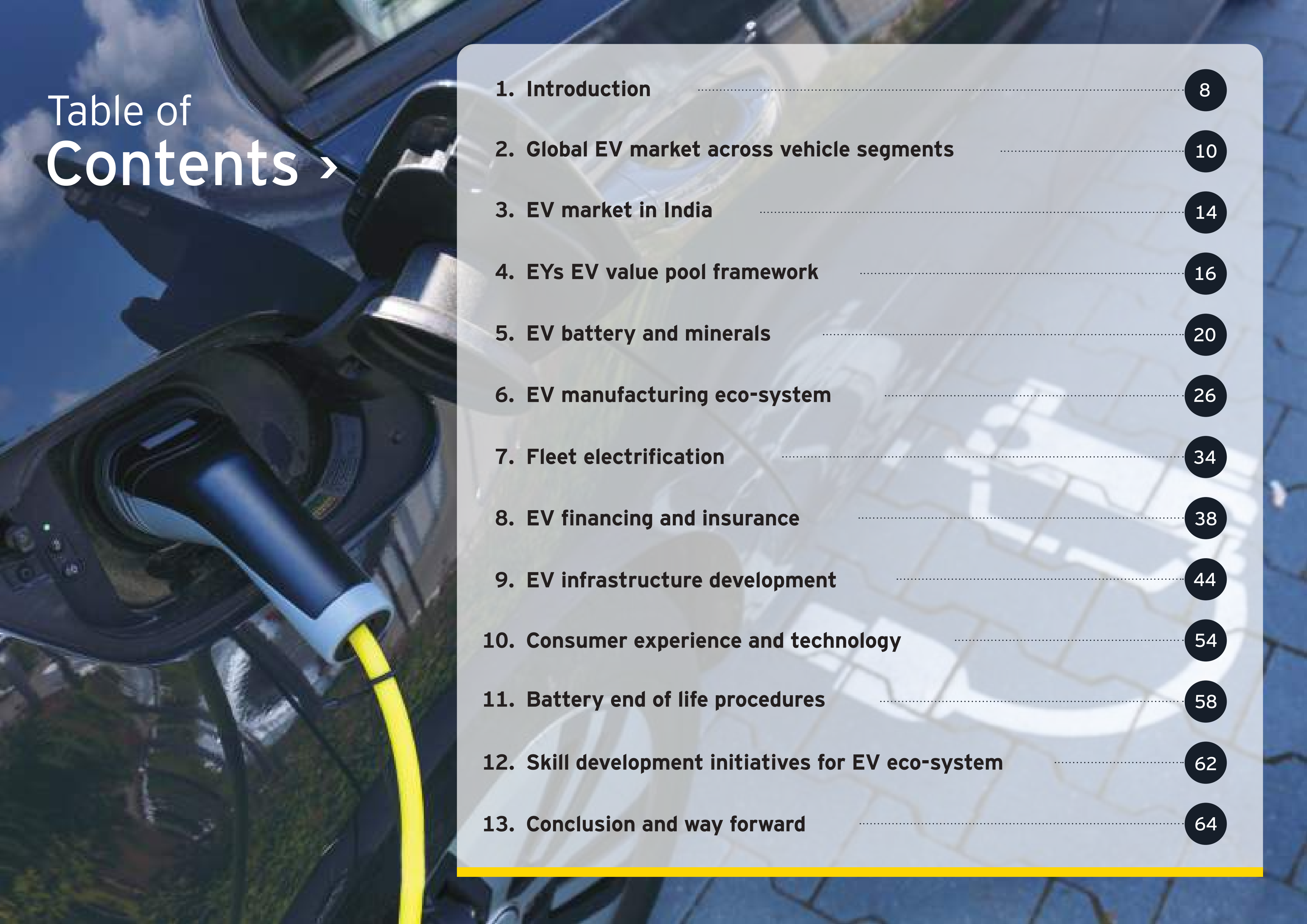
Unlocking the Electric Mobility Value Pools along the eMobility Value Chain

EVtech Delhi 2022

SOCIETY *of* MANUFACTURERS *of* ELECTRIC VEHICLES

Building a better working world



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Foreword

At COP21, India had pledged to reduce its carbon footprint by 33-35% by 2030 below 2005 levels. It has also made a commitment to increase the share of non-fossil fuels-based electricity to 40% by 2030. To achieve their target, India would have to shift its power generation towards renewable sources of energy, and distancing itself from fossil fuel-based transportation. The exponential rise in automobile adoption in the country in the past decade has witnessed the Indian transport sector become the third-largest user of oil world-wide, with road transportation contributing 80% of the consumption. To achieve the GHG emission target committed under NDC, the transition towards greener mobility technologies in transport can play a crucial role.

Even though avenues for clean mobility are gaining momentum in India, still there is visible need for large scale adoption to make a considerable impact on savings in import bill, reduction of GHG emissions and energy security for the future. EVs have emerged as a promising alternative that could help in drastically reducing the adverse environmental impacts caused by conventional vehicles. Government of India's National Electric Mobility Mission Plan 2020, which seeks to enhance national energy security, alleviate adverse environmental impacts from road transport vehicles and boost domestic manufacturing capabilities for Electric Vehicles, is a step in the right direction.

Several state governments have introduced EV-specific policies, intending to provide both supply-side and demand-side incentives to attract investment and generate employment in their respective states. Incentives offered often include capital interest subsidy, stamp duty reimbursements, tax exemptions, SGST reimbursement and provision of interest free loans to incentivize EV manufacturers.

The evolution of electric mobility ecosystem in India may follow a different growth trajectory as compared to the developed or economically varied global EV market. In India, the transition is more likely expected to be driven by two-wheelers and three-wheelers that clearly dominate the shared mobility space. Further, business plans such as the battery swapping model would make a business case in India, as it significantly reduces upfront EV cost and increases commercial run time of e-vehicles.

Envisioning the arc of growth of future of mobility, we hope that this thought leadership will serve as a reference point for stakeholders aiming at accelerating electric mobility. It would undoubtedly help new entrants make a start by understanding the fundamentals of electric mobility, while those at advanced stages will be benefited by finding detailed insights on policies and technologies.

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Abbreviation	
ACC	Advanced Chemistry Cell
ACMA	Automotive Component Manufacturers Association
ARAI	Automotive Research Association of India
BEV	Battery Electric Vehicle
BIS	Bureau of Indian Standards
BCS	Battery Charging Station (BCS)
BLDC	Brushless Direct Current
BMS	Battery Management System
BSS	Battery Swapping Station
CBU	Completely Built-Up
CCS	Combined Charging System
CECRI	Central Electro Chemical Research Institute
CSIR	Council of Scientific and Industrial Research
DISCOM	Distribution Company
EOL	End of Life
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FAME	Faster Adoption and Manufacturing of Electric Vehicle
FMCG	Fast Moving Consumer Goods
HV	High-Voltage
ICE	Internal Combustion Engine
IEC	International Electrotechnical Commission
IRDAI	Insurance Regulatory and Development Authority
LCV	Light Commercial Vehicle

Abbreviation	
LFP	Lithium Iron Phosphate
LTV	Loan-to-Value Ratio
MCV	Medium Commercial Vehicle
NBFC	Non-Banking Financial Company
NDC	Nationally Determined Contribution
NITI	National Institution for Transforming India
NMC	Nickel-Manganese-Cobalt
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
OMC	Oil Marketing Companies
PDU	Power Distribution Unit
PLI	Production Linked Incentive
PMSM	Permanent Magnet Synchronous Motor
PPP	Public-Private Partnerships
PSL	Priority Sector Lending
SCV	Small Commercial Vehicle
SIAM	Society of Indian Automobile Manufacturers
SLB	Second Life-of-Battery
SMEV	Society of Manufacturers Of Electric Vehicles
SRM	Switched Reluctance Motor
TCO	Total Cost of Ownership
UPI	Unified Payments Interface
WTW	Well to Wheel
ZEV	Zero Emission Vehicle

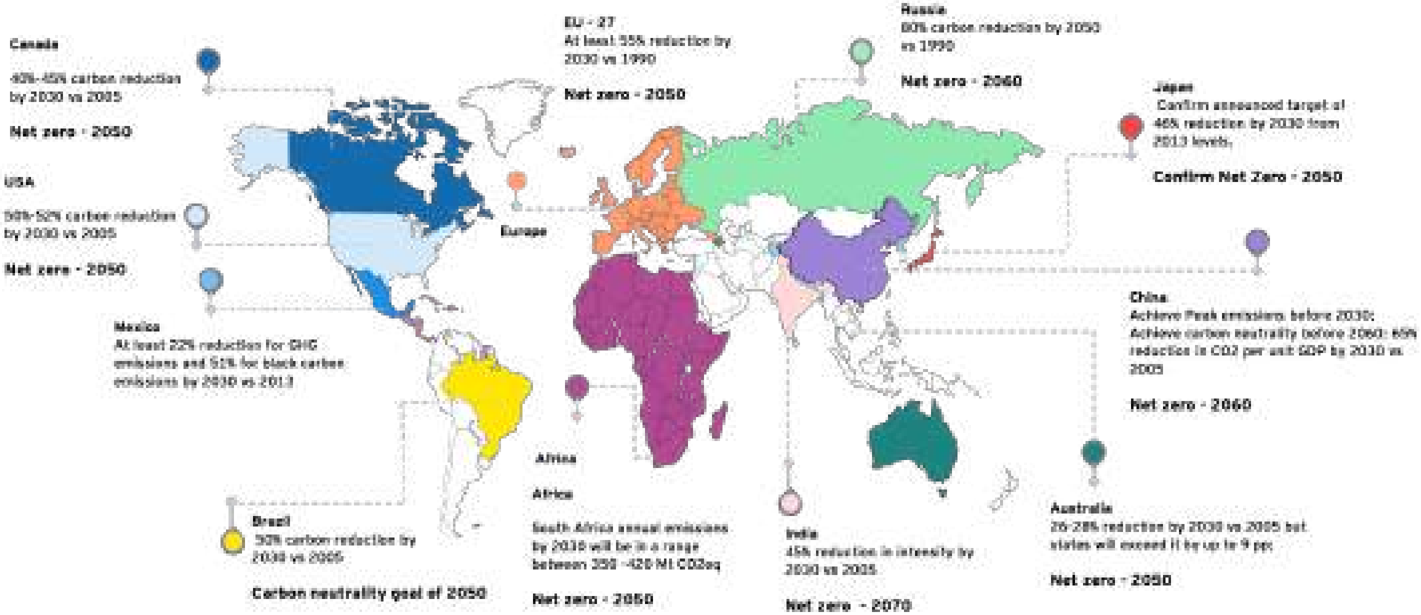
1

Introduction

With a population of over 1.4B, India imports approximately 84% of its crude oil needs, making it the 3rd largest oil consumer and imports in the world. With a marked increase in oil prices, increase in imports and decline in domestic oil production, India's crude oil import bills are rising. India is set to cross the $100B mark in oil imports in the current fiscal, with an expenditure of $94.3B from April 2021 to Jan 2022. January alone accounted for $11.6B when oil prices had started to surge, as compared to $7.7B last year[1]. In February 2022, oil prices crossed $100 per barrel which can result in 2x increase in import bill to $110-115B by the end of FY22[2].

COP26 is driving increased momentum towards reducing fossil fuel needs as more countries set carbon reduction targets. Clean transport incentives and other policy initiatives will drive a rapid increase in electric vehicles, renewables, and energy storage (Figure 1). At the COP26, the Honourable PM Modi had announced that by 2030, India would increase its non-fossil energy capacity to 500 GW, fulfil 50% of its energy requirements from renewable sources, reduce its carbon intensity of economy by 45%, and reduce total projected carbon emissions by 1B tonnes. The Hon'ble Prime Minister also pledged net-zero emissions by 2070, and demanded developed countries deliver $1 trillion in climate finance[3]. These are much more ambitious announcements than the 2016 NDCs, which included reducing carbon intensity of the economy by 30-35% below 2005 levels, having 40% installed capacity of renewable energy, and creating a carbon sink capable of absorbing 2.5 to 3B tonnes of carbon dioxide by 2030[4].

Figure 1: COP26 pledges across the globe[3]



With the transport sector accounting for greater than 70% of diesel consumption, 95% of the petrol consumption and approximately 14% of the CO2 emissions in India, it becomes critical to de-carbonize the automotive industry to achieve the target set by the government[5]. To do so, alternate fuel and electric powertrains are the need of the hour depending on the use case, cost of ownership and availability of an ecosystem to drive adoption. EVs are emerging out as a promising alternative that could help in drastically reducing the adverse environmental impacts caused by conventional vehicles when compared to traditional fossil fuels.

1 Petroleum Planning & Analysis Cell (PPAC)
2 Economic Times, March 2022
3 26th United Nations Climate Change conference (COP26)
4 Paris Climate Accords, 2015-16
5 Ministry of Petroleum and Natural Gas, 2014

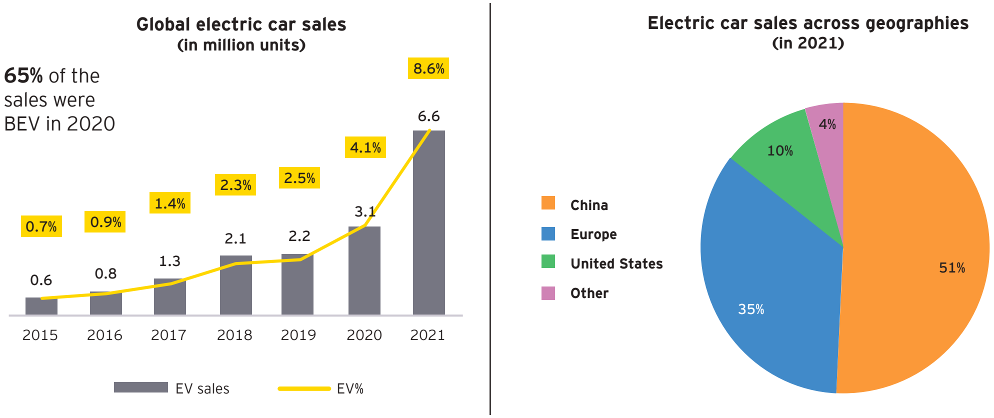
2

Global EV market across vehicle segments

2.1 Passenger vehicle segment

The global electric car market (including passenger and light duty commercial vehicles) has witnessed a strong uptake specially over the last 3 years, even as the global pandemic shrank the market for conventional cars as OEMs were hit with supply chain bottlenecks, production restrictions and lockdowns. In 2021, electric vehicles sales more than doubled to 6.6M, representing close to 9% of the global market with greater than 3x increase in market share as compared to 2 years earlier[6].

Figure 2: Historical trend in global electric car sales and adoption across geographies[6]

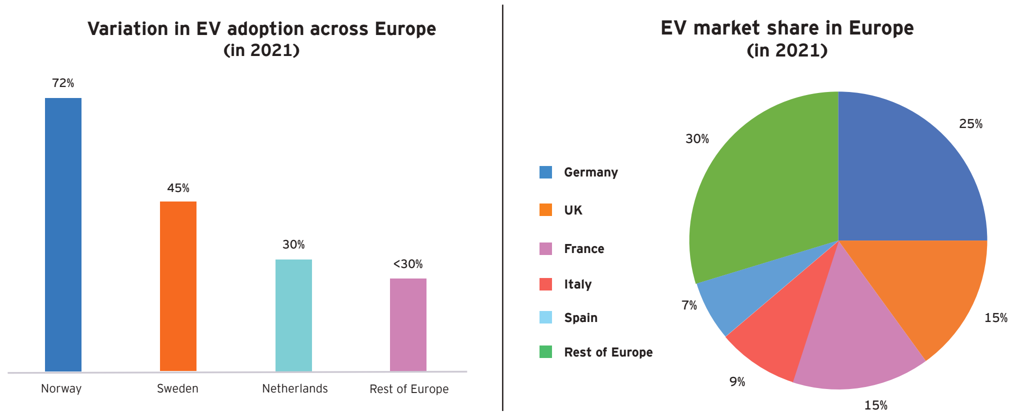


China has been the leading contributor to the growth in electric vehicles as its sales nearly tripled to 3.4M in 2021 with the government targeting a 20% EV adoption in 2025. The government had also extended electric car subsidies for two years after the pandemic with a reduction of 10% in 2021, and 30% in 2022. The growth suggests China's EV market is starting to mature, driven by the combined effects of consumer preferences for the new model offerings such as entry level mini EVs, residual national subsidies and continued preferential treatment for EVs at the local level (e.g., local subsidies, exclusion from city-level purchase limitations).

6 IEA, January 2022

In Europe, EV sales grew by ~70% in 2021 to 2.3M, with >50% being plug-in hybrids. While the overall car sales in 2021 were 25% less than in 2019, the spurt in EV volumes was partially driven by new CO2 emissions standards and the increase and expansion of EV purchase subsidies to most major European markets. In December 2021, electric cars sales surpassed diesel vehicles for the first time with a 21% market share. Overall, electric cars accounted for 17% of total European sales in 2021, but there were significant differences in adoption and share across markets (Figure 3).

Figure 3: EV adoption and market share in Europe[6]



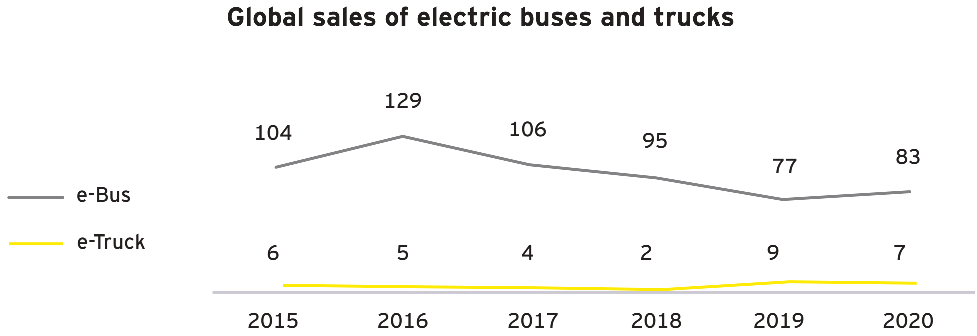
2.2 Other vehicle segments

For the lighter 2W and 3W segments, China accounts for >99% of the global market by clocking a domestic sale of >3.9M in 2021 with a YoY growth of 3.4%, resulting in an EV adoption of ~20% in these segments combined[7]. For the heavier electric buses and trucks, the volumes have stagnated over the last few years with China accounting for ~94% and 90% respectively[8].

7 China Motor World, January 2022

8 Global EV data explorer, IEA

Figure 4: Global sales of heavy electric vehicles (Trucks and buses)[8]



Over the last few years, many governments and OEMs alike have set targets to phase out internal combustion engine vehicles within the next 20 years. The US government announced a 50% electrification target for new cars by 2030 enabled with the installation of over 0.5 million charging points. The EU Commission proposed to bring the CO2 emission standard for new cars to zero by 2035. At the same time, several automakers announced electrification targets.

Table 1: Overview of EV policy and regulations across the globe[9]

Policy / incentive	Canada	China	EU	India	Japan	USA
ZEV mandate*	🟡	🟡	🔴	🔴	🔴	🟡
Fuel economy standards**	🟢	🟢	🟢	🟢	🟢	🟢
Vehicle incentives	🟢	🟢	🟢	🟢	🟢	🟢
Charger incentives	🟢	🟢	🟢	🟢	🟢	🟡
Charger H/W standards	🟢	🟢	🟢	🟢	🟢	🟢
Building regulations	🟡	🟡	🟢	🟢	🔴	🟡

🟢 - Announced at a country level, 🟡 - Announced at a state / provincial / regional level to reach a target, 🔴 - NA

*Varying EV credits offered, **Varying fuel economy standards across countries

In a drive to reduce the carbon footprint, more than 20 countries have set electrification targets or ICE bans for cars, and 8 countries plus the EU have announced net-zero pledges. Also, the EV100 initiative brings together over 100 companies in 80 markets committed to making electric transport the new normal by 2030. Many countries have also joined the EV30@30 campaign setting a collective aspiration goal to reach 30% EV adoption by 2030.

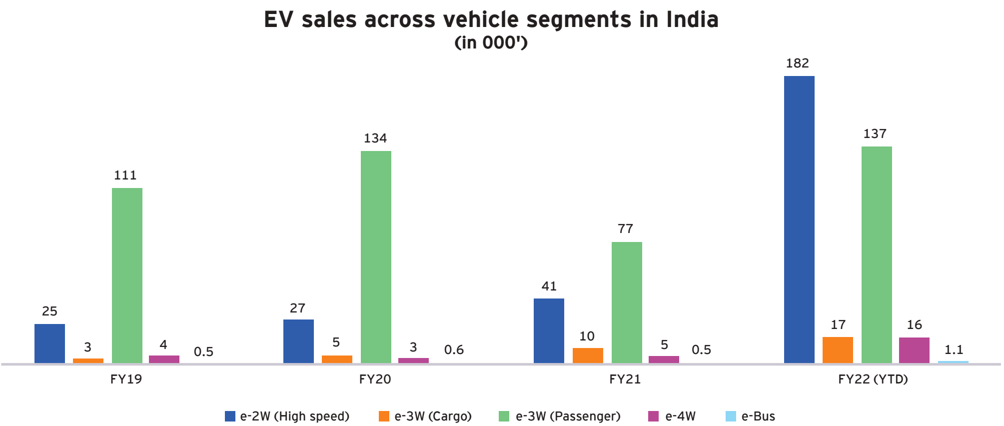
9 Assessment of EV policy, IEA, EY analysis

3

EV market in India

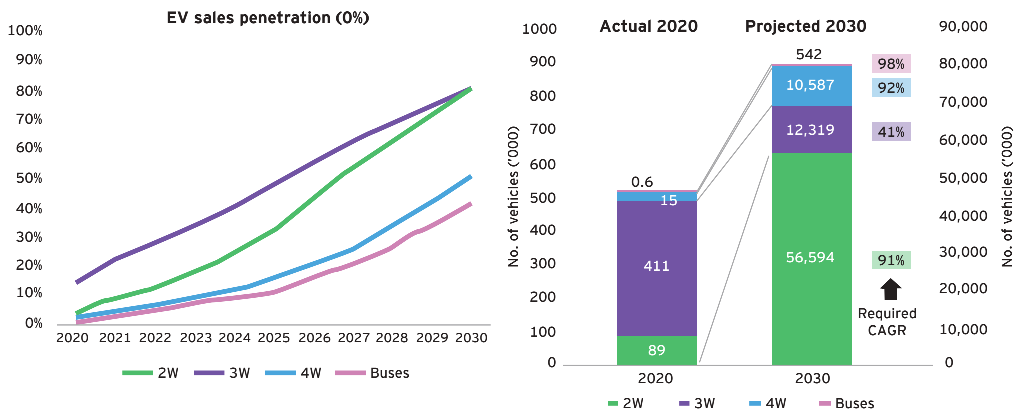
Over the past few years, the India EV industry has witnessed rapid uptake. In FY21, registered EV sales stood at 236,802 with the e-2W segment accounting for over 60% of the market. However, the low-speed segment accounted for a massive 71% share of the e-2W sales. In FY22, this trend reversed with the high-speed segment accounting for 61% of the e-2W sales in CY21[10]. With the growth of e-commerce, the e-3W (Cargo) segment is on the rise accounting for ~12% share in the e-3W market as compared to ~4% in FY20. The e-bus and e-4W segments have also witnessed triple digit increase in sales with a low baseline.

Table 2: EV sales in India (excluding the low-speed 2W segment)[11]



While the rising fuel prices are resulting in a shift towards EVs specially for the lighter vehicle segments, this is to be accompanied with adequate charging infrastructure to support the ecosystem. As of March 2022, India has a total of 1,742 operational public EV chargers, of which 9 cities – Surat, Pune, Ahmedabad, Bengaluru, Hyderabad, Delhi, Kolkata, Mumbai, and Chennai – account for >50%[12]. The implementation of GoI initiatives such as affordable EV tariffs, residential charging, technical standards, revenue sharing models, and a rapid increase in charging infrastructure by OMCs, becomes vital for India to support the growth in EVs. NITI Aayog's forecast for the adoption of EVs is given in the image below.

Figure 5: Forecast of EV adoption[13]



EY point of view:

Evolution of electric mobility ecosystem in India may follow a different growth trajectory as compared to developed or economically varied global EV markets. In India, the transition is more likely expected to be driven by private two-wheelers and public three-wheelers that clearly dominate the shared mobility space.

For both these segments, the TCO is favourable for electric powertrains, making them early adopters. With 2Ws accounting for over 70% of the petrol consumption in India, the electrification of this segment will enable a significant reduction in crude imports. These segments make the battery swapping model viable for India as it significantly reduces upfront EV cost and increases commercial run time of the e-vehicle.

Supportive policy, falling battery prices, charging infrastructure and supply chain localization are among the key factors that have to come together to power growth for EVs, while ensuring solutions customized for the India market are adopted.

Mr. Naveen Munjal (MD, Hero Electric, President, SMEV)

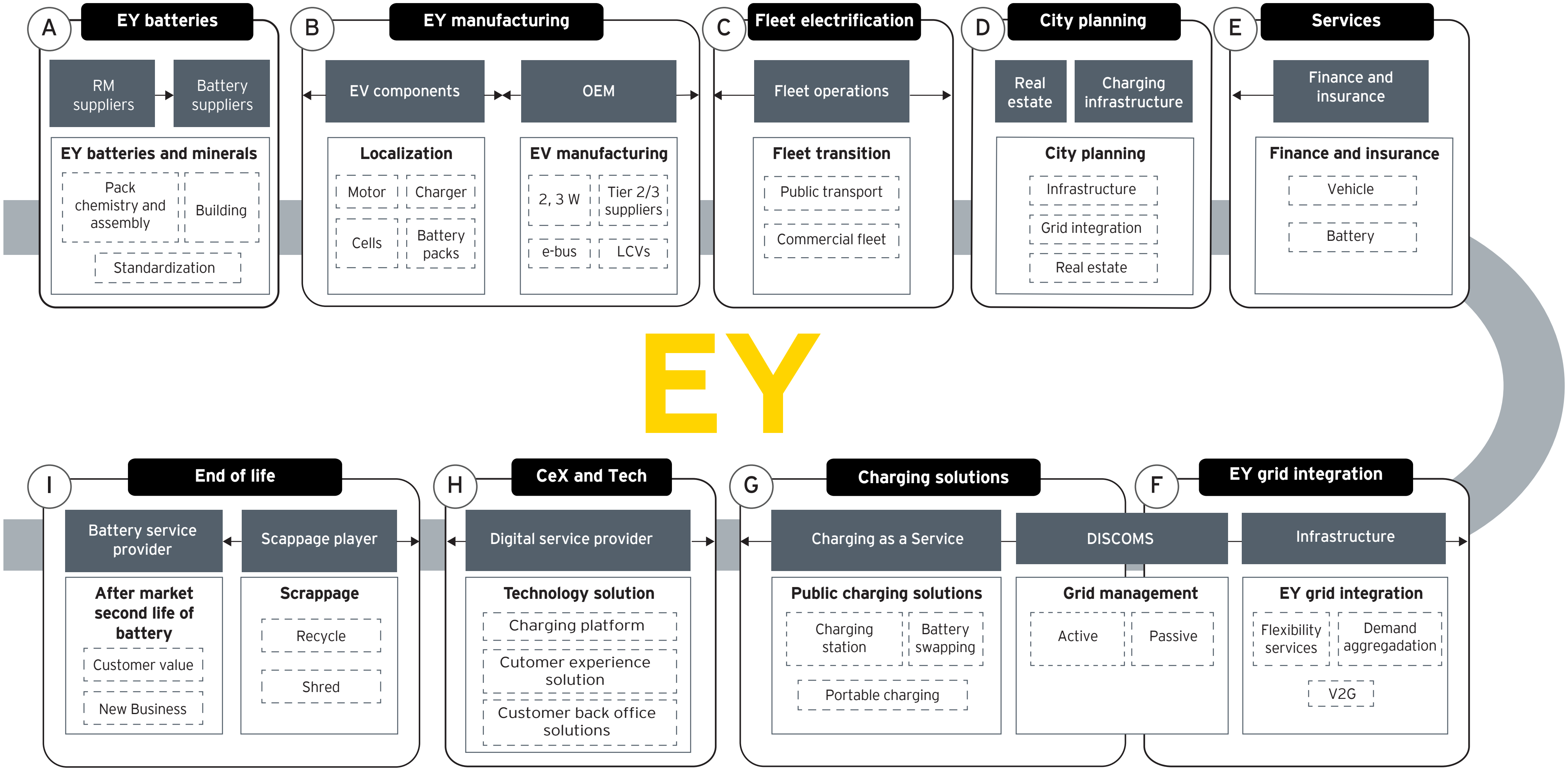
"While e-mobility in India will grow at different rates across vehicle segments, a unidirectional policy with a long-term vision and practical deadlines is required for the ecosystem to fall in place. Apart from localization and infrastructure development, the journey has to address the push for B2B transition, a framework for leasing and financing, the criticality of vehicle testing in Indian driving conditions, aftermarket setup to name a few."

10 SMEV, Economic Times, January 2022
11 SMEV, JMK Research
12 Bureau of Energy Efficiency (BEE)
13 Status quo analysis of various segments of electric mobility and low carbon passenger road transport in India - NITI Aayog

4

EYs EV value pool framework

EY's EV value pool framework: opportunities from emerging EV ecosystem



EY EV Value Pool

EY has conducted extensive research and defined the EV value pool, that describes the various intricacies of the EV ecosystem. We look at the EV ecosystem from manufacturing of battery packs to the end-of-life processes for discarded batteries. The EV value pool as defined by EY is comprised of nine different individual ecosystems, all interlinked and performing towards a sustainable future of EVs in India. EY believes that for the EV industry to replicate the success of the Indian auto market sector, this value pool must be developed, and the market be mature for indigenous production, with the help of support policies developed by national, state and local government entities.

The EV battery manufacturers should develop capabilities that include building and recycling of battery materials once they reach their end of life. The value pools further recommend indigenous manufacturing of EV components such as motors and chassis components, as well capacity building for major sectors of road transportation – 2W, 3W 4W, LCV's and e-buses. Development of fleets for public use – e-3W and e-buses, and development of private fleets using electric vehicles should be encouraged using policy support from national and local agencies. New innovative models need to be developed for financing EV for consumers, as the current model does not consider challenges specific to electric vehicles such as residual value of vehicle at the end of life, or that a single component- the battery, accounts for nearly 40% of the cost of the vehicle.

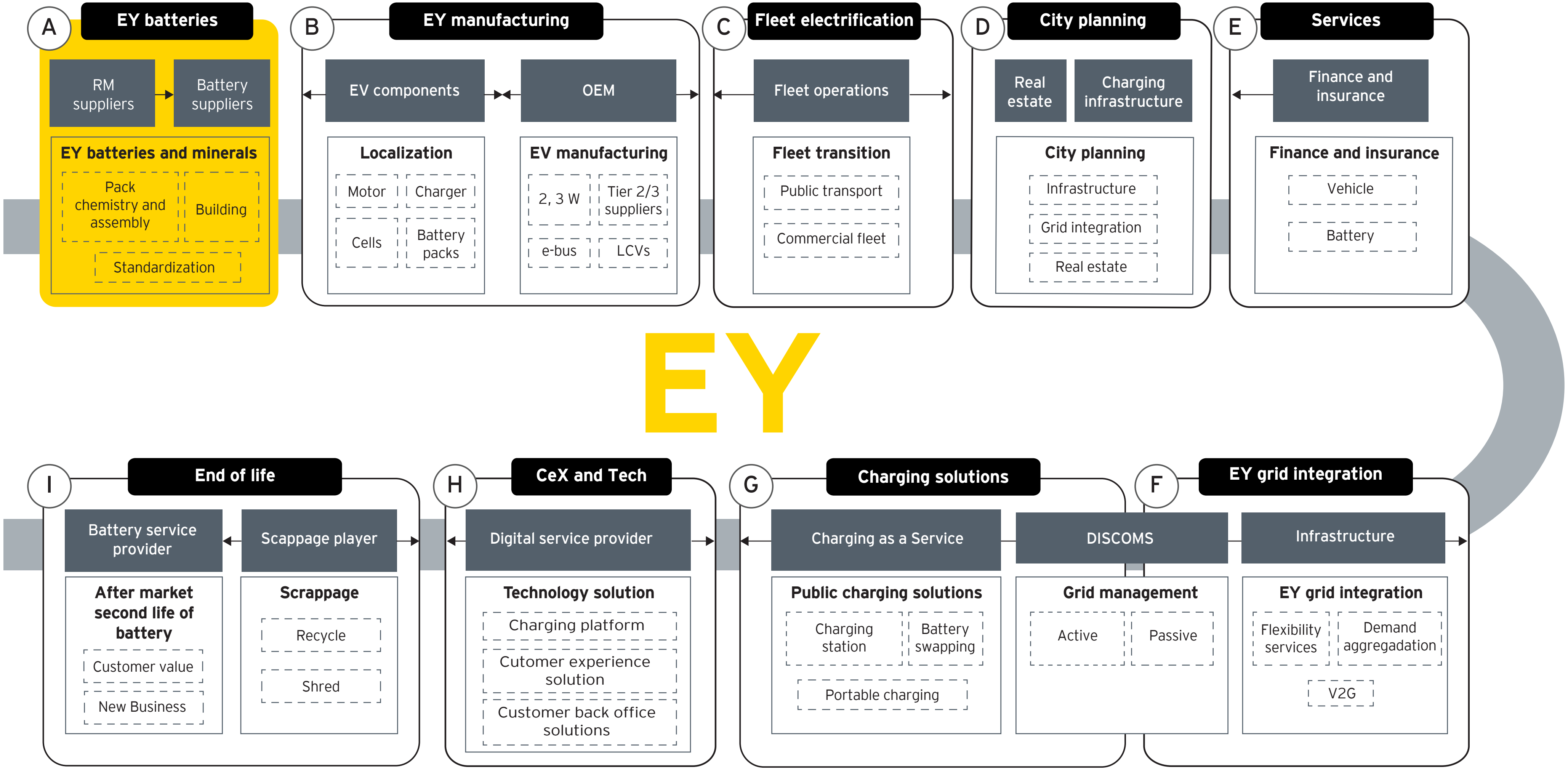
In addition to the EVs, stakeholders should also focus on the development of the charging infrastructure. With ambitious EV targets for the upcoming decade, it is necessary to address challenges such as range anxiety and the development of a robust grid network to address the growing energy needs of the country. Development of DISCOMs to allow for wider charging infrastructure deployment, as well as developing specific rate structure to deploy retail charging outlets for EVs. Additionally, charging solutions such as battery swapping needs to be encouraged at least at the fleet level to ensure faster turnaround for vehicles and higher utilization of the fleets.

To ensure an integrated approach to the EV ecosystem, the EY value pool also emphasises the need for an integrated battery charging solution for consumers providing resources such as charger locations, estimated wait time, digital payment methods and an overall consumer experience like that of a retail petrol outlet, but in an online application instead. Moreover, electric vehicles have been making sales through online portals more successfully than their ICE counterpart. New start-ups in the electric mobility have also shunned the dealership method and have made their products, especially e-scooters, available through various web portals. These examples, coupled with the digital marketplace growing during the COVID-19 pandemic, prove that EVs will have a higher digital presence as compared to ICE vehicles. Lastly, the EY value chain focuses on the need to recycle batteries at vehicle end of life and scrapping the vehicle components sustainably. All values pools have been approached in detail over the subsequent chapters of this document.

5

EV battery and minerals

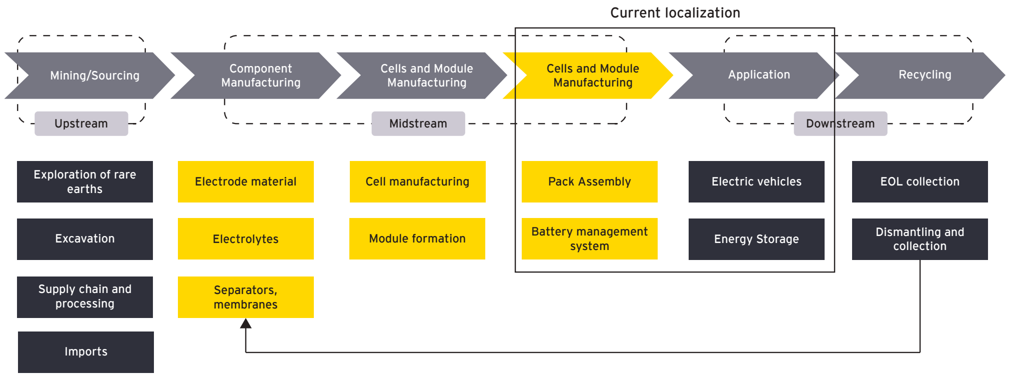
EY's EV value pool framework: opportunities from emerging EV ecosystem



5.1 EV battery ecosystem in India

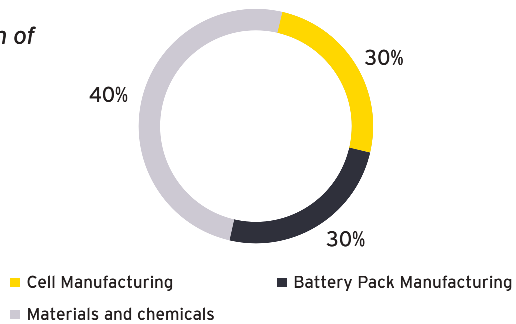
Battery eco-system consist of various stages critical for the batteries to be used for automotive application. From sourcing of minerals to packing the active materials into the cell to recycling the used batteries, the battery eco-system has an integrated supply chain[14]

Figure 7 - EV Battery Value Chain



India participates in certain stages of the eco-system due to increasing application in electric vehicles. Currently, manufactured cells are imported from China, Japan and South Korea and assembled into modules and battery packs. This has led to higher costs of batteries and consequential increase in EV prices in India, and keeps India exposed to volatility of global supply chain[15]

Figure 8 - Cost breakdown of EV battery



India has local eco-system for sub-components of battery packs including battery pack housing and BMS systems, however lower volume and lack of standardization has led to increase in the cost of such components. However, the Govt. of India has taken several steps in building domestic battery manufacturing capability for the future.

5.2 Cell chemistry roadmap for India

One of the most critical components in a an electric vehicle is the battery pack and its cells. Within the cell, cathode chemistry plays an important role in deciding the performance of the battery pack. There are multiple cell chemistries that are being researched and explored for battery manufacturing, however NMC and LFP cell chemistries have witnessed the highest adoption for EV application. These lithium-based cell chemistries have higher adoption due to matured technology and production processes to meet cost economics for vehicle application. But these lithium-based cell chemistries have significant challenges in the long term due to supply side constraints, high energy consumption and environmental concerns raised during the mining and processing of active cathode materials. However intensive research on multiple chemistries needs to be undertaken to develop advanced cell chemistries for future requirement.

Figure 9 - Cell chemistry performance comparison[16]

Battery Cell Types	Units	LFP	LMO	NMC	NCA	LiS	Li-Air	NiMH	LTO	NaS (Sodium Ion)	Solid State
Nominal cell voltage	V	2.5-3.65	3.0-4.2	3.0-4.2	3.0-4.2	2	2.91	1.2	2.3	2	5
Energy density	Wh/litre	160	130	400-700	500-730	140-270	Up to 2,000*	140-300	177	151	>1500
Specific energy incentives	Wh/kg	90-120	100-150	150-220	200-300	160-300	1000*	85	60-110	75-150	>500
Specific power incentives	W/kg	2,000-3,000	1500-3,000	600-1,500	500-1,500	590-1,300	400-1,000*	250-1,000		200	374.7
Charge rate (continuous)	c	1-2C	0.7-1 C	0.7-1 C	0.7-1 C	n/a	n/a		1-5C		1-4C
Discharge rate (peak)	c	2C	10C	2C	1C	1C	n/a	0.2-0.5C	10 C	1C	1C
Lifecycle	-	3,500-5,000	300-700	1,000-2,000	1,000-2,000	110-1,000	<100 (under dev)	>2,000	3000-7000	>4,200	>800
Safety[1]	-	High	Med	Low-Med	Low-Med	Very high	Med	Med	Very High	Low	Med

1 Inherent thermal stability of chemistry

Note: All values for cell level, not considering packed battery systems
Source: Published data various journals

14 Department of Industry, innovation and science, Australia - 2018
15 A guidance document on accelerating electric mobility in India, WRI
16 Electric Vehicles charging towards future

In the near term, to meet the immediate demand for lithium-ion batteries, production should focus on lithium-based cell chemistries. However, within the lithium-ion cell chemistries, focus should be on LFP chemistry over the NMC categories as India has challenges in supply chain and environmental conditions for NMC chemistry. Figure 10 explains why LFP would be the preferred cell chemistry for the Indian EV industry.

Figure 10 - Advantages of LFP Cell Chemistry

1 **Performance Advantage**
LFP has a more efficient heat dissipation that provides better thermal stability, which is ideal for the hot-tropical climate in India. LFP cells also have a life span of up to 3000 cycles, which is estimated to last 5 years.

2 **Supply Chain Advantage**
Apart from Lithium, all active material such as iron oxide, phosphate and graphite can be sourced domestically. Compared to NMC, where active materials are sourced from foreign reserves, LFP would offer a short, stable supply chain.

3 **Price Advantage**
Critical minerals such as Nickle and Cobalt experience significant volatility in their prices, creating a significant business risk for cell manufacturers. Nickel prices have grown over 107% over the last two years, reaching record levels in March 2022.

In the long-term, Indian cell manufactures should focus on more advanced cell chemistries including metal air batteries, sodium ion batteries and solid-state batteries. These technologies are currently being tested and would take some development cycles before they are commercially viable. For example, one of the world's leading cell manufacturers announced advancement in Sodium ion cells and expects to have commercial deployment soon, these second-generation cells are expected to have energy density of 200 Wh/kg which is similar to that provided by LFP cells.[17]

17 PV Magazine, July 2021

5.3 Battery pack assembly

(i) India has established local capacities for battery pack assembly to serve the local demand from electric vehicles. However, there is lack of standardization in battery pack design which leads to increase in related to tooling and assembly. Multiple battery pack suppliers with less capacities further adds to increased overhead cost for battery assembly.

(ii) India has varied climate condition across different regions and different time of the year which has an impact on the overall performance of the battery pack. Cells have optimal thermal operating range for safe and efficient performance, thus thermal management of the cells become critical for safer and longer life of the vehicles. Battery pack suppliers need to build modules and packs with integrated thermal management for vehicles based on their area of application.

5.4 Battery management system

(i) Battery management system, considered to be the brain of battery pack, is required for safer and optimal performance of electric vehicle batteries. Battery management system requires advanced algorithms for monitoring individual cell and take required actions based on inputs on voltage, current and temperature from each cell.

(ii) Extensive testing and tunning of BMS to operate in Indian conditions is required to ensure safer and longer operations of the battery pack and thus complete local design and manufacturing capabilities needs to be established by battery pack suppliers in their offering.

5.5 Battery standardization

Battery standardization can play a major role in the development of the EV sector in India. The focus should be towards low-speed application as well as towards public fleet vehicles such as e-3W and e-buses. With a market that is highly sensitive to price changes, any cost reduction achieved through standardization would be applicable to the consumer, allowing for faster adoption of EVs.

Advantages of Battery Standardisation

- **Lower cost to consumer:** With all OEMs using same battery technology, it would be easier to achieve economies of scale and thus lower production costs which can be passed onto the consumer.
- **Lower cost to OEMs:** With standardization, the cost for battery chemistry development and deployment will be shared amongst the OEM's reducing overall cost for R&D for an individual OEM.
- **Easier recycling:** With a single type of manufacturing, the process for recycling battery material can be streamlined. This will reduce costs for OEMs, who are legally responsible for safe disposable of batteries after their end-of-life.
- **Second life applications:** With a similar type of battery, determining use cases for second life of batteries that have reached their EV end-of life would be easier due to less technical requirements.

Disadvantages of Battery Standardisation

- **Stifling innovation:** With the market for EV at its nascent stage, development of EVs is driven by market growth. Design flexibility and innovation in the market would be removed as battery standardisation would not allow OEMs to use their initiative to build better EVs.
- **Reluctance from early adopters:** Early adopters of EVs, who have already invested heavily in the then-unknown market of EV would be reluctant to hand over the fruits of their R&D over the past years to other OEMs without reaping the rewards of a larger market share. With performance tied heavily to battery technology, similar performing vehicles can be expected from battery standardisation, which would further increase competition for early adopters.

Battery standardisation: a look at China's model

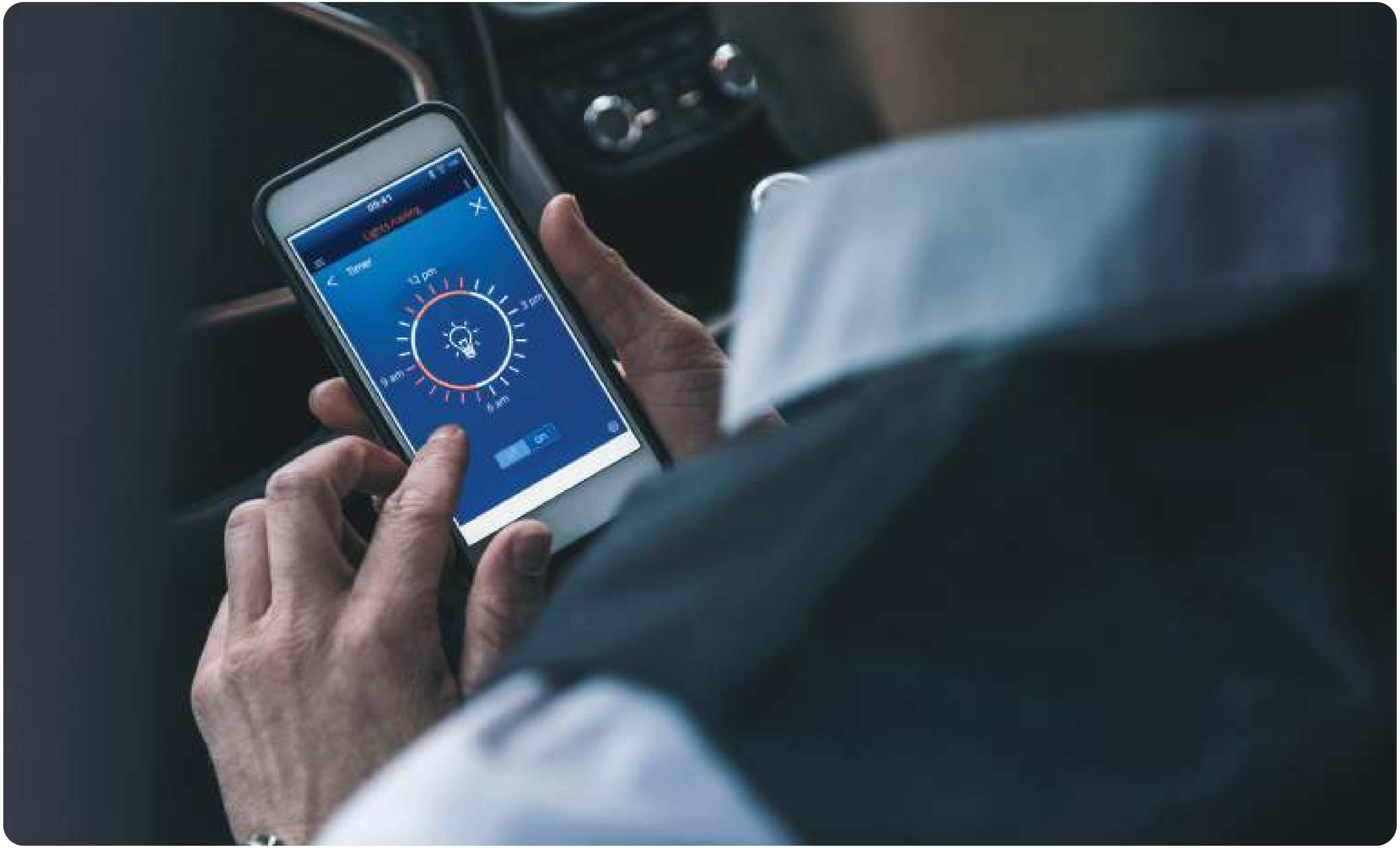
Battery standardization has already taken into effect in China. In March 2022, China announced standards for EV swappable batteries, to confront the rising cost of electric vehicles. With swappable batteries, the cost of the vehicle is reduced by up to 40%m as the battery is owned by the operator and not the EV consumer. Even though a large percentage of vehicle owners would be unable to opt-in as their existing EVs will not be able to participate in the program, China has proven that moving forwards, battery standardization can have a meaningful impact on the upfront cost of the vehicle. With the nascent stage of EVs in India, the Indian auto-market should look at the battery swapping model closely to replicate the cheaper upfront costs for potential EV owners.

EY point of view:

Battery cell manufacturing would be key to achieving the ambitious EV targets set forth in India. Focus should be put on acquiring capital goods required for building production lines, rather than importing the necessary cells and repacking them as battery packs. Scaling manufacturing capacity to achieve economies of scale would be important in bringing down costs for consumers and manufactures alike.

A robust supply chain and integrating tier 2 and 3 suppliers within a consortium to purchase raw materials cheaper from the global market should be prioritized as a focus area. In addition, choosing the right cell chemistry, and building capacity for domestic source of raw material production should be preferred over repackaging imported cells. A domestic supply chain, along with reducing supply costs, will also provide strategic benefits with battery prices not being linked to international market volatility.

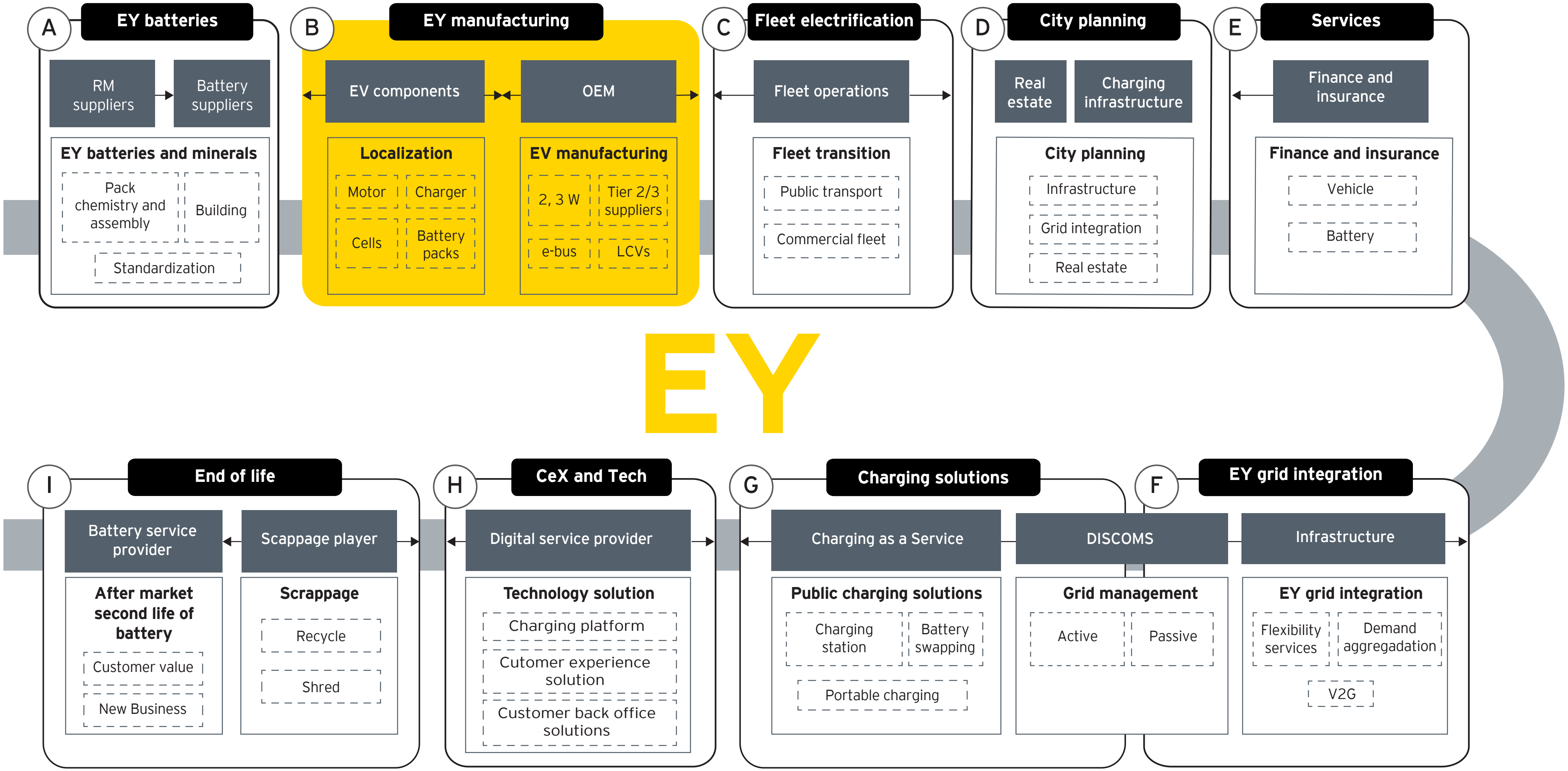
Battery standardization, especially for low speed and fleet-based applications should also be given consideration as they would enable companies to develop a single technology resource for battery recycling and allow for easier deployment of charging solutions such as battery swapping.



6

EV manufacturing eco-system

EY's EV value pool framework: opportunities from emerging EV ecosystem

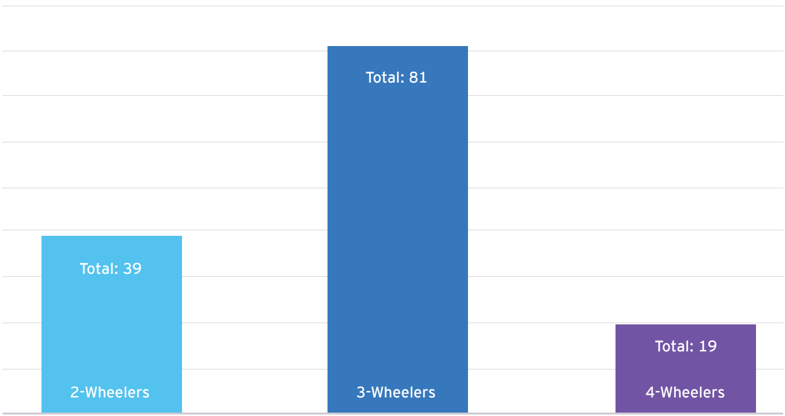


Automotive industry contributes upto 7.1% in India's GDP[18] which includes vehicles manufacturing, auto component manufacturing and dealer distribution. With the global and domestic automotive industry transitioning from ICE vehicles to electric vehicles the industry could be at risk of reducing employment opportunities and GDP contribution therefore, setting-up local EV manufacturing and supporting supply chains should be of strategic importance to India. Since the launch of FAME scheme which incentivized adoption of electric vehicles, India has witnessed an increase in domestic manufacturing of electric vehicles. Policies focus on localization and increase on import duty for CBUs lead to automotive players setting up local assembly lines in India. Lower production volumes and lack of technology and manufacturing capabilities for major components led to OEMs relying in components being imported.

6.1 EV vehicle manufacturing

Till 31st July 2021, there were about 380 organized electric vehicle manufacturers in India. With the increasing adoption of electric vehicles in the landscape, this number is only expected to increase further. The models approved by FAME-II along with their manufacturers are as follows.[19]

Figure 11 - Number of FAME approved EV models



Increasing adoption and localization value add conditions will require OEMs to invest in setting up additional design and manufacturing capacities. Major OEMs in the country have announced fresh investment for EV manufacturing as part of automotive PLI scheme.

6.1.1 Focus areas for EV manufacturers

With increasing production capacities and number platforms for each OEM, vehicle manufacturers will have to focus on strategies that improve vehicle efficiency and range of vehicle, reduce overall cost of the vehicle, and increase profitability for EV manufacturing. OEMs will require to address existing gaps and challenges to meet the strategic goals which will require OEMs to focus on the following areas.

Figure 12 - Strategic goals for EV manufacturing

1. **Build technology capabilities –** In order to build new platforms for electric vehicles OEMs will require new technologies, processes, and manufacturing operations to reduced development and cost. Thus, OEMs should focus on establishing best in class technology competencies and manufacturing expertise to ensure the components provide value to end user and call also create a benchmark for global markets.

18 Business Standard - Aug 2021
19 Niti Ayog

"India is a different region compared to other regions thus extensive design, manufacturing and testing capabilities needs to be established by local players. There should be no hurry in launching product. Extensive testing should be priority for OEMs" – Mr. Naveen Munjal, MD, Hero Electric, President, SMEV

2. **Develop new dedicated platforms –** Most of the current electric vehicles rely on designs of ICE vehicles to manufacture electric vehicles, thus OEMs and component suppliers need to work towards dedicated EV platforms in order to increase vehicle range, efficiency and performance to meet the expectations from end users

3. **Make or Buy Decision –** Due to limited component manufacturing capabilities, many organizations have adopted vertically integrated manufacturing strategies with in-house design and capabilities from vehicle assembly to component manufacturing. OEMs will have to evaluate the make vs buy strategies for components to reduce the vehicle development and manufacturing cost.

Figure 13 - Make vs Buy situation for OEMs

	Case 1	Case 2	Case 3	Case 4	Case 5
Cells	Make	Make	Make	Make	Buy
Battery Pack	Make	Make	Make	Make	Buy
Motor	Make	Make	Make	Buy	Buy
Electronics	Make	Make	Buy	Buy	Buy
Charger	Make	Buy	Buy	Buy	Buy

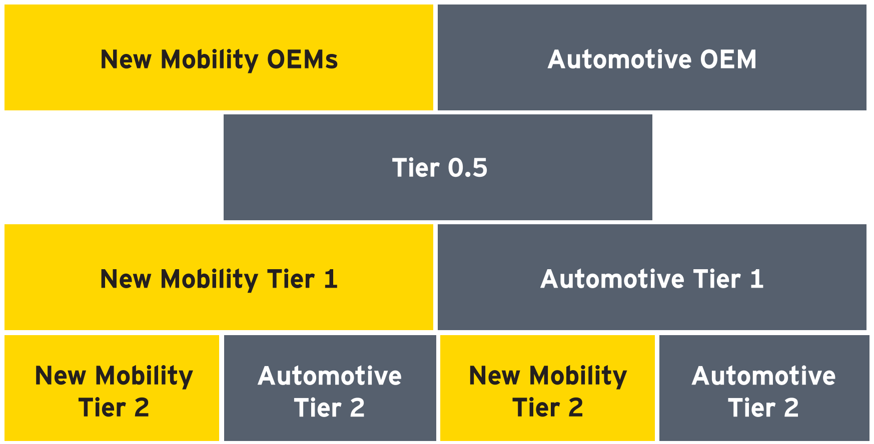
"OEMs are building components in-house due to low volumes and lack of local manufacturing but in long term with higher volumes components will be manufactured by Tier 1s. Reliability and product quality will drive component manufacturing towards Tier 1 suppliers" – Leading auto component manufacturer.

4. **Build a repair and service network –** Even though electric vehicles under limited wear and tear compared to ICE vehicles, service requirements for electric vehicles are different from ICE vehicles, thus in order to provide end users with a seamless EV experience, manufacturers should build an extensive network for repairs and services of components.

6.2 New models for EV ecosystem

1. Electric vehicle industry across the globe has seen participation from new players, industry incumbent, tech companies, mobility players and auto-component players. Thus, entry of new players will have an impact on the vehicle manufacturing and create new relationships between an OEM, Tier 1 suppliers, Tier 2 suppliers thereby creating a more integrated manufacturing value chain.
2. These will require industry bodies such as SIAM, ACMA, SMEV to increase collaboration amongst players in the eco-system.

Figure 14 - How automakers can master new mobility



6.3 EV component manufacturing

1. Indian auto component players can leverage the EV opportunity to safeguard and grow in important export markets. As per ACMA Indian auto component industry derives 29%[20] of its revenues from the global market with Europe and North America accounting for 62%[21] of exports from India.
2. These markets would undergo significant development/modification with electrification, hence, the industry must be future-ready and take a closer look at the opportunities presented by electrification. This is to retain and also expand its share in the global market that has supported the industry during domestic downturns. >
3. Many segments of the ICE auto component industry can be carried forward to EVs with some modification, while many other capabilities can be leveraged to enter the EV specific segment with new products. Further, with relatively low entry barriers in the EV industry, many component manufacturers are finding it easier to move up the value chain.
4. With new components and technologies driving EVs (Cells, Powertrain & Electronics, Telematics, etc.), various OEM - supplier engagement models are emerging with a higher degree of collaboration over the traditional transactional approach. Besides existing parameters of cost, time, and quality; other parameters such as technology strength, R&D capabilities, development, and design validation, lifetime ownership of component performance, level of value chain integration, etc. will gain more importance.

Figure 16 - EV Manufacturing Eco-System

The current focus should be to strengthen Tier-1 Suppliers, net Localization will automatically improve as the volumes again momentum

	Lithium Ion cell	Cell Assembly	BMS	Motors and Controllers
Current Scenario	No local manufacturingcapacities; fully imported	Cell assembly is being undertaken by small unlisted players	'Smart' BMS' used by premium EV OEMs are imported; other unorganized OEMs use 'Basic BMS'	'Motors (and Motor Controllers) are currently imported
	• Nearly all the OEMs in across the vehicle segments are importing cells from South Korea and China • NMC and LFP cell chemistries have been used in most of the vehicles whereas more advanced cell chemistries like sodium ion are under development and testing	• Cell assembly is being undertaken by many players in the country • It includes new players and Tier 1s setting up GWh capacity assembly plants • Smaller players are assembling batteries for the majority of the Two Wheeler and Three Wheeler OEMS	• Premium e2Wh OEMs are using SMART BMS but with limited functionalities like temperature control, overcharging protection. • Analytics platform to monitor BMS data is also being developed by players	• Its not the capability but volume issue. Nearly all the OEMs across the vehicle segments are currently importing Motors and Controllers. • For localized motor manufactures, there is significant import dependence on China for permanent magnets
	Scenario once volumes pick up, accelerating localisation			
Future Scenario	• The proposed Advanced Chemistry Cell (ACC) PLI scheme to incentivise the setting up of local cell manufacturing capacities • New advanced chemistries like sodium ion can have a complete local eco-system for battery and cell manufacturing	• Majority of LI battery assembly is done by the cell manufacturer itself or in conjunction with the OEM. Hence, its expected that pure play cell assemblers will either end up becoming Tier 2 suppliers (vs Tier1 currently) or be rendered obsolete.	• A 'Smart' BMS ensures State of Health Active thermal cell monitor and control (heating/cooling), Battery pre-charging and Data collection for predictive algos. Smart BMS' are currently being used by Premium EV OEMs. • Expect an industry wide shift to Smart BMS' going forward, which might impact operations of local BMS player	• Domestic components suppliers are partnering with technology partners for motor and controllers. • But this can be short lived because due to Industry migration towards hub and Motors or E-axle adoption as complete package. • SRM technology in motors could lead to reducing of import dependence for magnets

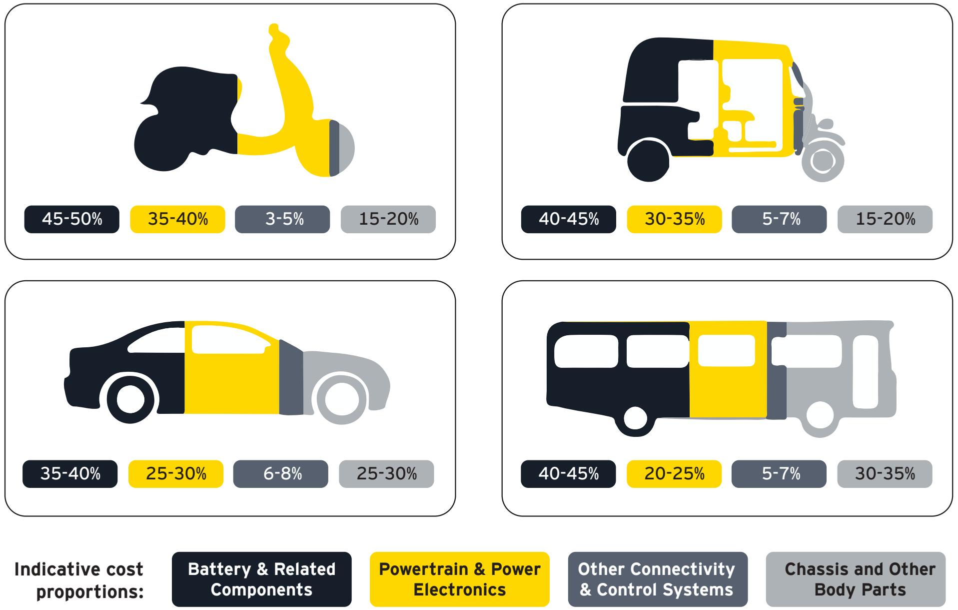
Electric vehicles require new components that are not present in ICE vehicles and thereby requires establishment of dedicated EV eco-system. This new technology requirement will allow new component manufacturers to build design and manufacturing capabilities.

6.3.1 Segment wise EV technology and component value composition

1. e-2 Wheelers - BLDC motor, PMSM hub/mid-mount (48-72 V)
2. e-3 Wheelers - BLDC motor, PMSM, AC Induction Axle (48-72 V)
3. e-4 Wheelers - PMSM, AC Induction Axle (96-300+ V)
4. e-Bus - AC Induction, PMSM Axle (350-800 V)

20 ACMA | EY Analysis
21 ACMA | EY Analysis

Figure 16 - Component manufacturing by percentage[22]



6.3.2 Tier 2/3 component manufacturing

1. Tier-2 firms feed subcomponents to Tier-1 companies; these are typically medium- to small-scale firms
2. Tier-3 companies constitute raw material suppliers and could range from very large to very small companies constituting job shops offering specific services like welding/ soldering/heating/ grinding, etc.
3. Typically, Tier 2 and 3 are in form of an umbrella of micro, medium and small enterprises around the vehicle manufacturers, who are their primary consumer
4. Tier 2 and Tier 3 supply auto parts worth ~60-70%[23] of the total cost of an ICE car
5. The value chain of a conventional vehicle in India comprises OEMs and the auto component suppliers in tiers 1, 2, and 3 of the auto industries, who work in tight symbiosis with the OEMs
6. Changes in-vehicle platform design and components used in electric vehicles, will push Tier 2/3 component suppliers to adapt to the new design and technology requirement

6.4 Safety standards for battery manufacturing

With the recent concerns over EV vehicles catching fire dominating the news, it is important that EV manufacturers focus on the safety of battery technologies, and the development of battery management systems. More rigorous testing needs to be conducted, specifically in the two-wheeler market segment, where the instances of vehicle safety being compromised has spanned various manufacturers and top selling models. With ambitious targets of EV adoption is India, it is important that manufacturers take the safety standards laid forth by ARAI and in BIS regulations seriously, lest they undermine consumer confidence in this growing automotive sector.

On the other hand, considerations need to be made by regulators to ensure that battery standards are being met by manufacturers, and that the safety standards set in place are in-line for the hot-tropical climate of India and that the issues of vehicle fire are investigated thoroughly to avoid scepticism in consumer adoption.

India has published voluntary testing standards for battery manufacturers, which has been summarized in Figure 17[24].

Figure 17: Battery testing requirements in India

L Category Vehicles	M and N Category Vehicles
AIS 156 is prepared in line with UN R136	AIS038 Rev2 is prepared in-line with GTR20Phase1(UNR100Rev3)
Vibration test	Vibration test
Thermal Shock and Cycling Test	Thermal Shock and Cycling Test
Mechanical drop test for removable REESS	Mechanical Shock
	Mechanical Integrity
Fire Resistance	Fire Resistance
External Short Circuit Protection	External Short Circuit Protection
Overcharge Protection	Overcharge Protection
Over-Discharge Protection	Over-Discharge Protection
Over Temperature Protection	Over Temperature Protection
Hydrogen Emission Test	Over-Current Protection
	Thermal Propagation Test
	Hydrogen Emission Test

22 EY| Yes Bank Analysis
23 WRI Report | EY Analysis
24 EV Reporter

Battery safety standards in Europe vs India:

India has developed the Automotive Indian Standards (AIS) 156, that covers vehicle category L and provides substantial testing requirements for vehicles. Similarly, AIS 038 Rev 2, published in September 2020, covers testing requirements for vehicles in the M& N category of vehicles. However, these testing standards are currently voluntary in nature, and need to be incorporated in the Central Motor Vehicles Rules to be mandated by the government. Both these standards are based on UN regulations (UN R136 and UN R100 Rev3 respectively). Europe also follows the same set of regulations, but the challenges faced by the Indian EV market is that these regulations do not consider the variations in ambient temperature present in India vs Europe.

Mr. Robert Lamanna

(Deputy General Manager, BAE Systems - Power and Propulsion Solutions)

"Global value chains, both for components and manufacturing need to be established to meet the need. Rising material, manufacturing, and shipping costs on a global basis will require diversification from traditional sources to serve both local and export demand.

Second, is the knowledge infrastructure to safely implement and care for electrification components. Development and training to deal with high power systems is paramount at the local level. Full-scale implementation of ZEV will provide opportunities to assemblers, and maintainers alike to raise their technical capabilities and knowledge.

Last, we must establish an eco-system for product development and hardware. Local requirements, use cases, and duty cycle must be accounted for to maximize ZEV efficiency."

EY point of view:

Domestic manufacturing potential

Table 3

	E-motor	EV Power Electronics	Power Converters	On-Board Connectivity & Electronics	Body Frame/ Chassis-Related Components	Battery Systems
Short Term	Software capabilities can be leveraged for EV Industrial motor capabilities need to be upgraded for auto application Transmission and gear manufacturing capabilities need to be upgraded	Electronic hardware design and software capabilities can be leveraged to develop solutions for EV application	-	Existing auto capabilities can be leveraged for EVs with no minor tweaks	Designing components suitable for dedicated BEV platforms Enhancement of material used for component manufacturing (focus on lightweight and durable components) Sealants and cooling systems to be adapted for EV application	Battery packs BMS
Medium Term	-	Complete hardware and manufacturing capabilities for motor controllers and vehicle control units HV connectors used for EV	Components such as AC/DC - DC/DC converter, on-board charger, PDU have low manufacturing complexities and can be localized efficiently	-	-	Cells
Long Term	Completely indigenous technology for motors, Ex- SRM motors Integrated systems to reduce costs	Semiconductor manufacturing for microcontrollers and MOSFETs	Designing integrated units for battery economics	-	Lightweight manufacturing capabilities	Minerals

Redesign Parts to Improve Applicability

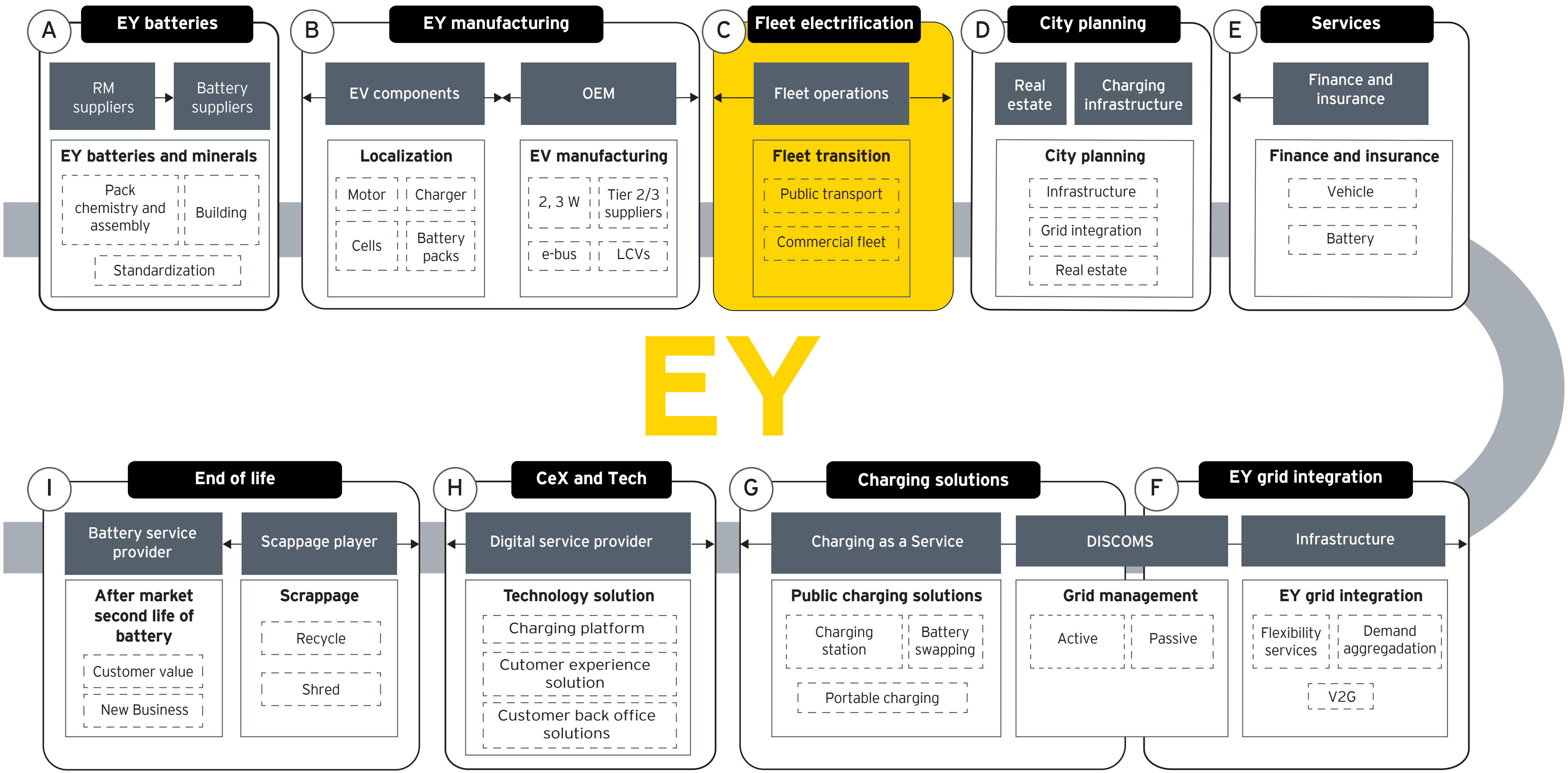
1. **Focus on bundled solutions –** Manufacturers focus on providing integrated solutions to OEMs. Additionally, combining components helps in an easier vehicle integration
2. **Growing start-up ecosystem –** The start-up ecosystem for auto components is growing strongly with close to ~613[25] Mn already invested in ~300[26] companies. OEMs, as well as tier-1 suppliers, are actively investing in start-ups that are working towards revolutionizing the EV component space.
3. **Dynamic manufacturing –** Dynamic manufacturing is highly flexible and is designed with a high degree of adaptability. High automation results in lowered labour costs.
4. **JV and tech partnerships –** Partnerships and JVs across the value chain to harness partner capabilities and technology. Additionally, major component manufacturers acquire smaller players to increase product and service offerings.

25 Yes Bank | EY Analysis
26 Zee News | EY Analysis

7

Fleet electrification

EY's EV value pool framework: opportunities from emerging EV ecosystem



India's cumulative energy consumption from freight transport between 2020 and 2050 under a business-as-usual (BAU) scenario is expected to be around ~5.5 – 6 billion tonnes of oil equivalent (TOE)[27]. India, however, can reduce this consumption by up to ~50 percent under an efficient scenario[28] through efficient and optimal truck usage, use of alternate powertrain, and fuel-efficient vehicles.

Limited fuel saving technologies and lack of awareness limit profitability of Indian fleet operators. With low availability of capital, fleet operators are hesitant on investing in fuel-saving technologies, EVs, and other alternate powertrain vehicles owing to their higher upfront acquisition costs and limited access to finance. At present, Internal combustion engine vehicles dominate India's on-road freight activity, while EV penetration in commercial vehicle sales is less than 1 percent[29]. Additionally, commercial vehicles in India have a low fuel mileage, impacting operational costs. Fuel costs account for more than half of the total cost of vehicle ownership (TCO)[30]. This leads to an unfavourable TCO scenario for the fleet operator. Alternate powertrains with low fuel costs and high efficiency will lead to long-term benefits and positive economic returns for the fleet operators. Following are the TCO scenarios for different vehicle segments:

(i) EV 2-wheeler segment is ~50%[31] more efficient compared to ICE

(ii) EV 3-wheeler segment is ~60%[32] more efficient compared to ICE

(iii) EV 4-wheeler segment is ~10%[33] more efficient compared to ICE

(iv) E-Bus segment is ~5%[34] more efficient compared to ICE

(v) E-LCV segment is ~40%[35] more efficient compared to ICE

(vi) E-MCV segment is ~20%[36] more efficient compared to ICE

The announcement of the national vehicle scrappage policy will also require fleet operators and other freight management organizations to consider alternate powertrain options or powertrain retro fitment to replace their existing fleet. According to the policy, ICE commercial vehicles can ply on roads for 8 years after which they need to apply for a vehicle fitment certification *(additional cost to the owners)* every year until 15 years of age after which they will be deemed unfit for application and will be scrapped. Post 8 years, fleet operators/freight management players can choose to either sell their existing vehicle and purchase a new vehicle, upgrade to a new alternate powertrain vehicle, or select the option of retrofitting their current vehicle with a new alternate powertrain.

27 RMI Analysis

28 IBID

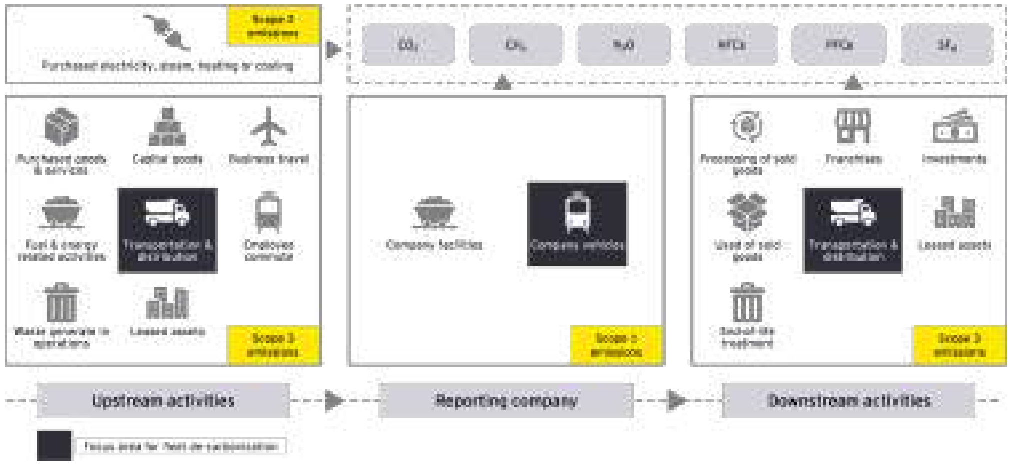
29 RMI Analysis

In addition to this, major sectors are making commitments toward EV100, a movement aimed toward ensuring 100%[37] fleet electrification for goods freight. Players in major sectors such as e-commerce, automotive, steel, cement, food delivery, FMCG/retail, and logistics have announced plans for complete fleet electrification and a stronger commitment toward carbon neutrality in India.

Figure 18 - Focus on fleet de-carbonization

The focus of fleet de-carbonization is on the reduction of scope 1 and 3 emissions related to movement of goods by adopting alternate powertrains such as EVs, NGVs, biofuels...

For the fleet de-carbonization journey, the focus segments will include the company-owned fleets which fall under the scope 1 emissions bucket and the fleets owned by the 3PL service providers for in-bound, out-bound and in-plant movement of goods which fall under the scope 3 emissions



30 RMI Analysis

31 WRI TCO Evaluator: 2-wheeler

32 WRI TCO Evaluator: 3-wheeler

33 WRI TCO Evaluator: 4-wheeler

34 WRI TCO Evaluator: Bus

35 WRI TCO Evaluator: LCV

36 WRI TCO Evaluator: MCV

37 Climate Group | EY Analysis

The government has initiated the transition towards green mobility to meets several key strategic targets such as:

1. Choosing a sustainable way forward – India has committed to be carbon negative by 2070[38] under the Paris agreement 2021. Currently, 22 of the top 30[39] most polluting cities globally are in India.

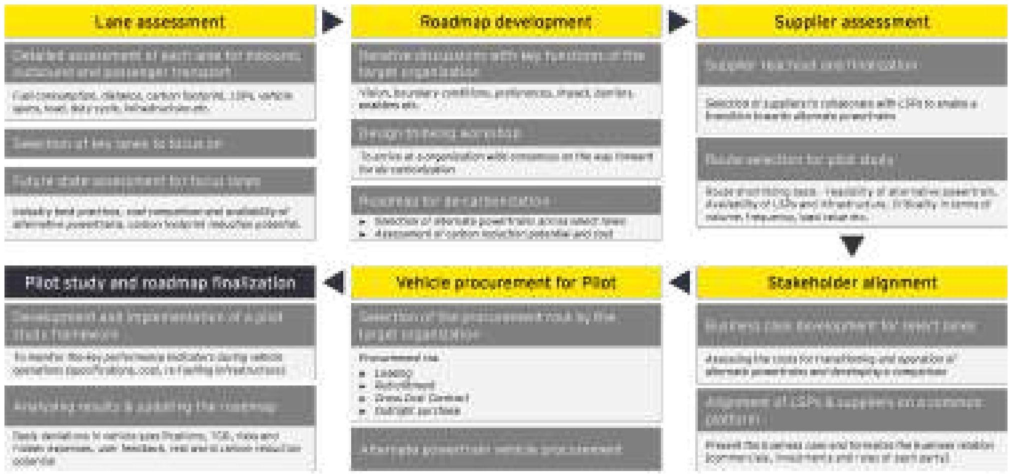
2. Harbouring on strategic advantages – India can save ~ $ 14 Bn[40] through decreased dependence on crude while factoring in increased EV penetration by 2030.

3. Leverage the paradigm shift – Promoting local battery and EV manufacturing will result in the absorption of manpower currently employed by the Automotive sector.

4. Take advantage of the falling battery prices – Battery prices are expected to fall from the current of ~$140 to ~60[41] by 2030 through the onset of economies of scale making EVs even more affordable for mass fleet adoption.

7.1 Fleet electrification roadmap

Figure 19 - EY Analysis – Fleet Electrification Roadmap



38 COP 26

39 The Weather Channel

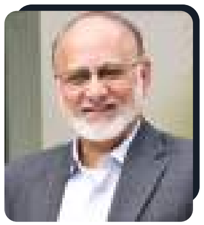
Public transport fleets will also play a key role in the adoption of electric vehicles. The 3W market has the highest penetration in terms of sales, with the majority of share being attributed to e-3W rickshaws. There has also been a push to include electric three wheelers in the autorickshaw fleets, such as in Delhi, Kochi and Amritsar. Additionally, states have designed ambitious targets for the development of their e-bus fleets, all of which would be funded through the state transportation departments. Adoption of EVs in these sectors will provide opportunities for the robust manufacturing capabilities and development of infrastructure will be critical for growth of these auto-sectors.

EY point of view:

Fleet operators need to be actively engaged in the development of their charging infrastructure. Route planning should consider the existing infrastructure, ensuring fleet deployment is modelled around charging needs, managing the range expectation of the vehicle, and scheduling drivers around the necessary charging requirement.

Companies should pursue electrification in a phased, pilot-driven model. This will ensure that profitability of the vehicles is ensured through the pilot program, while a staggered approach will reduce the upfront capital required. Exploring new vehicle purchase vs. retrofitting should be carefully investigated to determine the total cost of ownership and ensuring low-profit bleeding for the company. A successful approach can be replacing short-range vehicles initially, while completing a pilot study to understand real-world performance before achieving 100% electrification.

Depending upon the vehicle expectations and needs, some industry sectors will be able to achieve their electrification targets earlier. Taking into account state and local policies, fleet managers should strive for the low-hanging fruit before approaching more ambitious targets.



Mr. Sohinder Gill
(Director General, Society of Manufacturers of Electric Vehicles)

"In India, the e-mobility revolution is being driven by electric two-wheelers in the personal vehicle category, electric three-wheelers in the commercial category, and in the electric four-wheeler category, we expect the demand for EVs to be driven by fleet-based operators, and then gradually in the personal space"

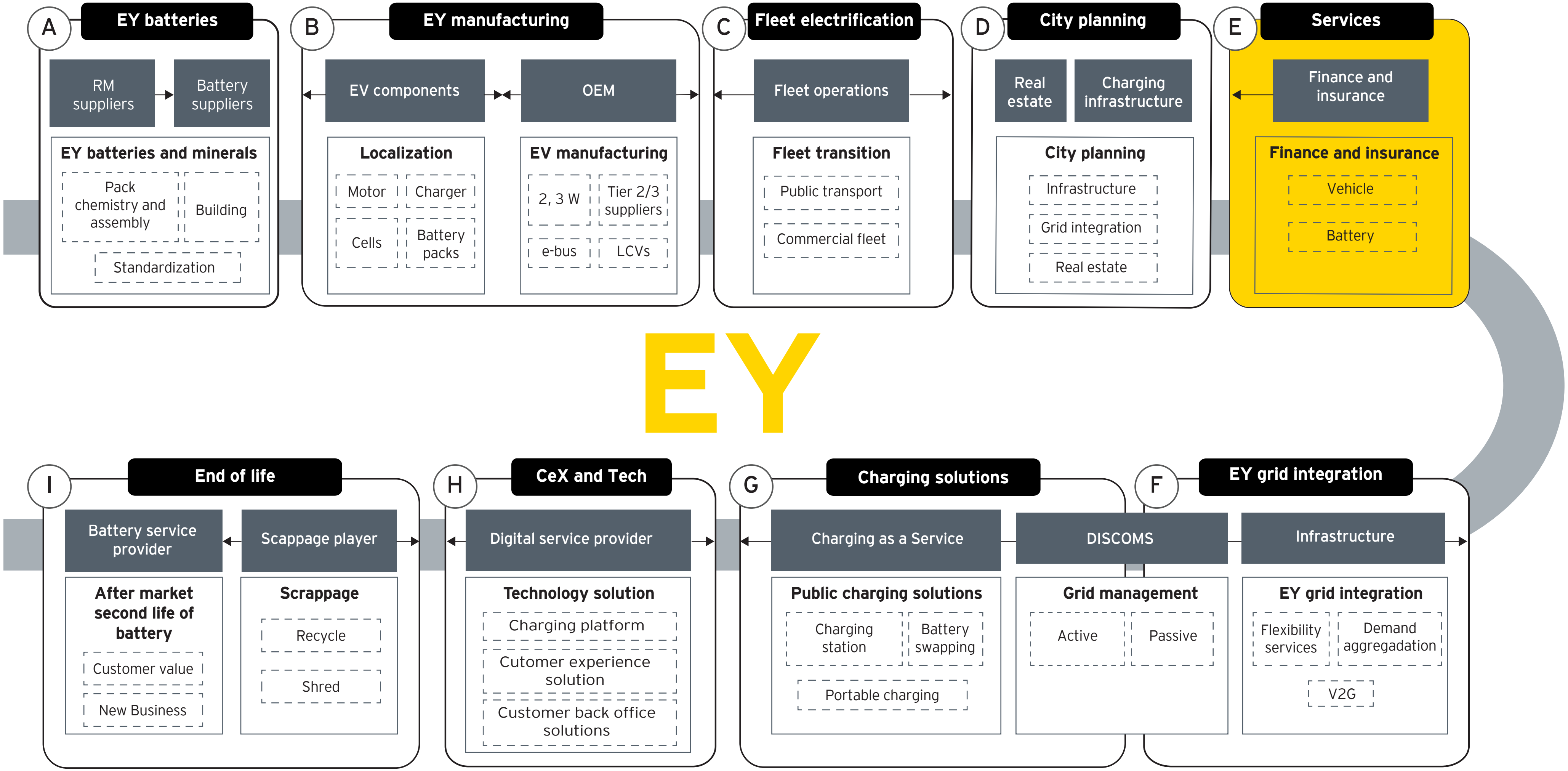
40 CEEW (Council of Energy, Environment and Water)

41 Niti Ayog

8

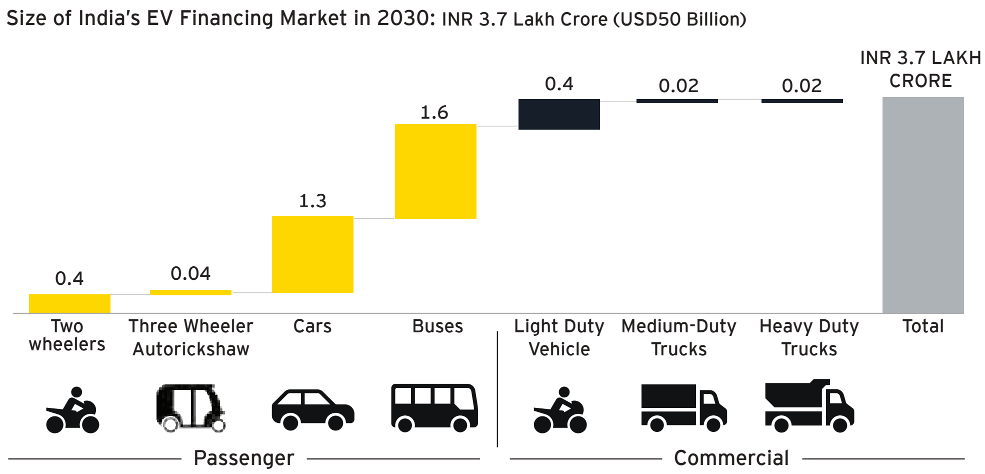
EV financing and insurance

EY's EV value pool framework: opportunities from emerging EV ecosystem



Estimates showcase that the cumulative capital cost of the country's EV transition between 2020 and 2030 is INR 19.7 lakh crore across vehicles, charging stations, and batteries. The projected size of the annual loan market for EVs in 2030 is INR 3.7 lakh crore.[42]

Figure 20 - Size of EV Financing Market[43]



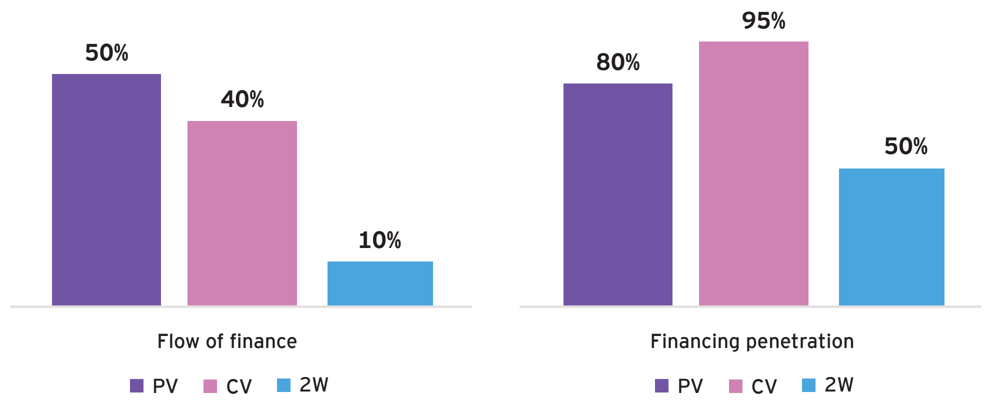
Key points on the Indian vehicle finance industry

India's retail vehicle finance industry is estimated to be ~US$ 60 B

Flow of finance from the organised sector (banks & NBFCs)

Share of vehicles financed through loans by the organized sector

Figure 21 - Representation of vehicle finance industry[1]



8.1 Major players in the electric vehicle ecosystem

Two key players in the Indian Automotive finance ecosystem are:

(i) Banks - Public sector banks, Private sector banks

(ii) Non-Banking Financial Companies (NBFC's)-Captive vehicle financers, non captive vehicle financers, Fintech companies

8.2 Major impediments

8.2.1 EV Financing impediments by segment[44]

1. Electric two wheelers: High rate of interest charged to EV owners due to non-availability of data to validate the performance and resale value of the vehicle.
2. Electric three wheelers: They largely rely on the non-captive NBFC's due to lack streamlined monetary support, no credit history to name a few. The rate of interest charged on the buyers in this vehicle segment would be considerably higher with low LTV.
3. Electric passenger vehicles: PV owners with good credit history largely rely on organized financing. On the contrary, PV owners in the commercial vehicle category would encounter higher premiums, and in some cases outright rejection from the organized market.

42 Mobilising Finance for EVs in India - RMI India
43 Mobilising Finance for EVs in India - RMI India
44 Mobilising finance for EV's in India: RMI

4. E-buses: The bus category involves upfront investment of 25% as a down payment which locks up a significant amount of money of the operator while purchasing a fleet of e-buses. Bank guarantee coupled with the fact that cost of an e-bus is 6-7 times that of an ICE bus, financing of e-buses remains a major challenge in India.

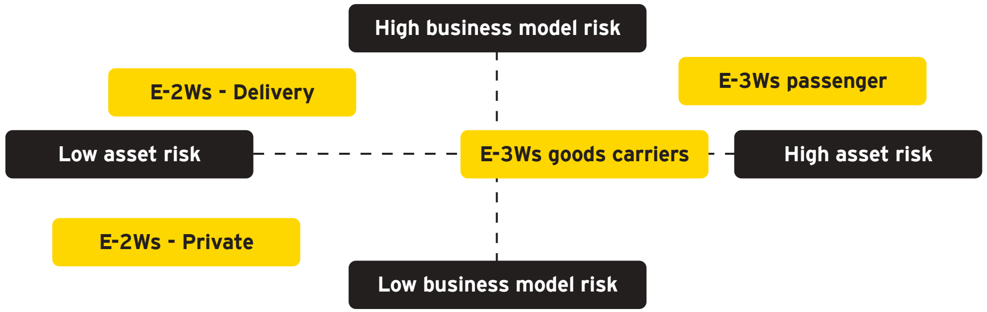
8.2.2 Major challenges in the EV financing eco-system[45]

1. **High interest rates:** The interest rates charged by the organised sector are favourable for a buyer with a good credit score. On the flip side the interest rates charged by captive and non-captive NBFC's are above the 20% and range close to 24% for some buyers
2. **Low loan to value ratio:** Providing low loan to value for buyers puts immense pressure on their pockets. This would also drive people to still buy ICE vehicles where the buyers can avail higher LTV for the vehicle.
3. **Limited financing options:** Lack of financing options for electric vehicles except for some reputed public sector institutions. The need to attach collateral for new electric vehicles coupled with low LTV and shorter repayment periods limits new EV buyers from purchasing them.
4. **Insurance:** The EV's are charged higher insurance due to the fear of technology failing and allocation for high repair costs. Lack of data on the lifetime of an EV deprives insurance companies from providing low insurance

8.2.3 Risks Associated with Electric Vehicles

1. **Technology risk:** The ever-changing battery technologies from lithium ion to graphene, sodium sulphur, sodium ion and zinc manganese poses a harder challenge for financers to fund the vehicle. The increasing number of EV fires in the country highlights the need for a fool proof technology.
2. **Resale Risk:** Electric vehicles are being adopted at a gradual pace. The nascent ecosystem coupled with the depreciating battery performance may propel financing institutions to refrain from financing second sale EV's.
3. **Product Risk:** The new age OEMs who have come up in the recent times are playing in the 2W and 3W electric vehicles. Lack of experience in the manufacturing of automobiles deters financers from trusting the technology and its performance.
4. **Business Risk:** The utilisation of the vehicle by businesses and fleet operators would help in realising the value of investing an electric vehicle. Higher utilisation would culminate to better returns for a buyer.

Figure 22 - Risk of Representation per Vehicle Segment for 2W and 3W



8.3 Comparison of finance options available for ICE vs EV

Table 4 - Comparison on Interest Rates

	ICE	EV
Rate of Interest by Organised financers	7%-10%	9%-13%
Rate of interest by NBFC's	12-16%	20%-24%

8.3.1 Financing options by vehicle segment:

1. **Two wheelers:** The 2-wheeler sector is majorly serviced by the NBFC segment in the market at an interest rate ranging from 18%-24%
2. **Three wheelers:** The three-wheeler segment is of low interest due to the higher risk of default. This segment of the market is catered by the NBFC segment which charges a premium 22%-24% of interest.

45 Mobilising finance for EV's in India: RMI

3. **Passenger vehicle:** The passenger vehicle segment is serviced by the organized sector at an interest rate of 2-4 percentage points higher than the ICE vehicles. This discourages consumers from owning a new EV. The used car market is further challenging for new owners with interest rates over 10 percentage points higher than a new electric vehicle interest rate.
4. **Commercial vehicles:** The organized sector would prefer serving large fleets due low risk attached and a presence of credit history of the borrower. A single commercial vehicle owner would be less to be approved for a loan due to the unclear credit history and high asset value of the vehicle.

8.4 EV Insurance

8.4.1 Reasons for high EV insurance fees

1. **High cost of the vehicle:** Electric vehicles are charged higher insurance as they cost 30%-40% higher than a conventional Internal combustion engine vehicle.
2. **High repair cost:** An EV contains fewer, but high value parts as compared to an ICE vehicle. The cost of replacement for each key component is therefore greater.
3. **Uncertainty of the technology:** EVs are a relatively new technology with an unknown penchant for claims, which allows insurance providers to charge a higher premium for electric vehicles.
4. **Dearth of EV service centres:** The low acceptability of EV insurance across the limited number of OEM supported EV service centres also drives-up premium costs.

Table 5 - Comparison of EV Insurance premium between EV and ICE vehicle

Electric Model	Cost of the vehicle* (INR)	Premium (INR)	Petrol Model	Cost of the vehicle* (INR)	Premium (INR)
Vehicle 1 (Crossover)	14.8 - 19.24 L	61,000-67,000	Vehicle 1 (Crossover)	7.5 - 13.90 L	38,000-47,000
Vehicle 2 (Sub 4m Sedan)	12.2 - 13.64 L	47,000-52,000	Vehicle 2 (Sub 4m Sedan)	5.98 - 8.7 L	28,000-35,000

*Cost is ex-showroom pan-India

Vehicles fitted with telematics devices would help in managing insurance losses by enabling providing the exact information on the usage pattern, type, and extent of damage of the vehicle. Electric vehicles fitted with telematics devices would allow insurance companies to charge lower premiums based on the usage pattern.

EY point of view:

EV insurance is currently pegged at higher premiums than ICE vehicles which is being compensated by the government by discounting EV insurance to the tune of 15%. The evolving EV ecosystem would follow the path of **pay as you drive** by incorporating data analytics in a connected car.

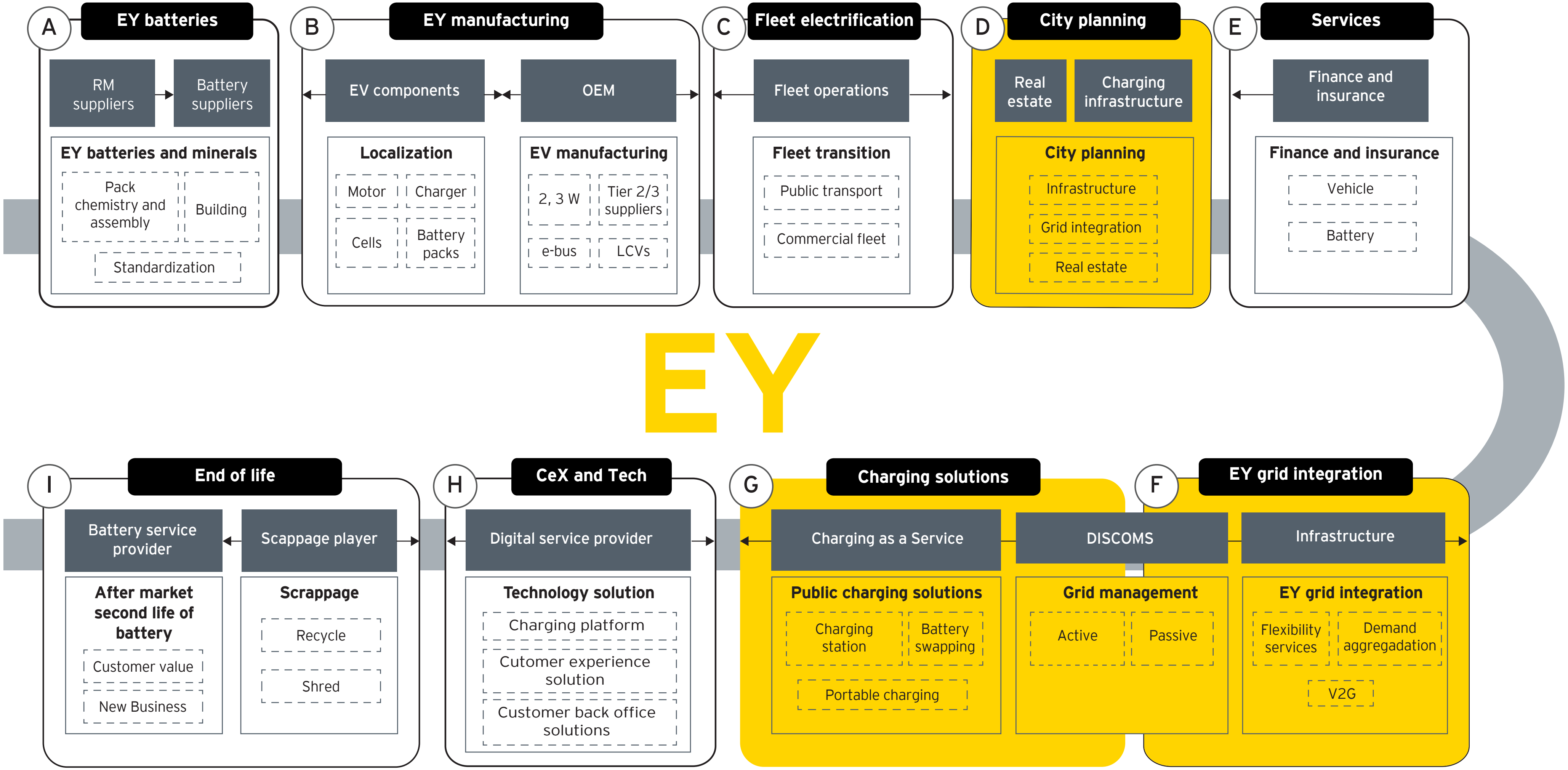
Incorporating EV financing under priority sector would propel the financial institutions to offer financing options to EV customers. On the contrary, high financing cost coupled with uncertainty in technology, unexplored re-sale market of EV’s needs to be addressed to build trust in the electric mobility ecosystem.

Tailoring EV financing options as per the use case of the vehicle would reduce the burden off private vehicle owners and encourage them to own an electric vehicle. OEM attached finance companies should pave the way in offering lower interest and insurance rates to build trust in their EV offerings.

9

EV infrastructure development

EY's EV value pool framework: opportunities from emerging EV ecosystem



9.1 EV charging ecosystem

The transportation sector is in a transformational phase undergoing electrification. Electric vehicle adoption has had strong traction on the back of government initiatives and policy support programs nationally. Further, the development of charging infrastructure is required to support EV adoption as a mainstream mode of transportation. Electric vehicle charging infrastructure can be divided into two broad categories i.e. charging infrastructure (using electricity to charge the battery pack within the vehicle) and battery swapping (replacing a used battery pack with charged battery pack).

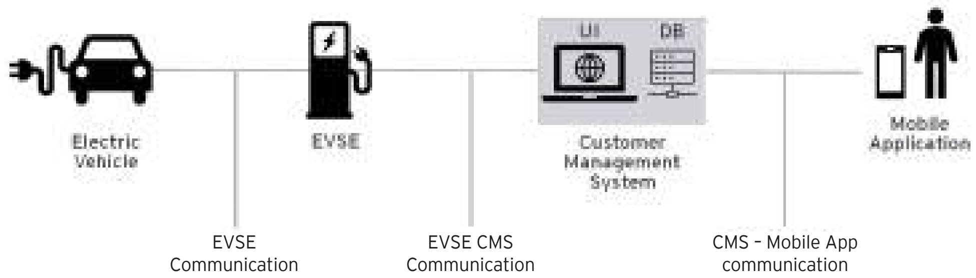
Key factors for planning and development of charging infrastructure include:

- The availability of charging stations
- the safety of operation
- the type of vehicle (time to charge)

9.1.1 EV charging systems

Electric vehicle supply equipment (EVSE) is a base component required to set up an EV charging infrastructure. The control system enables operations such as authentication, authorization, data capture, network, and data privacy and security.

Figure 23: Architecture of EV charging ecosystem



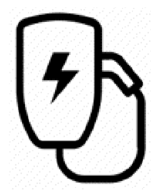
1. Ensure safe and secure supply of energy for battery charging
2. Grid related info; authorization, billing and other data
3. Locating charging point, reservation, billing details and information tracking

The charging can be done in two ways i.e., wired and wireless. The wireless mode requires additional inputs from the supply-side for technology upgrades and addition. The wired mode is the most preferred globally. It is highly efficient in terms of energy consumed for charging and can be easily controlled as well in case of an emergency. The EV charging ecosystem can be divided into two broad categories as shown in

Figure 24: Types of charging infrastructure

1 Charging Stations

Home Chargers



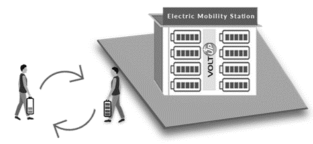
- Early adopters in the passenger vehicle segment will go for home charging solution
- In-short term preferred for e-4W
- In medium to long term preferred by e-2W (personal use)

Public Charging

- Required for mainstream adoption
- Public charging availability will improve consumer confidence in adoption if EV
- It will reduce the initial cost burden while purchasing EV (home charger not required)
- Preferred by buses, trucks, and other commercial application

2 Battery Swapping Stations

Swapping Stations

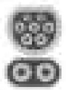
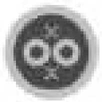
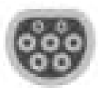
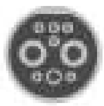
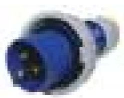


- Most preferred by vehicle with smaller battery packs such as; e-2W and e-3W (goods)
- Commercial e-2W will use it for delivery / last-mile connectivity use case
- However, for long-term game battery design standardization and operational safety regulation to be developed by the government to ensure interoperability.

9.1.2 Charging technology in India

The charging technology is defined by the type of connectors, some of the connectors are mentioned in Table 6.

Table 6: Common Charging Standards in India

Charging Type	Connector	Power Rating	Additional Information
Fast Charger	 Combined Charging System (CCS) 2	50kW - 150 kW	DC rapid charging of 50kW or more
	 CHAdeMO	3 kW - 150 kW	Bi-directional charger being used by 400 members and 50 charging companies. CHAdeMO is the original DC charger for fast charging
	 Type 2 Charge	Up to 43 kW	The maximum voltage is 500 V AC., and can be used for charging electric 2W, 3W and 4W.
Slow/Moderate Charging2	 Bharat DC-001	Up to 15kW	Based on the GB/T connector, the Bharat DC001 standard can deliver up to 200A of current and operate at 48V/60V/72V.
	 Bharat AC-001	Up to 3.3 kW	The connector is IEC 60309, and it also has OCPP 1.5. AC-001 is mainly a low power charging delivering up to 15A.

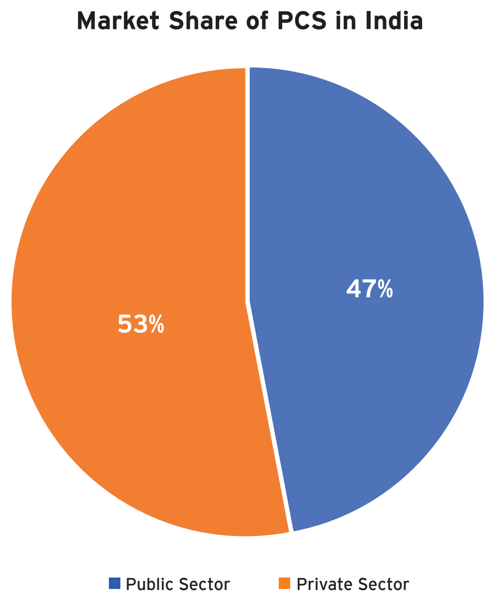
EV adoption will be driven by the light vehicle segment particularly in the commercial sector such as warehouse management (inventory), last-mile delivery and connectivity, and the e-commerce industry. Electric 2W and 3W are the highest gainers in the e-commerce ecosystem. EV adoption in the passenger vehicle segment is led by Intermediate public transport sector focusing on decarbonization.

9.1.3 EV charging infrastructure

The national electric mobility mission plan was envisioned to bring electric vehicles into the mainstream transportation sector with an intent to reduce carbon emissions and import crude oil. Under the mission, the FAME initiative captured the attention of the industry players. The sanctioned public charging stations were 520 (FAME Phase 1), 2,877 (FAME Phase 2), and 1,576 (FAME Phase 2 on 9 expressways and 16 highways).

The EV charging station growth will be driven by the OMCs in this decade, as they plan to leverage their existing refuelling station network for setting up EV charging options. Currently, India has around 90,000 ICE refuelling stations network across the country.

Table 7 - Share of Public Charging Station Operators in India



9.1.4 Swapping stations business models

Battery swapping charging solutions have seen a keen interest from the Indian startup industry with innovative business models offering to target a wide range of customers. Some of the models are:

1. Energy as a Service – separating the battery from vehicle purchase and offering a pay-as-you-go service for using battery pack. It is leasing a battery pack and paying precisely for the utilization. The upfront vehicle cost is reduced drastically as the battery is not a part of it (which has a majority share in the build cost of EV). This is one of the affordable purchasing options for low-moderate range customers.
2. Battery-as-a-Service – renting/leasing a new fully charged battery in exchange for a discharged one. This model can be further elaborated as:
   - Subscription – a monthly/annual subscription contract for the specified number of battery swaps with small per swap fees to accommodate for administrative expense
   - Actual utilization in real-time – no subscription required, directly access compatible battery pack exchanged against a discharged battery. Costing heads are subjective to offered business model unlock charge, the cost per kWh, a charge per swap, and a monthly subscription charge.
   - Connected battery – digitalizing the service with IoT-enabled tech help monitor battery function, the storm left capacity, battery location tracking, and energy utilization behaviour basis energy expense.
   - The battery is not a part of the vehicle which brings down upfront cost and makes it affordable owing to the battery swapping option.

Figure 25 - Swapping Stations Business Models "Battery as a Service"

Business Model 1 | **Monthly Subscription fees** | **Utilization fees**

- Subscription fees is an assurance of enrolment of a customer on the service with the company
- Utilization fees would be by kWh or per swap

Business Model 2 | **Monthly / annual Subscription fees**

- For fixed number of swaps in the subscribed period
- It is inclusive of utilization of battery as well, all cost is bundled into one subscription amount

Business Model 3 | **Utilization fees**

Pay-as-you-go model no upfront cost/subscription required only pay when using the service and for the amount of use

The projection considers various variables impacting the adoption of battery swapping vehicles. The primary consideration was the battery pack size required for the vehicle function, a smaller battery that is easy to switch, and the best use case for a quick switch at the swapping stations. The battery swapping technology is a promising option for last-mile delivery and connectivity application for 2W and 3W.

9.1.5 Battery swapping vs fixed battery[46]

Advantages of Battery Swapping

1. **Reduction in EV acquisition cost:** Battery accounts for a significant cost, nearly 30%-40% of the total cost in an EV. In the battery swapping model, the battery is not part of the total cost of the vehicle, as it is owned by the operator.
2. **Reduction of risk associated with batteries:** With the battery owned by the operator, mishaps caused by battery would be under the purview of the manufacturer/operator and not the consumer, allowing for lower risk to insurance companies.
3. **Low financing cost:** Reduction in the battery cost would in turn reduce the finance amount which the consumer would like to avail to purchase an electric vehicle.
4. **Longer vehicle life:** Low finance and insurance costs would increase the adoption of electric vehicles over ICE vehicles.

Challenges of Battery Swapping

1. **Standardisation of battery packs:** The battery packs need to be standardised across all vehicle segments to successfully execute this model. This standardisation would snatch away the OEMs freedom of designing the vehicle as per their needs.
2. **Reliability of the battery pack:** The battery packs available to the user should be of same specifications and quality. Any disparity in the functioning of the battery packs would result in damage of the vehicle.
3. **Private Ownership:** A private owner will also be unwilling to use batteries that they have not purchased, or can guarantee chain of command of, as can be viewed as a potential risk to their vehicles. Also, with lower adoption rates in the country for private vehicles, battery swapping is not commercially viable currently, as owners would prefer to charge at home.

46 https://www.financialexpress.com/auto/electric-vehicles/rechargeable-battery-vs-battery-swapping-in-electric-vehicles/2467989/

Mr. Saurabh Agarwal
(EY Partner, Auto Tax Services)

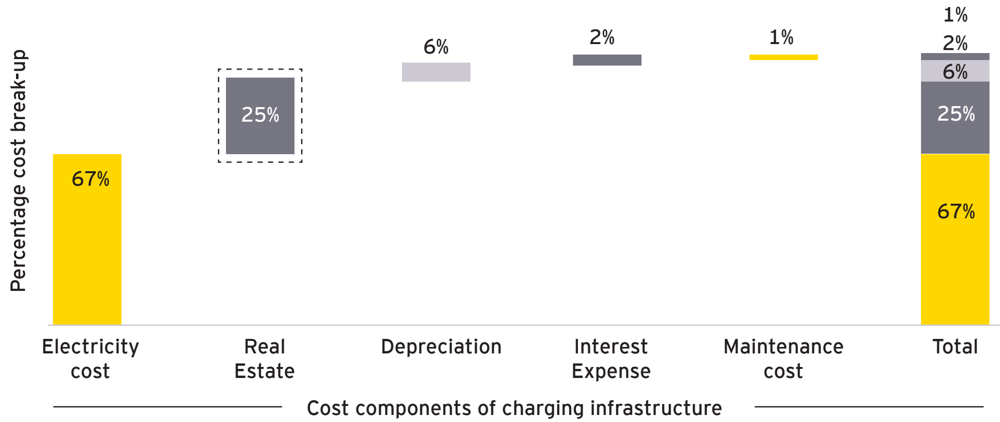
" The draft BSP policy appears to be promising and in line with the global commitments made by India toward enabling a greener environment. However, it is noted that presently, the EVs with fixed batteries are popular, which requires end-users to spend considerable time charging such vehicles and there is insufficient charging infrastructure available in the country, which is leading to lesser adaptability with the public at large. The positive intent and approach of the stakeholders during implementation would be key to the success of the Battery Swapping Policy, thus, reciprocal cooperation amongst private players and the government would be required"

9.2 City planning

9.2.1 Why is real estate important to EV infrastructure development?

The cost structure for operating an electric vehicle charging point/station includes electricity cost, real estate, depreciation and interest expense, and maintenance cost. Electricity cost has the major share in cost, considering it is the fuel followed by the real estate segment accounting for about 25% of the overall cost. Real estate might include, land purchase/leasing, utilizing/developing supporting facilities required to operate charging stations such as road connectivity, renting / construction of complex buildings, etc. The following chart shows a breakup of cost heads for a charging station operation.

Figure 26 - Cost components of charging infrastructure

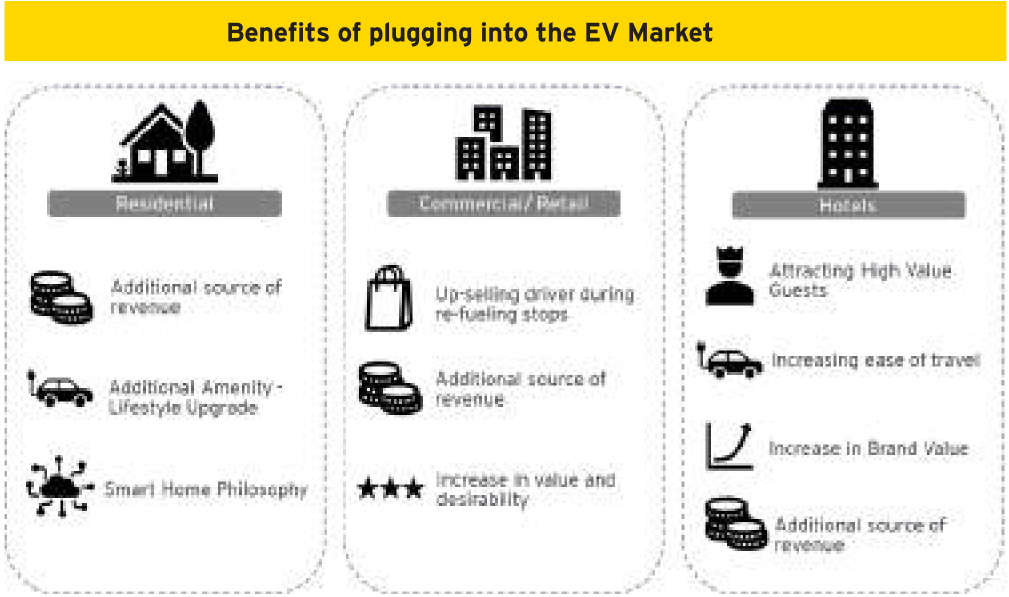


Impact on Real Estate Developer's Project Planning

1. The relators could use its set up to offer services to residents/visitors as well as operate as an open charging service provider like an ICE gasoline refueling station.
2. Locations, where the relators can plan for charging points, are residential complexes (high scope in new projects, can increase the base rate by 2-5%[47] with the facility within the complex), malls and shopping complexes, corporate and commercial towers, recreational centers and hotels. An efficient space and infrastructure plan could help relators leverage charging services even outside the area of the complex.

9.2.2 Opportunities

Figure 27: Business opportunities for real estate players in the EV ecosystem



47 Times Property, Feb 2022

9.2.3 Policy push for EV charging stations in real estate market

1. Certain states have even modified the building laws to accommodate EV charging infrastructure basis built-up area and parking space capping. For instance, in states like Andhra Pradesh, Kerala, Madhya Pradesh, and Uttar Pradesh the residential and commercial complexes with a built-up area above 5,000[48] sqft have been mandated to have a charging facility within the complex. Tamil Nadu and Delhi have defined EV parking reservations of 10% and 20% respectively for setting up EV charging infrastructure. States are also focusing on developing e-zones to promote public awareness and demand.
2. Most industry experts believe that the ease of availability of charging stations within the residential or commercial complex is expected to push EV adoption in the short-medium term. The pre-existence of the EV charging infra in a complex; will allow the users to own EVs without worrying about the infrastructure investment cost.[49]

9.3 Grid integration

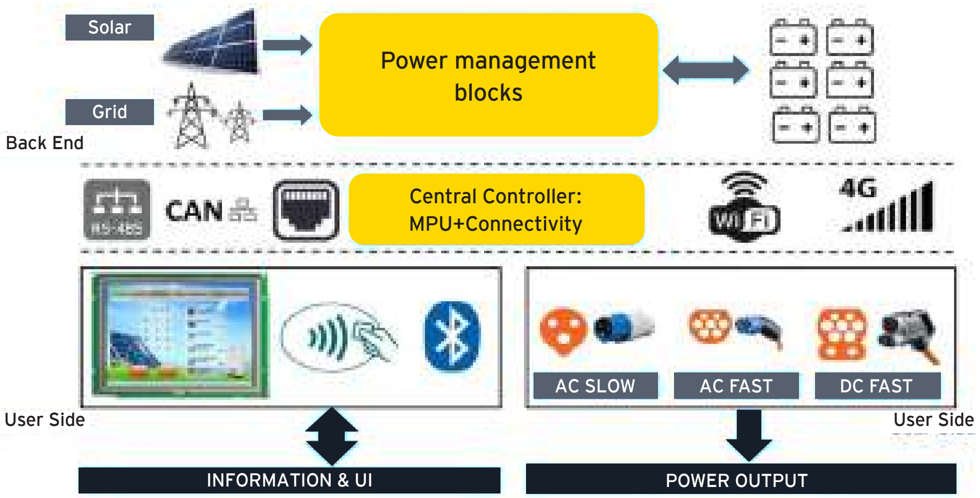
Grid integration is the practice of developing efficient ways to deliver variable renewable energy (RE) to the grid. Vehicle and grid integration marries the transportation and energy markets. It involves data driven planning and prediction of when and where EV load can come from.

India has now surpassed 50 GW of cumulative installed solar capacity, as on 28th February 2022. Of the 50 GW installed solar capacity, an overwhelming 42 GW comes from ground-mounted Solar Photovoltaic (PV) systems, and only 6.48 GW comes from Roof Top Solar (RTS) and 1.48 GW from off-grid solar PV[50].

The abundance of solar power for India can be leveraged in reducing the energy consumption from non-renewable sources as shown below:

Figure 28 - Representation of solar integration into the grid >

48 Times Property, Feb 2022
49 Times Property, Feb 2022
50 The Hindu|16th March 2022



In addition to the integration of solar into the grid, it is also essential for the inclusion of Smart Meters in the grid setup. Smart meters will support energy management between the supplier (DISCOM) and the consumer, allowing for better planning for grid capacity. Singular smart meters for EVs can enable vehicle-2-grid integration, allowing for EVs to act as battery backups for the grid in times of high demand, without having to add generation capacity or building utility scale battery storage. Smart meters can also help the consumer save electricity as they are able to participate in Time-of-Use smart electricity tariffs, allowing the consumer to charge their vehicle when the cost of electricity goes down in off-peak hours. Overall, smart meters can prove to be a valuable instrument in the integration of EVs in the grid, both from a consumer and from a DISCOM point of view.

9.3.1 Benefits associated with EV grid management[51]

1. **Customer benefits:** Reduction in costs for customers who resort to choosing incentives and avoiding high demand charges
2. **Distribution System benefits:** Renewables would be better integrated coupled with reduction in the backflow on distribution system in high solar penetration areas
3. **Transmission system benefits:** The transmission capacity expansion can be deferred with better operational efficiency
4. **Compliance benefits:** The country as a whole would benefit with states meeting the renewable energy targets
5. **Frequency regulation:** The power grid is set up at a frequency of 50Hz. The occurrence of a supply demand mismatch would lead to variations in frequency. The response of EV batteries in a short span of time would mitigate any grid instability
6. **Alternative storage for renewable power:** The EV's can be utilised as a storage of renewable energy when there is a high demand for power. The stored energy can be supplied back to the grid when necessary to maximise renewable energy usage.

9.3.2 Challenges of Future EV Grid Integration to Indian DISCOMS[52]

1. **Voltage instability:** Sudden load changes due to EV charging can disrupt the power system from maintaining steady voltage.
2. **Harmonic Distortion:** Nonlinear loads in the charging ecosystem would lead to harmonic distortion. This type of distortion would lower the power system efficiency to a great extent.
3. **Power losses:** The increased load due to EV charging may result in power losses in the whole distribution network of the region. The increased load may be in different times of the day (generally during the evening).
4. **High Cost of power in the spot market:** DISCOMs would have to purchase power in the spot market due to higher demand of power in the peak hours. Higher cost of procurement would lead to higher cost of supply.

9.3.3 Solutions to Discoms for handling the EV grid integration challenges[53]

The solutions of EV grid management are classified into:

1. Passive management: Encompasses techniques to influence the EV user's behaviour by charging low tariffs in a non-peak hours. Incentives under passive management would be to provide rebates for customers choosing lower level of charging.
2. Active power management: which can be further classified into:
   (i) Unidirectional power management
   (ii) Bidirectional power management

51 Vehicle - Grid Integration: A new frontier for electric mobility in India (Shakti Sustainable Energy Foundation)
52 Vehicle - Grid Integration: A new frontier for electric mobility in India (Shakti Sustainable Energy Foundation)
53 Vehicle - Grid Integration: A new frontier for electric mobility in India (Shakti Sustainable Energy Foundation)

Mr. Awadesh Kumar Jha (Executive Director, Fortum Charge and Drive)

"The V2G infrastructure in India is in its nascent stage of development with first pilot project of load balancing in certain parts of Delhi.

V2G model is essential for the Indian market as the solar power backed grid would be supported by an EV which acts like virtual power source

The charger point operator, OEM, charger manufacturer and Discoms have to work in tandem to make it viable"

EY point of view:

EV policy landscape should focus on end-to-end supply chain development for the segment to streamline in terms of component availability and localization, standardization of EVSE to encourage interoperability, and phase-wise implementation of the regulatory framework to ensure ease of doing business.

State policies should be introduced to incentivize electric tariffs for electric vehicles, focusing on non-peak hours to ensure grid operability and avoiding excess capacity building. Battery swapping should be given serious consideration for supporting commercial fleets in the short and medium term until battery technology has matured to allow for faster turnaround time.

Fast charging would remain the norm for HDVs, as well as for commercial 4-wheeled vehicles. Battery swapping can be the solution for last-mile delivery operators, especially in the two and three-wheeler market segments, reducing downtime and improve profitability. Private vehicle owners, both in the two and four-wheeler market segments would rely on at-home or -at-office charging, which would precipitate the development of charging solutions for home, offices and retail.

Strategic analysis for deployment of fast chargers, including site analysis and power grid requirements should be conducted holistically across the national grid. Highways should have rest stops with facilities to allow consumers to use the charging site to rest and recharge, providing a business opportunity to the charge-point operators.

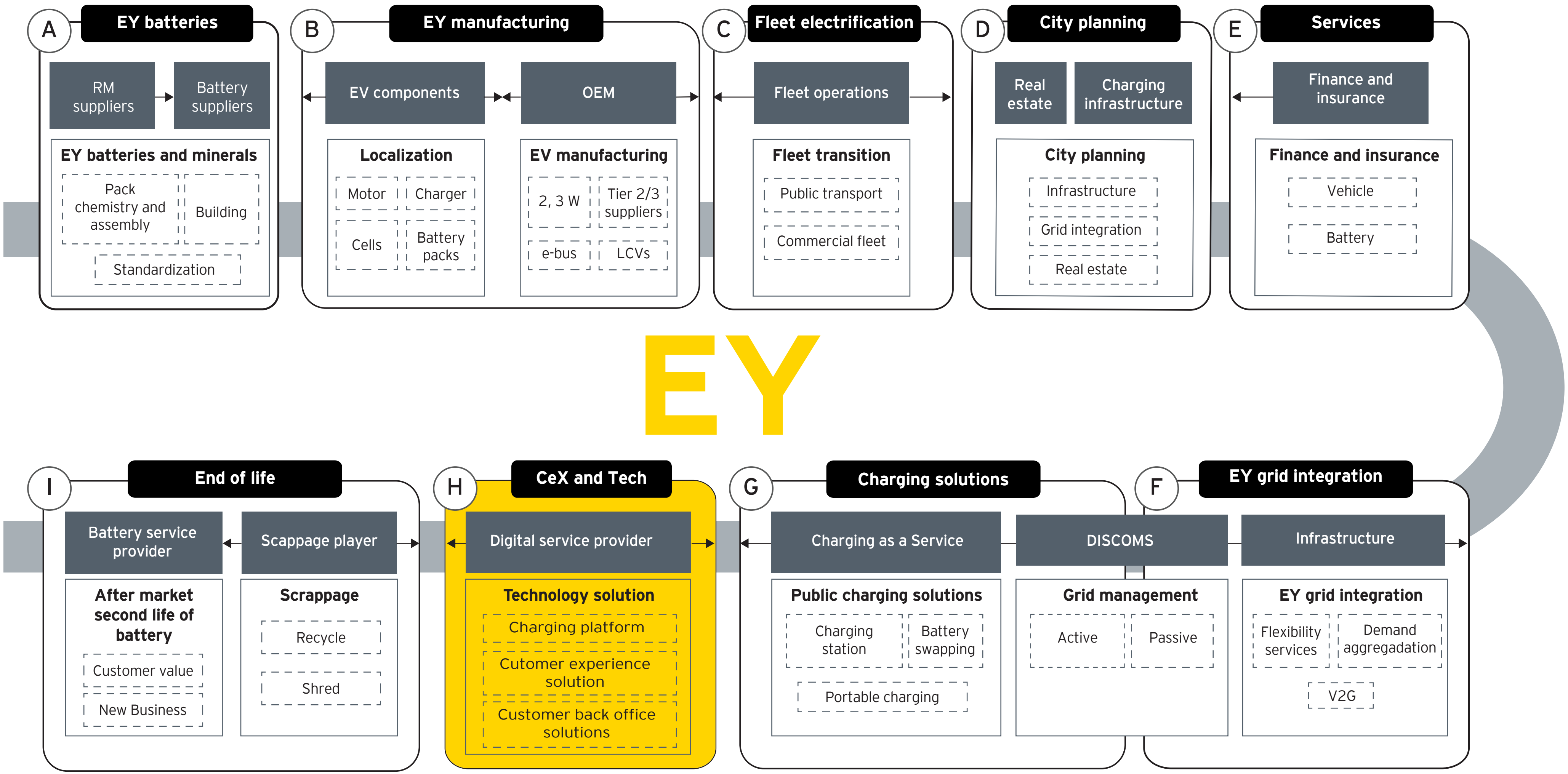
The concept of smart metering in combination with smart charging may iron out dynamic spikes in the power demand and would also not hamper the battery life. An EV grid management plan should be incorporated to account for system boundaries and dynamic fluctuations in power demand. The creation of an intelligent grid would address the dynamic spikes in power demand and iron out the load curve.

EV charging data management and analytics would emerge as a new business opportunity for DISCOMs, charging service providers to ensure improved grid management. The pay as you go model would be more suitable to Indian conditions than the V2G model, considering the paucity of chargers and the range anxiety problem which users face.

10

Consumer experience and technology

EY's EV value pool framework: opportunities from emerging EV ecosystem



10.1 Enhancing consumer experience

Consumer experience expectations while owning an EV are substantially different as compared to a standard ICE vehicle. With the majority of components being monitored through a battery management system, it is easy for an EV to be digitized to the point where individual components of the car can be connected to the consumer using a mobile application. From pre-sales information to after-sales service, the experience of an EV owner has largely shifted online.

Due to the high charging time involved, and the unavailability of chargers on a scale like that of retail petrol stations, it is important the consumers are able to locate and reserve chargers without having to go to the charger. Similar applications exist outside India, which provide a real-time status of chargers, allow for reserving time slots for charging, make digital payments through methods such as UPI or online wallets, and allow the consumer experience to be entirely digital without having to interact with an attendant. This saves the company money as it eliminates the need for them to have an on-site representative and allows consumers to save time and effort to locate an available charger. All this digitisation is in a bid to remove brick-and-mortar stores of traditional ICE vehicles.

Digital payments, and a unified payment method available to pay for charging is also important. Providing feedback such as total energy consumer, and past charging events in a single application will allow the consumer to derive greater value from the application. Online charging platforms are often built with the fleet management in perspective. They can offer route optimization, driver management, and a detailed telematics system integrated with the charging platform, allowing fleets to have a one-stop solution for their needs. This Software as a Service solution has grown in the last few years, and it is imperative that Indian stakeholders take note of this.

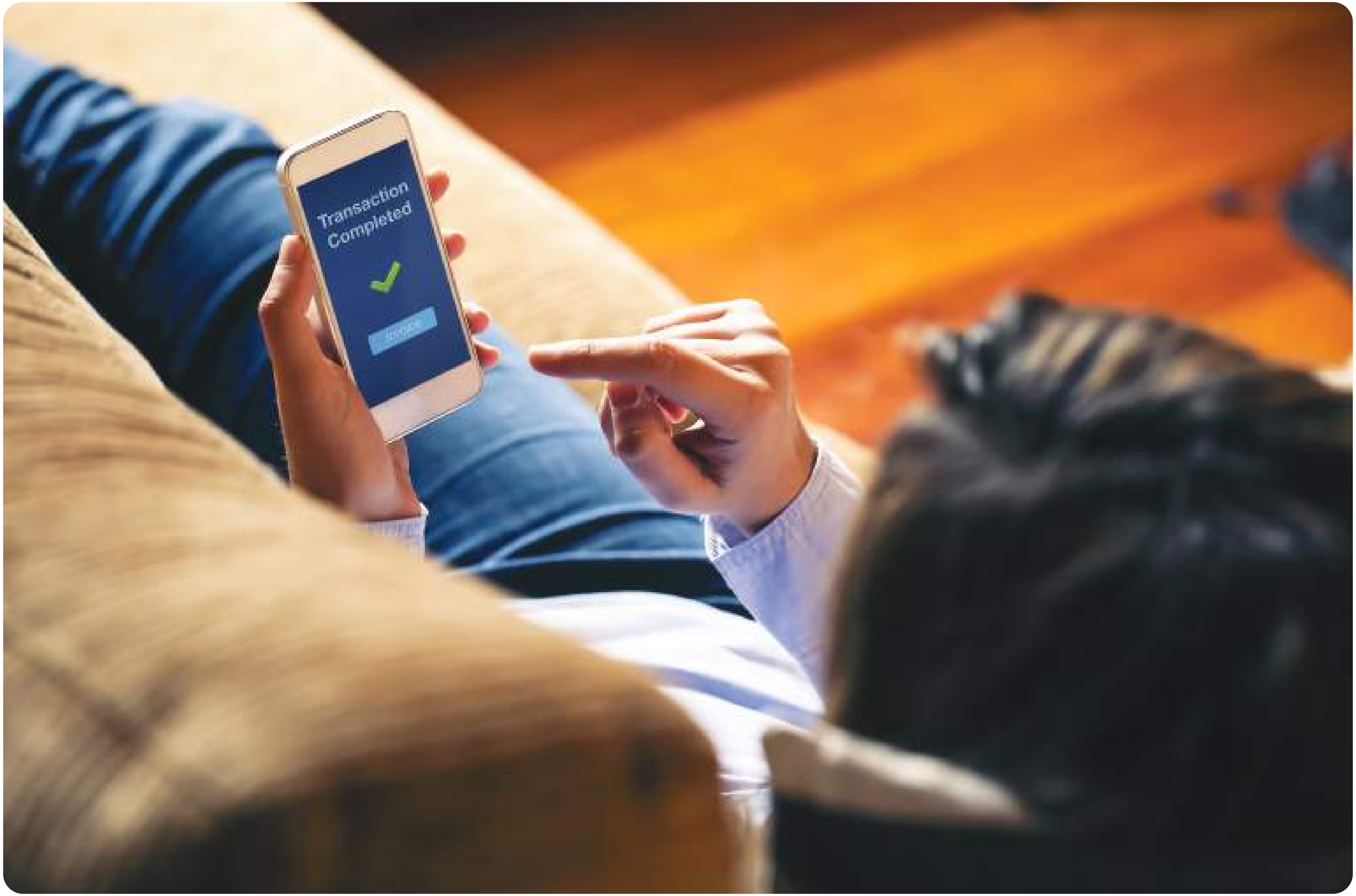
The Bureau of Energy efficiency is planning to launch a mobile application detailing the location of chargers in major cities across India. The application will provide the consumer with real-time information regarding charger status, its availability, allow for time slots to be reserved for charging and allow for digital payments through the UPI or online wallet systems.

10.2 Customer solutions

As mentioned earlier, EVs being connected to the backend allows for over-the-air updates for their software, including their battery management systems. This has further developed into full solutions where OEMs are offering anti-theft protections, vehicle support, built-in navigation etc. All of this is managed through a dedicated customer back office, which can provide support in the case of emergencies, as well as monitor the life of the battery. Additionally, for fleet consumers, these services can be offered as a bespoke solution for fleet needs, such as route development and tracking vehicles.

EY point of view:

The government is urging its agencies to move towards large-scale digitization; thereby ensuring paperless processing of documents. Keeping the said objective in mind, the government would be introducing a single-window portal for all administrative activities. To enhance the end-user experience, the government should also introduce guidelines mandating the use of IoT-based battery monitoring systems and other enabling technologies to provide real-time statistics relating to charge levels, nearby charging stations. The portals should also provide online methods to report all disputes arising as a result of any inconvenience caused to the customer including quality issues, deficiency in services, etc, resolving such disputes in a timely manner and if required, offer compensation to damages caused to customers.


Transaction
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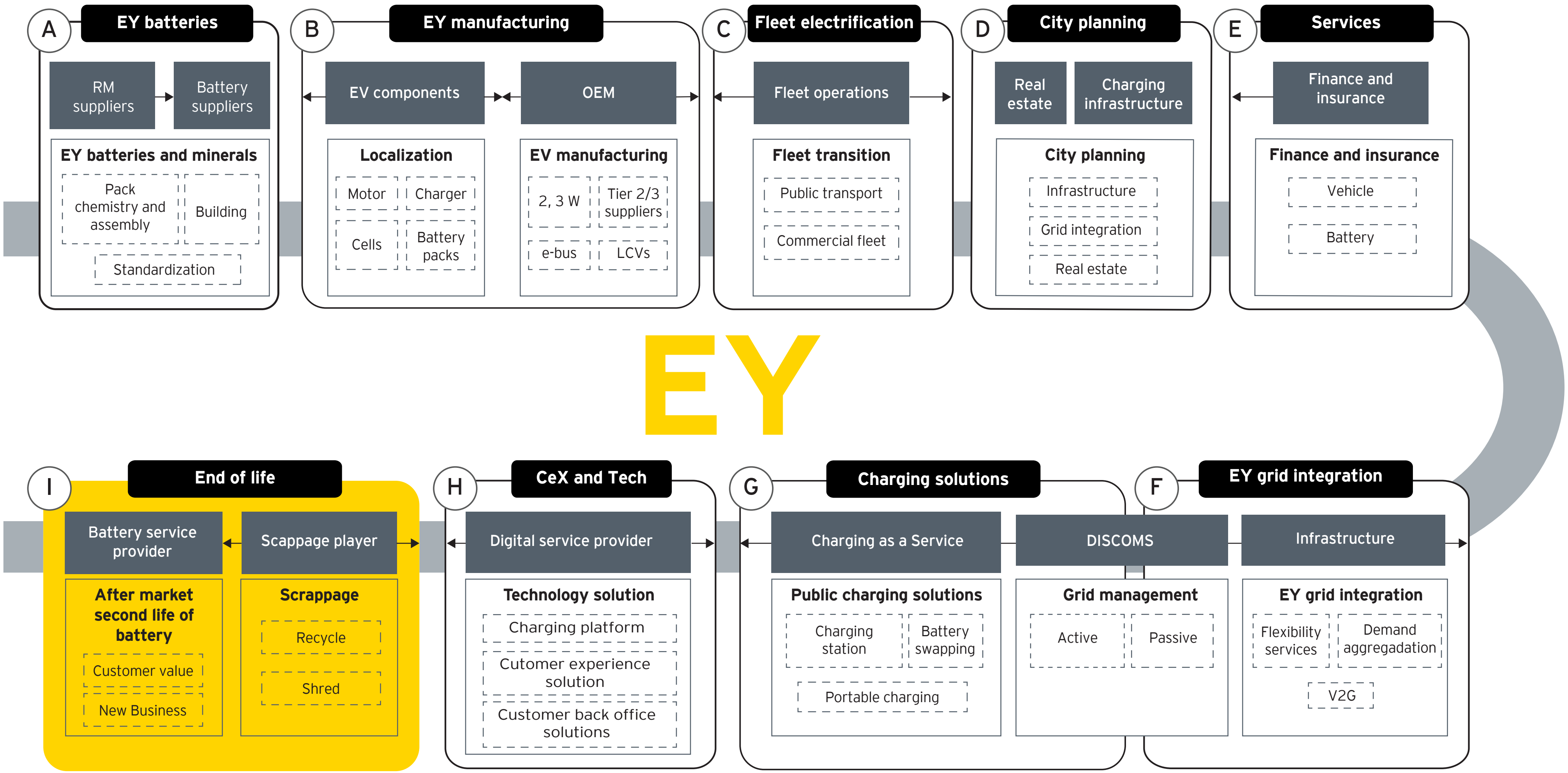
11

Battery end of life procedures

EY's EV value pool framework: opportunities from emerging EV ecosystem



11.1 Scrapping and recycling

Battery scrapping and recycling has so far taken a backseat in the Indian context. There are no set procedures detailed by regulators, and the onus of battery recycling has been left onto the manufacturers. However, in case a manufacturer is no longer active, there is no precedent on the methodology that will be followed for the disposal of the vehicle.

With limited reserves of rare earth metals like Lithium, Cobalt and Nickel, battery recycling can offer a shorter supply pool for new EV battery manufacturers. Instead of importing these metals from the international market, which can be influenced by world events (such as those seen in the Russia-Ukraine conflict), recycling can help establish a domestic supply from used batteries, as well as attach a residual value to the battery at its end of life. This will offset the total cost of ownership for the consumer, making EVs more affordable in the longer run.

11.2 Second life of battery

Electric vehicle batteries typically operate for upto 3000-5000 cycles before they are deemed inefficient for direct use in the vehicle. These batteries retain 70%-80% of their original battery capacity, with only a 5% expected self-discharge rate over a 24-hour period, making it extremely viable for non-transportation related secondary application. A SLB can improve the value proposition of electric vehicles, making them even more attractive by using the full potential of the battery value chain.

Some of the advantages and use cases for a second-life battery are given below:

- Business opportunity: Second life of batteries offers a business opportunity to OEMs, that are ultimately responsible for the recycling/dismantling of batteries once they reach their end-of-life period for EV usage. These batteries can perform well in a less-demanding use case, and help offset their recycling costs.
- Value for customer: Figure 29 highlights the cost differential at the end of use for EV battery once it has been used in secondary application[54]. These savings can be used to offset upfront costs for electric vehicles, allowing for a reduced total-cost of ownership for the EV consumer, promoting faster adoption.

54 Bloomberg New Finance-Quint

Figure 29: Cost differential between new and reused battery

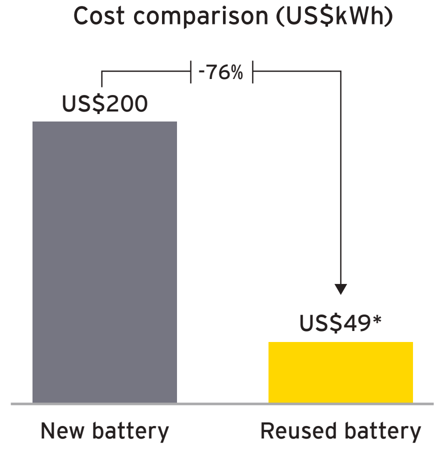


Figure 30: Applications of SLBs

Key applications of second-life batteries

1 **Renewable energy storage**
Used EV batteries are ideal for storing electricity from solar panels and wind turbines and allowing its usage when needed.

2 **Grid stabilization**
Batteries can be used for handling the load shifting when there is high peak demand.

3 **Power backup**
Batteries can be used for backup power supply and improving power quality inside residential and commercial buildings.

4 **EV charging**
Stored energy in used batteries can be leverages to offer EV charging services in locations where constructing a high-power connection whould be very costly.

Major industries	Telecom	Utilities	Real estate	Automate

The primary challenge to the application of an SLB is the lack of a standardized product available in the market. Some battery chemistries are not as adept to repurposing as others, while the unpredictable lifetime of the batteries poses a threat to guarantees in secondary application. Additionally, re-using batteries in a heavily regulated secondary market, such as the utility sector, poses serious challenges in the approach and deployment of SLBs, which may make the re-purposing commercially unviable.

Mr. Som Kapoor (EY Partner, Future of Mobility and Auto Retail Leader)

"EV batteries are costly, but their value chain – use, reuse, recycle – offers revenue potential. Developing a used battery market presents a major opportunity for industry participants to create new assets, access valuable new revenue streams, secure supplies of raw materials and drive EV use. It is a critical aspect of the future viability of EVs and will be a major competitive differentiator for those that drive the market as opposed to those that sit on the sideline."

EY point of view:

EV policy landscape should focus on end-to-end supply chain development for the segment to streamline in terms of component availability and localization, standardization of EV batteries to allow for ease of battery recycling and developing SLB solutions.

The benefits offered through developing a localized recycling policy will be reflected in the cost of batteries, reducing the upfront cost. A residual value placed on the batteries after their end-of-life as a EV battery, encouraging local businesses to explore opportunities in the SLB market, reducing India's need to import rare earth materials and improving the local supply chain.

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Skill development initiatives for EV ecosystem

On the academic forefront, India has been striving meticulously towards development of efficient energy storage systems, particularly batteries. CSIR-CECRI has developed a prototype Li-ion fabrication facility for 18650 cells. It is India's first pilot plant facility which will manufacture Li-ion cells with a capacity of 1500 mAh/3.7 V, dedicated to improving the capacity of Li-ion batteries. IIT-Madras has been working on electrode materials and novel redox couples for vanadium redox flow batteries. IIT-Bombay is primarily focused on developing energy storage materials for Li-ion batteries and fuel cells towards EV applications.[55]

However, major industry players will be required to collaborate with leading institutions to support research and development for EV technologies, globally organizations are collaborating with academic institutions to fund research and development initiatives ex. One of the leading cell manufacturing companies in Japan plans to invest 15.1 trillion won by 2030, including 9.7 trillion won in R&D. It will build an institute in South Korea for training in battery technology, expected for completion in January 2023.[56]

Thus, skill development initiatives will need to be undertaken from all stakeholders including industry, academia and government bodies. Some of the focus areas for skill development include,

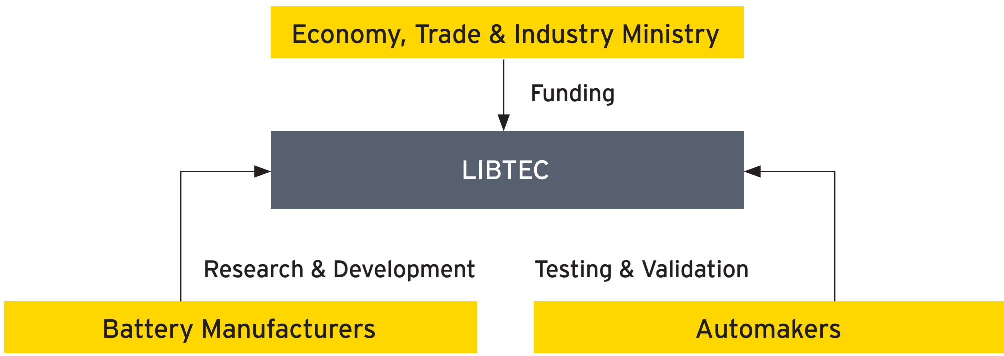
1. Addition of new courses in the syllabus and adapting the content based on final application - For EVs, mechatronics, the technology that combines electronics and mechanical engineering, is gaining currency. As a multidisciplinary engineering branch, it serves both electrical and mechanical systems, with skill sets useful in the advanced automated manufacturing segment.

Figure 31 - Skill domains for EV

Domain	Application
Electronics & Communication	Firmware and application software for power electronics & controllers
Chemical Engineering	Lithium Ion cells manufacturing & assembly
Mechanical Engineering	Thermal management & vehicle design
Mechatronics	Component & vehicle design
Automation	Shopfloor automation for assembly of components
Computer Engineering	CMS software, analytics platforms
Electrical Engineering	Charger development, HV wiring harness

2. Focused R&D with collaboration from stakeholders – Industry players with funding from Ministry and industry for EV technologies and develop testing and validation infrastructure for components, a similar approach is adapted in Japan for battery research and development

Figure 32 - Japan EV battery development consortium



3. EV manufacturing skill upgradation – Manufacturing EV vehicles requires new assembly and production practices, these will require employees to be reskilled, industry players can develop in-house training programs for upskilling the workforce or collaborate with institutions for on-the-job training programs. For example, assembling electric car involves dealing with high voltage systems and thus proper training will be required to ensure safe working environment for the employees working on production lines.

55 Department of Science & Technology, 2020

56 Bloomberg report, 2021

13

Conclusion and way forward

While the overall EV ecosystem is still at a nascent stage in India, it is accelerating with a strong momentum. The spike in fuel prices is providing a compelling business case for the transition towards EVs and alternate powertrain vehicles across personal and commercial segments alike. To support this transition, different aspects of the EV value pool will need to evolve in conjunction going forward:

- A mix of vehicle ownership models and business models for charging infrastructure have to be planned, based on the target use case, operational pattern, locations, and available resources. The higher upfront cost of EVs can be offset by Vehicle-as-a-Service (VaaS) or Battery-as-a-Service (BaaS) models specially for commercial applications with battery swapping options for 2Ws, 3Ws and SCVs along with Gross Cost Contract (GCC) or Cost per Kilometre (CPK) models for heavier vehicle segment. Fleet operators can also evaluate EV retrofitment in their transitionary phase. For infrastructure, while public sector initiatives and collaborations with DISCOMs is sufficient at the introductory stage, as the EV landscape matures other models such the PPP model may be better suited.
- The current market share of manufacturing unique EV parts in India is merely 1%. This number is expected to rise to 5% in the next few years[57]. The large manufacturing volume will reduce the costs of making EV parts in India with economies of scale kicking in. While the government is doing its bit by rolling out the Faster Adoption and Manufacturing of Electric Vehicles (FAME Phase II) Scheme with an outlay of INR 10,000 crores, Production Linked Incentive (PLI) Scheme for automobiles and automobile components with an outlay of INR 26,000 crores, OEMs are taking advantage of it, with the PLI estimated to catalyse fresh investments of over INR 42,500 crore in the automobile sector[58]. To de-risk from import dependency and disruptions such as the on-going semi-conductor shortage, developing a resilient supply chain will prove to be vital.
- To address the localization of battery and cell manufacturing, the PLI for Advanced Chemistry Cell (ACC) has been approved to build an annual capacity of 50GWh by FY30. A sum of ~US$2.42 B has been made available for giga factories with at least 5GWh of annual production capacity per site[2].
- Currently, an EV exceeding 65 KW costs insurance premiums of ~ INR 6,700 and for 30-65 KW capacities it costs ~INR 2,700. On other hand, third party premiums come in the range of INR 3,211 for a 100-1500 cc vehicle[59]. While the IRDAI has announced a 15% discount on third party premiums for EVs, and tax benefits for EV loans, going forward the inclusion of EVs under Priority Sector Lending (PSL) will prove to be beneficial to incentivise banks and NBFCs to scale their financing towards EVs. The large volumes of data captured can also be leveraged to provide customized financing plans based on usage.

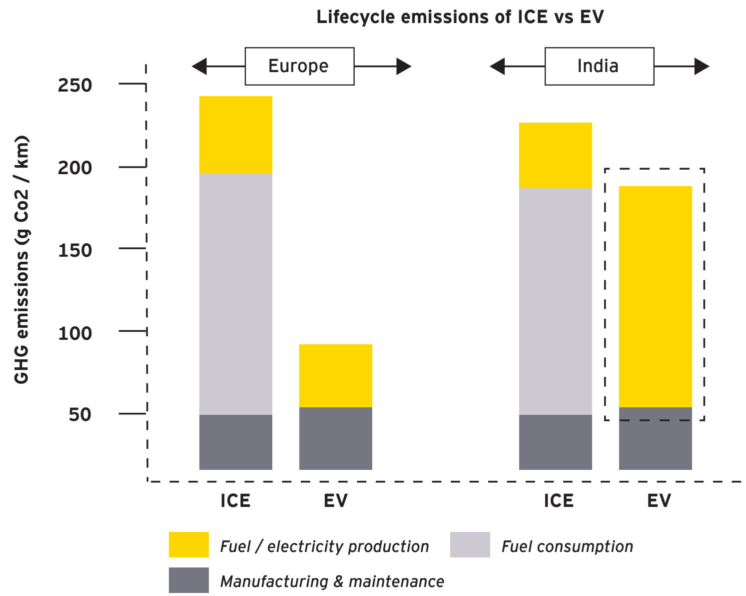
As the EV revolution in India picks pace it will become critical for focus to be driven on End of Life (EOL) management. In this respect, recycling is the best way forward for India to address the safe disposal of end-of-life batteries as well the availability of raw materials for lithium ion batteries. Apart from creating awareness, India will need to take cues from global best practices such as:

- Development of systematic processes, standards and guidelines to promote seamless battery reuse, refurbishing, and recycling.
- Incorporate traceability across the value chain to strengthen the battery retrieval process
- Definition of responsibilities of battery manufacturers, OEMs, recyclers and the govt stakeholders for appropriate EOL management.

Apart from recycling, the sustainable generation of electricity would be required for reducing the GHGs and Well-to-Wheel (WTW) emissions going forward. India's dependence on thermal coal for its power generation indicates its EVs have the highest GHG emissions compared to other developed markets (refer figure 33). Renewable energy for charging should be planned as the way forward as this has significant upsides for the EVs of the future as compared to traditional powertrains.

57 Motoroids, Kabra Extrusiontechnik, January 2022
58 DHI, MoRTH, Automotive PLI Scheme
59 IRDAI, TimesNow, December 2021

Figure 33: Lifecycle emissions of ICE and electric cars in India and Europe[60]



In the ambitious journey to achieve the govt. target of 30% EV adoption in new vehicles sales by 2030, PM and NOx emissions could reduce by 17%, CO2 emissions can reduce by 18% and GHG emissions by 4%. With the crude oil demand growing by 3-4% YoY, resulting in a consumption of ~7M barrels a day by 2030, the targeted EV adoption could lead to a 1.1 lakh crore (15% reduction) in the import bill[61].

To realize all this potential, synergies and collaboration are the key principles to the success of electric vehicles entailing stakeholders to come together to generate a sustainable ecosystem of mobility for the future.

60 IEA, Sustainable development scenario, 2021

61 Council on Energy, Environment and Water (CEEW), March 2022

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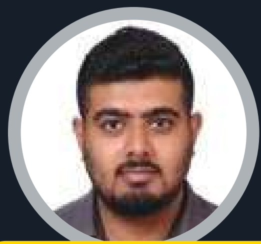

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About SMEV

SMEV is the registered association representing Indian manufacturers of electric vehicles and electric vehicle components. SMEV works closely with the central and state governments to assist the formulation of policies and processes supporting the EV ecosystem. SMEV has contributed significantly to the cause of promotion of EVs in the country through the NEMMP-2020 and FAME policy, the rationalization of import duties and reduction of local taxes and levies. SMEV is keen to play an active role in the discussion of the issues faced by the Electric Vehicle industry and practical aspects to help enhance the penetration of Electric Vehicles towards meeting the goals of our nation.

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