market is likely to be one of the fastest growing in the world. However, car ownership is likely to grow since it is a highly aspirational purchase and first time buyers will drive the market, at least, over the next decade or so.

### Smart mobility spawning a whole new automotive industry ecosystem

<table>
<thead>
<tr>
<th>Product Centric</th>
<th>Value Added/Infra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ride hailing</td>
<td>Multi-modal solutions + mapping</td>
</tr>
<tr>
<td>Ride sharing</td>
<td>Connected car</td>
</tr>
<tr>
<td>Car sharing</td>
<td>On-demand delivery</td>
</tr>
<tr>
<td>Bike sharing</td>
<td>Smart parking</td>
</tr>
<tr>
<td>Fleet management</td>
<td>Clean Tech/ Electrification</td>
</tr>
<tr>
<td></td>
<td>Autonomous vehicles</td>
</tr>
</tbody>
</table>

**Note:** The list of ecosystem services above is non-exhaustive

Sources: EY analysis

At present, the industry is in generation 1.0 and has already implemented ride sharing and ride-hailing models. The adoption of new innovative models and technology advancement will drive the industry into the next generation mobility solutions, where vehicles will be considered as a platform. Smart mobility will also increasingly lead to boundaries blurring in multiple industries such as automotive, insurance, car rentals, logistics, telecoms, energy and media creating a whole new industry ecosystem.
6.1 Considerations for key stakeholders

**Vehicle manufacturer**
- Develop and operationalize a future of mobility strategy to position the business in the evolving market landscape
- Re-design the organizational structure to include new businesses such as vehicle/battery leasing through captive arms
- Explore niche markets and use cases that are more amenable to EV adoption

**Component suppliers**
- Re-align business model in view of changing powertrain requirements
- Explore tie-ups/collaborations to penetrate the EV market
- Assess opportunities in localization of manufacturing operations
- Battery manufacturers to tie-up with charging operators for battery swapping

**Utilities**
- Develop smart grid capabilities such as smart metering and Vehicle to Grid charging
- Offer special time-of-use rates for charging
- Explore innovative business models such as pay per use
- Set up independent line for charging stations

**Mobility providers**
- Identify business models and specific use cases where EVs could offer better value proposition over ICE vehicles
- Target cities as customer: Align current vehicle portfolio to include EVs to match city-specific mobility needs
- Explore alliances/partnerships with other stakeholders
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