Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany

In Cooperation with
सत्यमेव जयते
NITI Aayog

Status quo analysis of various segments of electric mobility and low carbon passenger road transport in India

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
World Resources Institute
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International Transport Forum
SLOCAT Partnership
Agora Verkehrswende
REN21

Foreword by NITI Aayog

In 2015, India signed the historic Paris climate agreement along with more than 170 nations, marking a significant step that brought together developing and developed nations in combating global warming by cutting down on greenhouse gas emissions.

At COP21, India had pledged to reduce its carbon footprint by 33-35% by 2030 below 2005 levels. It has also pledged to increase the share of non-fossil fuels-based electricity to 40 per cent by 2030. Considering the same, it is high time to switch to alternative fuel options to minimize air pollution and rising crude oil import bill of the country so that we can meet our commitments at the global level.

The transport sector in India is the largest user of oil and second largest source of CO2 emissions world-wide. India has seen a rapid increase in adoption of automobiles since the last ten years. Currently, Indian transportation sector accounts for one-third of the total crude oil consumed in the country, where 80% is being consumed by road transportation alone. It also accounts for around 11% of total CO2 emissions from fuel combustion.

Government of India had notified the National Electric Mobility Mission Plan 2020 which seeks to enhance national energy security, mitigate adverse environmental impacts from road transport vehicles and boost domestic manufacturing capabilities for Electric Vehicles. In addition to this, the Government has notified Phase-II of Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme to stimulate the market of EVs in the country, de-licensed the charging infrastructure business and specified guidelines & standards for charging infrastructure for electric vehicle thereby opening up the market of public charging infrastructure & ensuring a roadmap for development of charging infrastructure, and introduced various financial incentives to reduce upfront cost of EVs and charging infrastructure.

While, Government of India has taken crucial steps towards faster adoption of EVs, there are several challenges and gaps existing in the EV ecosystem that must be addressed. In this context, the report on "Status quo analysis of various segments of E-mobility and low carbon passenger road transport in India" is a welcome initiative. It is believed that that the report will stimulate concerted and coordinated efforts by Policy makers, Regulators, Utilities, OEMs and other value chain players to understand the existing gaps in current landscape of EV industry India and the key action items required for enabling accelerated adoption of EVs to support India's vision of transitioning to sustainable and green mobility.

The team acknowledges and appreciates the contributions of all the stakeholders, who provided critical inputs in shaping up the report.

About the study

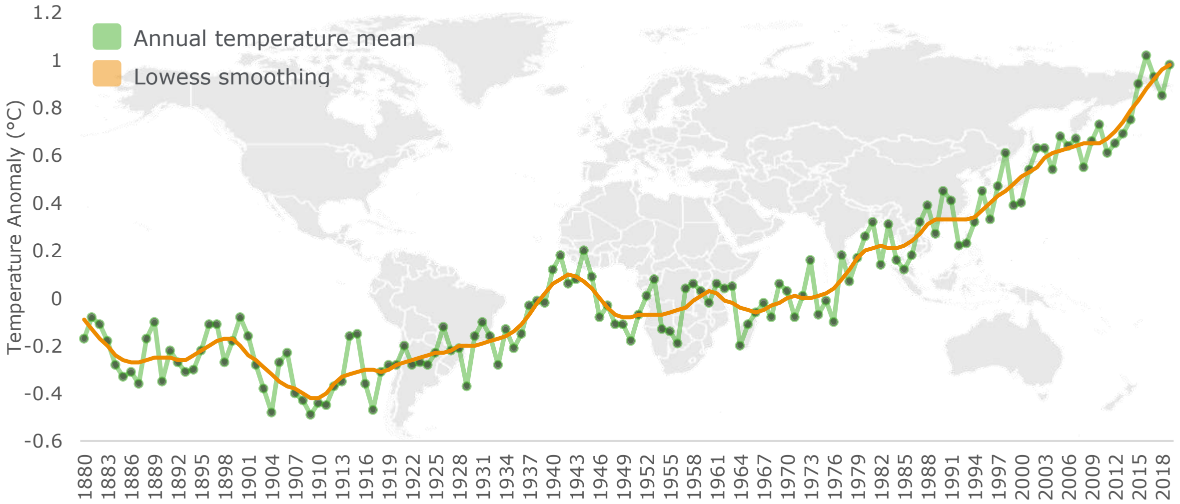
On behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Nationally Determined Contribution-Transport Initiative for Asia (NDC-TIA) is a joint project of seven organisations and with the engagement of China, India, and Vietnam. It aims at promoting a comprehensive approach on decarbonizing transport i.e. a coherent strategy of effective policies that are coordinated among various sector ministries, civil society, and the private sector. The overall aim of the project, which is being implemented by the consortium of seven organisations together to support countries in facilitating and informing these stakeholder processes and in developing selected climate actions. This enables partners to make a sectoral contribution towards achieving their NDCs and increase ambition in transport sections of long-term strategies and 2025 NDCs.

In this context, under the regional technical assistance programme NDC-TIA; one of the activities was to "Perform a status quo analysis/investigation on different segments in India" (e.g. 2W, cars, trucks, buses, freights) under its International Climate Initiative (IKI). This analysis provided us the existing status, opportunities, challenges, gaps, and way forward for low carbon road transport in India. Different types and technologies, services, business models, standards, protocols, contribution in India's long-term NDCs and other climate action and clean energy targets were assessed for various segments of low carbon road transport including electric mobility.

The main objective or goal of this study is to examine the Low-Carbon Road Transport (LCRT)/E-mobility development, accomplishments so far, supported by the policy, schemes, and regulatory interventions in India.

The global average temperature is on a continuous rise and has been a cause of worry for leaders across the world. As per NASA, 19 out of the 20 warmest years have occurred in the 21st century. The rise in change in global temperature was an alarming bell and therefore needed immediate global attention. The 21st yearly session of the Conference of the Parties (COP21) took place in Paris on 30 November 2015. It laid the foundation for global climate change agreement that came into being on 04 November 2016. The central aim of the Paris Agreement was to strengthen the global response to the threat of climate change by limiting the global temperature rise to 1.5 - 2 degree Celsius above pre-industrial levels for the 21st century, along with increasing the ability of countries to deal with the impact of climate change. Worldwide, Energy Sector had contributed 73% of GHG emission[1] in 2016. Within the energy sector, transportation accounted for 7.9 GtCO2e in 2016, or 15% of total emissions.

Figure 1 Change in global surface temperature relative to 1951-1980 average temperatures



Source: 1 NASA's Goddard Institute for Space Studies (GISS)

[1] Greenhouse Gas Emissions by Countries and Sectors (access here)

Transport industry of India and emission challenges

With one of the lowest motorization rates in the world (22 cars per 1,000 people[2]), India is among the fastest growing countries in transportation sector. From 2011 to 2020, India's domestic vehicle sale (2W, 3W, Passenger Vehicle, Commercial Vehicle) has grown at ~4% CAGR. With rising income and rapid urbanization, the Indian mobility market is expected to expand rapidly.

Transportation, however, has contributed significantly in India's overall GHG emission. During year 2016, transport sector contributed to 270.6 MT CO_2e of GHG emission[3], third highest, only after power industry and industrial combustion. Within transportation, road transport has been the highest contributor to the GHG emission[4]. With the rising transport industry, India is also facing intense emission challenges.

Figure 2 Pollution level in India in the past has been alarming

Source: 2 IQAir

India therefore has a great opportunity to leapfrog towards decarbonizing the transport system to meet its NDC commitments and to overcome environmental issues which would likely to become more severe, if remain unaddressed, as India has huge prospects for growth.

LCPRT and e-mobility: India's solution for sustainable growth of transportation sector

As India is experiencing acute challenges in controlling its carbon emissions, the country expects the emission level to grow even further as its transport industry is expanding. To tackle the emission from the transport industry, India is moving towards "zero or low carbon emission" transportation model by promoting the use of alternative fuel vehicles and Electric Vehicles (EVs).

In 2009, through its National Biofuels policy, India sets an "aspirational" target to blend 20% biofuels into the diesel and petrol mix by 2017. However, it has fallen well short of these targets. So far, it has attained only around 2% bioethanol and 0.1% biodiesel blend in 2018. Further, India came up with its first passenger vehicle fuel efficiency standards in 2014 that came into being in 2017. However, they are still less stringent than the EU norms.

In addition, India has also set the national target of achieving 30% EV sales penetration by 2030 and launched National Mission on Transformative Mobility and Battery Storage to promote localization of EV component manufacturing. Alongside the various central level interventions, several states have also notified their respective policies for promoting Electric Vehicles which cover subsidy and tax exemptions, among other incentives, for consumers/ buyers.

However, with all these efforts in place, the market for EVs in India hasn't picked-up as expected.

Low growth in this domain instigates to do a deeper analysis to identify the barriers, challenges and gaps existing in the EV ecosystem that needs to be addressed to unveil the growth of e-mobility and other LCPRT systems in India.

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[2] India motorization rate (access here)
[3] The Carbon Brief Profile: India (access here)
[4] Distribution of greenhouse gas emissions from the transport sector in India in 2014 by type (access here)

The structure of the report is highlighted as follows:

Chapter 1 deals with the As-is state of passenger road transport system in India including existing options for clean mobility and review of passenger transport vehicle technologies.

Chapter 2 provides the market landscape of EV components, EV charging infrastructure, role of distribution utility, consumer perception and roles of financial institutions.

Chapter 3 highlights the Central and State level policies on e-mobility, key gaps and recommendations and also covers the Regulations and Technical standards covering e-mobility and clean fuels.

Chapter 4 provides a deep-dive into the forms and business models of e-mobility, charging infrastructure, e-buses and provides a review of Model Concession Agreement for procurement of e-Buses and highlights key gaps / improvement areas.

Chapter 5 provides the overview and key outcomes of stakeholder consultations and highlights the key barriers in adoption of EVs and charging infrastructure through a mix of such consultations and international best practices.

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Abbreviations

2W	Two-wheeler
3W	Three-wheeler
4W	Four-wheeler
AC	Alternating Current
AIS	Automotive Industry Standards
APERC	Andhra Pradesh Electricity Regulatory Commission
AQM	Ambient Air Quality Monitoring
ARAI	Automotive Research Association of India
ARR	Aggregate Revenue Requirement
BBMP	Bruhat Bengaluru Mahanagar Palike
BDBP	Biodiesel Blending Program
BEE	Bureau of Energy Efficiency
BEV	Battery Electric Vehicle
BHIM	Bharat Interface for Money
BHP	Brake Horsepower
BIS	Bureau of Indian Standards
BMS	Battery Management System
BOO	Build Own Operate
BOOT	Build Own Operate Transfer
BS	Bharat Stage
BSS	Battery Swapping Station
CAB	Current Account Balance
CAFÉ	Corporate Average Fuel Efficiency
CAGR	Compound Annual Growth Rate
CAN	Controller Area Network
CCS	Combined Charging System
CCTV	Closed-circuit television
CEA	Central Electricity Authority of India
CHAdeMO	CHArge de MOve - Japanese fast-charge, Direct Current (DC) standard for electric vehicles
CMS	Central Management System
CMV	Central Motor Vehicle

CNG	Compressed Natural Gas
COD	Commercial Operation Date
COP	Conference of Parties
CPCB	Central Pollution Control Board
CPUC	California Public Utilities Commission
CSFC	Constant-speed Fuel Consumption
DC	Direct Current
DER	Distributed Generation
DHI	Department of Heavy Industries
DISCOMs	Distribution Companies
DMRC	Delhi Metro Rail Corporation
DR	Demand Response
EBPP	Ethanol Blended Petrol Programme
ECU	Electronic Control Unit
EESL	Energy Efficiency Services Limited
EM Cities	Electric Mobility Cities
EMSP	Electro Mobility Service Provider
EPF	Employees' Provident Fund
EV	Electric Vehicle
EVCS	Electric Vehicle Charging Station
EVSE	Electric Vehicle Supply Equipment
EVSEO	Electric Vehicle Supply Equipment Operators
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India
FY	Financial Year
GCC	Gross Cost Contract
GDP	Gross Domestic Product
GFR	General Financial Rules
GHG	Greenhouse Gas
GNCTD	Government of National Capital Territory of Delhi
GPS	Global Positioning System
GVA	Gross Value Added
GVW	Gross Vehicle Weight
HEV	Hybrid Electric Vehicle

HMI	Human-Machine Interface
MoHI&PE	Ministry of Heavy Industries and Public Enterprises
HPCL	Hindustan Petroleum Corporation Limited
IBEF	India Brand Equity Foundation
ICE	Internal Combustion Engine
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
INDC	Intended Nationally Determined Contributions
INR	Indian Rupee
IOCL	Indian Oil Corporation Limited
IoT	Internet-of-Things
IRR	Internal Rate of Return
IS	Indian Standard
ISO	International Organization for Standardization
KPI	Key Performance Indicators
LAN	Local Area Network
LCO	Lithium Cobalt Oxide
LCPRT	Low-Carbon Passenger Road Transport
LCV	Light Commercial Vehicle
LED	Light Emitting Diode
LFP	Lithium Iron Phosphate
LMO	Lithium-ion Manganese Oxide
MCA	Model Concession Agreement
MCV	Medium Commercial Vehicle
MoEF&CC	Ministry of Environment, Forest and Climate Change
MPERC	Madhya Pradesh Electricity Regulatory Commission
MSL	Minimum Service Levels
MTOE	Million Tonnes of Oil Equivalent
NAAQS	National Ambient Air Quality Standards
NABL	National Accreditation Board for Testing and Calibration Laboratories
NAMP	National Ambient Air Quality Monitoring Programme
NBEM	National Board for Electric Mobility

NBP	National Biofuel Policy
NCC	Net Cost Contract
NCEM	National Council for Electric Mobility
NCR	National Capital Region
NDMC	New Delhi Municipal Council
NEMMP	National Electric Mobility Mission Plan
NMC	Nickel-Manganese-Cobalt
NPV	Net Present Value
NSP	Network Service Provider
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
OICA	Organisation Internationale des Constructeurs d'Automobiles International Organization of Motor Vehicle Manufacturers
OMC	Oil Marketing Companies
OSCP	Open Smart Charging Protocol
PAT	Perform Achieve and Trade
PCI	Public Charging Infrastructure
PHEV	Plug-in Hybrid Electric Vehicle
PISC	Project Implementation and Sanctioning Committee
PMP	Phased Manufacturing Programme
PPP	Public Private Partnership
QCBS	Quality and Cost Based Selection
REIL	Rajasthan Electronics & Instruments Limited
SDO	Standards Developing Organization
SERC	State Electricity Regulatory Commission
SIAM	Society of Indian Automobile Manufacturers
SNA	State Nodal Agencies
SOC	State of Charge
SOH	State of Health
STU	State Transport Utility
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
TCO	Total Cost of Ownership
TOU	Time of Use
TPEM	Technology Platform for Electric Mobility

TSIIC	Telangana State Industrial Infrastructure Corporation
UNFCC	United Nations Framework Convention on Climate Change
UPI	Unified Payments Interface
VGF	Viability Gap Funding
VPP	Virtual Power Plant
WAN	Wide Area Network
WHO	World Health Organization

1. As-is state of passenger road transport system in India

1.1 Road transport industry in India

India has the second-largest road network in the world, spanning a total length of 5.89 million Kms[6]. Road transport contributes towards 64.5% of the country's overall goods movement and caters to 90% of India's total passenger traffic (Figure 3).

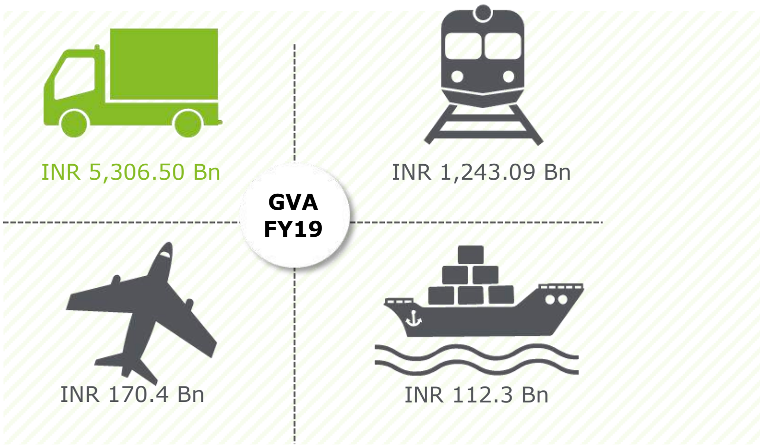
Road transport has been a preferred mode of transport for any passengers and goods movement vis-à-vis other modes of transport like air, water and rail transport.

Road transport generated the highest Gross Value Addition (INR 5.31 Tn) amongst other transportation segments in FY19. It contributed ~78% towards the overall GVA added by transportation sector during the year.

Road transportation contributed towards ~78% of the total GVA generated by the entire transportation sector, which accounts for 5.73% of the total GVA added by the services sector in India.

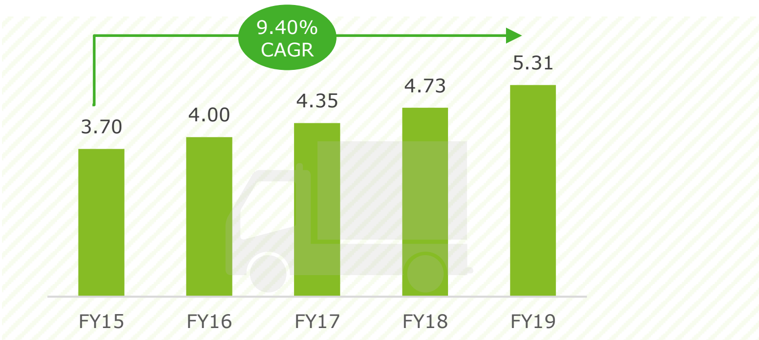
Growth in urbanization has affected the growth of road transportation industry as well. From FY15 to FY19, India's rate of urbanization increased from 32.78% to 34.47%[7]which further led to the road transport industry to grow at a CAGR of 9.40%, resulting in a commensurate growth of the automobile sector over the same period.

Figure 3 Gross Value Added (GVA)[5] contribution from transportation sectors during FY19



Source: 3 EMIS India transportation sector 2020/2024

Figure 4 GVA (INR Tn) from road transport sector (FY15- FY19)



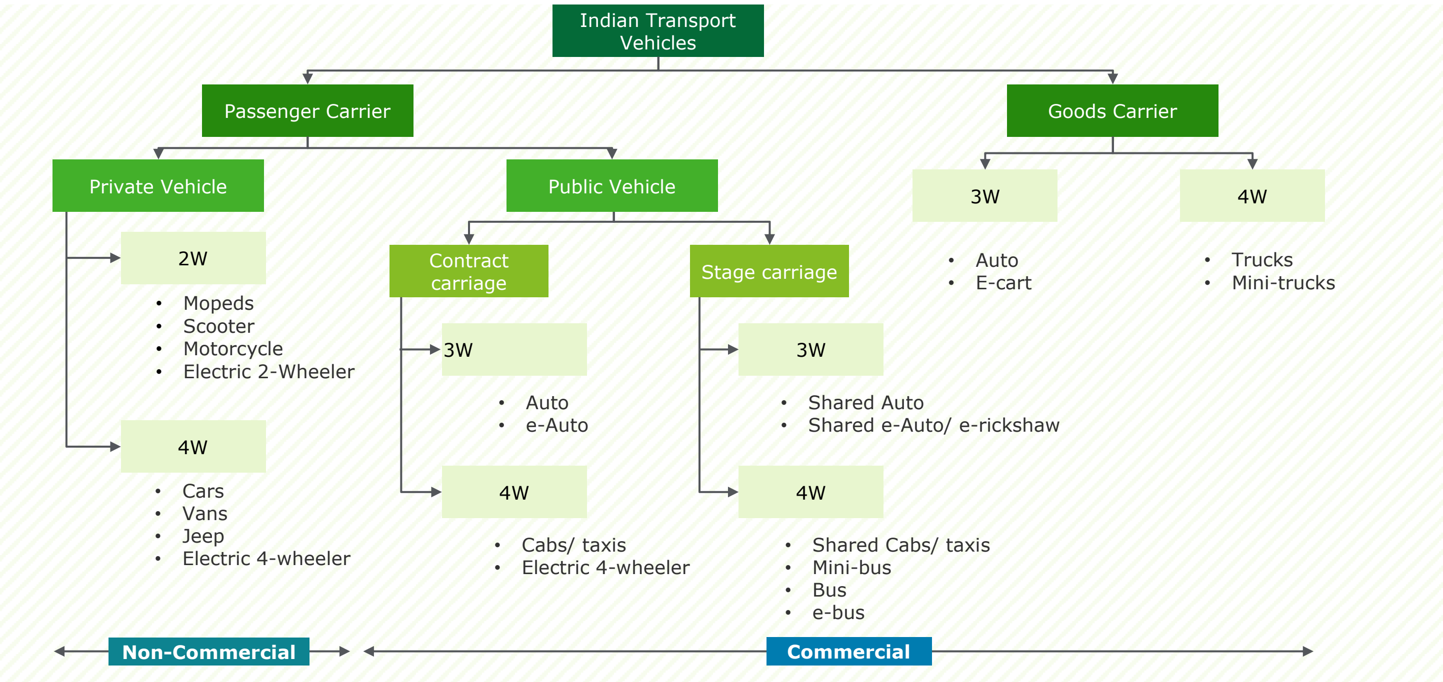
Source: 4 EMIS India transportation sector 2020/2024

1.2 India's automobile sector

India is the **fifth** largest automobiles market in the world, with 3.82 million units sold in 2019[8]. Following schematic highlights the categorization of automobiles in India.

[5] As per the System of National Accounts (SNA), gross value added, is defined as the value of output minus the value of intermediate consumption and is a measure of the contribution to GDP made by an individual producer, industry or sector. At its simplest it gives the rupee value of goods and services produced in the economy after deducting the cost of inputs and raw materials used.
[6] Road Infrastructure in India (access here)
[7] India: Degree of urbanization from 2009 to 2019 (access here)
[8] Ranking provided by OICA (International Organization of Motor Vehicle Manufacturers) and includes only passenger and commercial vehicle sales (access here)

Figure 5 Vehicle categories and associated services in Indian market



Source: 5 IEBF, Motor Vehicles Act, 1988

Note: In **Contract carriage**, single contract with vehicle owner is entered into expressly or impliedly with full control over the vehicle. Whereas, in **Stage carriage** there is no single contract with the vehicle owner with no full control over the vehicle and individual fares are paid. Source – MoRTH (access here)

India manufactured 26.36 Mn vehicles in FY20. The production volume has been increasing at a CAGR of 2.44% since FY15 commensurate with the demand for vehicles, which has also seen a similar steady increase over the years barring FY20, owing to multiple factors such as slump in economic activities, delay in consumer purchase decision in hope of availing heavy discount on BS IV vehicles, liquidity crunch due to collapse of some non-banking financial companies, weak rural demand[9] for two-wheeler passenger vehicles, etc.

Figure 6 Domestic vehicle production trend of India

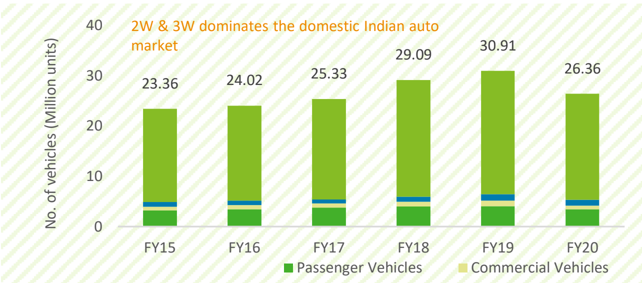
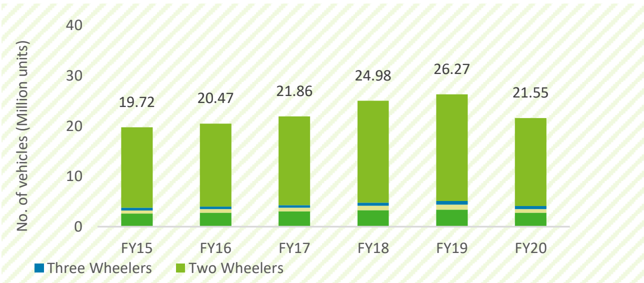


Figure 7 Domestic vehicle sales trend of India

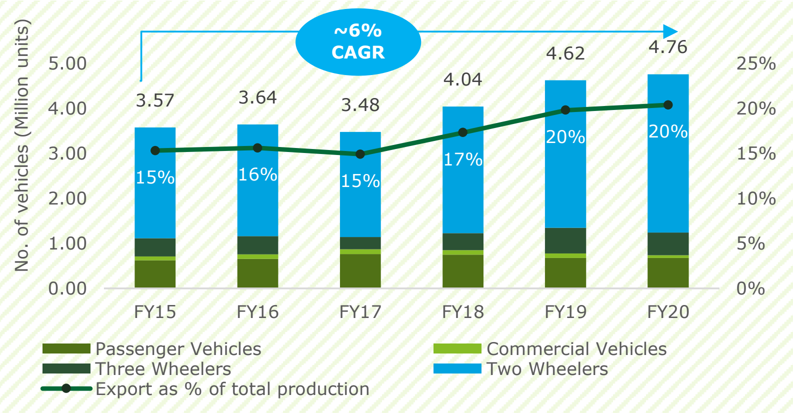


Source: 6 SIAM[10]

Due to decline in domestic demand for vehicles in FY20, OEMs had resorted to increasing exports to achieve the desired sale. During FY20, exports of vehicles grew to 4.76 Mn vehicles from 4.62 Mn vehicles in FY19.

[9] Weak rural markets hurt 2-wheeler sales (access here)
[10] Data has been represented as per the vehicle categorization provided in SIAM report (access here)

Figure 8 Category-wise vehicle export trend in India from FY15 to FY20

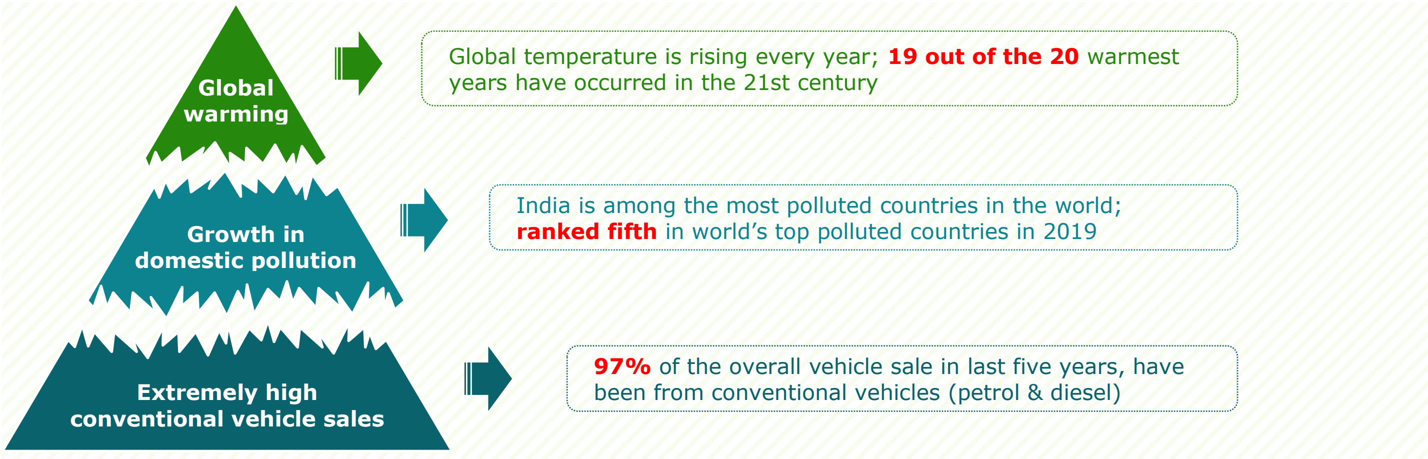


During FY15 to FY20, export volumes have expanded from 15% to 20% of total vehicles manufactured in India

Source: 7 SIAM[11]

It is expected that with growth in urbanization coupled with likely impact of increasing per capita income, the slump in vehicle sales, as observed during FY20, will not continue in the future. However, the concerns around environmental impact of conventional fuel and import dependency have pushed India to re-think its automobile/ transport sector expansion strategy.

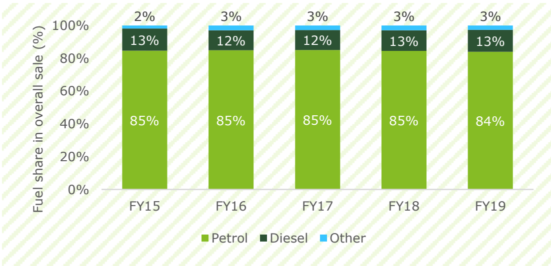
Figure 9 Need for India to shift its mobility strategy



In COP21, India had committed to reduce the emission intensity of its GDP by 33-35% by 2030, from its level in 2005. At present, 97% of Indian vehicles are propelled by petrol and diesel that have an adverse impact on environment. Therefore, in order to achieve the GHG emission target committed under INDC, it is inevitable that India transits to greener mobility technologies in transport.

Sustained high share of conventional vehicles in overall passenger automobile mix, would aggravate the energy security concerns, increase the risk of exposure to oil price fluctuations in future and lead to increasing GHG emissions. Therefore, it would be a wiser move to embark the journey towards green mobility.

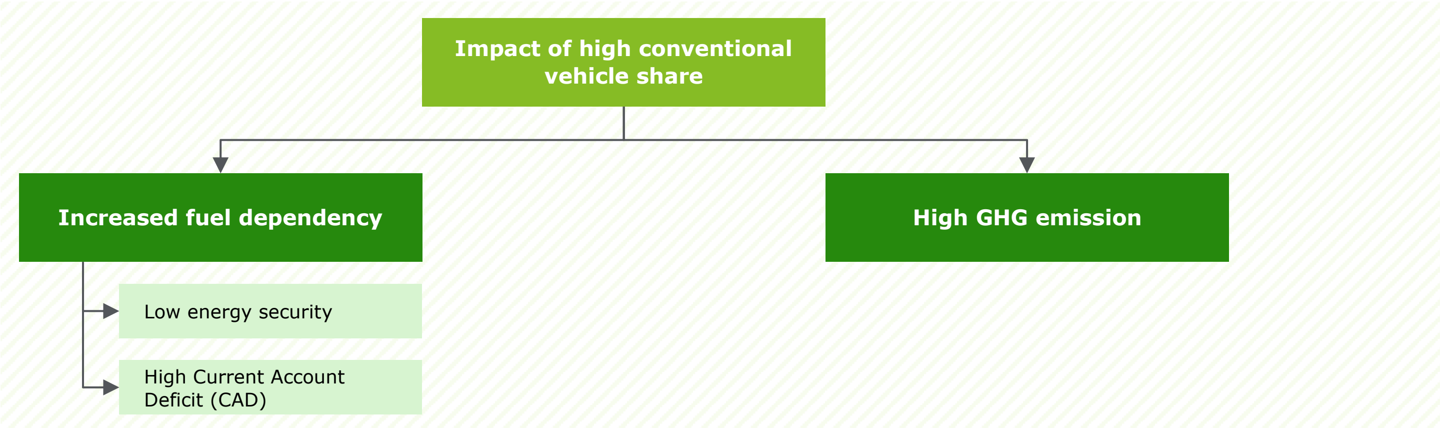
Figure 10 Fuel-wise share in overall vehicle sale



Source: 8 Vahan portal

[11] Data has been represented as per the vehicle categorization provided in SIAM report (access here)

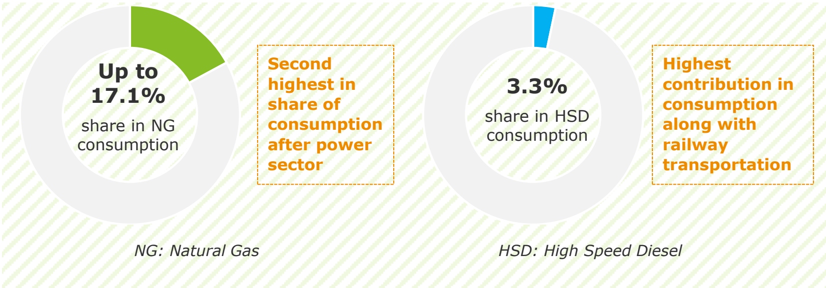
Figure 11 Issues arise from high conventional vehicle on the road



1.3 Fuel import status of India

Road transportation industry is among the highest consumers of natural gas and high speed diesel in India (Figure 12).

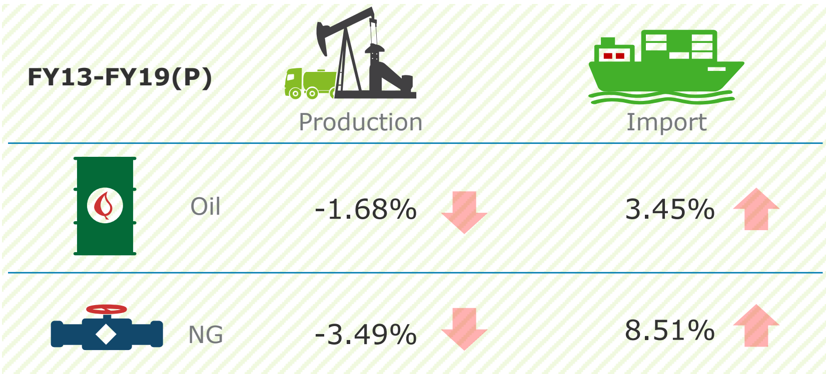
Figure 12 % consumption of fuel sources by road transport industry



Source: 9 Indian Petroleum and Natural Gas Statistics 2018-19

During FY19, only 12% of overall crude oil demand and 64% of natural gas demand was met from domestic production and balance was met through imports. Import trends of crude oil and natural gas for last five years (FY13 to FY19) depicts that it has increased considerably owing to the growth in the road transport sector.

Figure 13 Change in production and import of crude oil and natural gas (FY13-FY19(P))



Source: 10 Indian Petroleum and Natural Gas Statistics 2018-19

Decline in production of crude oil and natural gas during FY13 to FY19 has further contributed towards country's import dependency

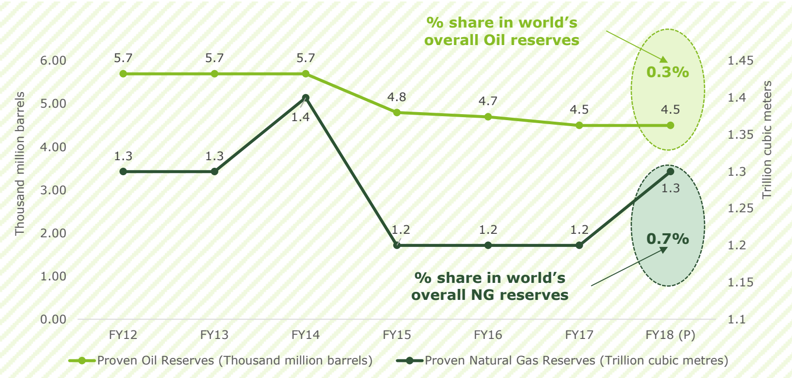
The import dependency of India on crude oil has been increased from 84% in FY13 to 88% in FY19, whereas, for natural gas, it has increased from 23% to 36% during the same period.

Crude Oil import dependency: **88%** (FY19)

Natural Gas import dependency: **36%** (FY19)

Limited availability of proven reserves of crude oil and natural gas is an area of concern, as they are not commensurate with the long term demand of crude oil and natural gas.

Figure 14 Oil and Natural gas reserves in India and their share at global level



India's proven reserves of crude oil and natural gas have declined during FY12 – FY18. Crude oil reserves have reduced at a CAGR of 3.86%, whereas natural gas reserves have remained at the same level as that of FY12 levels.

India's share in proven global reserves stands at only 0.3% and 0.7% for crude oil and natural gas respectively.

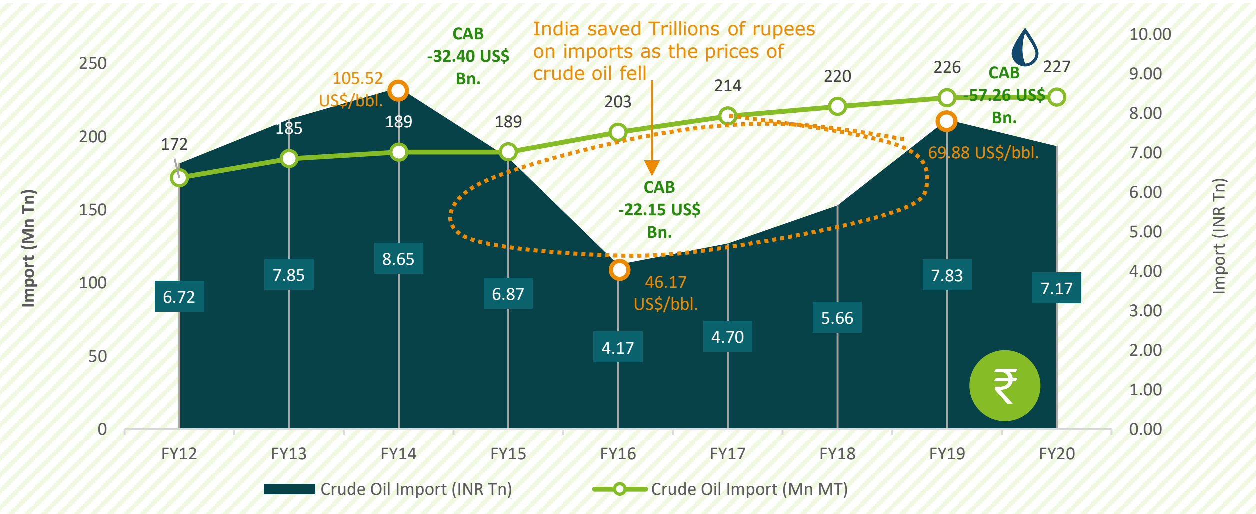
Source: 11 Indian Petroleum and Natural Gas Statistics 2018-19

India needs to swiftly move away from conventional vehicle technology in order to avoid higher import dependency

1.3.1 Fuel import and India's Current Account Balance (CAB)

International crude oil prices have had significant impact on India's current account balance. Trend of expenditure on imports as a function of import volumes of crude oil for last nine years is provided at Figure 15.

Figure 15 Impact of oil price fluctuation on India's oil import bill



Source: 12 Petroleum Planning and Analysis Cell, Ministry of Commerce and Industry

For year FY16, when oil prices were at 46.17 US$/bbl, CAB was (minus) 1.1% of GDP[12], whereas it reached to (minus) 2.1% of GDP[13] during FY19 when oil prices were at 69.88 US$/bbl, although the import volume remained the same.

Decoupling of Indian automobile sector from oil and natural gas would improve the overall trade balance of the country

[12] RBI Annual Report 2016-17
[13] RBI Annual Report 2019-20

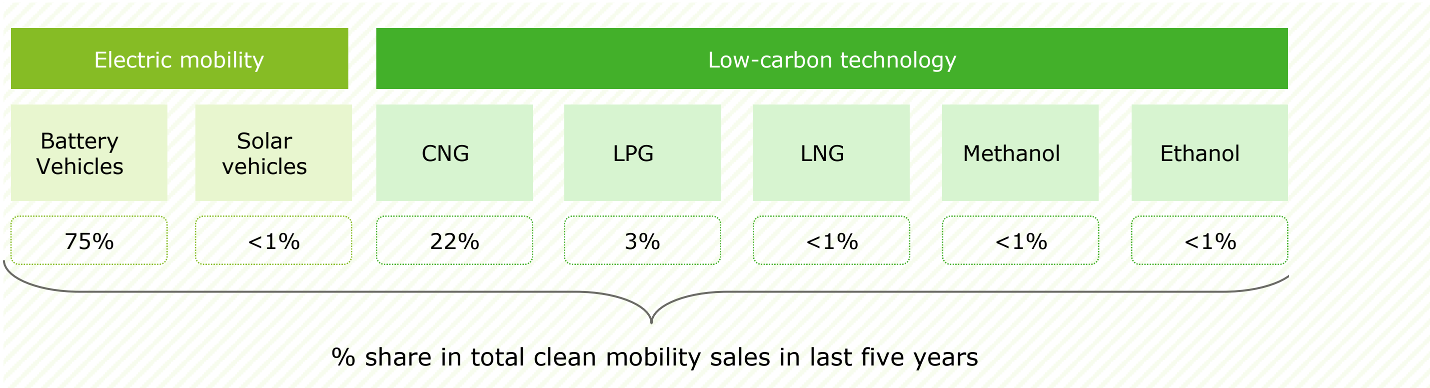
1.4 India's options for clean mobility

Although avenues for clean mobility are gaining momentum in India, there is need to have a large scale adoption to witness a considerable impact on savings in import bill, reduction of GHG emissions and energy security for the future.

Overall share of electric vehicles and low-carbon road transport technology in total vehicle sales is less than 1%[14]

Among available clean/ low carbon mobility technologies, electric vehicles and CNG vehicles are most preferred in India. Availability of fiscal incentives for electric vehicles and low prices of CNG compared to petrol and diesel could explain such preference for these technologies.

Figure 16 Clean and low carbon technologies on road in India with share in sales



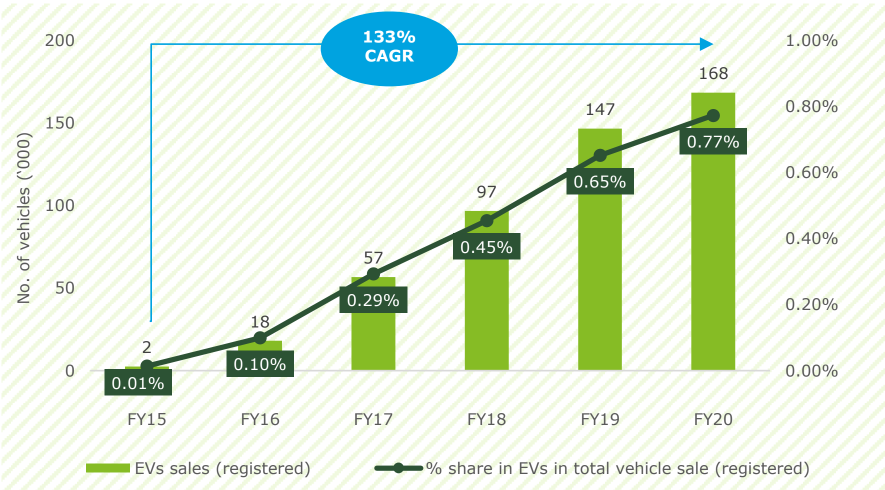
Source: 13 Vahan dashboard; % figures are rounded

1.4.1 Electric vehicles

EVs have emerged out as a promising alternative that could help in mitigating the adverse environmental impacts caused by conventional vehicles.

As on July 2020, total registered EVs in India were **5,18,110**

Figure 17 Year-wise EV sales trend from FY15 to FY20 in India



Source: 14 Vahan dashboard (accessed 25th July 2020)

[14] This does not include hybrid vehicles (conventional plus non-conventional fuel technology)

Although the numbers of EVs are rising in the country, however, the adoption across vehicle categories is uneven. The sections provided below aims to explore the possible reasons for such observed phenomena.

Figure 18 Category-wise distribution of EV sales in India

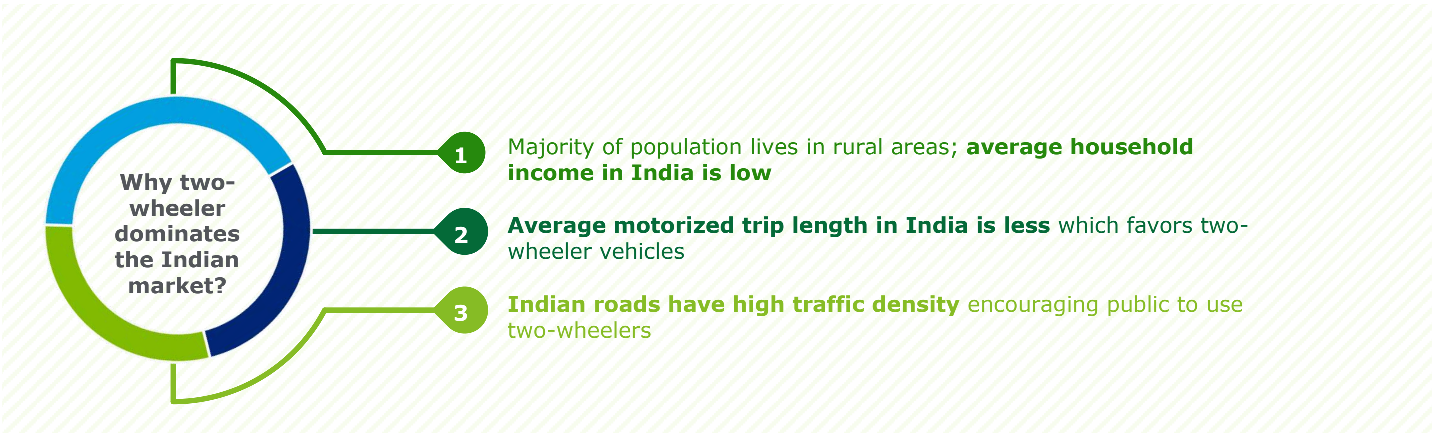
Source: 15 Vahan dashboard

~79% of the EV addition is from three-wheeler segment, followed by two wheelers (17%); the four-wheeler segment contributes only 3% towards the overall EVs on the road

1.4.1.1 Two-wheeler EV segment

The Domestic vehicle sales data (refer Figure 7, *depicting trends for domestic vehicle sales data cumulative for conventional and electric vehicle*), signifies that the two wheeler segment, with more than 80% contribution towards total vehicle sales, is the major driver for increased sales in the Indian automobile sector. The factors which could explain the dominance of two wheeler segment in India is provided at Figure 19.

Figure 19 Reasons for domination of two-wheelers in Indian automobile market



Source: 16 SIAM

Two-wheeler EV segment has grown at a CAGR of 62% in last four years (FY16-20)[15]. The growth is fuelled by the incentives offered by GoI under its FAME II scheme. Several states have also come up with their EV policies which provide for fiscal and non-fiscal incentives over and above as provided by GoI.

Although the share of two-wheeler EVs is merely 17% of the overall EV population in the country, it is likely to follow the similar trend as it is observed in conventional vehicle market today. So far, concerns around new technology, relatively high prices of EVs (for same performance compared to ICE vehicles), range anxiety, adequate availability of charging facilities etc. have prevented the uptake of two-wheeler EVs. However, with the maturity in EV technology, price parity achievement and development of the peripheral infrastructure, the share of two-wheeler EVs is expected to increase. OEMs are also increasingly considering the two-wheeler EV market as an attractive avenue and therefore many start-ups such as Ather, Revolt, Okinawa, Evolet etc. have entered this space. The entry of conventional 2W players such as TVS, Bajaj and

[15] JMK Research & Analytics – Two wheeler India Market Outlook, May 2020

Hero in the EV segment have further proven the attractiveness quotient of this market. Snapshot of players in two-wheeler EV segment along with their range of products and prices is summarised below.

Table 1 2W (Conventional and EV) offerings by traditional OEMs

	Conventional vehicles		Electric vehicles	
	No. of models	Price range	No. of models	Price range
Hero	11 models	47k – 111k	8 models (2 upcoming)	35k – 79k
TVS	11 models	44k – 240k	1 model	115k
BAJAJ	10 models	43k – 194k	1 model	100k – 115k
Mahindra Rise.	3 models	43k – 211k	1 model	80k

Source: 17 Deloitte Analysis

Note: Variants within the model are not considered separately

Figure 20 Emerging players in 2W EV space (1/2)

	ATHER		AMPERE By GREAVES	TORK MOTORS	YObykes
Entry year	2013	2015	(10 years in India)	2010	(Since 2006 in EV)
No. of models	2	8	7	1	4
Price range	113k – 150k	39k – 108k	34k – 67k	125k	36k – 51k

Source: 18 Deloitte Analysis

Figure 21 Emerging players in 2W EV space (2/2)

	REVOLT	PURE ELECTRIC VEHICLE	BattRE #DontBeFuelish	EVOLET
Entry year	2019	2015	2017	2019
No. of models	2	3	3	6
Price range	111k – 129k	51k – 80k	59k -80k	39k – 60k

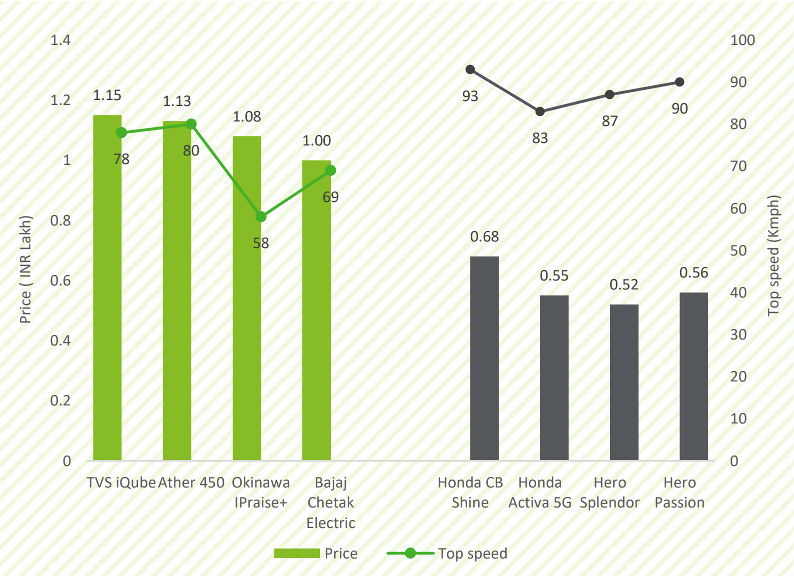
Source: 19 Deloitte Analysis

It is evident from above that as the segment is evolving, the companies are offering varieties of models with competing price ranges to the customer. This is a good indicator for future prospect of 2W EVs.

The high prices of electric vehicles compared to ICE vehicles is still posing a big challenge in its adoption. A cost comparison of EV and ICE 2W vehicles, for similar performance, is shown at Figure 22.

Surveys conducted by Deloitte and various other agencies have also indicated that the huge price difference is acting as a barrier in large scale adoption of electric vehicle over the conventional vehicle.

Figure 22 Variation in cost of 2W EV and conventional vehicles (ICE)



Current prices of 2W electric vehicles are higher than the ICE 2W vehicles in the similar performance range.

High upfront cost including future battery replacement cost posing challenge in its adoption.

Source: 20 Deloitte Analysis; Ex-showroom price – Delhi

As projected by Bloomberg, lithium battery prices are expected to drop with 10% CAGR during 2018 to 2024[16]. Drop in battery prices and consequential fall in prices of EVs may provide necessary thrust for high uptake of two-wheeler EVs by bringing them at par with conventional vehicles. It is expected that sales penetration of 2W would reach to ~24% in 2024[17] from current <1% sales penetration (2019).

Government of India, through FAME II scheme, is also supporting the adoption of two wheelers. Under the scheme, government is providing maximum subsidy of INR 30,000 on the purchase of 2W electric vehicle. However, since the scheme is supportive for high speed 2W vehicles, the market is therefore expected to be shifting towards high speed vehicles.

Box 1: FAME II & high speed 2W vehicles

Under FAME II, electric two-wheeler are mandated to have a minimum range of 80 km per charge and minimum top speed of 40 kmph to qualify for the incentive.

CRISIL, in their assessment of the product portfolio of various EV manufacturers indicated that, *"the electric two-wheeler segment would be impacted the most by FAME-II rules. More than 95 per cent of the electric two-wheeler models being produced now will not be eligible for incentive under FAME-II."*

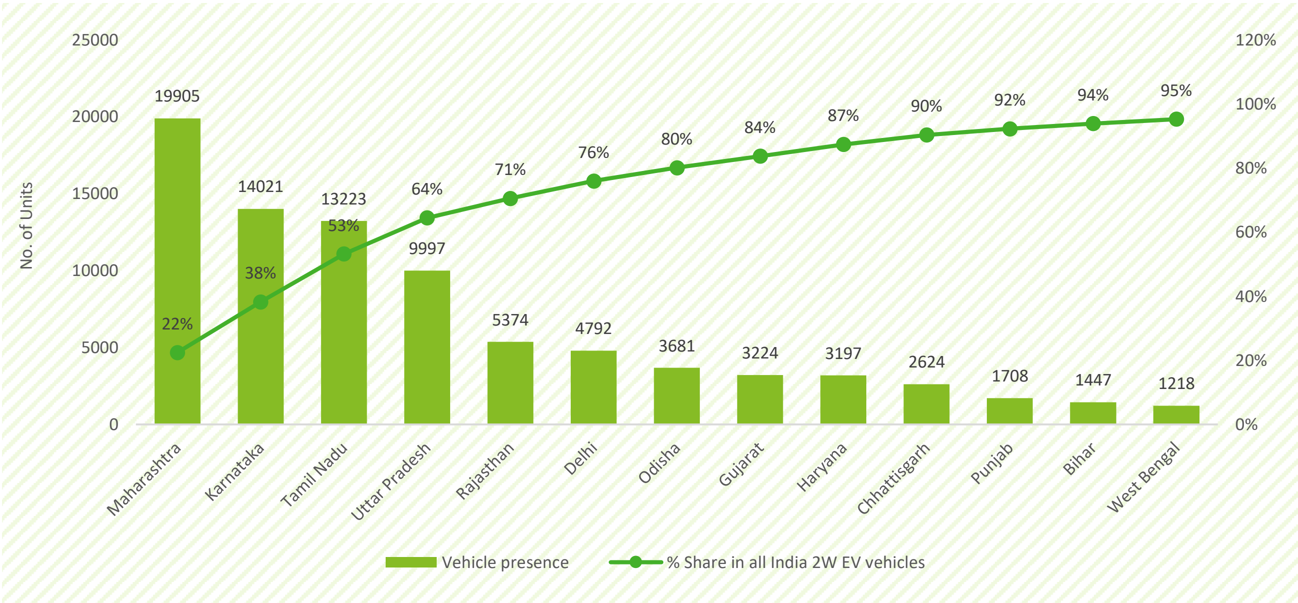
Source: 21 FAME-II to impact electric 2-wheeler segment most: CRISIL (access here); FAME II dashboard (access here)

[16] A Behind the Scenes Take on Lithium-ion Battery Prices (access here)
[17] India's Electric Mobility Transformation (access here)

Going forward, it is expected that high speed electric vehicles will be preferred in the Indian 2W market

Maharashtra accounts for the highest number of 2W EV presence among other Indian states. Thirteen states in the country account for 95% of all India 2W EV population.

Figure 23 State-wise 2W EV presence and their share in all India 2W EV population (till July 2020)



Source: 22 Vahan dashboard

1.4.1.2 Three-wheeler EV segment

Three-wheeler EV segment contributes to 79% of overall EV presence in India. Currently, this segment is driving the electrification of the Indian automobile industry. Such high population of 3W EVs could be described through following reasons:

1.	Three-wheelers are not only a mode of transportation but serve as the lifeline for several people formally / informally employed by their use.
2.	3 W offers better value proposition in the shared mobility space. A ride as low as Rs.10 attracts passenger to take ride in E-Rickshaw[18]
3.	There is a growing need for last-mile connectivity with increase of shared mobility through Rail-Metro, Buses etc. (E-rickshaws tend to bridge the gap between demand and supply of last mile connectivity in the peripheral areas and areas far off from urban connectivity network). Companies such as Kinetic Green and SmartE are working with government agencies to offer their e-rickshaws for the last mile connectivity from metro stations.
4.	The cost of maintenance of 3W EV is almost reduced by 80 per cent compared to an ICE vehicle
5	Driving on smaller and known route – no range anxiety issues (which otherwise is a concern for other electric vehicle categories)
6	E-rickshaws are quieter, cleaner and cheaper to maintain than a traditional auto rickshaw. They also are less strenuous than cycle rickshaws, which require manual peddling

[18] Prices may vary with city, however it still remain low as compared to other conventional means of travel

The above factors are expected to drive the business case for investments in in 3W by various OEMs. For instance, **Mahindra and Mahindra has revised its strategy to focus aggressively on development and sales of electric three-wheelers instead of electric cars in the coming years.**

Box 2: Mahindra & Mahindra revisiting their strategy on EV – shifting focus to 3W from 4W segment

Background: M&M was initially focusing on developing electric cars, but they realized that factors like lack of infrastructure and high prices are keeping customers at bay. The company has thus decided to focus on three-wheelers which are more commercially viable and can attract considerable passenger demand.

Target: The Company has set a target of selling 10,000 units of 3W electric vehicles on a monthly basis, and has also been engaging with different state governments and private entities to push these zero-emission vehicles

Recent development: The Company has launched its electric three-wheeler, Treo, in 2019, and has also invested in a manufacturing capacity for these vehicles in Karnataka. The company has already started supplying these vehicles to fleet aggregating platforms like SmartE and others.

Government is offering subsidy to three-wheelers in the range of INR 32,200 to INR 68,923. Total ten OEMs have been identified as eligible for subsidy under the FAME II scheme. The list has been provided in the tables below:

Table 2 List of OEMs approved under FAME II scheme (1/2)

OEM	Best Way Agencies Pvt. Ltd	Champion polyplast	Energy Electric Vehicles	Khalsa Agencies	Kinetic Green Energy and Power Solutions Ltd
No. of Models approved under FAME II	2 models	3 models	1 models	1 model	4 models

Source: 23 FAME II dashboard

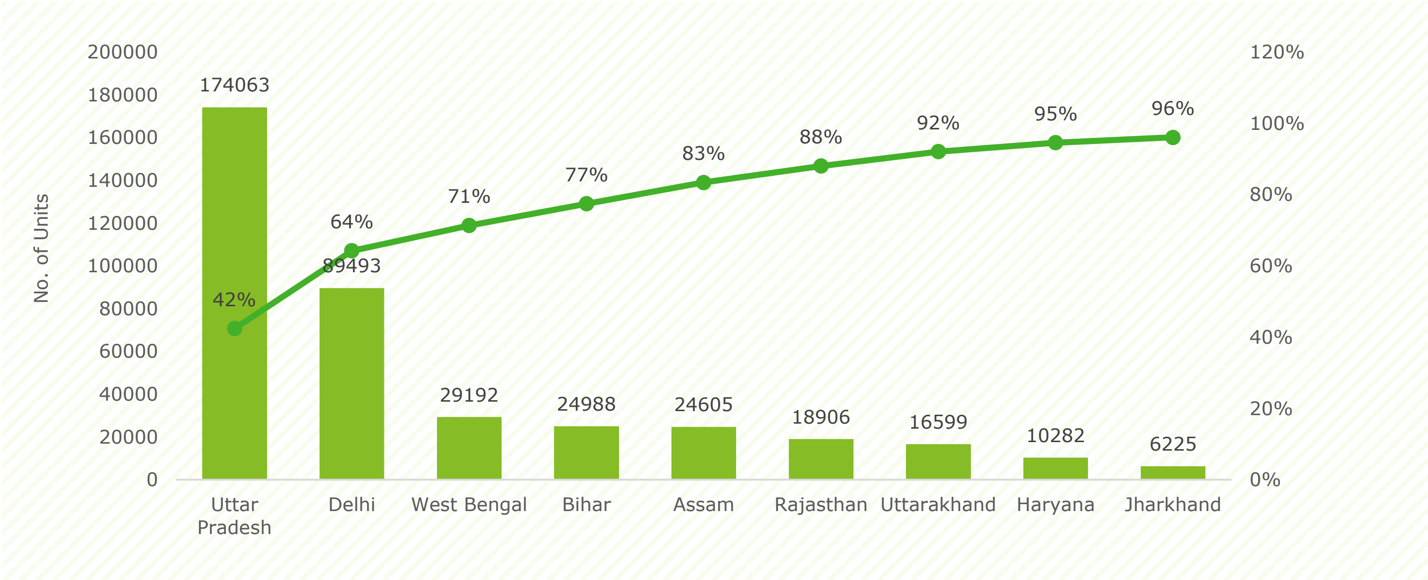
Table 3 List of OEMs approved under FAME II scheme (2/2)

OEM	Mahindra	Saera Electric Auto Pvt. Ltd.	Thukral Electric Bikes Pvt Ltd	Victory Electric Vehicles	Y C Electric Vehicle
No. of Models approved under FAME II	4 models	1 model	1 model	4 models	1 model

Source: 24 FAME II dashboard

Uttar Pradesh accounts for the highest number of 3W EV population among other states in the country. Cumulatively, nine states contribute to ~96% of total 3W EV population of the country.

Figure 24 State-wise 3W EV presence and their share in all India 3W EV population (till July 2020)



Source: 25 Vahan dashboard

1.4.1.3 Four-wheeler EV segment

The four-wheeler EV segment contributes to only 3% share of the country's overall EV population. There are limited models available in EV 4W segment. However, major OEMs have planned to introduce more EV models suitable for Indian market in the future which could possibly increase competition in the market and boost their adoption.

Table 4 Four wheeler offerings (conventional and EV) by key OEMs in India

	Conventional vehicles		Electric vehicles	
	No. of models	Price range	No. of models	Price range
TATA	8 models (3 upcoming)	5L – 20L	4 models (2 upcoming)	10.54L-25L
Mahindra Rise.	10 models (2 upcoming)	5.5L – 37L	5 models (2 upcoming)	5.5L-18L
	9 models	4.57L-22L	1 model	23.75L
MG	2 models	13L – 18L	1 model	20.88L - 23.58L

Source: 26 Deloitte Analysis; L: Rupees Lakhs

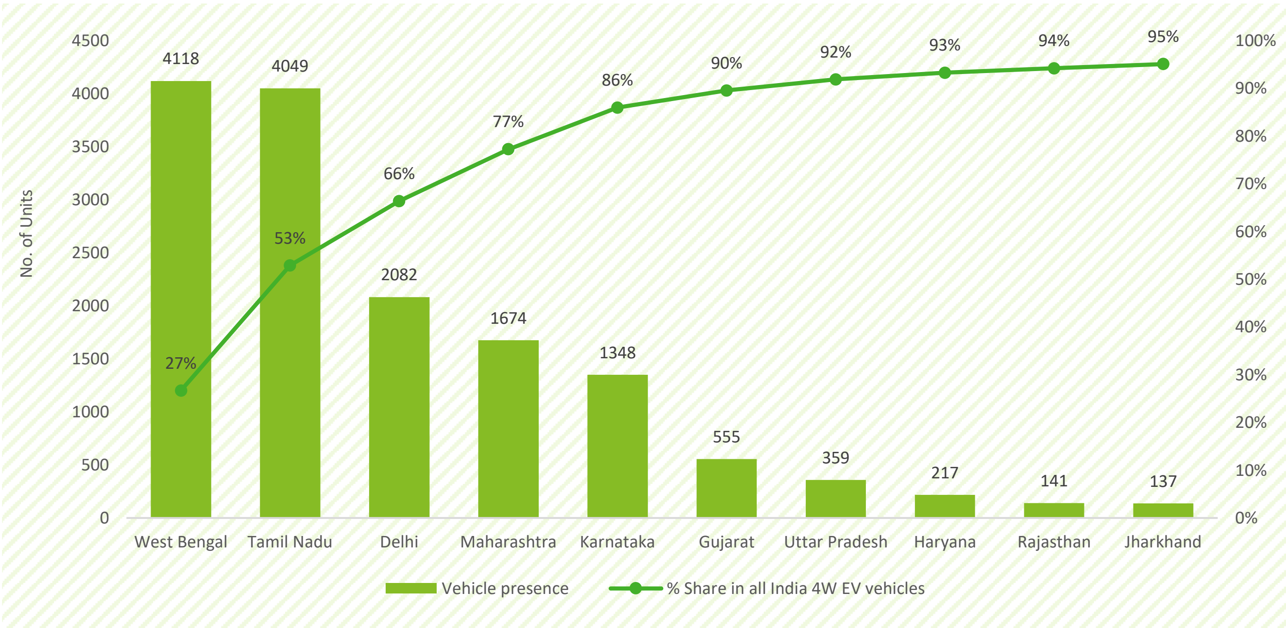
Similar to the other EV vehicle segments, high prices are a major concern for large scale adoption of 4W EV. One of the key reasons for high EV prices is limited presence of ancillary manufacturers in India. Most of the auto-parts of these vehicles are imported, with China being the major supplier of EV components to India[19], which leads to the increase in prices of EVs. Hence, developing local manufacturing hubs for EV components

[19] Impact of EV penetration on Indian Automotive Component Industry (access here)

could play a major role in bringing down the EV costs in the future and enable the sector to be resilient to supply disruption due to geo-political disturbances.

As on July 2020, West Bengal has the maximum number of 4W EV presence in the country, followed by Tamil Nadu.

Figure 25 State-wise 4W EV presence and their share in all India 4W EV population (till July 2020)



Source: 27 Vahan dashboard

1.4.1.4 E-buses

Electric buses are the least adopted vehicle segment among EV, in India. However, with the growing focus of the GoI to transform the public transportation landscape in the country, several players have ventured into this arena and have started launching their electric bus models. An illustrative list of such players are mentioned below:

Figure 26 Major players in e-buses segment in India

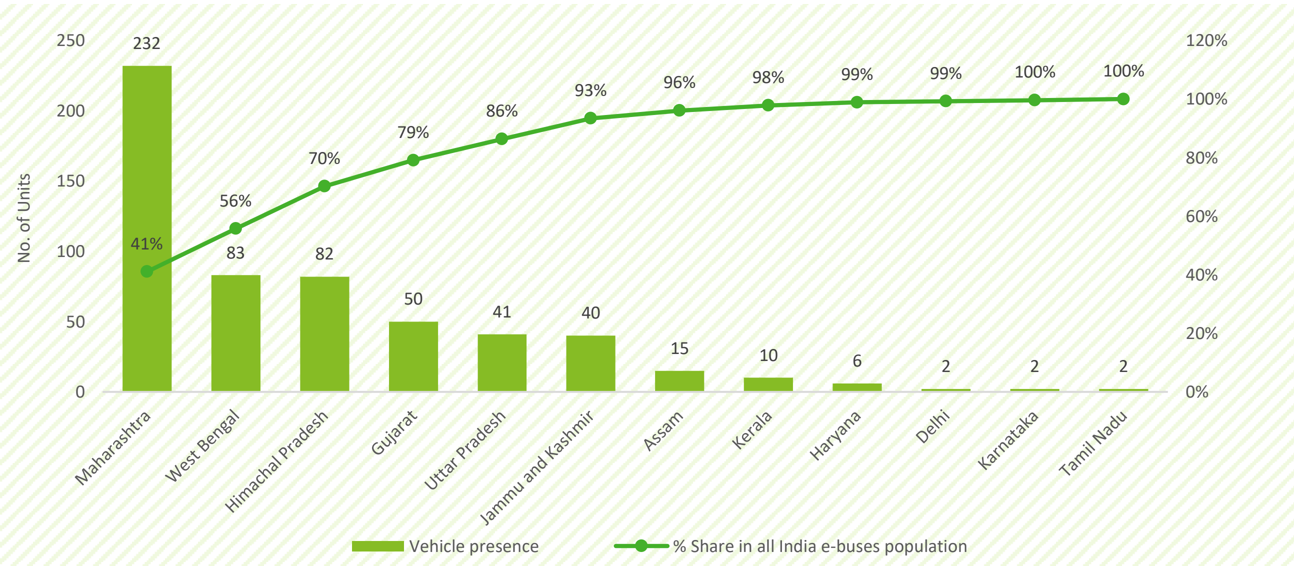
OEM	Model	Range (Km/charge)	Price	Key highlights
Olectra	K6	200	Above INR 2 Cr.	Olectra is owned by Megha Engineering. It has collaborated with BYD for e-buses. First company to deploy 100 electric buses in India. Has 160+ buses deployed in India and has won a tender for 600 more buses under FAME-II
	K7	200		
	K8	300		
	Star Bus Ultra Electric 6/9	215	NA	60% market share in FAME-I bus

OEM	Model	Range (Km/charge)	Price	Key highlights
TATA	Star Bus Ultra Electric 9/12	151		deployment. Has won order for 300 e-buses from Ahmedabad Janmarg Limited and 220 bus contract under FAME-II
ASHOK LEYLAND	Circuit – S	50	Above 1.5 Cr	First battery swapping bus project in collaboration with Sun Mobility in Ahmedabad
JBM Group Our milestones are touchstones	Ecolife Electric	150	Above INR 2 Cr.	JV with Polish bus maker Solaris
PMI Driving a greener tomorrow	Urban	144	Above INR 1.91 Cr.	JV between PMI Electro Mobility and Beiqi Foton Motor (China). Won contract for 760 buses under FAME-II
	Regio	168		
	Lito	NA		

Source: 28 Deloitte Analysis

By observing the sales trend of e-buses in Indian states, Maharashtra, West Bengal and Himachal Pradesh could be identified as the early adopters of e-buses.

Figure 27 State-wise cumulative e-buses sales (FY17 onwards) and their share in all India e-buses population (till July 2020)



Source: 29 Vahan dashboard

1.4.1.5 Electric Vehicles @2030

The Government of India has targeted 30% EV penetration by 2030. However, the momentum required to achieve the target would require transformational and radical measures to be adopted by Policy makers in this space.

"NITI Aayog and RMI projected EV sales penetration of 80% for two and three-wheelers, 50% for four wheelers, and 40% for buses by 2030"

Figure 28 EV Sales penetration projected by NITI Aayog by 2030

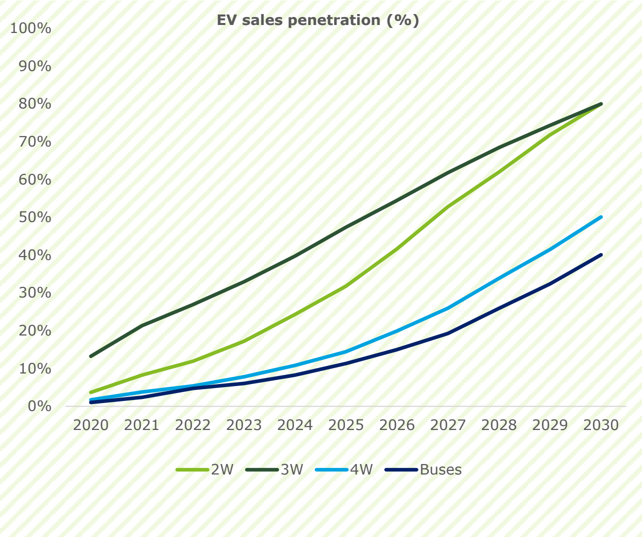
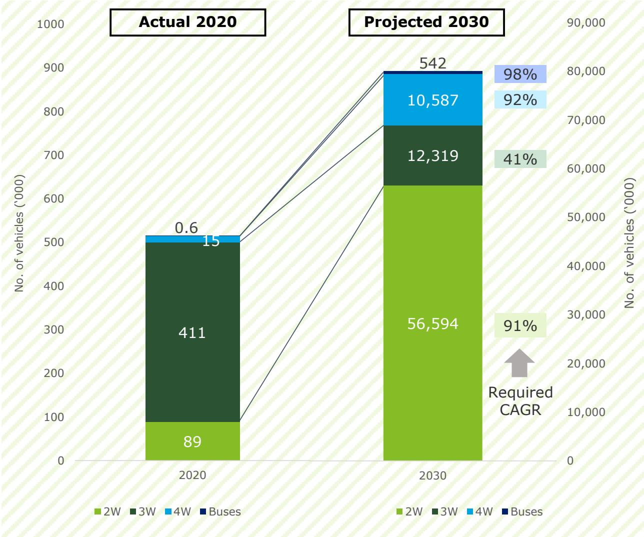


Figure 29 Actual and projected EV sales by 2030 as per NITI Aayog projections



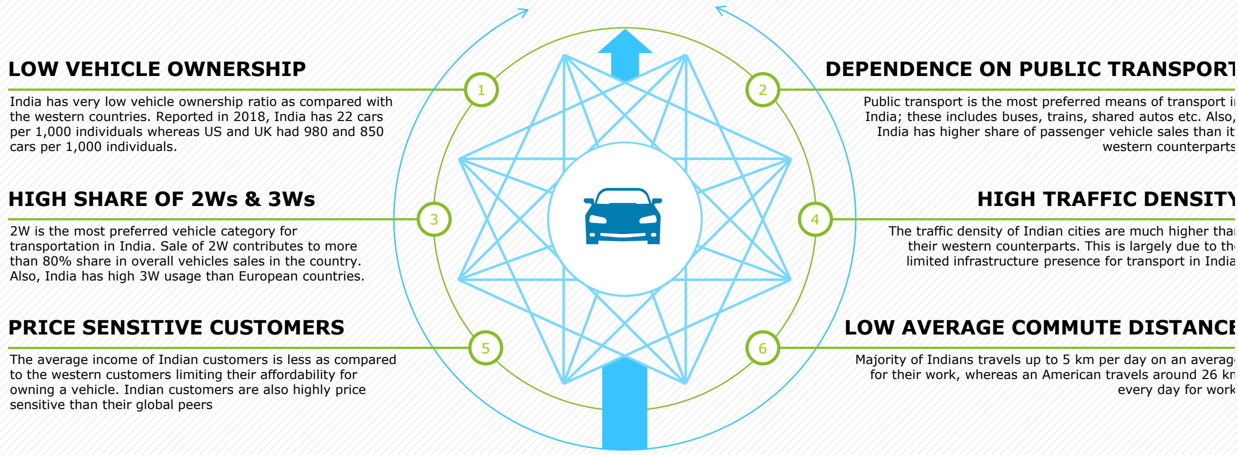
Source: 30 India's Electric Mobility Transformation (access here)

The ambitious target of adoption of EVs, if achieved, would result in savings of 474 MTOE of oil (approx. INR 15.21 Tn) annually and would cut down CO_2 emission by ~846.3 Mn Tons annually.

Box 3: India's mobility landscape and possible EV adoption

When compared with the advanced countries, India's mobility landscape is very different. The industry is matured in the western countries, whereas, in India, it is still evolving. Therefore, the dynamics for EV transition in India are bit different compared to most of the western world, having developed economies and high per capita income. The key differentiating factors are shown below:

Figure 30 Overview of Indian mobility landscape



Noting the above-illustrated differences in Indian mobility landscape, EV adoption in the country is also expected to be influenced by these factors. Table below enlist the expected EV adoption path in the country:

Table 5 Anticipated EV adoption path in India

1.	2W EVs segment would be the early adopters compared to 4W EVs	✓ 2W EVs fits perfectly in the equation of Indian mobility: o Low upfront cost as compare to 4Ws and low cost of operation; o Most suitable means of commutation in high traffic areas; o Ideal for short distance commutation (within city/village)
2.	Rise in adoption of 3W EVs	✓ 3W EVs are the solution for cheap last mile connectivity. Which is essentially a driving factor for its higher adoption. ✓ As 3W are source of earning for many Indians, will low cost of operation, uptake of 3W EVs can be expected increase further
3.	Greater adoption of EVs in commercial/ public segment	✓ As Indian customers prefers public transport, it is expected that public transport will play greater role in curbing CO2 emission ✓ With low vehicle ownership, commercial fleets are expected to turn electric owing to their low operation cost
4.	Introduction of EVs in shared mobility	✓ Indian customers are price sensitive, and shared mobility is a cost effective way to commute. With EVs, the operation cost is even lower and therefore bringing down the overall cost of vehicle sharing for customers resulting in higher uptake.

1.4.2 Hydrogen

Along with using electricity (preferably renewable) to power vehicles, hydrogen is another strong option to ensure a cleaner future. It has always been considered as a clean energy carrier which can be produced from renewable and nuclear energy and it also emits clean water.

Although adoption of hydrogen ensures a clean future, it has a high production cost and is highly inefficient when compared with other technologies (electric vehicles). Storage and transportation of hydrogen is another challenge that has hampered its large scale adoption in various countries as well.

However, with technological advances and growing concerns over global warming, hydrogen has emerged as the “future of energy”. It is the most abundantly found element on earth which can be extracted from a wide range of substances—including oil, gas, biofuels, sewage sludge and water.

Hydrogen is the “single” solution for the energy needs of multiple sectors. Table 6 below provides the applications of hydrogen in different sectors.

Table 6 Applications of hydrogen in various sectors

Sector	Applications
H_2 **Replace existing hydrogen feedstocks**	• The primary use case for green hydrogen is to replace the massive amounts of the gas that are already produced using carbon-intensive methods to satisfy industry needs.
Power generation and grid balancing	• Decarbonized hydrogen can be used as a fuel for power generation, to provide load balancing for intermittent renewables, particularly for seasonal storage - a longer time period than is possible with battery storage. • Hydrogen is also a source of distributed power for off-grid applications, such as the military, public safety, and remote communities, providing primary power and cooling and heating energy. • Some modern gas turbines can already burn up to 30% hydrogen and 70% natural gas. They could be retrofitted to run on 100% hydrogen, producing zero carbon emissions. • Existing nuclear plants can be used to produce high quality steam at lower costs than natural gas boilers and potentially used in many industrial processes to allow utilities to produce and sell hydrogen regionally as a commodity in addition to providing clean and reliable electricity to the grid.
Transportation	• Powering fuel-cell vehicles is one of the leading use cases for green hydrogen. This can play an important role in certain transportation segments such as long-haul trucks, heavy equipment, cars, vans, minibuses, trains, ships, planes and material handling equipment. Both high efficiency and low emissions could be achieved.
Buildings	• Renewable hydrogen presents an opportunity for gas utilities to respond to growing pressure to decarbonize their distribution systems. • Blending hydrogen with natural gas for water and space heating applications can help decarbonize the building sector in the US with minimal or no end-use appliance upgrades. • It can complement the use of heat pumps by meeting heating needs during peak cold periods. It can produce combined heat and power (e.g., district heating systems) to provide building climate control. • Onsite hydrogen fuel cells can provide heat and electricity to buildings.
Industrial Processes	• The ‘lowest hanging fruit’ for large-scale use of hydrogen in decarbonization is the conversion of existing industrial uses to lower carbon sources of hydrogen since no process retrofits would be needed (the processes are already running on hydrogen). • They can serve as a source of decarbonized heat in industrial processes, especially in high-grade (over 500°C) and medium-grade (100 to 500°C) heat applications, which are difficult to electrify.

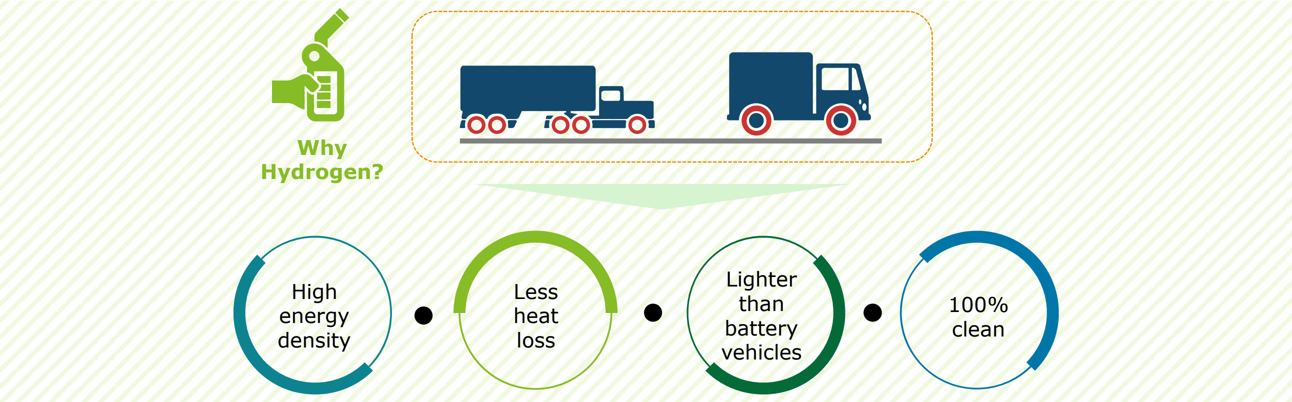
Acknowledging the advantages of hydrogen, countries across the globe have taken numerous initiatives towards production, distribution, and usage of hydrogen.

European Union, in July 2020, mapped out its vision to promote renewable hydrogen, which is expected to lure an investment of up to 470 billion euros ($530.72 billion).

In transportation, hydrogen holds great advantage especially for long haul and freight vehicles. These vehicles are operated year-around covering distance of 1,00,000 – 2,00,000 Kms every year. Majority of these vehicles use diesel fuel which emits higher pollutants.

An IEA study[20] suggests that, road freight accounts for more than 35% of transport-related carbon dioxide (CO2) emissions, and around 7% of total energy-related CO2 emissions.

Figure 31 Advantages of hydrogen over conventional and battery vehicles for long haul and frieght vehicles



Hydrogen can help eliminate the pollution causing from diesel heavy duty vehicles. It has energy density (~120 MJ/kg) around three times more than diesel or gasoline. Half the energy generated by an internal combustion engine is wasted as heat, whereas Fuel Cell EVs only lose 10%. When compared with battery vehicles, fuel cell vehicles also hold advantage in terms of their weight. Fuel cell vehicles offer higher range than battery vehicles at same or even less weight.

Hydrogen production technology is not fully matured yet. One of the clean process of hydrogen production is through electrolysis which uses power generated from renewable plants. However, researches have been undergoing to improve the electrolyser in order to make the process more efficient.

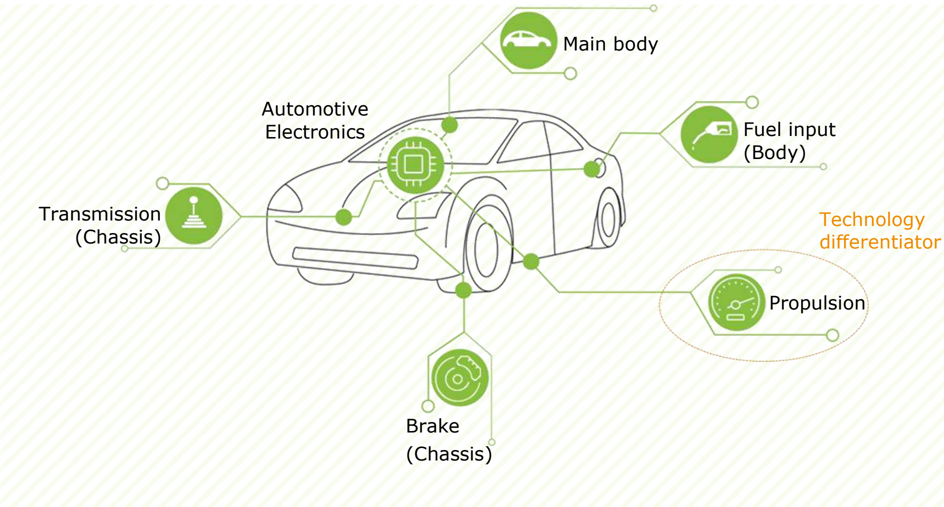
Once the technology matures and the cost of hydrogen production comes down, hydrogen is expected to be used in transport industry and majority of energy use sectors.

1.5 Passenger transport vehicle technologies

Components of a vehicle can be categorized as: (i) Propulsion system; (ii) Chassis; (iii) Automotive Electronics and (iv) Body. However, to assess vehicles on the basis of technology, the propulsion system is considered.

[20] Road-Freight and Fuel Economy: IEA analysis (access here)

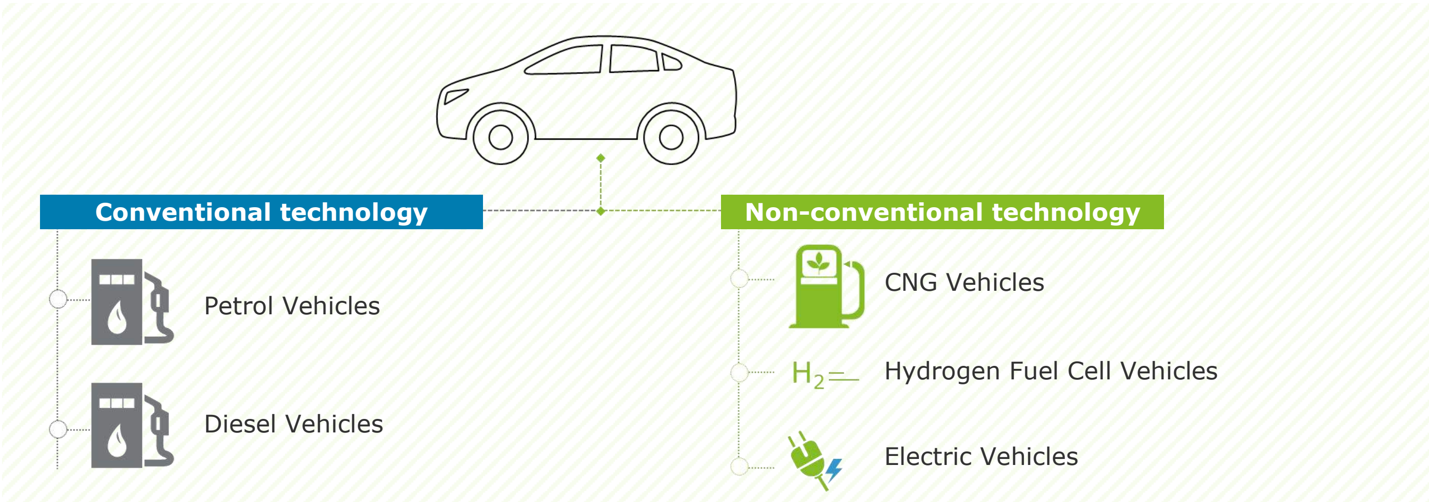
Figure 32 Vehicle components and the technology differentiator



"All vehicles are mostly similar in terms of vehicle components, except for propulsion system; it is the technology differentiator."

Propulsion system of a vehicle includes components such as storage system, fuel system, drive train and exhaust system. Globally, propulsion system using conventional technologies have been used for decades. However, concerns over global warming have caused a paradigm shift towards development and deployment of low carbon or electricity based vehicles. Figure 33 represents the conventional and key non-conventional technologies for vehicles used in India.

Figure 33 Conventional and non-conventional fuel technologies in passenger vehicles in India

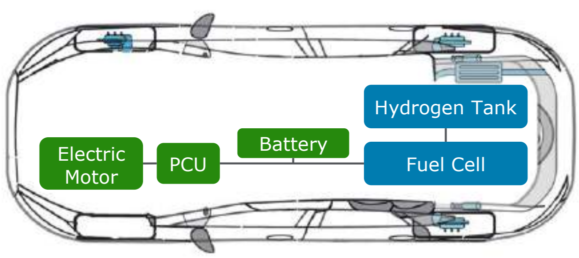


Note: Details about conventional technology and CNG technology is provided in Annexure - 6.1. Hydrogen fuel cell vehicles and electric vehicle technology is discussed in the below sections:

1.5.1 Hydrogen fuel cell vehicles

Hydrogen is the single most abundant substance in the universe. More than 200 years ago, hydrogen was used in the very first internal combustion engines by burning the hydrogen

Figure 34 Propulsion system of a hydrogen fuel cell vehicle



itself, similar to burning gasoline today[21]. However, this did not prove to be quite successful, due to safety concerns as well as low energy density of hydrogen[22]. Rather, in a modern fuel cell, hydrogen is a carrier of energy, by reacting with oxygen to form electricity.

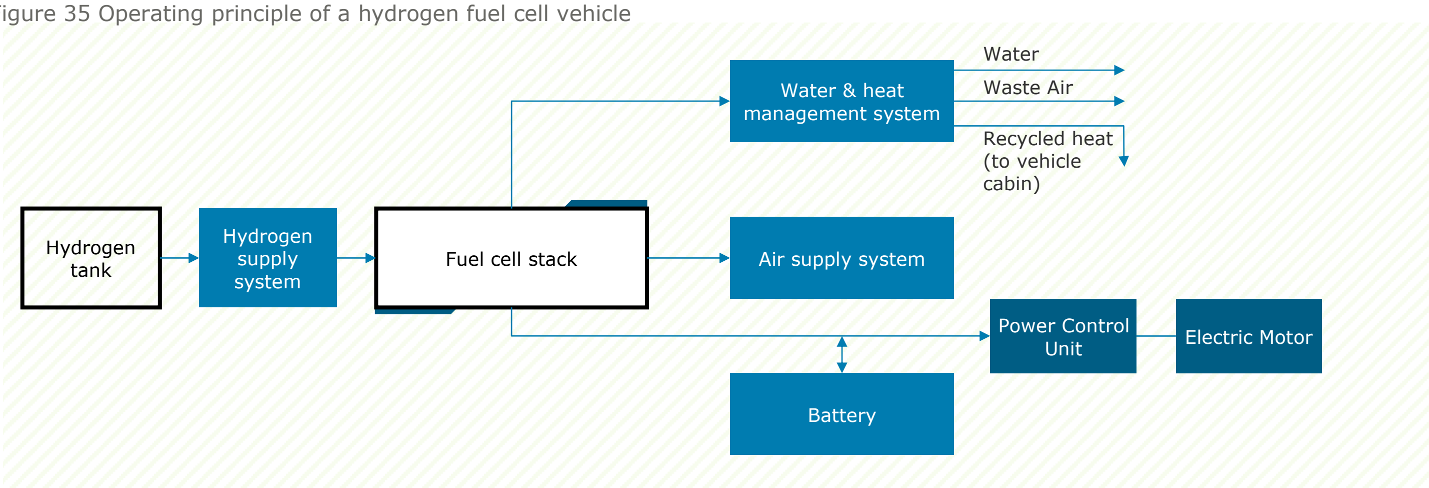
The propulsion system of the hydrogen fuel cell vehicle includes hydrogen tank as storage system; fuel-cell and battery pack as fuel system; electric motor and drive train; and an exhaust system.

In a hydrogen fuel cell vehicle, the fuel cell system is comprised of a fuel cell stack and assistant systems. As seen in Figure 35, the fuel cell stack is the core component which converts chemical energy to electrical energy to power the car.

Besides the fuel stack, there are four assistant system in the fuel cell: hydrogen supply system, air supply system, water management system and heat management system. The hydrogen supply system transits hydrogen from tank to the stack. An air supply system, which is comprised of an air filter, air compressor and humidifiers, provides oxygen to the stack. Water and heat management systems with separate water and coolant loops are used to eliminate waste heat and reaction products (water).

Through the heat management system, heat from the fuel cell could be harvested to heat vehicle cabin and improve vehicle efficiency. The electricity produced by the fuel cell system goes through a power control unit ("PCU") to the electric motor with assistance from a battery to provide additional power when needed.

Figure 35 Operating principle of a hydrogen fuel cell vehicle



1.5.2 Electric vehicles

1.5.2.1 Overview

An electric vehicle (EV) is propelled by an electric motor, powered by rechargeable battery packs. Below are the key components of an EV:

i. An electric motor;

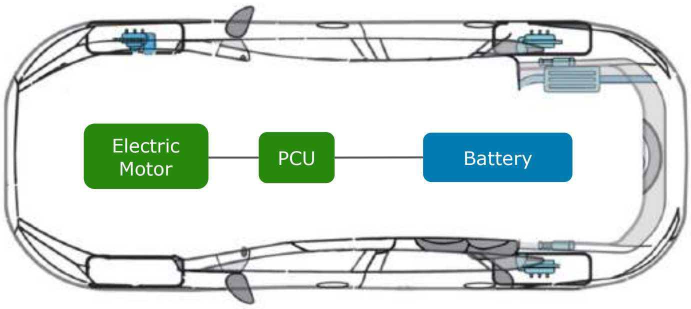
[21] A History of the Automobile (access here)
[22] Hydrogen in internal combustion engines (access here)

ii. A power control unit; and
iii. A rechargeable battery

The electric motor gets its power from a controller which in turn is powered by a rechargeable battery.

1.5.2.2 Operating principle

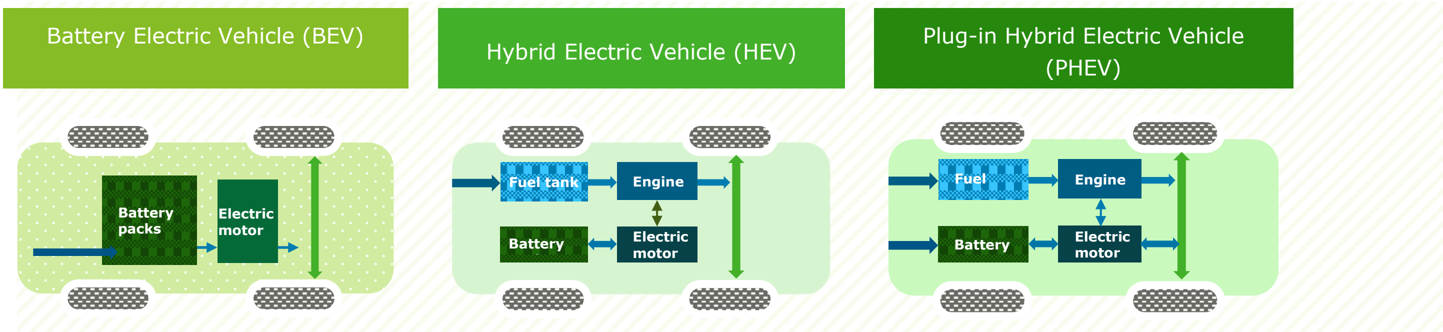
Figure 36 Propulsion system of an electric vehicle



The electric vehicle operates on the principle of converting electricity to kinetic energy to drive motor(s) which in turn rotates the wheels of the vehicle. It uses batteries which are charged to store power for running the electric motor(s). Unlike conventional technologies, there are no tail-pipe emissions from electric vehicles.

1.5.2.3 Types of powertrains

Based on the input used to power the vehicle, electric cars (powertrains) are categorized into three distinct types:



Battery Electric Vehicles (BEV) run entirely on a battery and electric drive train. These are fully-electric with rechargeable batteries and no gasoline engine. BEVs are charged by electricity from an external source.

BEV vehicles in India: Hyundai Kona Electric, Mahindra e-Verito, Mahindra e2o, Tata Nexon EV 2020 etc.

Hybrid Electric Vehicles (HEV) are powered by both fuel and electricity. The electric energy is generated by the car's own braking system to recharge the battery(also called 'regenerative braking'). HEVs start off using the electric motor and subsequently the gasoline engine is called in as load or speed rises. Only conventional fuel is utilized by such vehicles.

HEV vehicles in India: Toyota Camry, Toyota Prius, Volvo XC90 T8 Excellence etc.

Plug-in hybrid electric vehicles (PHEV) are powered by conventional fuels and by a rechargeable battery pack. The battery can be charged up with electricity by plugging into an electrical outlet or electric vehicle charging station (EVCS). PHEVs have much larger battery packs when compared to other HEVs and therefore can run larger distances on battery energy.

PHEV vehicles in India: BMW i8, BMW 740e iPerformance, Toyota Prius Prime etc.

1.5.2.4 Battery technologies

Battery play a vital role in overall development of electric vehicle industry. The last decade has experienced critical innovations in the field of battery technology. Lithium-ion batteries (Lithium Iron Phosphate-LFP, Nickel Cobalt Manganese-NMC, Lithium Cobalt Oxide-LCO etc.) have emerged as a perfect combination for electric vehicles. These batteries offer higher number of cycle life as compared to traditional lead-acid batteries, however the main reason for their high adoption in EVs is their high energy density characteristic.

High energy density allows lithium-ion batteries to store more energy in less weight / volume which is an ideal requirement for e-mobility applications.

Along with lithium-ion batteries, there have been advancements in other battery technologies such as metal-air, solid-state, lithium-sulfur batteries etc., however, these are still under research.

Figure 37 Illustration of a lithium-ion battery

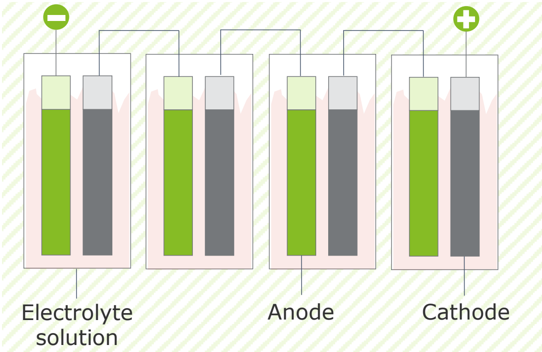
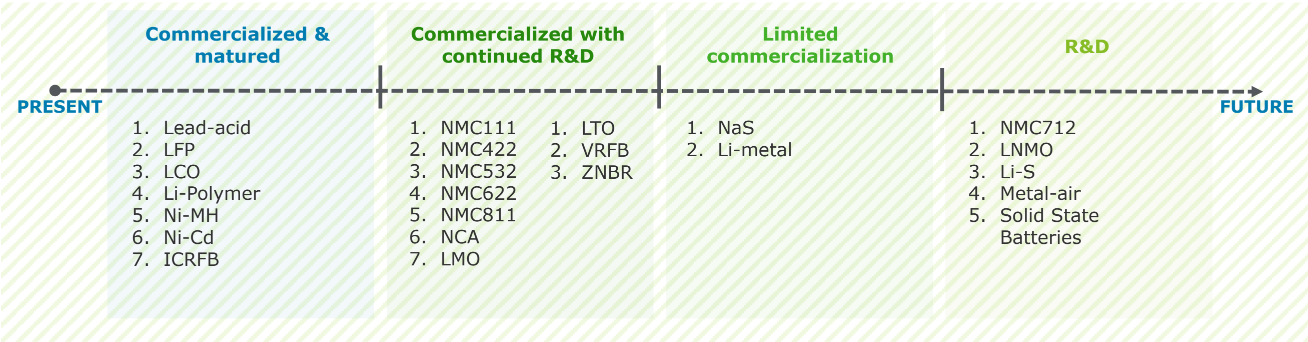


Figure 38 Commercial stage of key battery technologies

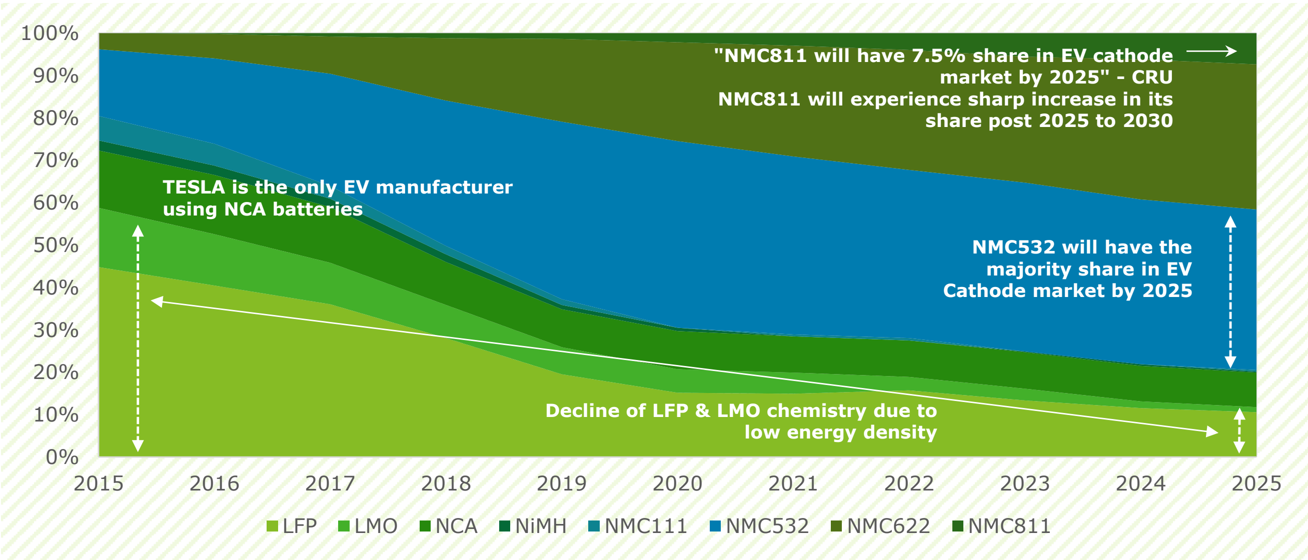


Source: 31 Deloitte analysis

LFP, NMC and NCA batteries have been widely used in vehicles. All Tesla's electric vehicles have NCA batteries; BYD uses LFP batteries, and Chevy Volt, BMW uses NMC batteries in their respective EV models.

It is estimated that in the next five years, use of LFP and LMO batteries will reduce due to their low energy density, and chemistries such as NMC532, NMC622 and NMC811 will experience increase in adoption.

Figure 39 EV cathode market share by 2025



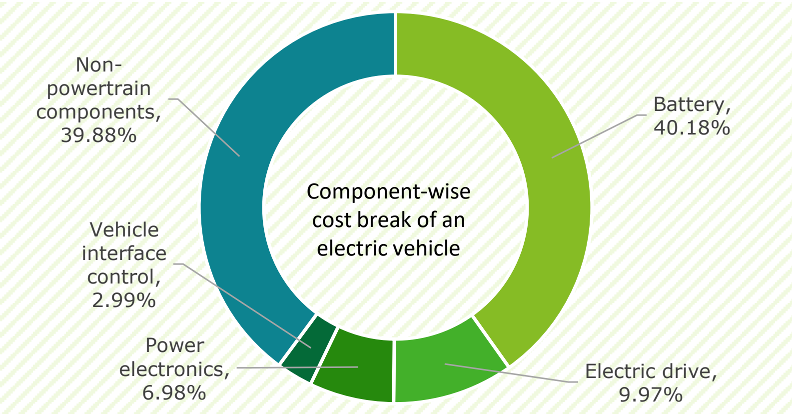
Source: 32 CRU

1.5.2.5 Cost of an electric vehicle

The cost of an electric vehicle is currently higher compared to a conventional vehicle with similar characteristics and performance. One of the major reasons for the same is the high price of the battery which accounts for nearly 40% of the total EV cost.

Although the prices of batteries have fallen considerably in the last decade[23], they are still at a level which makes EVs difficult to attain cost parity with their conventional counterparts.

Figure 40 Category-wise vehicle export trend in India from FY15 to FY20



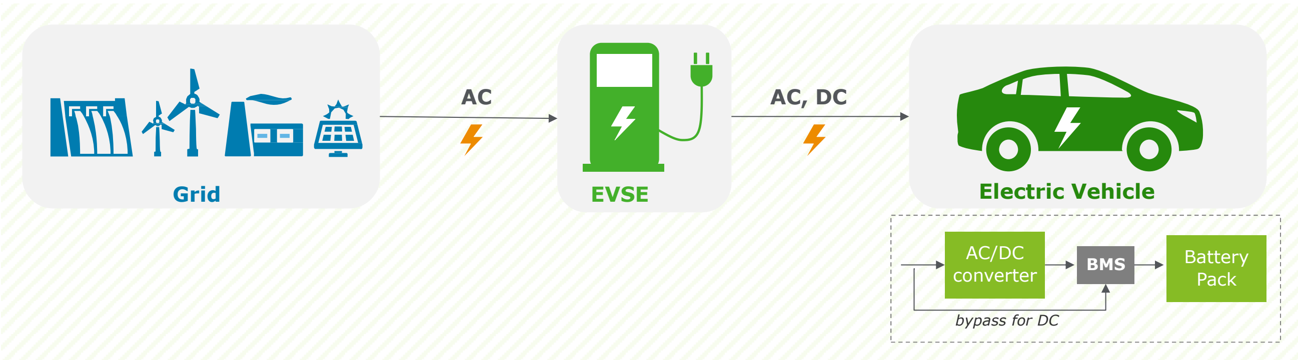
"Battery contributes as the major cost component for an electric vehicle; industry expects this share to come down to 18% by 2030 which may increase affordability of electric vehicles"

Source: 33 India's Electric Vehicle Transition (access here)

1.5.2.6 Electric vehicle charging infrastructure

Electric Vehicle Supply Equipment (EVSE) is an equipment or a combination of equipment, which provides dedicated functions of supplying electric energy, from a fixed electrical installation or supply network to an EV for the purpose of charging. There are different ways to classify an EVSE, depending on power supply (AC or DC), power rating levels, speed of charging, communication and connector type.

Figure 41 Classification by EVSE output – AC and DC



In AC charging, the vehicle has an on-board charger to convert AC from the grid into DC to charge the vehicle. A DC charger, on the other hand, can be used to charge the vehicle directly using the Battery Management System. An AC EVSE comes in different power ratings ranging from 3.3 kW to 43 kW. A DC EVSE is able to supply higher power rating ranging from 10 kW to 240+ kW. There are three levels of charging stations available, with each successively providing faster charging capability. Details about charging levels is provided in Annexure - 6.1 (Table 52).

[23] A Behind the Scenes Take on Lithium-ion Battery Prices – BNEF (access here)

India has laid guidelines for minimum requirement for setting up of Public Charging Infrastructure (PCI). Minimum technical requirements for fast and slow charging stations as provided in Annexure - 6.1 (Table 61).

Details on EV charging is provided in Section 2.3.

1.5.2.7 Information and Communication Technologies (ICT)

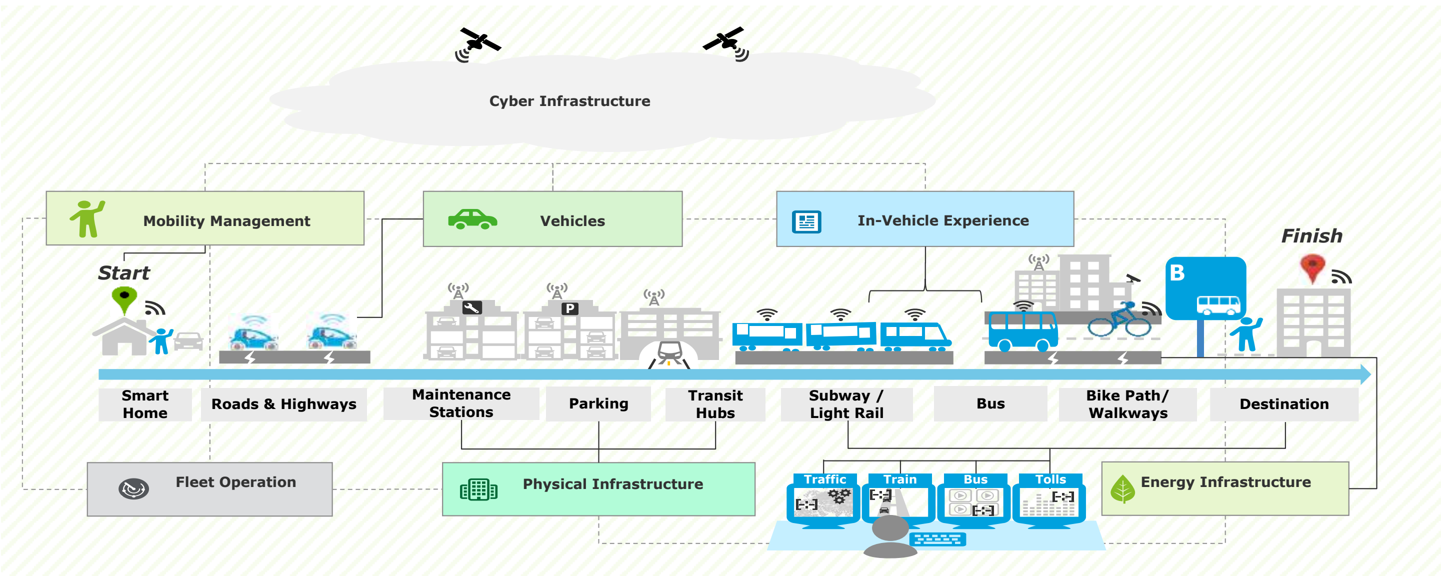
ICT provides access to information through telecommunication. ICT is based on communication technologies and integrates computer system/hand held system, audio video display with Internet/IoT.

ICT covers all forms of Computer and Communications equipment as well as the software used to create, store, transmit, receive, interpret, and manipulate information in its various formats. It deals with all the systems involved in creating, storing, sending or transmitting, receiving and manipulating these kinds of information. The ICT system includes both hardware devices and the software that allow the hardware device to carry out their intended functions. The hardware devices include computer system, monitor/ display screen, communication devices such as modem, router, hubs etc.

ICT uses transmission media such as cables, telephone lines, cellular link, satellite links etc. and communication networks such as Local Area Network (LAN), Wide Area Network (WAN), Internet, Satellite links etc. However, in case of electric vehicles, the communication network will mostly be wireless.

Information and Communication technology is widely getting used in fields such as Education, Agriculture, Medicine, Defence, E-governance E-Commerce, Banking etc. With no exclusion, transportation is another emerging space where ICT have added significant value and holds promising potential for future growth.

Figure 42 Application of ICT across transportation



Source: 34 Deloitte analysis

ICT has been used in vehicles for decades now and is available in the form of electrics, electronics, and software. It has helped in introducing many innovations in the automotive sector such as anti-lock braking system, electronic stability control, emergency brake assist etc.

With the rise of technology in automotive industry, ICT will play huge role in the next generation vehicles. Some of ICT's role in future vehicles is provided in the below figure.

Table 7 ICT - bridge between conventional and smart vehicle

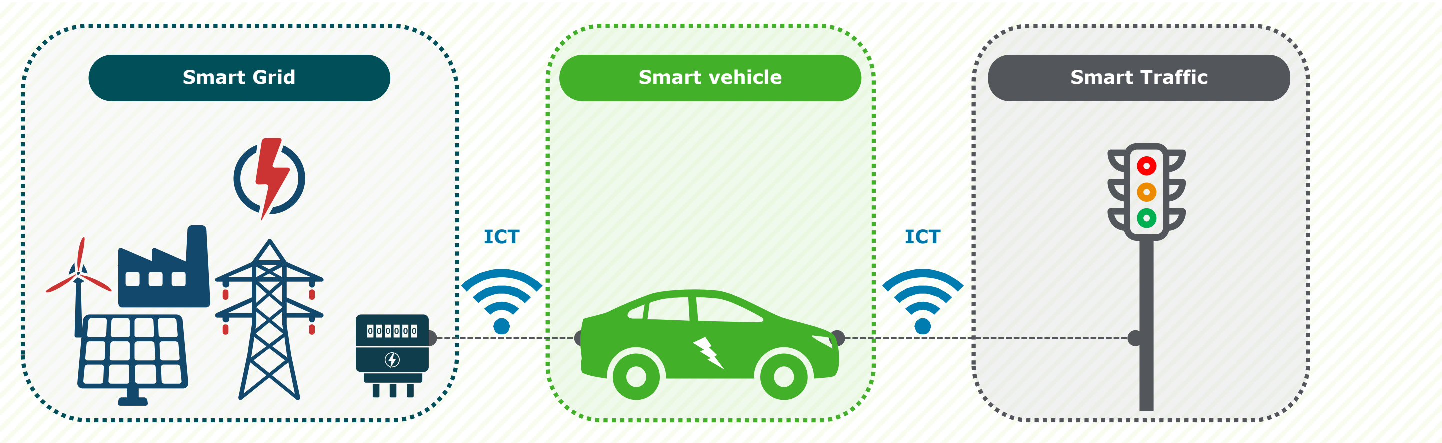
Energy and cost efficiency	ICT will be useful in implementing functions using software which uses hardware previously (e.g. Steer, brake-by-wire) thereby reducing the weights of the overall car. It can also use intelligent predictive management to reduce energy consumption.	**Reducing accidents**	Using its pro-safety function, ICT can greatly help in bringing down total number of accidents. With the help of ICT, vehicles will be able to interpret their environment and act autonomously in dangerous situation.
Seamless connectivity	Future vehicles will have seamless connectivity including the state-of-the-art in infotainment. ICT will help update the vehicle frequently to keep track with the advances in multimedia and infotainment technology.	**Personalization**	Personalization is expected to be the demand of future customer. ICT will enable transfer secondary vehicle functions to a personal mobility device.

Source: 35 The Software Car: Building ICT Architectures for Future Electric Vehicles (access here)

ICT is the way forward for "smart" vehicles and infrastructure

ICT adds value to electric mobility through interconnection of existing and new platforms. It enables coordination between smart grid, smart vehicle and smart traffic allowing them to operate seamlessly.

Figure 43 ICT - Key for smart mobility



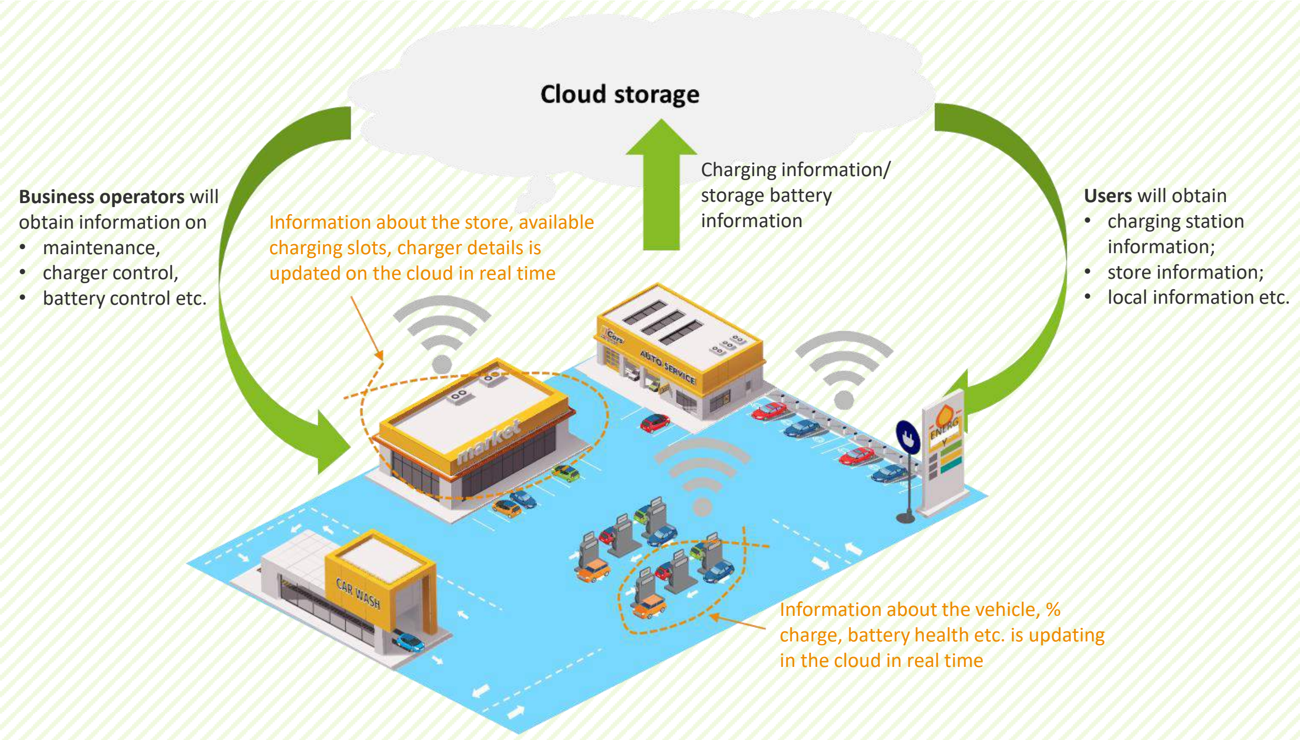
Source: 36 ICT for electric mobility II: Smart Car – Smart Grid – Smart Traffic (access here)

Growth in EVs has the potential to increase loading of distribution networks with consequential issues regarding variations in voltages at tail end of the network and line congestion during charging. Suitable ICT technologies including Active Managed charging, V2G, etc. will enable optimal charging of electric vehicles in a manner which does not cause substantial strain on the distribution network.

Also mentioned in Table 7, ICT can help vehicles in reducing the weight and cost. Other than emergency situations, ICT has the capability to enable controlling of the electric vehicle such as breaks, steering, infotainment function etc. ICT can also help in connecting platforms such as vehicle, charging infrastructure, energy grid and traffic management. It assists in controlling vehicle traffic flow and grid load management for implementing new mobility concepts. The technology uses cloud computing which is accessible through all mobile technologies. It helps in providing and analysing information regarding the vehicle, route planning, energy systems and traffic situation.

ICT also plays important role in charging of electric vehicles, as it enables EV owner, charging operator and other associated players in coordination of overall EV charging process. An illustrative example of the same in provided in Figure 44.

Figure 44 Utilizing ICT in real time data updation and communication for during EV charging



Source: 37 NEC Electric Vehicle (EV) Charging Infrastructure (access here)

With the help of ICT, EV owners will be able to receive real time information on the nearest charging station, availability of the station, real-time price of charging, status of the battery, remaining run time, etc. Charging station operators can also monitor the health and utilization of charging stations, schedule maintenance activities and manage the charging process remotely.

1.5.2.8 Battery management system (BMS)

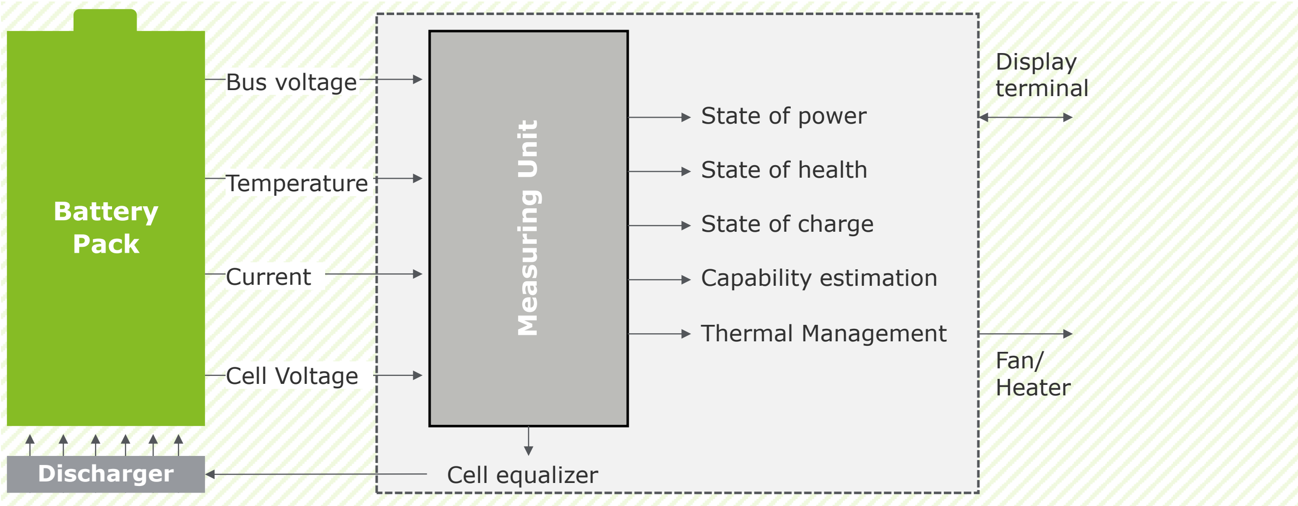
A battery management system is said to be the brain behind the batteries. It is one of the most critical components of an electric vehicle.

The purpose of the BMS is to guarantee safe and reliable battery operation.

To ensure the same, a BMS monitors and evaluates charge control and cell balancing in the battery. Overcharging results in overheating which causes structural damage and raises risk of explosion and fire. Every time a battery is drained below a critical level, its capacity gets reduced to a certain extent permanently. BMS ensures that the battery's charge doesn't go above or below the threshold limits. Along with this, the BMS measures how much energy is left in the battery (State of Charge). It also monitors the rate at which energy is getting utilized and estimates the duration it will last. Thus, the role of BMS can be categorized into three aspects:

Protecting the battery	Operating the battery with safe limit of current, voltage and temperature	Measuring and estimating the battery state

Figure 45 Illustration of a battery management system (BMS)



Source: 38 Towards a Smarter Battery Management System for Electric Vehicle Applications (access here)

The key blocks of a BMS system are provided below:

a. **Thermal Management Block:** This block measures the battery temperature and accordingly initiates the cooling or heating operation to maintain the temperature within the optimal range

   It also sends signals to ECU if the temperature goes beyond allowable limit.

b. **Measurement unit:** The measurement unit measures voltage, temperature, current at different places and the ambient temperature.

c. **Capability estimation block:** This block sends information regarding the safe charging / discharging levels to ECU and the charger unit.

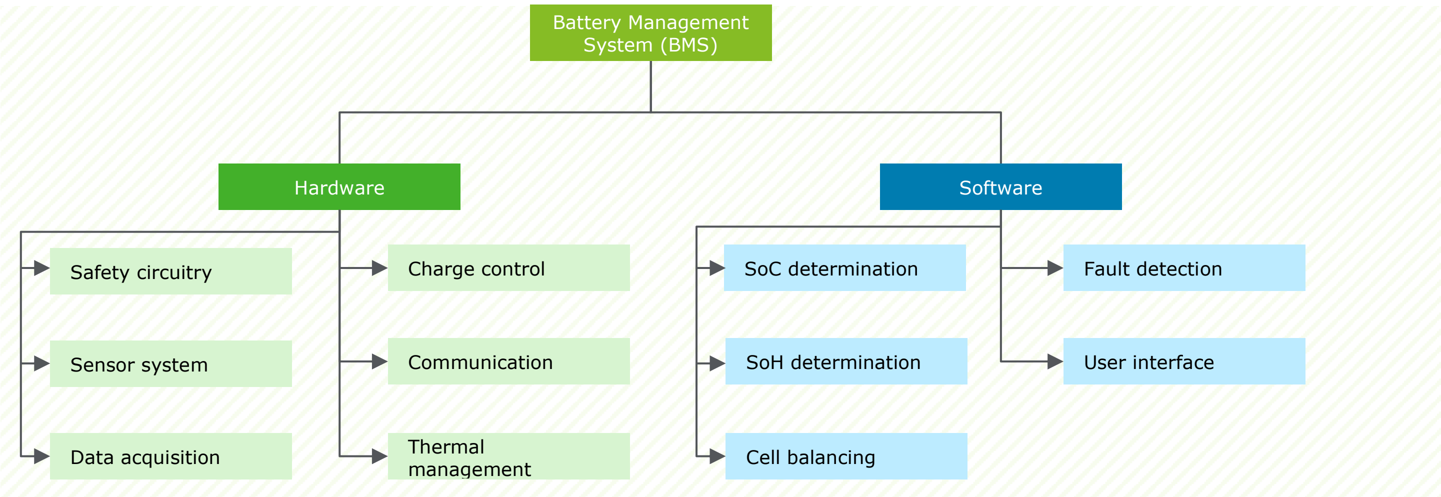
d. **Cell equalizer block:** It compares the highest and the lowest voltages across all the cells to apply balancing techniques

e. **State of Health (SoH):** State of Health (SOH) is a measure of the battery's ability to store and deliver electrical energy.

f. **State of Charge (SoC):** State of Charge (SOC) describes the level of charge of an electric battery relative to its capacity

The overall system architecture of a BMS can be divided into two categories: software; and hardware. Figure 46 represents system architecture of BMS:

Figure 46 System architecture of BMS



Source: 39 Battery Management Systems in Electric and Hybrid Vehicles (access here)

In the hardware part of the BMS, the safety circuitry is the core unit for ensuring its safety in the event of an overcharge, over-discharge or overheating. The sensor system monitors and measure battery parameters including cell voltage, battery temperature and battery current. Data acquisition helps BMS in analyzing and building a database for system modelling. Charge control helps in governing charge discharge control. Communication module helps in transferring data/ information from / to BMS. Thermal management helps in monitoring and ensuring that the cells operate at an optimum temperature.

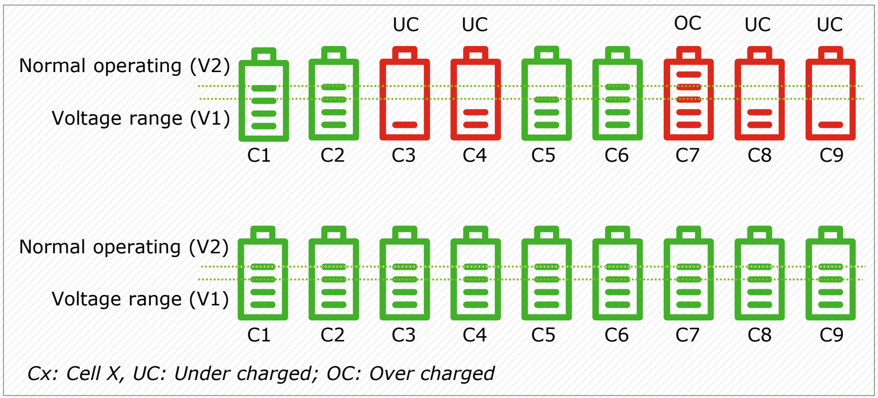
The software part of BMS is critical as it controls all hardware operations and analysis of sensor data for making decisions and state estimations. Activities such as switch control, sample rate monitoring, cell balancing control, and dynamic safety circuit design is handled by the software of BMS. BMS conducts automated data analysis that determines state estimation and fault detection.

Box 4: Cell balancing by BMS

BMS uses cell balancing technique to maximize battery pack performance.

In a battery pack, single cells are connected in series and in parallel in order to achieve higher voltage and capacity. However, every cell is distinct due to manufacturing and chemical offset, and for safety purpose, the charging/ discharging of cells is allowed only till any of the cell reaches its maximum or threshold limit. Due to this, the capacity of the battery pack is contained by the imbalance in the cells of the pack.

Figure 47 Cell balancing in battery pack



Thereby reducing the overall energy efficiency and lifetime of the battery pack.

BMS approaches balancing in two ways: active balancing and passive balancing. BMS uses SoC of each cell to provide balancing to the battery pack. It uses multiple algorithms to calculate accurate SoC of cells and ensures to keep same SoC for each cell at a given time.

In active balancing, BMS transfers energy from energy-excess cell(s) to energy-depleted cell(s) via bi-directional DC-DC power converter circuits. Whereas, in passive balancing, BMS dissipates energy from energy-excess cell(s) to their respective resistors.

The role of BMS gets very important while using it in EVs. Not only BMS ensures high efficiency and capacity to the battery, it also provides safety to the vehicle driver/ passengers.

1.5.3 Vehicle technology comparison

In this section, we would aim to assess fuel technologies on the basis of reliability, cost and their lifetime CO_2 contribution.

Box 5: Reliability: Electric vehicle vs Conventional vehicle

When it comes to reliability, EVs are far more superior to any other conventional vehicle. Forbes in 2018 reported that a drivetrain for a conventional vehicle has more than 2000 moving parts, whereas drivetrain of an EV has only 20 moving parts, reducing the risk of functional failure and increases reliability.

Source: 40 seven reasons why the internal combustion engine is a dead man walking (access here)

1.5.3.1 Total cost of ownership (TCO)

Cost plays an important role in selection of vehicle by consumers. Total cost of ownership (TCO) for electric vehicle is compared with TCO for other fuel vehicles.

BHP value has been considered as the criteria for selection of the vehicles for comparison. Vehicles with BHP values of 90-130 were considered (except Tata Tigor EV, BHP - 40.2). It is observed that the TCO of an electric vehicle (Tata Nexon EV) when compared with an equivalent conventional vehicle is very high. However, electric vehicles which are available at prices comparable to conventional vehicles tend to have relatively inferior technical specifications (Tata Tigor EV).

Table 8 Total cost of ownership calculation of fuel technologies

	Tata Tigor EV	Tata Nexon EV	Petrol Ford Ecosport	Diesel Ford Ecosport	CNG Maruti Suzuki Ertiga Vxi
Cost of running for 5 year (Rs.)	~10 Lakh	~16 Lakh	~12 Lakh	~12 Lakh	~9 Lakh

Source: 41 Deloitte analysis

Among electric, petrol / diesel and CNG vehicles, the Total Cost of Ownership is found to be the least for the CNG vehicle. On the other hand, the highest TCO was that of EV primarily due to its very high ex-showroom price (in comparison with other vehicles). Detailed comparison tables are provided at Annexure - 6.1 (Table 59)

"High EV prices are delaying their adoption among consumers. Early achievement of cost parity with ICE vehicles would favourably shape the EV market in India"

1.5.3.2 Environmental impact

Electric vehicle holds a great advantage in terms of improving the air quality of the region. It helps in reducing the CO2 emissions as well as particulate matter (PM), nitrogen oxide (NOx), carbon monoxide (CO) etc. In the below sections, we will review some of the studies that were conducted to assess environmental impact of electric vehicles.

1.5.3.2.1 Lifetime CO_2 emission study

Altigreen Propulsion Labs conducted a study in October 2015, to estimate the lifetime CO_2 emission for various Indian vehicles. The overall lifetime CO_2 emission of a vehicle was bifurcated into three categories: (i) Manufacturing emission; (ii) Indirect emission; (iii) Direct emission.

a. Manufacturing emission

The report considered following manufacturing emission numbers based on the expected lifetime of the vehicle in terms of kilometres driven:

- Petrol vehicle: 40 g CO_2/km; Diesel vehicle: 20 g CO_2/km; CNG vehicle: 40 g CO_2/km; Electric vehicle: 70 g CO_2/km

Higher value for EVs were considered in the report assuming lesser lifetime (in terms of kilometres driven) and high energy intensive manufacturing processes.

b. Indirect emission

This emission category is also called as WTT (Well-to-Tank) and includes emissions from transport, refining, purification and conversion from primary fuel to usable forms. For electric vehicles, the numbers were calculated using India's power generation mix.

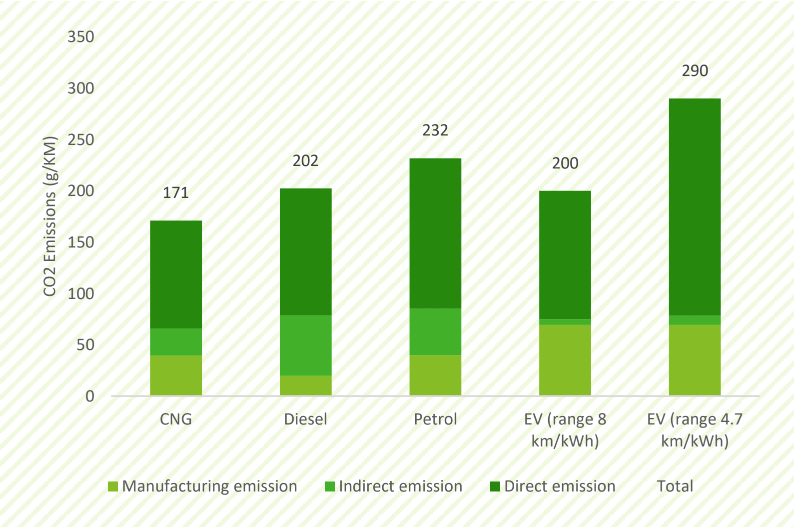
c. Direct emission

This emission category considers emissions directly from the vehicle exhausts. Data for the same was collected based on the actual tests done by the ARAI. For EVs, numbers were considered based on the range of EVs and the emissions from various power plants in India.

1.5.3.2.2 Study findings

The study found that petrol vehicles were the highest emitter of CO_2 in the conventional vehicle category. However, it was stated that the figures only represent the CO_2 emission and not its quality. The report also established that lifetime CO_2 emissions from EVs was calculated to be higher than petrol vehicles. Although, most of it was due to higher emission from associated thermal power plants in 2015 whose generated electricity flows into the grid to charge such vehicles.

Figure 48 Fuel category-wise lifetime CO_2 emission



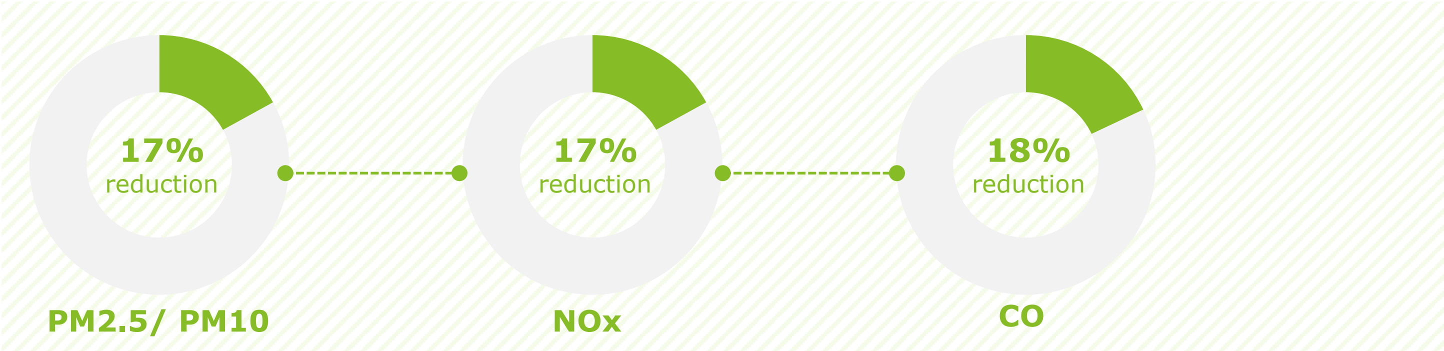
"As concluded from the study, petrol-based vehicles were the highest emitter of CO_2. The report also concluded that, it is essential to grow renewables in the generation mix to justify replacing conventional technologies for EVs"

Source: 42 Autotech review: lifetime CO_2 emissions in different Indian vehicles

1.5.3.2.3 Reduction in emission of air pollutants

In Nov 2020, CEEW published a study[24] which estimated the impact of EV adoption in India's overall emission level. The study found out that meeting the 30% EV penetration target in 2030 could lead to reduction in primary particulate matter (PM) by 17%, nitrogen oxide and dioxide (NOx) emission level by 17%, and carbon monoxide (CO) emission level by 18%. Also, achieving the 30% penetration target will lead to 4% reduction in greenhouse gas (GHG) emissions under the business as usual (BAU) scenario.

Figure 49 Environmental impact of achieving 30% EV penetration by 2030



Source: 43 CEEW - Can Electric Mobility Support India's Sustainable Economic Recovery Post COVID-19? (access here)

[24] CEEW - Can Electric Mobility Support India's Sustainable Economic Recovery Post COVID-19? (access here)

In 2017, SWEEP[25] assessed the impact of adoption of electric vehicles (EVs) over gasoline vehicles in Utah's Wasatch Front region.[26] It performed the analysis using the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) fuel-cycle model developed by the Argonne National Laboratory. From the analysis, it was found out that compared to a gasoline-fuelled vehicles, electric vehicles will reduce the pollutant emissions by—99% for Carbon Monoxide (CO), 90% for Nitrogen Oxides (NOx), 81% for PM2.5 and 57% for PM10.

In another study conducted by scholars of Denmark Technical University[27], if India achieves higher EV penetration, it may reduce its particulate matter (PM2.5) emission level by at least 50%.

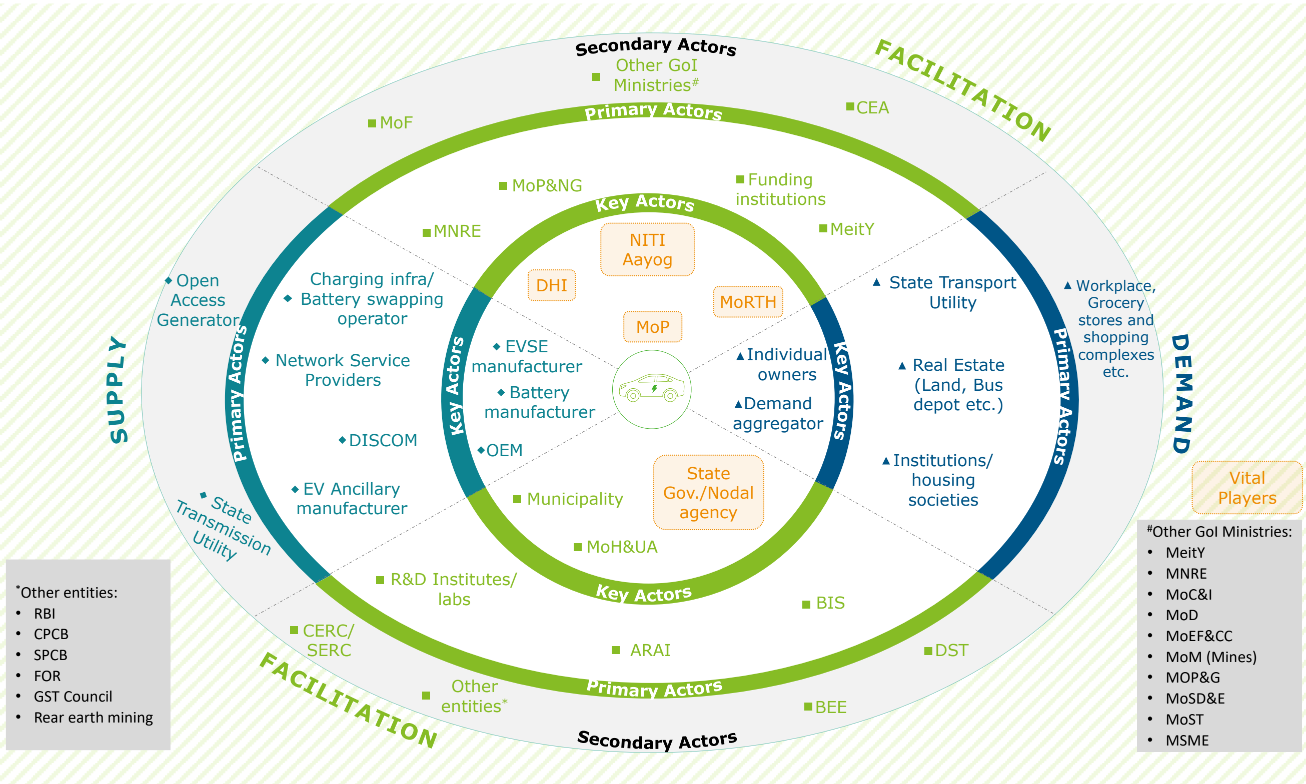
As suggested by studies and modelling analysis, introduction of electric vehicles will greatly influence reduction of air pollutants

[25] Southwest Energy Efficiency Project (SWEEP) is a public interest organization dedicated to advancing energy efficiency in Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming.
[26] The Potential for Electric Vehicles to Reduce Vehicle Emissions and Provide Economic Benefits in the Wasatch Front (access here)
[27] Electric vehicles and India's low carbon passenger transport: a long-term co-benefits assessment (access here)

2. Review and assessment of electric vehicle and charging infrastructure stakeholder landscape

The electric mobility ecosystem is composed of multiple stakeholders The primary role of developing a holistic ecosystem and providing the policy / regulatory support is played by Central/ State governments and the sector regulators. They enable investment, encourage adoption and ensure fair operation of the industry. An overview of the various stakeholders shaping electric mobility industry in India are outlined in the figure below.

Figure 50 Ecosystem of electric mobility in India



Source: Deloitte analysis

Note: Vital players are those players without support and participation of which, the targeted results cannot be achieved; **Key actors** are those players who will have direct participation in uptaking the electric mobility market in India; **Primary actors** are those actors who will support "key actors" in creating an ecosystem for electric mobility in India; **Secondary actors** are those players who would facilitate the growth of electric mobility space in India

2.1 Policy and regulatory landscape

As illustrated in Figure 50, there are several key ministries which are playing important role in creating holistic ecosystem for electric mobility in the country.

2.1.1 Roles of various ministries in EV ecosystem

2.1.1.1 Ministry of Heavy Industries and Public Enterprises (MoHI&PE)

Under MoHI&PE, Department of Heavy Industries (DHI) is spearheading the policy and implementation measures to fast-track adoption of Electric vehicles in India. To achieve the objectives of reduced emission and energy security, DHI has notified Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles in India (FAME) scheme, in March 2015, with the following four major focus areas:

Technology development	Demand incentives	Charging infrastructure	Pilot projects

The scheme provides financial incentives/subsidies to achieve the objectives of National Mission on Electric Mobility (NMEM). The total financial layout for the scheme was INR 765 Cr which was further increased to INR 895 Cr. In March 2019, the ministry notified FAME–II scheme, with increased layout of INR 10,000/- crores which includes a spill over from FAME-I of INR 366 Cr. The primary role of the ministry is to develop framework for implementation of FAME scheme.

National Automotive Board, under DHI, is an operating agency for implementation of FAME India schemes. This organization monitors the state-wise progress and maintains the web portal for dissemination of data related to the scheme. Further, the ministry has formed a **Project Implementation and Sanctioning Committee** to frame rules for sanctioning of projects under FAME scheme. This committee is responsible for awarding PCI project implementation agency.

Project Implementation and Sanctioning Committee (PISC)[28], an inter-ministerial panel, is setup by DHI for monitoring, sanctioning and implementation of projects under the FAME-II programme in March 2019. The committee is chaired by CEO, NITI Aayog and Secretaries, Financial Advisor and Directors of various ministries and association are the members of the committee. Key roles and responsibilities of the PISC is listed below:

- Sanctioning of projects under the FAME II scheme
- Modifying coverage of various components and sub-components of the scheme
- Modifying limits of the fund allocation under the scheme
- Review of demand incentive under the scheme, annually
- Review of vehicle-wise capping of incentive, annually
- Decide other scheme parameters for smooth implementation

2.1.1.2 Ministry of Road Transport and Highways (MoRTH)

The ministry is responsible for formulating policies and regulations pertaining to road transport. The Ministry also plays a key role in formulating non-financial incentives for promoting EVs by provisioning for parking infrastructure, priority lane access, etc.

Automotive Research Association of India (ARAI) under the ministry carries out research and engineering services on behalf of the Ministry. One of the functions of ARAI is to develop standards for vehicles and its components. These standards are marked as AIS-XXX standards. Till date about 220 standards are published by the organization. AIS 138-Part 1 and Part 2 are notified by ARAI which specifies the charging requirements (AC and DC) for all electric vehicles (2/3/4) wheelers with the exception of trolley buses, rail vehicles and off-road industrial vehicles.

2.1.1.3 Ministry of Power

The ministry is responsible for perspective planning, policy formulation, processing of projects for investment decision, monitoring of the implementation of power projects, training and manpower development and the administration and enactment of legislation in regard to development of Power Sector. The Ministry forms policies for the sector and has notified that electric charging stations are to be considered as service and not distribution of electricity implying it is a delicensed activity. Further, the Ministry has issued guidelines for implementation of Charging Infrastructure under which **Bureau of Energy Efficiency (BEE)** has been entrusted with the role of Central Nodal Agency (CAN). BEE has notified 25 **State Nodal Agencies (SNAs)** for various states. SNAs for states are various agencies including DISCOMs, nodal agency for RE and EE, transport authorities etc. whose responsibility is to enable implementation of charging infrastructure in states

[28] Constitution of PISC under FAME II (access here)

/ cities. Central Electricity Authority (CEA) under the Ministry is responsible for preparation of standards related to safety of EVSE. The committee on technical aspects of charging infrastructure has provided a report on the standards and technical specifications to be followed for PCI.

State Electricity Regulatory Commissions (SERCs) were formed under the provisions of the Electricity Act, 2003. These regulatory commissions are responsible for notifying electricity tariffs applicable for the PCI. In addition, as the PCIs can be installed in existing locations (parking lots, malls, shopping complex etc.) issues related to use of multiple connections in a single premise are addressed by the SERCs.

2.1.1.4 Ministry of Housing and Urban Affairs (MoHUA)

Encouraging "Electric Vehicles" as a viable option for phased transportation in terms of short and long distance trips with appropriate "Charging Infrastructure" is therefore, the pre-condition for this paradigm shift/ phased migration to sustainable transportation. In order to steer the development of charging facilities in commercial and residential building complex, MoHUA is playing a key role by amending building bye-laws. MoHUA notified that residential and commercial complexes will have to allot 20% of their parking space for electric vehicle charging facilities. MoHUA has also amended Urban and Regional Development Plans Formulation and Implementation Guidelines – 2014 to include the formulations of norms and standards for charging infrastructure in the city infrastructure planning.

2.1.1.5 Ministry of Finance

Ministry of Finance is one of the key ministries that has enormously helped in uptake of electric mobility in India. In 2019, Ministry of Finance rationalized the customs duty for all categories of vehicles, battery packs and cells to support Make in India. It also reduced the GST rates for the purchase of electric vehicles from 12% to 5% and announced income tax rebate of INR 1,50,000 on purchase of electric vehicles.

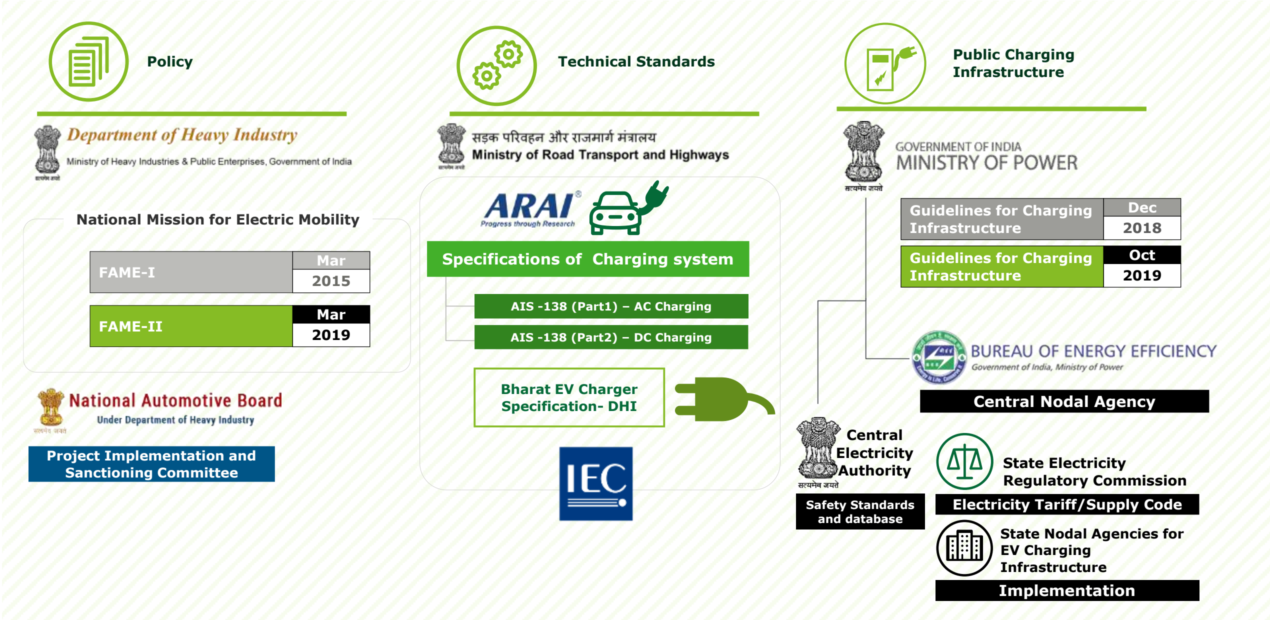
2.1.1.6 Ministry of Environment, Forest and Climate Change

Ministry of Environment, Forest and Climate Change is the main concerned union ministry in the “National Electric Mobility Mission Plan 2020” initiative. The ministry also notified Draft Battery Waste Management Rules, 2020 to strengthen the ecosystem for handling and disposal of batteries across India.

2.1.1.7 Ministry of Science and Technology

The MoST has formed a “Technology Platform for Electric Mobility (TPEM)”, funded primarily by the MoHIPE. MoST is playing a key role in forming electric mobility standardization roadmap for India.

Figure 51 Policy and regulatory structure for EVs in India



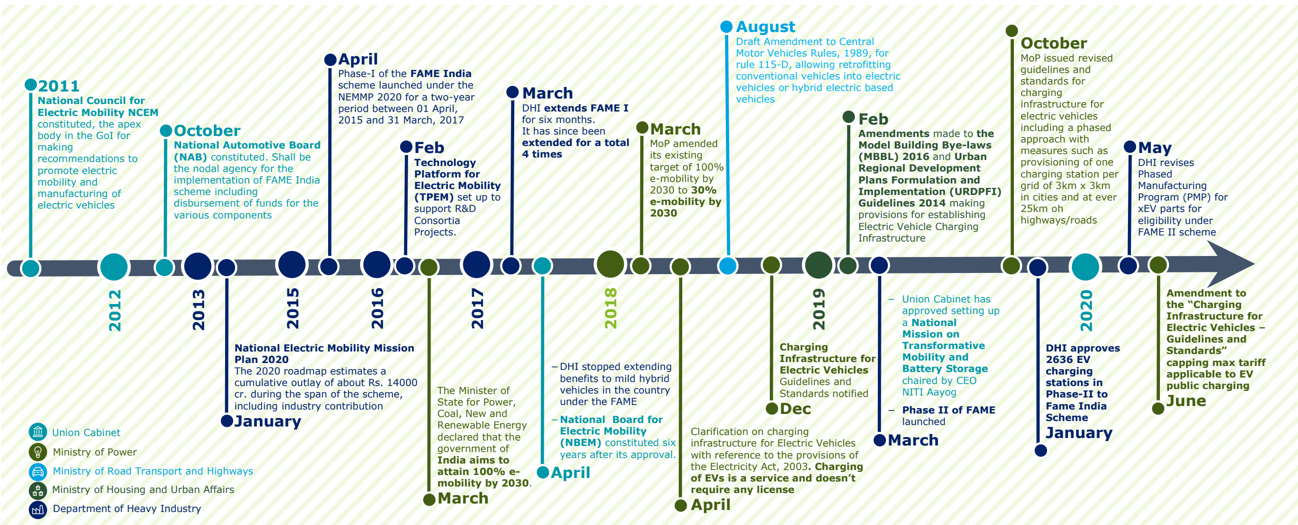
Source: 44 Deloitte analysis

India has taken multiple initiatives to promote electric mobility, with the policy and regulatory support, adoption of electric vehicles have started increasing in last five years (industry grew at 133% CAGR in past five years, *refer Figure 17*).

Central government in last 10 years has notified numerous promotional measures including fiscal incentives for electric vehicle buyers, public EV charging infrastructure development etc. to support uptake of electric vehicles in the country.

Timeline for various initiatives taken by policymakers and regulators is provided Figure 52:

Figure 52 Key national level initiatives to promote adoption of electric vehicles - Timeline



Source: 45 Government notifications

2.1.1.8 Review of key policies notified by central government

2.1.1.8.1 Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) – I and II

Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) programme was launched by DHI in 2015. It is the flagship scheme under the NEMMP 2020 mission plan of Central government to enhance hybrid and electric technologies in India. The overall scheme is proposed till FY 2022 to support market development for EVs. Phase 1 of the scheme has been implemented over a two-year period starting from FY 2015-16 to FY 2016-17 and was extended till FY 2018-19. Phase 2 of the scheme has been launched from FY 2019-20 till FY 2021-22. In March 2019, the ministry notified FAME –II scheme with increased layout of Rs 10,000/- crores, which includes a spill over from FAME-I of Rs 366 Cr (*for further detail on FAME scheme please refer to chapter 3*)

Initial Allocation of Funds under FAME-I			
Component	**2015-16 (Rs. cr)**	**2016-17 (Rs. cr)**	**Total Fund (Rs. cr)**
Technology Platform	70	120	190
Demand Incentives	155	340	495
Charging Infrastructure	10	20	30
Pilot Projects	20	50	70
IEC/Operations	5	5	10
Total	260	535	795

Initial Allocation of Funds under FAME-II				
Component	**2019-20 (Rs. cr)**	**2020-21 (Rs. cr)**	**2021-22 (Rs. cr)**	**Total Fund (Rs. cr)**
Demand Incentives	822	4587	3187	8596
Charging Infrastructure	300	400	300	1000
Administrative Expenditure	12	13	13	38
Total for FAME-II	1134	5000	3500	9634
Committed from Phase-I	366	0	0	366
Total	1500	5000	3500	10000

2.1.1.8.2 National Mission on Transformative Mobility and Storage

The aim of the mission is to drive strategies for transformative mobility and Phased Manufacturing Programmes for EVs, EV Components and Batteries. Following are the key roles, roadmap and anticipated impact envisaged under the mission:

Role

- Drive strategies for transformative mobility and Phased Manufacturing Programmes for EVs, EV Components and Batteries
- Creating a **Phased Manufacturing Program (PMP) to localize production across the entire EV value chain**
- Details of localization will be finalized by the Mission with a clear Make in India strategy for the electric vehicle components as well as battery
- The Mission will coordinate with key stakeholders in Ministries/ Departments/states to integrate various initiatives to transform mobility in India

Roadmap

- **Phased battery manufacturing roadmap** with initial focus on large-scale module and pack assembly plants by 2019-20 and Giga-scale integrated cell manufacturing by 2021-22
- Ensuring holistic and comprehensive growth of the battery manufacturing industry in India through PMP
- Preparing roadmap for enabling India to leverage its size and scale to produce innovative, competitive multi-modal mobility solutions that can be deployed globally in diverse contexts
- Roadmap for transformative mobility in "New India" by introducing a sustainable mobility ecosystem and fostering Make-in-India

Impact

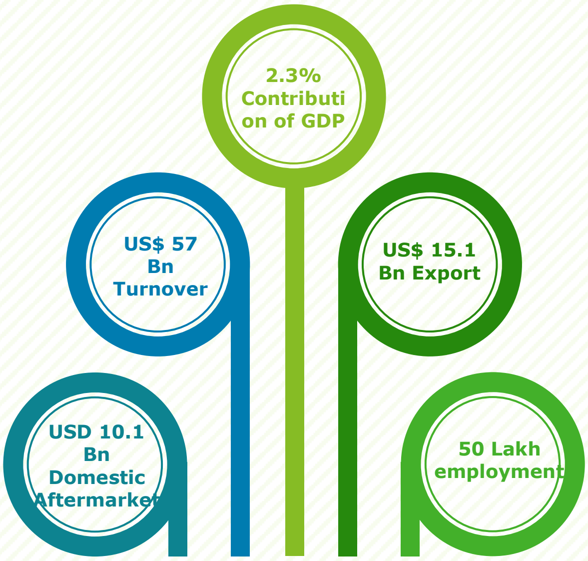
- Drive mobility solutions to benefits to the industry, economy and country
- Improving air quality in cities along with reducing India's oil import dependence and enhancing the uptake of renewable energy and storage solutions
- The Mission will lay down the strategy and roadmap which will enable India to leverage upon its size and scale to develop a competitive domestic manufacturing ecosystem for electric mobility
- Benefit all citizens as the aim is to promote 'Ease of Living' and enhance the quality of life of our citizens and also provide employment opportunities through 'Make-in-India' across a range of skillsets

2.2 EV components OEM landscape

India is the fifth largest market for automotive industry[29] and therefore has a strong presence of OEMs in the conventional vehicle segment. Further, there are numerous companies dealing in auto-ancillary components as well as companies dealing in aftermarkets. A snapshot of auto-ancillary industry is provided below:

[29] Ranking provided by OICA (International Organization of Motor Vehicle Manufacturers) and includes only passenger and commercial vehicle sales (access here)

Figure 53 Overview of India auto ancillary industry FY19



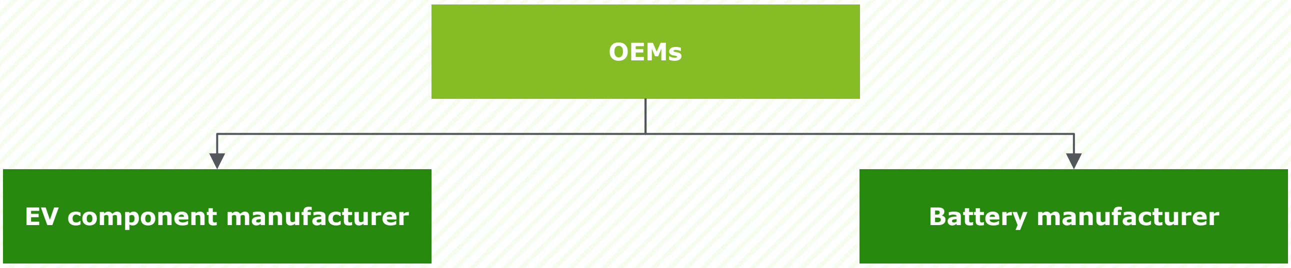
The present auto-ancillary industry plays a vital role in the development of automotive sector of the country. During FY19, it contributed 2.3% in India's GDP and 4% in overall export revenue. The industry is highly unorganized with more than 10,000 players catering to the market and employing more than 50 lakhs people in the country.

Source: 46 ACMA

Conventional automobiles are an assembly of more than 2000 different components. Whereas, the transition towards electric mobility have opened new avenues for few auto component manufacturers, the same has also posed a threat to several other players in ancillary segment of conventional vehicles . Many of the conventional automobile components such as engine parts, clutches, radiators etc. run the risk of being obsolete in a market dominated by EVs since it is expected that the EV market would be dominated by different sets of auto-ancillary manufacturer, having expertise in only electronics and electrical related auto-components. The broad classification of electric vehicle components of OEMs is provided in

Figure 54.

Figure 54 Categorization of OEMs in EV space



2.2.1 EV component manufacturer

In comparison with the conventional vehicles, the EV auto-component industry is at a very initial stage. In contrast to more than 10,000 auto component manufacturer in conventional vehicle segment, there are very few players in EV auto-ancillary manufacturing space currently. With the transition towards EVs, the existing auto component manufacturers would have to realign their product portfolio to suitably match the requirements of upcoming EV market. This would not only help in reducing the cost of EV (reduced existing import dependency) but also minimize the risk of unemployment in the conventional segment.

Figure 55 provides the likely impact of EVs on conventional auto-component industry.

Figure 55 Impact of rise of electric mobility on auto component industry

Auto-component	Impact	Auto-component	Impact
Electric Motor	Positive	Brake lining	Moderate
Batteries	Extremely positive	Headlights	Moderate
Inverters	Positive	Leaf springs	Moderate
Wiring harnesses	Extremely positive	Shock absorber	Moderate
Microprocessors	Positive	Engine parts	Extremely negative
Controllers	Positive	Clutch	Extremely negative
Steering systems	Moderate	Radiators	Extremely negative
Seats	Moderate	Gears	Negative

Extremely negative · *Negative* · *Moderate* · *Positive* · *Extremely positive*

As the complexity in manufacturing of vehicles reduces with the introduction of electric vehicles, it is expected that the need for core ICE vehicle parts such as engine, clutch, gears and radiators would come down

Source: 47 BEE - Technical study of Electric Vehicles and Charging Infrastructure (access here)

As shown in Figure 55, workers in auto-component industry having "extremely negative" to "negative" impact from the transition will have maximum risk of job losses. It will be crucial that these workers get proper training and skill development on newer automobile technologies to ensure job continuity.

2.2.2 Battery manufacturer

India has limited battery manufacturing capacity to cater to the EV market. Presently, most of the electric vehicles sold in India uses imported batteries as the major players in EV battery manufacturing such as BYD, Panasonic, CATL, CALB, LG Chem etc. have manufacturing facilities outside India. This also leads to higher costs of batteries and consequential increase in EV prices in India. However, the Govt. of India has taken several steps in building domestic battery manufacturing capability for the future. However, the scale and outcomes of the same remains to be seen in the future.

Box 6: Exide Industries and Leclanché JV

Exide Industries and Leclanché, entered in an exclusive agreement in June 2018 to form a new joint venture (75:25) to build lithium-ion batteries and energy storage solutions to power the growth of India's electric vehicle market. The plant is located in Gujarat and is expected to be operational in 2020.

"Nexcharge will focus on e-transport, on stationary energy storage systems and speciality storage markets. In e-transport, the target segment is fleet vehicles including e-buses, e-wheelers and e-rickshaws." - Nexcharge

2.2.3 Gaps and challenges

The localization of the supply chain, being promoted through the Phased Manufacturing Program (PMP), has already surpassed its previous deadline of achieving the targets. Yet the extent of localization achieved is very low. In September 2020, the Government has further pushed the effective date of indigenization of xEV parts for PMP under FAME-II to April 2021.

Table 9 Localization timelines under PMP for key components

Category	e-2W	e-3W	e-3W	e-4W	e-4W	e-Bus
Item Description	**L1&L2**	**E-Rick/ E-Cart**	**L5**	**M1**	**N1**	**M2/M3**
HVAC	NA	NA	NA	Oct 19	Oct 19	Apr 21
Electric compressor	NA	NA	NA	Apr 21	Apr 21	Apr 21
Power and control wiring	Apr 19	Apr 19	Apr 19	Oct 19	Oct 19	Apr 21
MCB/ Circuit breaker	Apr 19	Apr 19	Apr 19	Apr 21	Apr 21	Apr 21
AC Charging inlet Type-2	NA	NA	NA	Apr 21	Apr 21	Apr 21
DC Charging inlet CCS2/CHAdeMO	NA	NA	NA	Apr 21	Apr 21	Apr 21
DC Charging inlet BEVC DC001	NA	NA	NA	Apr 21	Apr 21	NA
Traction battery pack	Jul 19	Jul 19	Jul 19	Jul 19	Jul 19	Apr 21
Wheel rim integrated with Hub motor	Apr 21	Oct 19	Oct 19	Apr 21	Apr 21	Apr 21
DC-DC Converter	Apr 21	Apr 21	Oct 19	Apr 21	Apr 21	Apr 21
Electronic throttle	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21
Vehicle control unit	Apr 21	Oct 19	Apr 21	Apr 21	Apr 21	Apr 21
On-board charger	Apr 21	Oct 19	Apr 21	Apr 21	Apr 21	Apr 21
Traction motor	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21
Traction motor controller/ inverter	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21
Instrument panel	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21	Apr 21
Lighting	Apr 21	Apr 19	Apr 19	Apr 21	Apr 19	Apr 19
Body Panel	Apr 21	Apr 19	Apr 19	Apr 21	Apr 19	Apr 19

Revised in September 2020

Source: 48 Phased Manufacturing Programme (PMP) for xEV parts for eligibility under FAME II scheme (DHI) (access here)

As the domestic market is tuning to the transition, there has been limited capacity for production of localized components for electric vehicle. At this stage, the industry needs assistance from the government in realization of localization targets with support in implementation. A focused effort is essential for the development of localized market for EV component manufacturing, but the existing industry traction should also not be derailed in the quest for localization. This is a delicate challenge for the policy to address.

Further, there is need to support local manufacturers and workers in catching up with the electric vehicle technology. This could be done by providing funds to the manufacturers and facilitating skill development for the workers.

As per SIAM, support to local manufacturers to acquire and develop technology and collaborate globally with technology suppliers is essential. A pool of funds may be considered for technology acquisition for multiple manufacturers in India.

Nevertheless, steadily number of models achieving localisation requirement are increasing. **Out of approximately 50 plus electric two-wheeler models being produced in the country, only three L2**

and fifteen L1 models met FAME II localisation requirements[30] till September 2020. However, this figure has reached to four L2 and twenty-six L1 model by mid of December 2020[31].

Localization of the supply chain is critical from the perspective of bridging the cost differential between EVs and ICE vehicles. A well-established local supply chain can help reduce the cost of electric vehicles. However, in absence of any EV adoption mandate, developing local supply chain for EV component seems difficult. China, under its NEV Policy, mandated EV manufacturing and sale by way of NEV credit systems (case study provided below) and invested heavily in creation of charging infrastructure. Visibility of upcoming demand of EVs through adoption mandate has played an important role in development of local auto component manufacturing for EVs in China.

Box 7: Case Study: China localization of EV component

In 2009, China adopted a New Energy Vehicle (NEV) plan to leapfrog existing automotive technologies. It has launched pilot program in 10 cities to promote NEV. China adopted seven key tools as policy measures to promote NEV – mandated government procurement (at least 30% of EV in total vehicle procurement), reduced taxes (exemption from the standard consumption tax), direct subsidies to manufacturers, consumer subsidies, industrial policy Made in China 2025, NEV credit target (NEV credit targets for two years: 10% of the conventional passenger vehicle market in 2019 and 12% in 2020), Subsidies for development of charging infrastructure.

To boost local supply-chain of EV component key strategy adopted by China through above mentioned policy measures are as follows:

- Creation of certainty in upcoming demand for EV through government procurement mandate and NEV credit mechanism
- Invested in creation of charging infrastructure to strengthen EV ecosystem
- Enforced manufacturer to use local manufactured components (40% by 2020 and 70% by 2025). This policy coupled with NEV credit mandate pushed manufacturer to build and develop ecosystem of local suppliers of EV component.
- Actively done Lithium offtake deals with countries rich in lithium
- Increased production and mining of rare earth metals available in China

Further, abundant availability of raw material requires to manufacture EV auto components offered additional inherent advantage to create local supply chain for EV components.

However, supply chain localisation and availability of EV demand are not linearly correlated. The supply chain localisation depends on three major aspects that should co-exist – conducive Government policies, financial muscles of auto component manufacture and access to raw material. While government policy (PMP) provided the ample push for the local manufacturing and few auto-component manufactures have enough access to capital for investment, India is lacking in availability of raw material needed for manufacturing of key EV component having high share in EV value chain.

Battery commands nearly 30 - 35% of the EV cost in the value chain. Therefore, Government is weighing up plans to incentivize local battery manufacturing. NITI Aayog sought Cabinet approval in January 2020 to provide subsidies to investors upon setting up of giga-scale battery manufacturing facilities for Li-Ion batteries compatible to EVs in India. However, success of this program lies on the access of raw material from the countries that have its major reserve (Figure 56). Strength of inter-government bilateral ties and geopolitical situation would govern the India's ambition to become a major hub for battery production. Currently, Li-ion battery production facilities are largely concentrated in China, North America, Europe, Japan, and South Korea.

Key EV components and their potential to achieve localisation by 2030 is shown below.

[30] CNBC (access here)Very High
[31] FAME – II dashboard (access here), accessed on 16th December 2020

Table 10 2030 localization potential of EV components

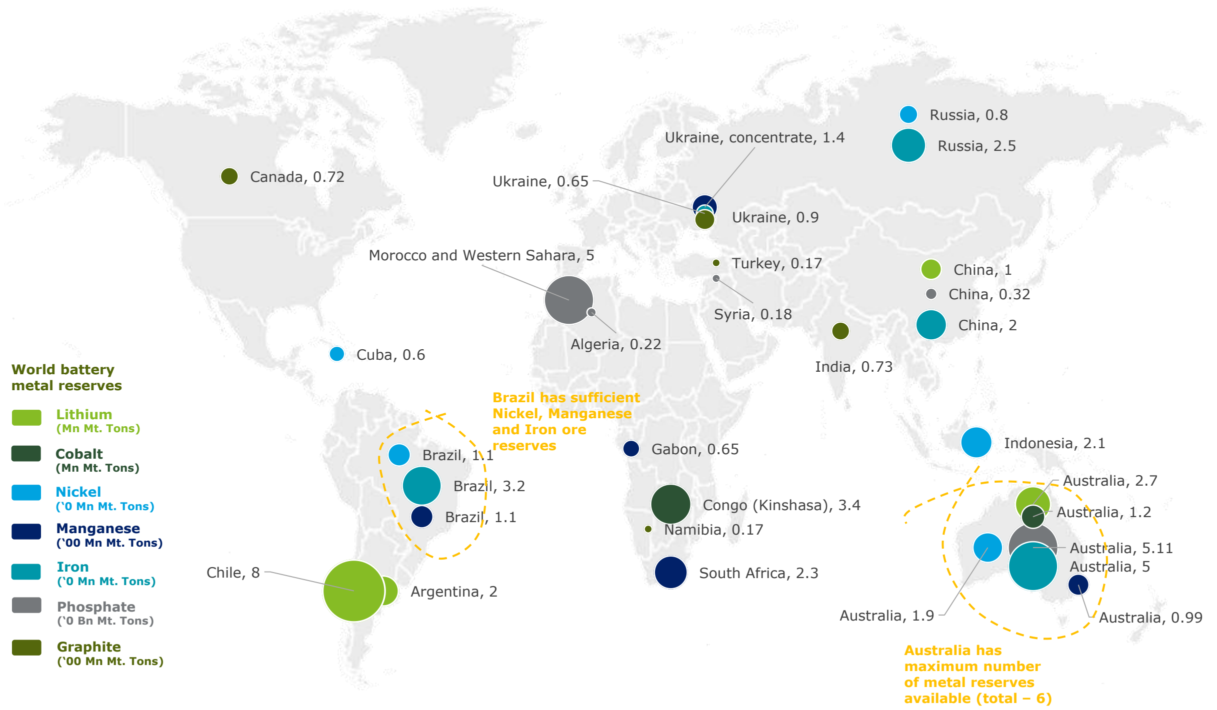
Component (% cost contribution)	Current localization	Localization potential by 2030	Rationale
Battery Cell (30-35%)	Very Low	Low	• Unavailability of core raw materials like lithium • Battery R&D is capital intensive • Rapid evolving of battery technology • Cost competitiveness of Chinese Li-ion batteries
Chassis and Body (10-15%)	High	Very High	• No requirement of special raw materials or technology • Manufacturing know-how already exist locally
BMS and TMS (10-12%)	Moderate	Very High	• Primarily require software • India is known for development and export of software
Motor (10-12%)	Very Low	Moderate	• Unavailability of rare earth magnets such as the Neodymium magnet • China is the leading producer of rare earth magnets accounting for over 90% production and over 40% reserves. Geopolitical risk involved in sourcing raw material.
Power Electronics (8-10%)	Very Low	Very High	• No major challenge exists except requirement for capital for doing R&D and setting-up of infrastructure
Others (HVAC, Control units etc)	Moderate	Very High	• Indian manufacturers have experience and know-how • Already manufacturing such system, minor adaptation is required for EVs

Source: 49 Analyst reports, Sector outlook reports, Deloitte analysis

To leverage India's cost advantage and achieve the high levels of supply chain localization for EV manufacturing in India, ecosystem stakeholders need to start with the following:

- Facilitate extensive support for Research, Development and Demonstration of technologies using raw material abundantly available in India, to find alternatives and reduce dependence on scarce natural resources required for EV manufacturing
- Commitment and investments in technology from incumbent OEMs and auto component companies
- Policymakers will have to strike a balance between promoting localization while making EVs economical. Need to re-think on waiving unrealistic riders of localisation requirement for availing subsidy, at least during demand creation phase.
- Invest in creating charging infrastructure, to build ecosystem for EVs. Prospects for future demand in EVs would bolster investor sentiments, leading to development of local supply chain for EV components.

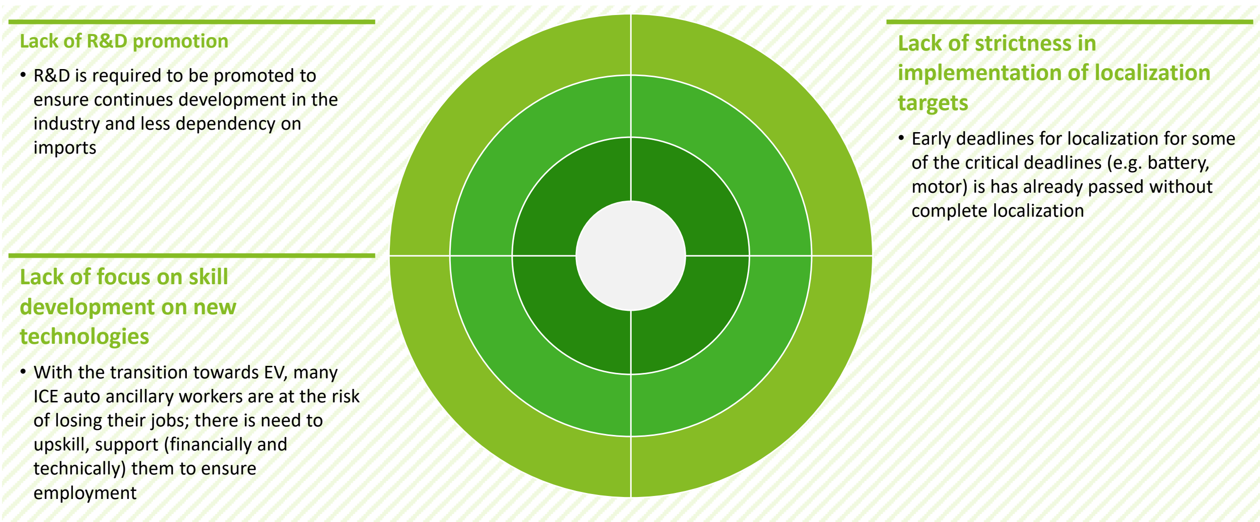
Figure 56 Global reserves for metal used in battery manufacturing



Source: 50 Deloitte analysis, USGS Mineral Commodity Summaries 2019

Summary of gaps in existing electric mobility market for OEMS is provided in Figure 57.

Figure 57 Summary of gaps in OEMs electric mobility market

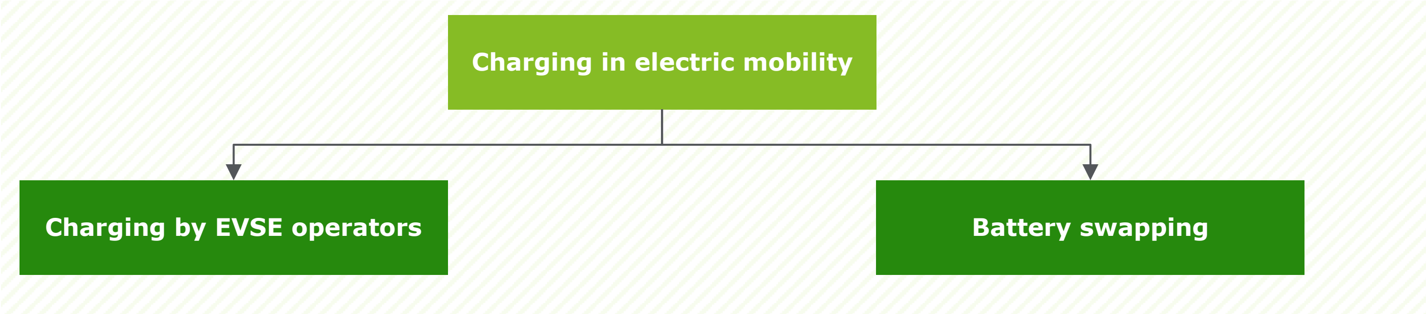


2.3 EV charging landscape

Abundant availability of EV charging infrastructure is one of the major drivers for enabling higher adoption of electric mobility. A robust and well developed EV charging infrastructure alleviates the charge anxiety of users and increases offtake.

The refuelling (charging) of EV batteries can be done in two ways: first, by charging the batteries; second, by replacing (swapping) the drained battery with the new one which is commonly known as Battery Swapping.

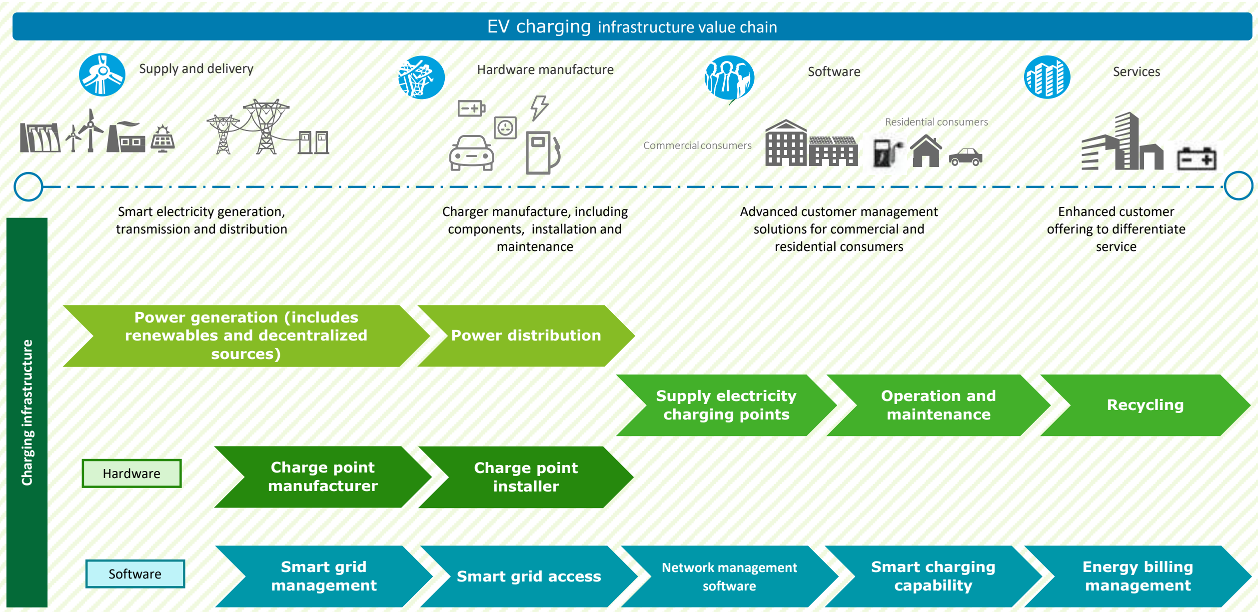
Figure 58 Refueling in electric mobility



2.3.1 EV charging infrastructure – market landscape

There are multiple services that are provided within the EV charging infrastructure value chain, an illustration of the same is provided below:

Figure 59 Value chain of EV charging infrastructure



Source: 51 Deloitte analysis

The Ministry of Power has directed CEA to develop a database for public charging infrastructure, available in India. However, as on date there exist no such database to have consolidated information of operating charging infrastructure in India. CEA reported that there are more than 372 public charging stations in Delhi[32]. As per charging infra dashboard developed by a research institution, total of 1827 charging stations have been deployed across the country.

[32] CEA - India EV Charger PCS Locations (access here)

Figure 60 Total EV charging stations in India - 2020

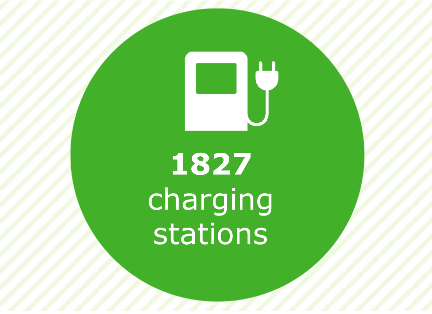


Figure 61 Share of Charging point operators

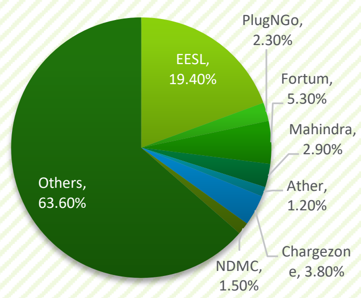
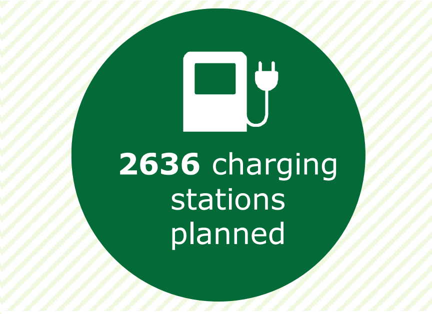


Figure 62 Charging stations awarded by DHI under FAME – II Scheme



Source: 52 EV charging dashboard (acces here), DHI

EESL: Charging station aggregator, EESL, has been the leading charging point operator in the country. EESL has installed about 92 public charging stations across India along with 308 AC and 180 DC captive chargers[33]. Further, the company has won a tender for installing about 600 PCI under FAME –II scheme. Tendering process for installing about 600 PCUI across 60+ cities in the country is underway. EESL intends to install 10,000 EV charging stations in India by FY22-23[34]. At present, EESL owns close to 20% of country's total charging stations. In July 2020, EESL has launched the first EV charging plaza[35] in the country.

Box 8: India's first of its kind public EV Charging Plaza inaugurated in New Delhi

India's first EV (electric vehicle) charging plaza was inaugurated on 20th July 2020 at Chelmsford Club in New Delhi. The plaza was setup by EESL (Energy Efficiency Services Ltd) in partnership with NDMC (New Delhi Municipal Council). The plaza has the capability to charge 5 EVs of different specification simultaneously.

REIL (Rajasthan Electronics and Instruments Limited): A public sector demand aggregator, REIL has installed about 200 Stations in India. In a recent tender floated by DHI, REIL has been awarded with 1000 charging stations under the FAME –II scheme. Further, the company has already started tendering work to install 270 PCI[36]

Tata Power: Tata Power, an electric utility, has installed about 100 PCS across the country, including 42 in Mumbai.[37] The company has signed MoUs for setting up commercial EV charging stations at HPCL, IOCL, and IGL retail outlets. TATA Motors as also partnered with TATA Power to set up 300 fast-charging stations across Mumbai, Pune, Delhi, Bangalore and Hyderabad.

Apart from above, there are multiple other charging infrastructure providers and EVSE operators that are operating in the market. Some of the key players are listed below.

Figure 63 Charging infrastructure provider and EVSE operators in India

DELTA	EV charging equipment including AC EV charger, DC quick charger, and Site Management	MASS-TECH CONTROLS PRIVATE LIMITED	AC and DC chargers of varying configurations and Installation
ABB	Manufacturing of Fast DC chargers and installation.	EXICOM POWER SOLUTIONS	Batteries and Bharat EV chargers. High Voltage all-in-one Harmony chargers — GB/T

[33] EESL - Electric vehicles & EV charging infrastructure (access here)
[34] EESL EVSE (access here)
[35] India's first of its kind public EV Charging Plaza inaugurated by Union Power Minister (access here)
[36] Rajasthan Electronics Seeks to Empanel Agencies for Setting Up EV Charging Stations (access here)
[37] Tata Power to Set Up 500 EV Charging Stations in India by 2020 (access here)

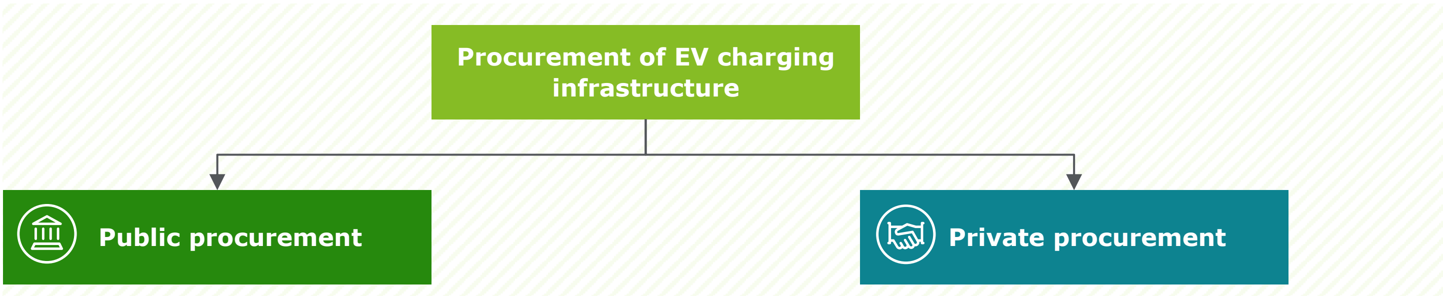
OPG OKAYA POWER GROUP	Charging station solutions for transport and fleet	EVQ Point Convenience Innovated	3.3kW AC Charging Station for offices, commercial and residential complexes.
BRIGHTBLU	AC Type 2 Charger and charging management software	magentapower Green Energy Solutions	'ChargeGrid' series (Lite, Pro and Ultra) of EV charging stations for homes, apartments, PCS and commercial spaces.
fortum	Charging stations providing charging services over Fortum's Charge and Drive platform	VOLTTIC	Offer Charging Station Solutions for home, cities and highways including CMS and end- user mobile apps.

Note: List is not exhaustive

2.3.2 Procurement of EV charging infrastructure

In India, there are primarily two modes of procurement for EV charging infrastructure:

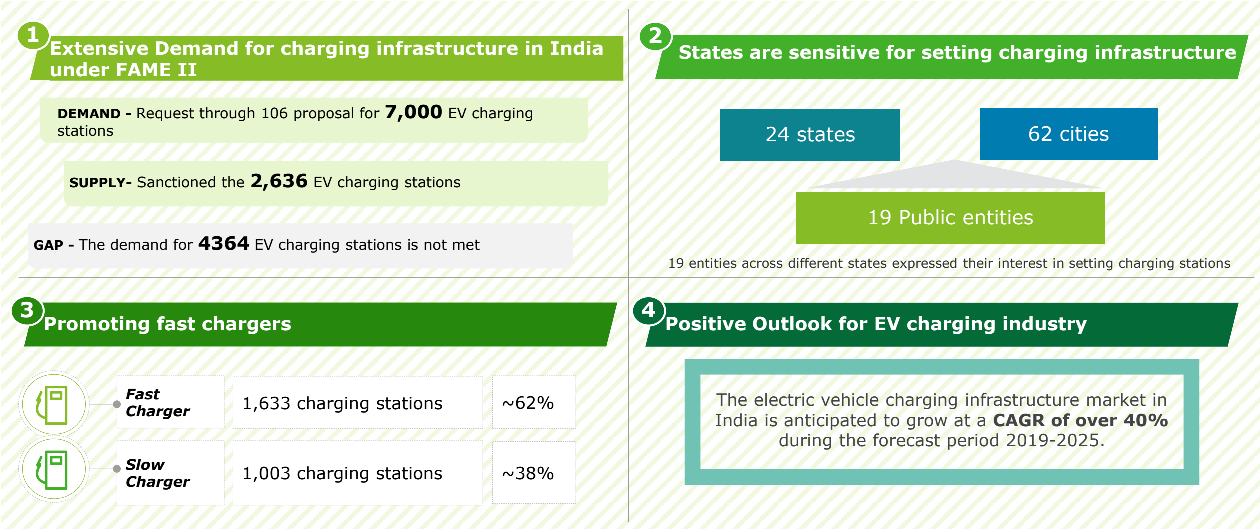
Figure 64 Procurement of EV charing infrastructure



In the public procurement process, government entities adopt competitive bidding to procure EV chargers. The procurement follows all the technical guidelines as laid out by concerned ministries and regulators. In addition to it, it also complies with the General Financial Rules (GFR) and other prevailing public procurement guidelines.

Under public procurement, Department of Heavy Industry invited Expression of Interest (EoI) from Indian cities and states for submission of proposal for deployment of EV charging infrastructure within Cities. In response to such proposals, DHI has sanctioned 2,636 Electric Vehicles (EVs) Charging Stations, amounting to Rs 500 Crore (Approx.) in 62 cities across 24 States/UTs under FAME scheme phase II.

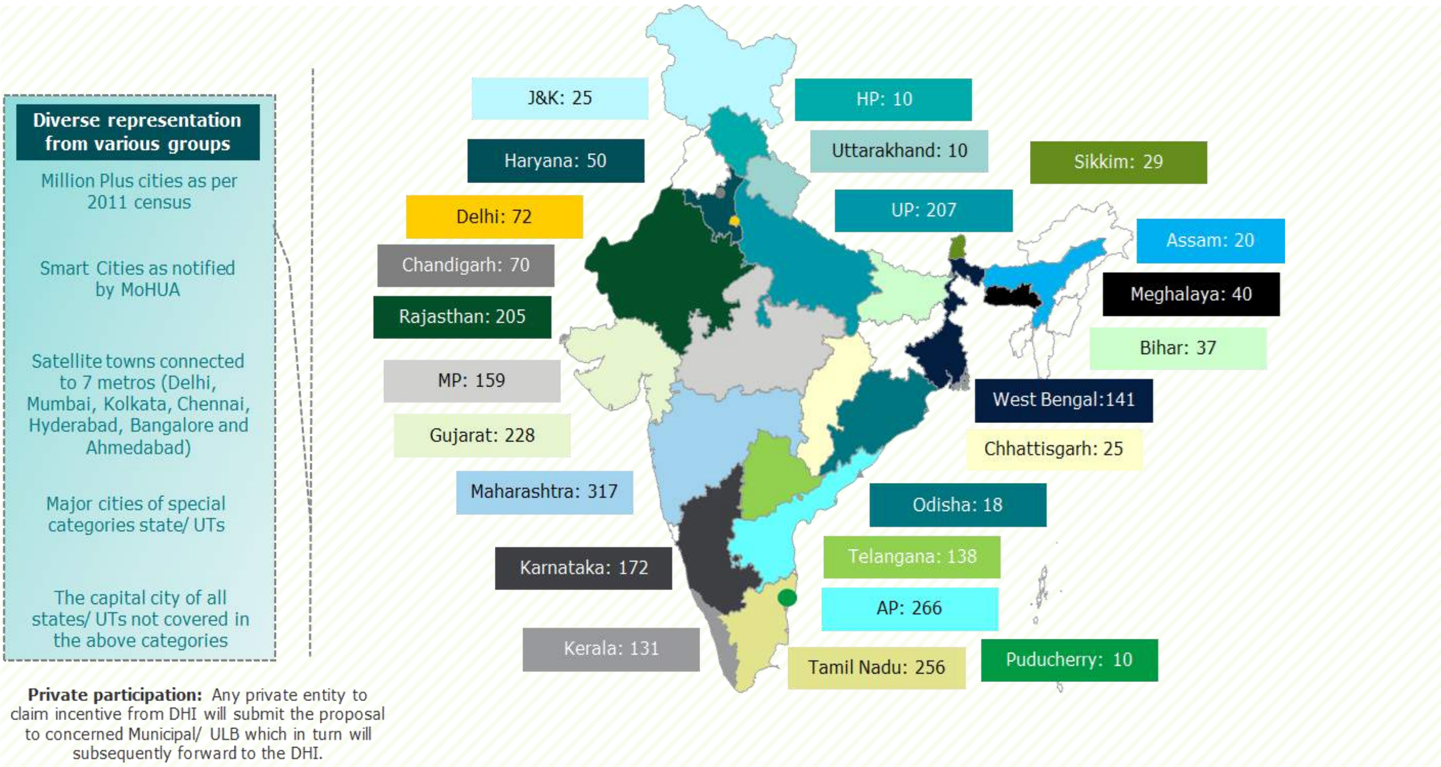
Figure 65 Key aspects of EOI released by DHI under FAME II scheme



Source: 53 DHI, Deloitte analysis

State-wise details of sanctioned EV charging stations is provided in Figure 66:

Figure 66 State-wise break-up of charging stations sanctioned by DHI



Source: 54 DHI

In addition to the previously sanctioned 2,636 charging stations, in September 2020, Ministry of Heavy Industries further sanctioned 241 charging stations in Madhya Pradesh, Tamil Nadu, Kerala, Gujarat and Port Blair.[38]

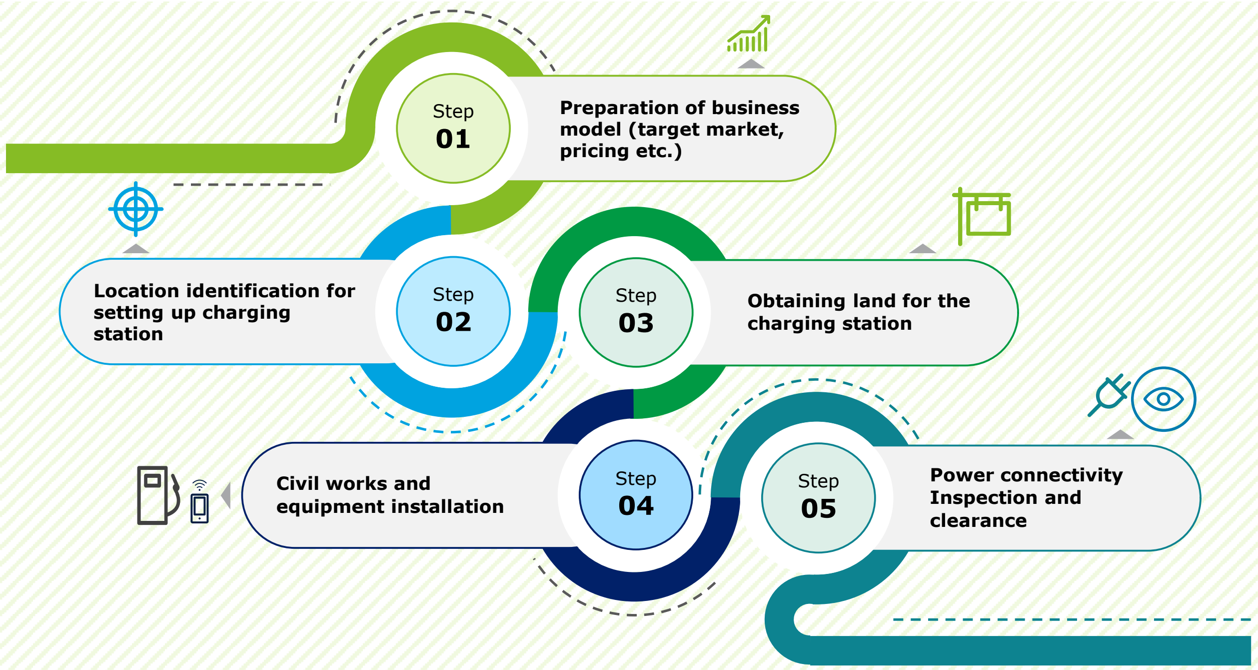
[38] 670 new electric buses and 241 charging stations sanctioned under FAME scheme (access here)

The next section elaborates on the process of installing an EV charging infrastructure in India.

2.3.3 Setting up EV charging infrastructure in India

Government of India has de-licensed the setting-up of an electric charging station. Any individual or organization is allowed to setup their own EV charging infrastructure as long as the charging station meets the technical standards laid out by Ministry of Power. Such an individual / organization needs to follow a standard process starting from preparation of business model to inspection and commercial operation. Figure 67 illustrates a five step process for commercial development of EV charging station.

Figure 67 Process of setting up an EV charging infrastructure



Source: 55 Deloitte analysis

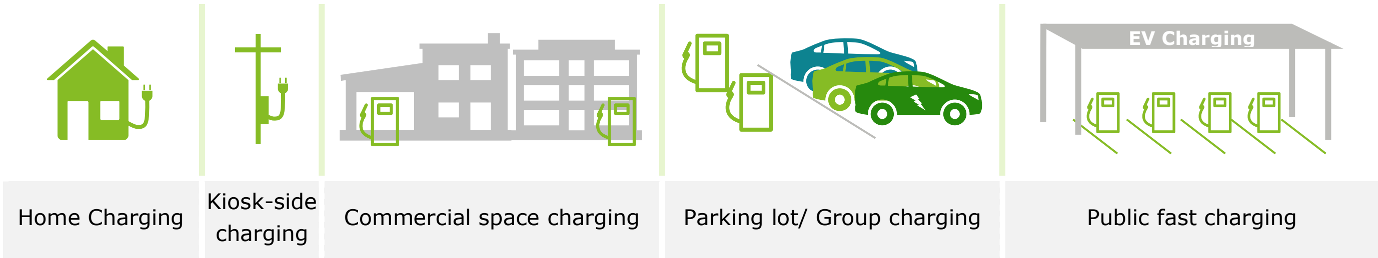
2.3.3.1 Preparation of business model

Preparation of business model include selection of type of charging station, identification of the target market, cost economics, pricing mechanism and ownership model.

2.3.3.1.1 Type of EV charging station

For any EVSE operator, it is crucial to decide on type of charging station requirement. Selection of a particular type of charging station will depend upon various factors such as traffic density, expected utilization, availability of power infrastructure, etc. Cost economics of a charging station is highly influenced by the location and type of charging station selected.

Figure 68 Types of charging stations

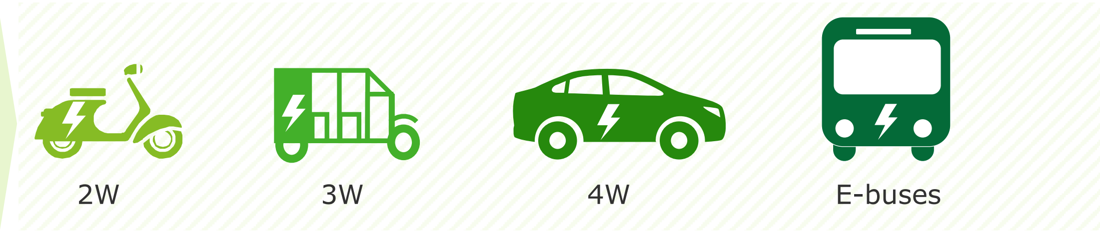


Source: 56 Deloitte analysis

2.3.3.1.2 Identification of target market

Target market for EV charging station relates to the category of vehicle the charging stations intends to cover. For instance, e-2w, e-3w be the possible target markets for slow charging stations. e-4W can be charged in both slow / fast charging stations depending upon the location. Identification of target market will help in ensuring highest possible utilization of the charging station and also helps in selection of the charger type (AC / DC).

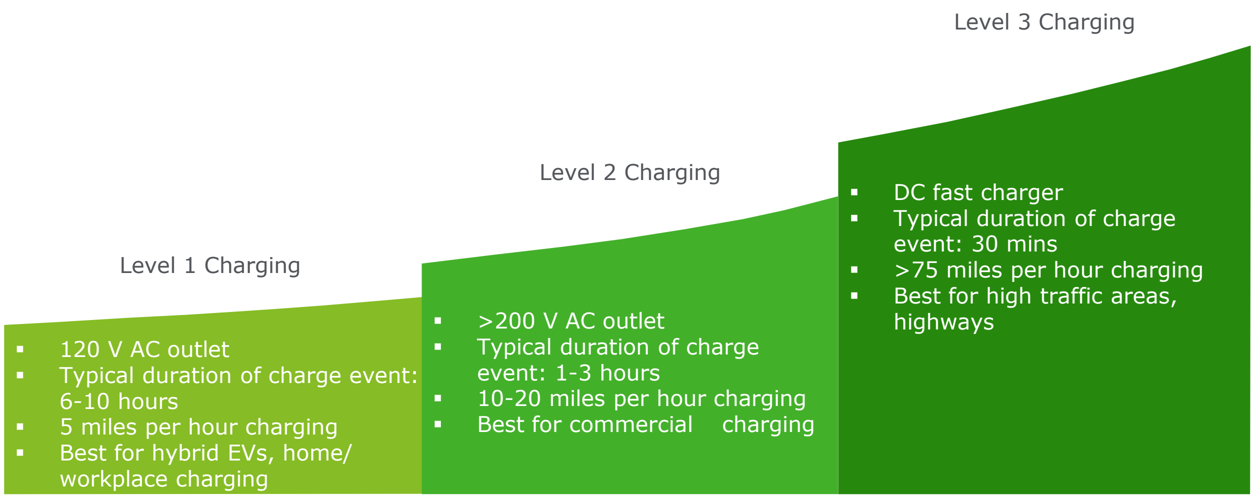
Potential vehicle segment(s) for EVSE operator to be picked as target market



2.3.3.1.3 Selection of EVSE charging

Once the charging station type and target market are identified, the next step is to select the suitable charging type/level for the station. EV charging is categorized into three categories: Level 1 charging, Level 2 charging, and Level 3 charging.

Figure 69 Levels of EV charging



Source: 57 Vehicle Charging – US Energy (access here), EVSE – Types of charging (access here), Understanding the Different EV Charging Levels (access here), Levels of Charging (access here), EV Charging Station Installation Guidebook (access here)

2.3.3.1.4 Determining cost economics

The cost economics of the charging station will include three components: capital expenditure, operational expenditure and the cost of power.

Capital expenditure	Operational expenditure	Cost of power
This will include cost of land, supply and erection of EVSE, CMS, meter, LED screens, CCTV camera etc.	This will include maintenance cost, and services cost such as payment gateway charges, parking charges, insurance premium etc.	This includes cost of power and other additional surcharges. Breakup includes: i. Demand charge;

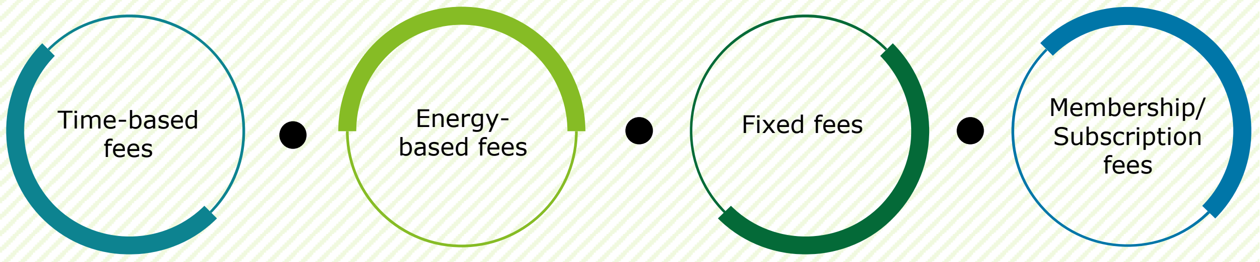
Capital expenditure	Operational expenditure	Cost of power
		ii. Energy charge; iii. Surcharges; iv. Electricity duty

Details about the capital expenditure, operational expenditure and cost of power (demand charge) can be estimated from the selected charging station type and charging methodology (levels).

2.3.3.1.5 Pricing mechanism

A suitable pricing mechanism allows the operator to recover its investment and also ensures realization of targeted IRR. The international experience suggests four key pricing mechanism that the EVSE operator can adopt.

Figure 70 Pricing mechanism options for EV charging



Source: 58 Deloitte analysis

In **time based fees**, EV owners are charged for the total time their vehicle is connected to the charge unit. Total energy consumed is not taken into consideration in time-based fees.

In the **energy-based fees**, EV owners are charged based on the total energy consumed during charging. This does not take time for charge into account.

In **Fixed fees,** EV owner is charged at a flat fee, irrespective of the time or energy consumed in charging.

In **Membership/ subscription fees,** EV owner is usually charged on monthly / annual basis and in return the EV owners can charge their vehicle at any of the operator's charging station.

Other than earning revenue from the charging service, the EVSE operators can earn non-energy revenue through advertisements as well.

2.3.3.1.6 Partnership model

Globally, there have been multiple established partnership based business models for public charging infrastructure. Some of these models are provided in the below figure:

Figure 71 EV charging station business models

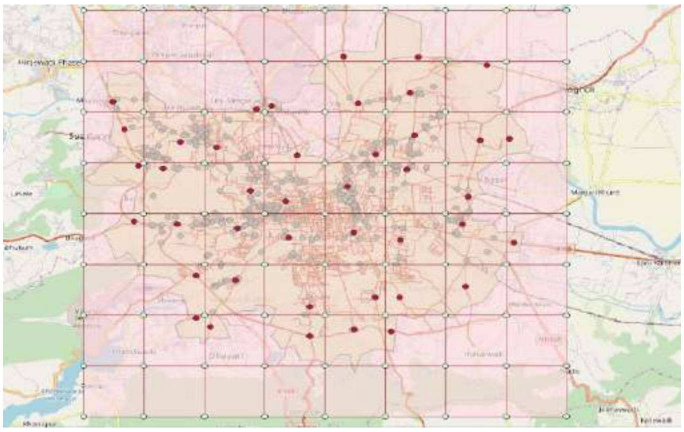
Source: 59 Deloitte analysis

Details about EV charging business model is provided in Section 4.2.2.1.

2.3.3.2 Location identification

Once all other information related to business model is determined, identification of location within the city is the next step for the EVSE operator.

Figure 72 3x3 Km grid for EV charging station (illustrative)



Ministry of Power, in its technical guidelines, has stated the requirement of at least one charging station in a grid of 3 Km x 3 Km along with one charging station at every 25 Km on both sides of highways and roads.

To identify the optimal siting, EVSE operator can evaluate several key locations such as city highways and other points of interest within the city (hospitals, malls, commercial complexes, offices, fuel stations, etc.). Further the operator can install its charging stations in such a way that it covers maximum points of interest. Figure 72 illustrates a 3km x 3km grid for a city. Each grid as highlighted is expected to have at-least one charging station. However, the optimal location within each grid needs to be evaluated through a multi-criteria decision matrix. The EVSE operator may refer below criteria for selecting location for charging infrastructure:

Network interface	Urban interface	Power interface
Whether the location witnesses adequate traffic and ensures convenience of charging	Whether the location has adequate demand and infrastructure enablers	Whether the location can sustain the EV load

To assess the criteria mentioned above, following factors can be considered to have data driven assessment of locations.

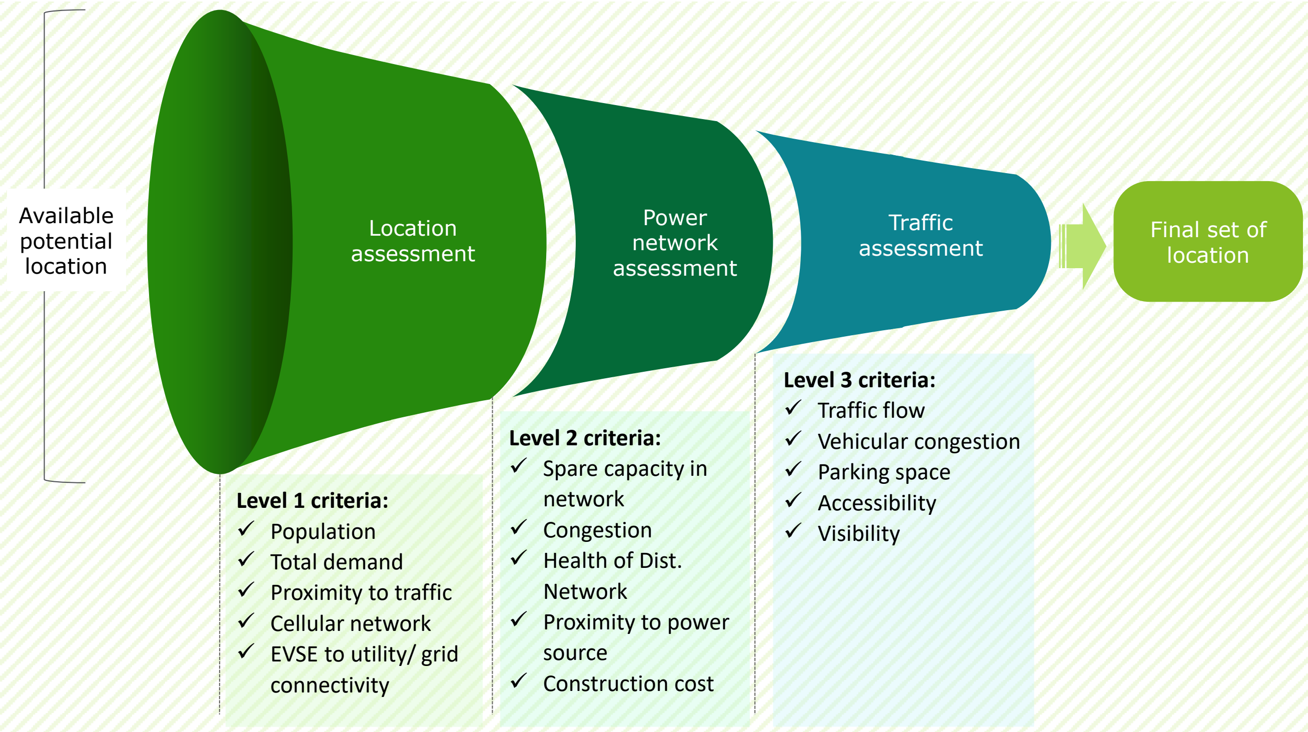
Table 11 Key factors to consider in multi-criteria decision making for selection of location for EV charging infrastructure

Parameters	Factors to consider
Location profile	Location, Topography, Demography, etc.
Type of transportation prevalent	Roadways, railways, airways etc.
Key statistics	Type of transport: 2 wheelers, 3 wheelers, 4 wheelers, Buses, Commercial vehicles, Personal vehicles Key attributes viz. • Spatial distribution of registered motor vehicles • Share of Different Modes of Transport in overall transportation sector (LCV, MCV etc.) • Average annual growth by category
Key areas	Ring roads, Commercial and industrial hubs, Expressways, Highways, Intra-city roads, Bus terminals
Forecasts for transportation sector	• Forecast for private and commercial vehicles • Forecast for freight transportation • Expected penetration of conventional vehicles and Electric vehicles in the future
Power infrastructure	• High level network overview with load growth forecasts • Overloaded / under-loaded areas • Optimal locations for solar power

Source: 60 Deloitte analysis

For selection of location, below is the shortlisting criteria for a detailed optimal location analysis for charging station within a specified grid in a city:

Figure 73 Shortlisting criteria for selection of location for EV charging station



Source: 61 Deloitte analysis

Locational enablers	Network enablers	Traffic enablers
▪ High demand and population ▪ Presence of C&I industry ▪ Availability of solar power ▪ Ease of monitoring of EVSE ▪ Robust network connectivity	▪ Spare capacity in DTs and feeders ▪ Optimal bus voltage ▪ Proximity to service transformers ▪ Space for electricity/ civil works	▪ Adequate flow of vehicles ▪ High daily run ▪ Adequate parking space ▪ Ease of access to EV users

Siting of EVSE should be such that the facility attracts enough traffic to be optimally utilized. Therefore, a site near office complexes, business hubs, commercial establishments, residential flats, etc. would make better business proposition.

i. **Adequate parking and lanes:** EVSE locations should have adequate parking space as well as entry / exit lanes for the vehicles and as such it becomes important to assess areas with similar provisions. Areas with huge traffic density would have lesser provision for the same but the charging demand at such locations would be high.

ii. **Traffic flow:** The number of electric vehicles now and in the future will be great where the traffic flow is large, so the same as charging demand and the benefit of EVCSs.

iii. **Distance from city centre:** While rental fees would be lesser in the city outskirts than the interiors, those are not suitable locations for ensuring maximum utilization of EVSE. User charges will be guided by rental and level of utilization of charging stations.

Choice for appropriate siting of an EV charging station is also dependent on whether the location has sufficient electrical grid capacity to absorb the EV load growth at present and in future. To ascertain the same, a detailed framework is adopted by the developer for distribution network load flow analysis. The aim of the network assessment is to determine:-

i. Location and spare capacities in distribution network
ii. EV penetration manageable in existing network
iii. Appropriate mix of slow and fast chargers
iv. Time of the day where EV charging can be curtailed/ throttled

2.3.3.2.1 Obtaining land for installation of charging infrastructure

Upon identification of suitable location for installation of charging infrastructure, the land is acquired or leased depending upon the respective state guidelines. Typical process for acquisition of land and the degree of difficulty in seeking administrative approval is provided in Table 12.

Table 12 Typical process for acquisition of land

Case	Type of land	Typical process	Degree of difficulty in securing Administrative approval
Private developer creating Charging infrastructure for Government bodies	Government	1. Government Body makes request to District Collector (DC) for transfer of land 2. If the land is not earmarked for any future development under the town and country planning Act, the DC initiate the process of transfer/lease of land with approval of State Government	Difficult
	Private	1. Government Body makes request to District Collector (DC) for acquisition of land 2. DC initiate the process as per the State Land Acquisition Act. 3. DC determines the compensation to be paid to the owner of such land	Very Difficult
Private developer creating Charging infrastructure for entity other than government body	Government	1. Developer makes request to District Collector (DC) for transfer/lease of land 2. If the land is not earmarked for any future development under the town and country planning act, the DC determines the fair value of land 3. Initiates the process of transfer/lease of land with approval of State Government 4. Developer needs to apply for changes in Land record in the office of Land and Revenue	Very Difficult
	Private	1. Developer and the owner of land either carry out a sale or lease transaction	Easy

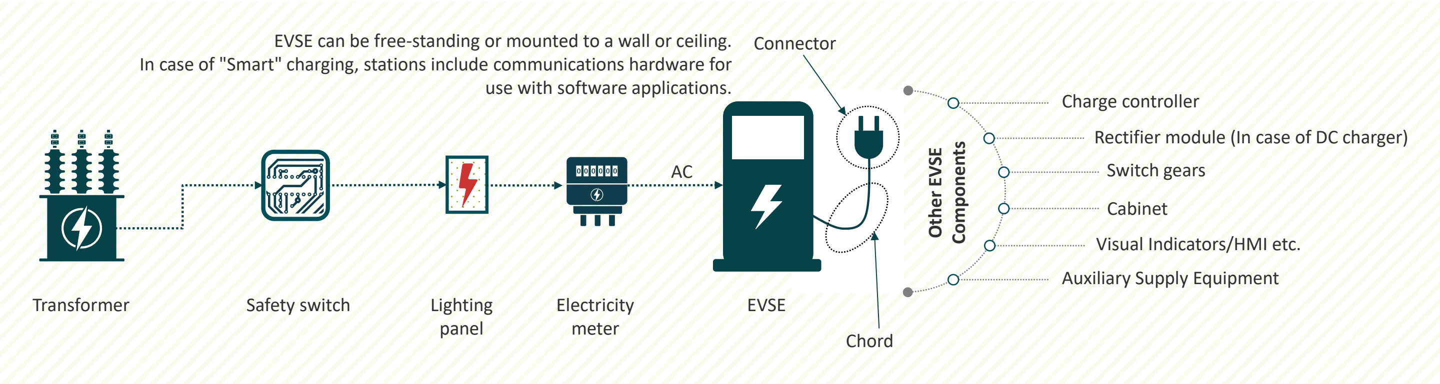
Source: 62 Deloitte analysis

In addition, there are additional administrative approvals required, if the identified land is an "Agricultural Land". In such situation, approval for change of land use needs to be taken before using such land for purpose other than agriculture.

2.3.3.3 Civil works and equipment selection

Selection of equipment is critical in setting-up of EV charging station. Figure provided below depicts the typical hardware infrastructure required to setup an EV charging station.

Figure 74 Hardware required to setup EV charging infrastructure



Source: 63 Siemens - Electric vehicles (EV) charging (access here), EVConnect - EV Charging 101 (access here), Deloitte analysis

Requirements for selection of right equipment has been detailed in sections below.

2.3.3.3.1 Government mandate

Equipment selection for the charging station must be in line with the government guidelines. For public EV charging stations, Ministry of Power (MoP) notified its guidelines on October 2019. Key requirements mentioned therein are summarized below:

- The charging station should have an **exclusive transformer** with all related substation equipment including safety appliance
- The charging station should include **33/11 kV lines/cables** and associated equipment including line termination etc.
- The charging station must have appropriate **cabling and electrical work** ensuring safety
- The charging station must have **adequate space for charging** and entry/ exit of vehicles
- The charging station should have any of the chargers shown below:

Figure 75 Approved EV chargers for public charging in India

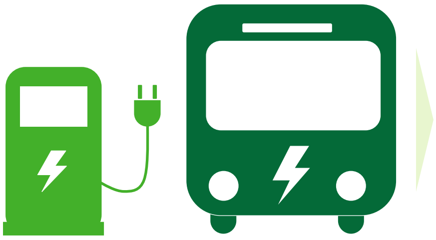
Bharat AC 001	Bharat DC 001	Type-2 charger	CHAdeMo charger	CCS charger
Power output: 10 kW Rated voltage: 230 V	Power output: 15 kW Rated voltage: >48 V	Power output: >22 kW Rated voltage: 380-415 V	Power output: >50 kW Rated voltage: 200-500 V	Power output: >50 kW Rated voltage: 200-750 V

Source: 64 MoP Charging Infrastructure for Electric Vehicles Revised Guidelines Standards (access here)

Note: 2W and 2W charging stations are free to use any charger other than those provided above. However, they must be in line with CEA's technical and safety standard

- The charging station must tie up with at **least one online Network Service Provider (NSP)** to enable advance remote/ online booking of charging slots.

- EVSE shall be **type tested** by a third party lab accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL)



For long range EV charging station, at **least two chargers** of minimum 100 kW power output of **different specification** (CCS/CHAdeMo etc.) with **single connector gun** each should be installed

2.3.3.3.2 Other selection requirements

Beyond the government mandates, there are several other factors that influence selection of an EVSE. There are multiple requirements that are required to be fulfilled by the EVSE operator while selecting the equipment. Some of the key such requirements are provided in the below figure.

Figure 76 Key requirements for selection of equipment

1	Environmental requirement	**2**	Mechanical requirement	**3**	Protection requirement
4	Specific requirement	**5**	Functional requirement	**6**	Communication requirement
7	Billing and payment requirement	**8**	Performance requirements	**9**	Marking and painting requirements
10	Cable requirement				

Environmental requirement

This includes the operational range of the EVSE in environmental conditions such as temperature, humidity, pressure, storage temperature etc.

Below are the environmental requirements stated in per AIS 138 Part I:

- Ambient Temperature Range: 0°C to 55°C (section 11.11.1.2)
- Ambient Humidity: 5% to 95% (Section 11.2)
- Ambient Pressure: 86kpa to 106kpa (Section 11.11.2.4)
- Storage Temperature: 0°C to 60°C

Mechanical requirement

The mechanical requirement of an EVSE tests the system for mechanical impact, ingress protection, mechanical stability and cooling function.

Below are some of the standards/ values accepted while procurement of a DC 001 charger:

- Ingress Protection: The minimum IP degrees for ingress of objects is IP 54
- Mechanical Impact: As per IEC 61851 -1 Section 11 .11 .2
- Mechanical Stability: As per section 11 .11 .2.2. of AIS 138 Part

- Cooling: Air cooled or forced cool for protection and safety of equipment from any fire hazards

Protection requirement

The protection requirement ensures the EVSE is equipped to sustain an electric shock, and provide Protection for Over current, under voltage, over voltage, Residual current, Surge protection, Short circuit, Earth fault at input and output, Input phase reversal, Over temperature and Emergency shut-down with alarm.

AIS 138 Part I specifies the standard for protection against electric shock and earthing:

- Protection against electric shock – Section 7.0
- Effective earth continuity between the enclosure and the external protective circuit - Section 6.4.1.2

Cable – As per AIS 138 Part ½; length of cord will be 5 meter; cord extension as per Section 6.3.1 of AIS 138 Part 1

Specific requirements

Specific requirement related to EVSE includes output power, charging current, load dump etc. These requirements are in accordance with IEC 61851 standard:

- Rated outputs and maximum output power: IEC 61851- 23 (Section 101.2.1.1)
- Descending rate of charging current: IEC 61851-23 (Section 1 01.2.1.4)
- Load dump: IEC61851-23 (Annex BB 3.8.3)

Functional requirements

The function requirement of EVSE equipment deals with its current and voltage level. The guidance for the same is provided in AIS 138-2 standard.

- Measuring current and voltage: AIS 138-2 (Annexure C3.1)
    - Voltage measurement: ± 0,5%
    - Current measurement: ±1 A if the actual current is less than or equal to (~) 50 A

Communication requirements

Appropriate communication system in an EVSE system is highly essential. The EVSE should have feature to remotely connect with a Central Management System (CMS) which will have the authorization to approve or modify any activity in the EVSE.

- Communication between EV and EV charging station should be through a physical layer of CAN (Controller Area Network) bus. CAN bus should comply with the requirement of ISO 11898 -2:2003

  AIS 138-2 provides details about the system definition for communication between DC EV charging station and electric vehicle

- For EVSE to Central Management System (CMS) communication, the general requirement is through Ethernet/Wi-Fi/2G/3G/4G technologies. Also, the CMS system must use Open Charge Point Protocol (OCPP).

  CMS must have the authorization for allowing/ disallowing charging of an electric vehicle through.

- Reliable Internet connectivity is another requirement of the EVSE system

- Metering is another requirement of EVSE. A grid responsive metering as per units consumption of the vehicle must be in place with the EVSE. The central system should be able to access the metering information from any remote location.

Billing and payment requirement

For billing and payments in the charging station:

- Billing should be done through a grid responsive meter which is in line with Indian metering standard, and
- Payments should be compliant with authorized mobile payment platforms (BHIM, Bharat QR, UPI etc.)

User interface and display requirements

The user interface and display of an EVSE system should have:

- ON/OFF (Start-Stop) Switches
- Emergency stop switch
- Visual Indicators
- Display
- Support language
- Display Messages
- User Authentication
- End of Charging

Performance requirements

The performance requirement of EVSE can assessed on the basis of output voltage and current. The approved value of the performance parameters is defined in AIS 138 standards. Below are some of such requirements:

DC output and current tolerance requirement:

- DC Output current regulation in Constant Current Charging (CCC): ± 2.5 A for the requirement below 50 A, and ± 5 % of the required value for 50A or more
- DC Output voltage regulation in Constant Voltage Charging (CVC): Max. 2 % for the max rated voltage of the EVSE

Control delay of charging current in CCC requirement:

- DC output current Demand Response Time: <1 s Ramp up rate: 20 A/s or more
- Ramp Down rate: 100 A/s or more

DC output current ripple limit of EVSE

- 1 .5 A below 10 Hz,
- 6 A below 5 kHz,
- 9A below 150 kHz

Periodic and random deviation (Voltage ripple)

- Max. Ripple voltage: ±5 V.
- Max slew rate: ±20 V/ms

Marking and painting requirements

Guidelines for markings on the EVSE is provided in AIS 138 standard. Some of the mandated markings given in AIS 138 standard are:

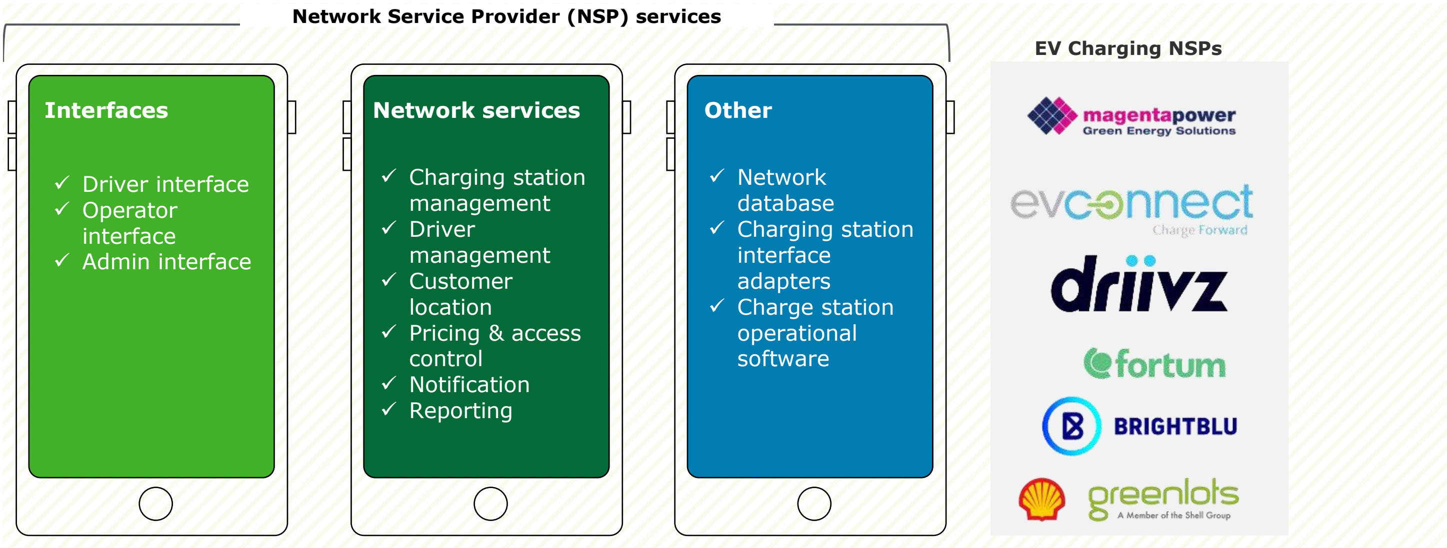
- Name or initials of manufacturer
- Equipment reference
- Serial number
- Date of manufacture; rated voltage in V; rated frequency in Hz; rated
- Current in A; number of phases;
- IP degrees

2.3.3.3.3 IT infrastructure for EV charging station

Suitable backend IT infrastructure is highly crucial for seamless operation of EV charging station. A Network Service Provider (NSP) is the responsible entity for managing and operating network related services for charging stations. Such an entity enables cloud based access of information regarding EV charging, location of charger, types and numbers of chargers and other details.

Overview of services provided by NSP is given below:

Figure 77 Services offered by NSPs and key players



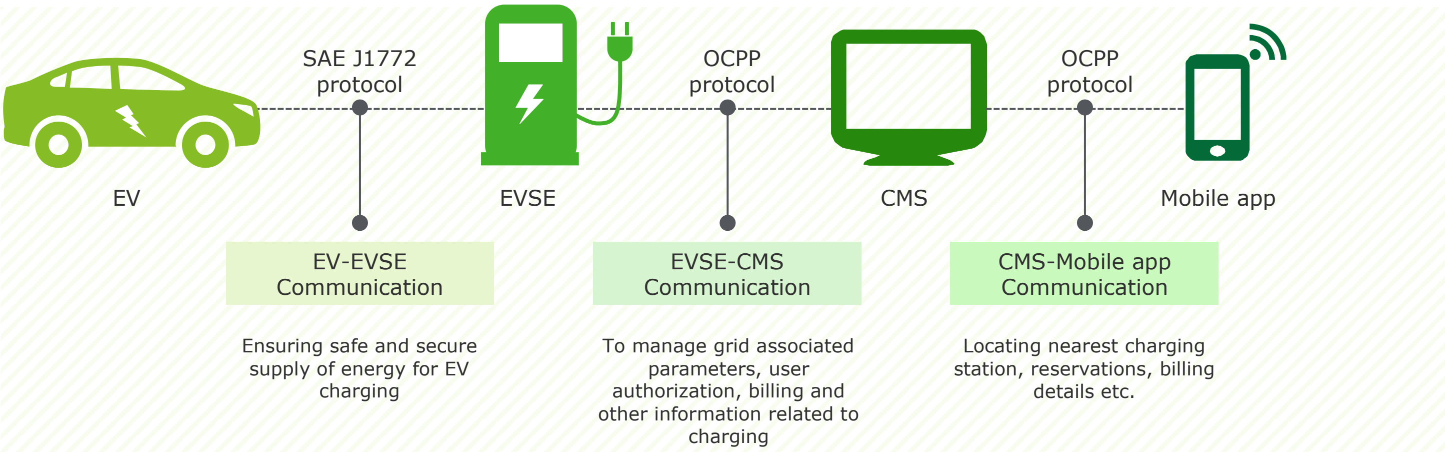
Source: 65 EVConnect - EV Charging 101 (access here), Deloitte analysis

Govt. of India has mandated Charging station operators to tie up with at least one online Network Service Provider (NSP).

Other than EV and EVSE, there are two other vital components that remotely access the information at charging station viz. CMS (Central Management System) and mobile apps. CMS is a cloud based backend system managed by the EVSE operator. It communicates with EVSE to manage user authorization, billing and rate of charging. The CMS also enables end-users to find nearest charging stations, reserves a charging slot and pay. Mobile applications are utilized for remotely accessing information about nearest charging station, its availability, operating status, etc.

Figure 78 illustrates the communication infrastructure in a typical EV charging process.

Figure 78 EV charging communication infrastructure



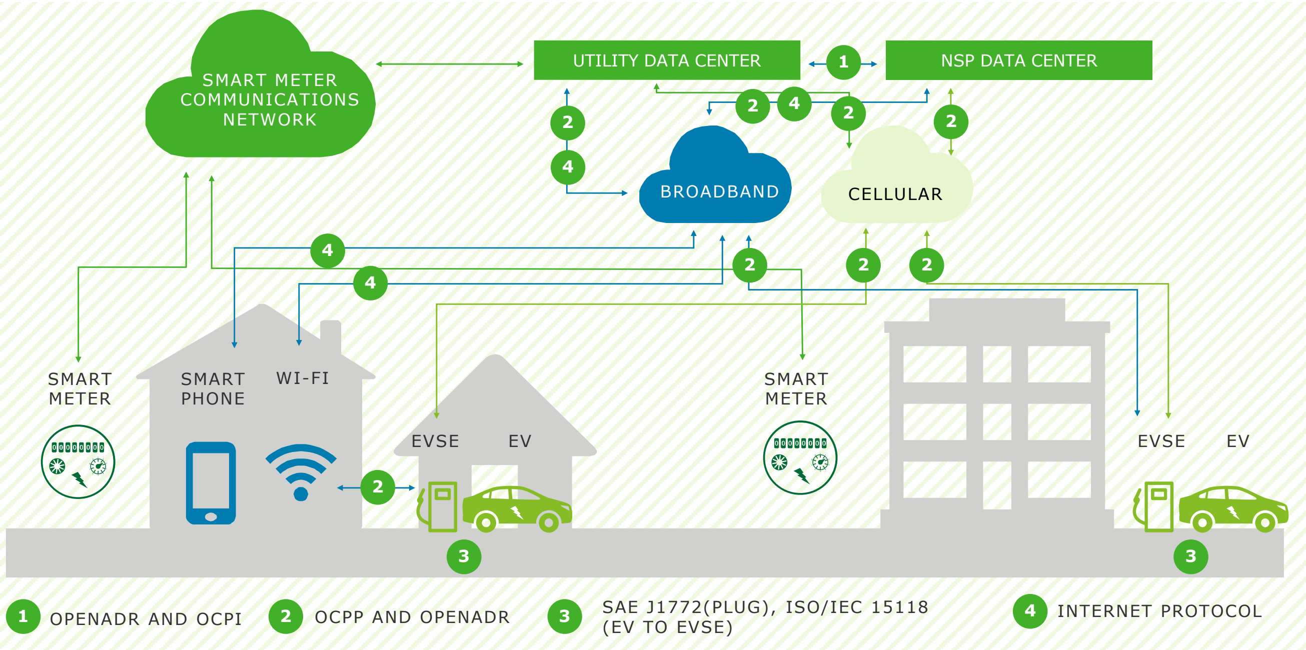
Source: 66 DHI - Committee Report on Standardization of Public EV Chargers

There is a need for communication between the vehicle, EVSE, CMS and user mobile app in order to efficiently operate the charging process. The EVSE communicates with the Battery Management System (BMS) of battery packs in EV, to enable it to charge at right rate, for maintaining State-of-Charge (SOC) of batteries. EVSE and Central Management System (CMS) communicates in order to enable maximum charging rate to be controlled depending upon the grid parameters.

EV public charging uses OCPP protocol remotely to communicate the EVSE status with the mobile app user

In case of managed charging, the utility *has remote access to connect/disconnect EV or alter the charging speed based on network parameters and conditions.* International experience suggest that there are multiple protocols that could be followed during managed charging.

Figure 79 Communication protocol for managed charging (Illustrative)



As shown in Figure 79, there are multiple messaging protocols layered between the EV, the EVSE, NSP and the utility, which can be leveraged for different purposes. Presently, there are no industry-wide standards for the entire "ecosystem" for information exchange and communication. Many industry stakeholders are advocating for open, non-proprietary communications messaging protocols to reduce the cost of managed-charging implementation.

Details about the standards presently used for communication is provided in Table 13:

Table 13 International communication standards and their description

Standard	Description
OSCP 1.0 **OCPP 1.5** **OCPP 1.6** **OCPP 2.0**	The Open Smart Charging Protocol (OSCP)and the Open Charge Point Protocol (OCPP) were developed by the members of the Open Charge Alliance (OCA). These are open protocols for communication between charging points and the EV charging network administrator. These protocols provide charging station owner an option of changing EV charging network administrator without stranding equipment assets. The OSCP acts between the charging station and the energy management system, can provide 24-hour prediction for local available capacity, and fits charging profiles to grid capacity. OCPP 1.6 includes smart charging support for load balancing. The most recent version, OCPP 2.0, includes support for ISO/IEC 15118 (among other things). Although not yet formalized as a standard and managed by a

Standard	Description
	recognized Standards Developing Organization (SDO), there is significant adoption of the OCPP protocol and efforts are underway to develop it into a full standard within the IEC.
OpenADR 2.0	The Open Automated Demand Response (OpenADR 2.0b is the most updated version) standard is currently managed by the OpenADR Alliance. It provides an open and standardized way for Virtual Top Nodes (e.g., electricity providers and system operators) to communicate with various Virtual End Nodes (e.g., aggregators, EV charging network operators, etc.) using a common language over any existing IP-based communications network. Originally developed as a peak load management tool, it has since expanded to include other DERs. Messaging protocols such as OpenADR can also be used in combination with other protocols, such as those used to communicate between a charging station and a network operator (e.g., OCPP76, IEEE 2030.5, etc.).
ISO/IEC 15118	ISO/IEC 15118 (also referred to as "OpenV2G"), enables the managed charging functionality in an EV, such as optimized load management. More specifically, it specifies the communication between the EV and the EVSE and supports, EV authentication and authorization (also known as "Plug and Charge"), and metering and pricing messages. Version 2 that will include V2G is currently under review, anticipated to come by end of 2020.
IEEE 2030.5/ SEP2.0	IEEE 2030.5 (formerly Smart Energy Profile 2.0 or SEP2.0), is an application layer protocol that defines messages between any client/server. Pricing, demand response, and energy use are among the types of information that can be exchanged using the protocol and can integrate a wide variety of DER devices, including EVs and EVSE.
IEC 63110	IEC 63110 is an international standard defining a protocol for the management of EV charging and discharging infrastructures. It is part of an IEC group of standards for electric road vehicles and electric industrial trucks and is assigned to the Joint Working Group 11 of the IEC Technical Committee 69. At the date of publication it was still under development

Other than protocols mentioned above, there are several proprietary protocols that can be used in communications. These protocols are:

- **GPS tagging:** Vehicles can be managed through an on-board diagnostic interface (OBD2) which has built-in capabilities, like GPS location software, which can be managed according to the local grid circuit.

- **Programming capabilities:** EVs can also have the ability to program their charging window that would enable the user to align charging with TOU or other EV rates. In addition to this, such vehicles also have the capabilities to receive price, emissions, or grid stress signals from utility or aggregator directly, so that the EV's charging program could intelligently align its charging schedule optimally.

A case study on offerings provided by Network service Provider highlighting the range of solutions provided is presented below in Box – 9.

Box 9: EV Connect – Overview of offering provided by NSP in New York

Background: EV Connect, a leading provider of EV charging solutions, was awarded a $4 million contract from the New York Power Authority (NYPA) to install and manage approximately 300 additional Level 2 EV charging stations throughout New York State. EV Connect provided management of the charging ecosystem, which includes the charging stations, host locations, electric utility interaction and the driver experience.

For the program, EV Connect partnered with GE and EV Box to provide the charging stations, and local contractors for installation work. EV Connect was also entrusted with activities such as initial site assessment, to recommending the right charging stations to fit the need, installation, on-boarding/training utility administrators and configuring admin portal with utility preferences. EV connect also provides on-going care and management 24/7.

Overview of the EV cloud platform: The EV Connect management system is consisted of a cloud-based network that communicates with the charging station, driver mobile app, site host portal, and utility. Communication from the EV Cloud to the stations is either via OCPP or a cloud-to-cloud integration. The platform can manage an unlimited number of geographically dispersed charging stations and provides the following features:

a) **Charge point management and operation:** The platform can manage chargers and sessions remotely, letting the user to monitor and adapt charging sessions based on up-to-date analytics. Chargers can be connected via an M2M connection to the Microsoft Azure cloud-based platform, which supports open protocols such as OCPP, OCPI and OSCP. Utility can also input remote commands including start/stop charging, unplug connector, remote firmware updates or change charger configuration and access a live KPI dashboard.

b) **Smart charging:** Smart Charging through the EV cloud uses algorithms to manage EV charging sessions. Thus the utility can smartly balance between the supply of power and available grid capacity and the demand for energy for charging the cars.

c) **Price control:** Set pricing policies unique to different stations, station groups, locations, and drivers. Some of the pricing policies include: charging per kWh, per connected time, per charging time, etc.

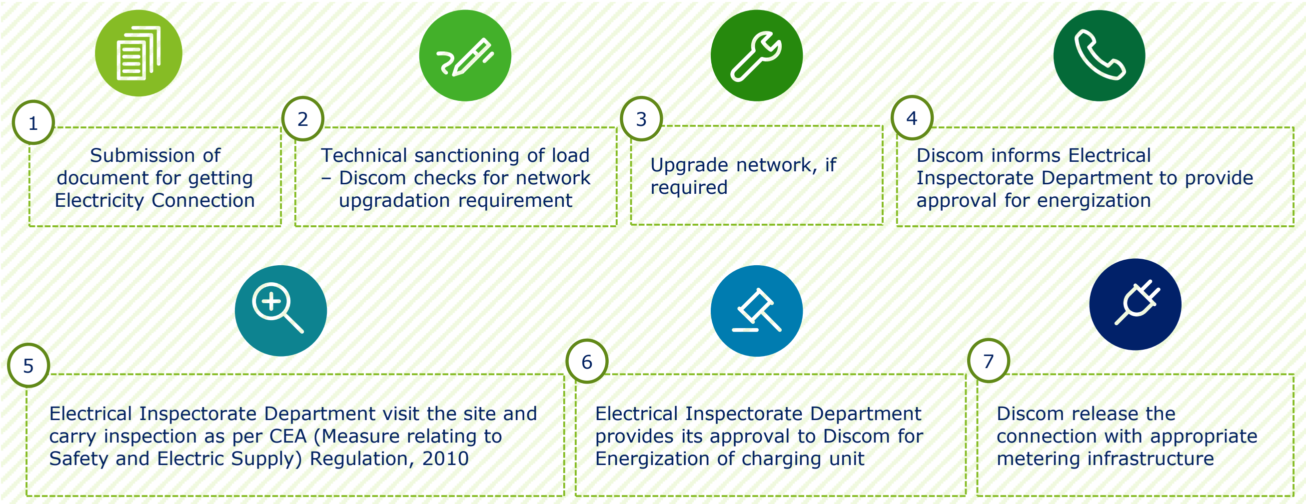
d) **EV-driver app and interactive map:** The EV connect can helps drivers find and monitor the perfect charge point; charge and pay with your app; see exactly how fast, how much and at which rate the car is charging etc. The platform also provides users information of health of charging stations, geographical locations and real-time availability

e) **Insights and Reporting:** The dashboard gives detailed insights on historical charging station data analytics, session data, energy usage, utilization by station or driver, and more.

2.3.3.4 Obtaining power connectivity and inspection

Process for obtaining electricity connection for charging station can vary as per state. However, an indicative process for obtaining connectivity is illustrated below:

Figure 80 Process for obtaining electricity connection for EV charging station



Source: 67 Deloitte analysis

As per inputs received from industry, average duration for receiving connectivity for charging station varies from 30 to 45 days that may further be extended in case network upgrade is required

As per policy mandates, before the commercial operation, the charging station will undergo an inspection by the appropriate authority. The authority evaluates the charging station on various parameters as per concerned guidelines laid down by CEA or as per International Standards. Some of these parameters are mentioned below:

Protection	Harmonic Current	DC Injection	Voltage Sag, Voltage Swell, Flicker, Disruptions, etc.	Overload
Lightning Protection	Protective device	Disconnection of EV from the supply	Locking of the coupler	Protection against overvoltage at the battery

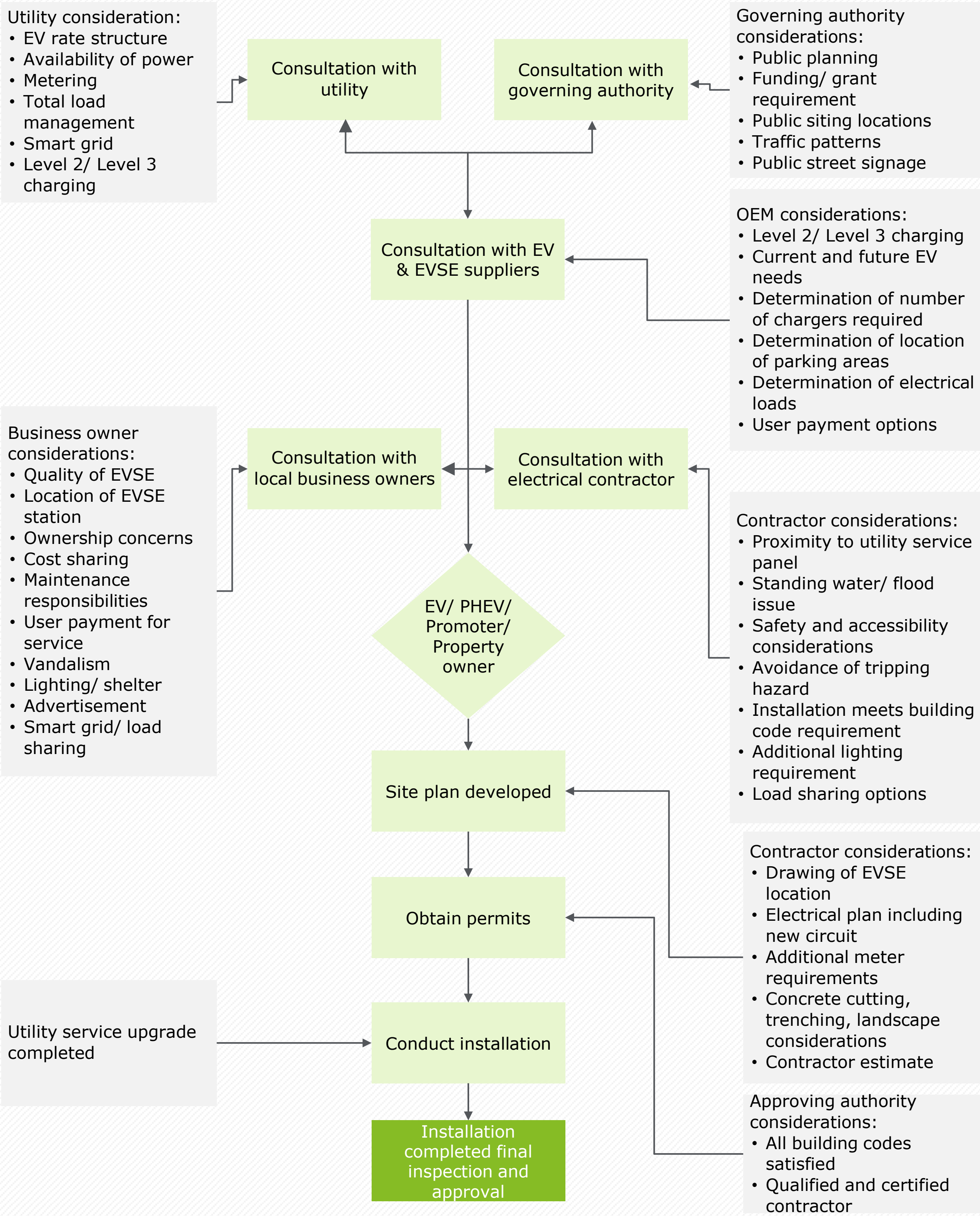
Note: Checklist for complete inspection of EV charging station is provided in Annexure 6.2

Once the inspection by the Discom official / Electrical Inspector is done, the charging station is made available for commercial use.

Box 10: International experience on process of installation of public charging station

The City of Houston laid down guidelines for setting up of EV charging infrastructure in the Great Huston Area. The guidelines were laid for all type of charging viz. home charging, outdoor charging, and public charging. Process flow chart of installing a public charging is provided below:

Figure 81 Process flow chart of installation of a public charging station in Greater Houston Area

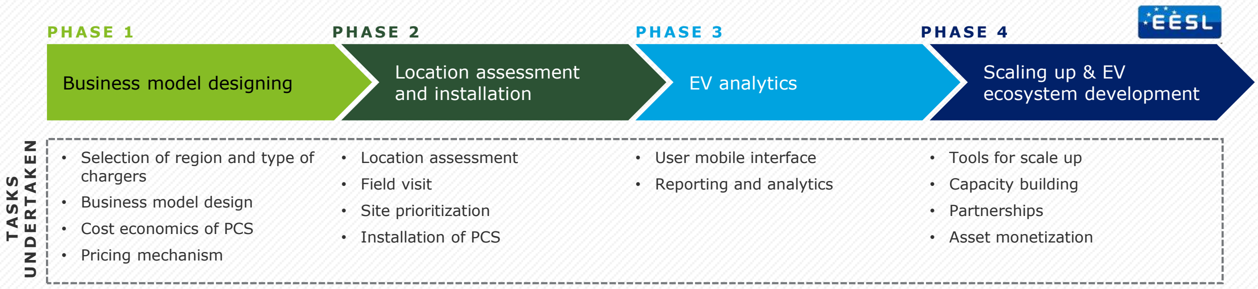


Source: 68 Recommended Electric Vehicle Charging Infrastructure Deployment Guidelines for the Greater Houston Area (access here)

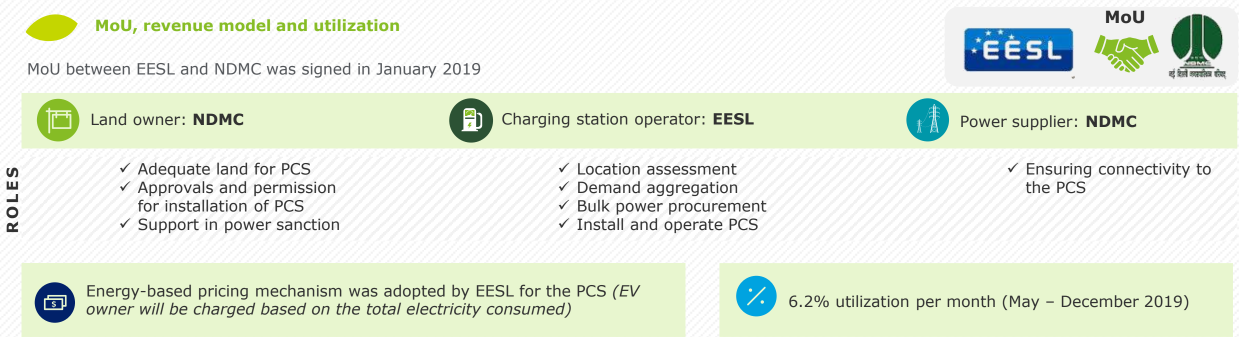
Box 11: India's experience on setting up of a public EV charging infrastructure

Background: The United States Agency for International Development (USAID), under its bilateral program with the Ministry of Power (MOP), was assisting EESL to develop and implement a scalable business model for deployment of Public Charging Station (PCS). EESL, in partnership with the USAID's Program, designed and implemented a first-of-its-kind large-scale roll-out of PCS project.

To setup the large scale PCS project, EESL identified activities under four phases:



Location for the setup of large scale EV charging infra, EESL signed MoU with NDMC in January 2019 to install up to 100 PCS in their region. NDMC was the land owner as well as the power supplier.



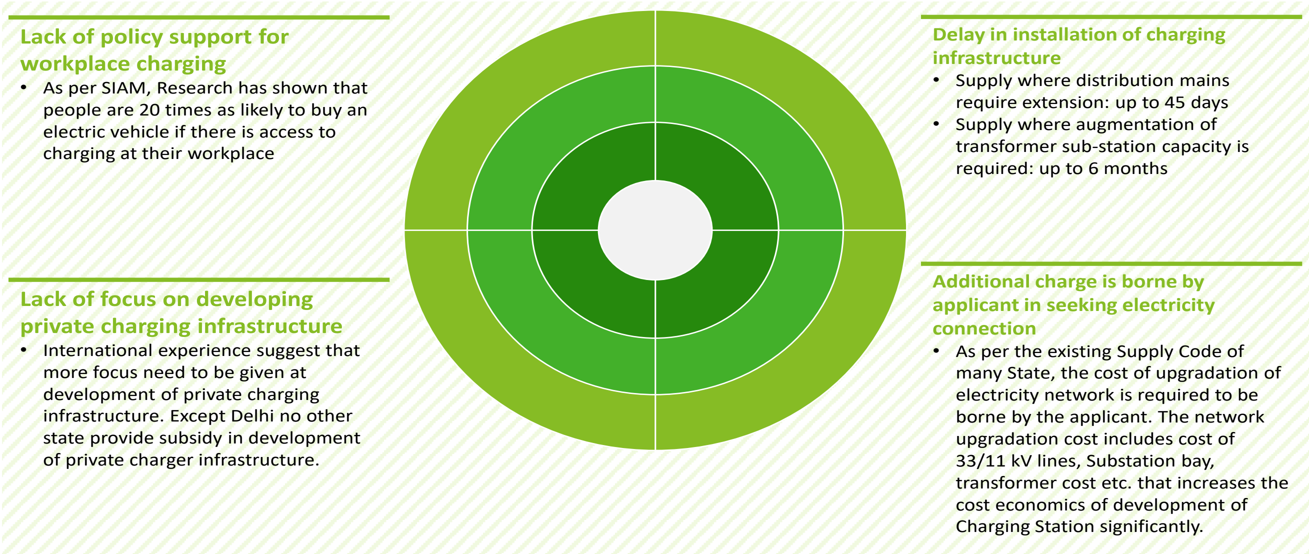
The PCS was operational from May 2019, and its average monthly utilization till December 2019 was 6.2%

Source: 69 Practitioner's Guide for Deployment of Public Charging Stations for Electric Vehicles- Learnings from first large-scale roll-out of public charging stations by EESL

2.3.3.4.1 Challenges

The key challenges in development of EV charging infrastructure are provided in Figure 82. For details, please refer information provided in the Annexure 6.2.

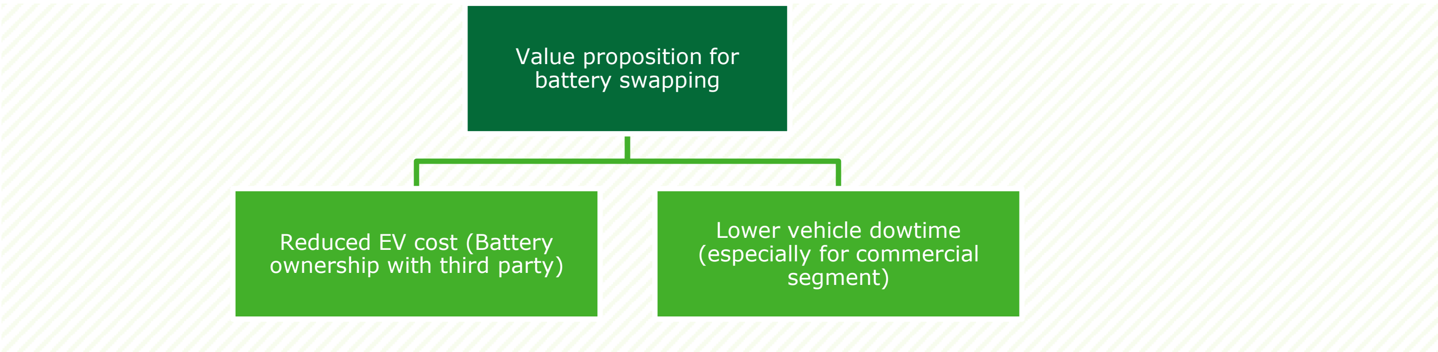
Figure 82 Gaps in existing EV charging infrastructure



2.3.4 Battery swapping – market landscape

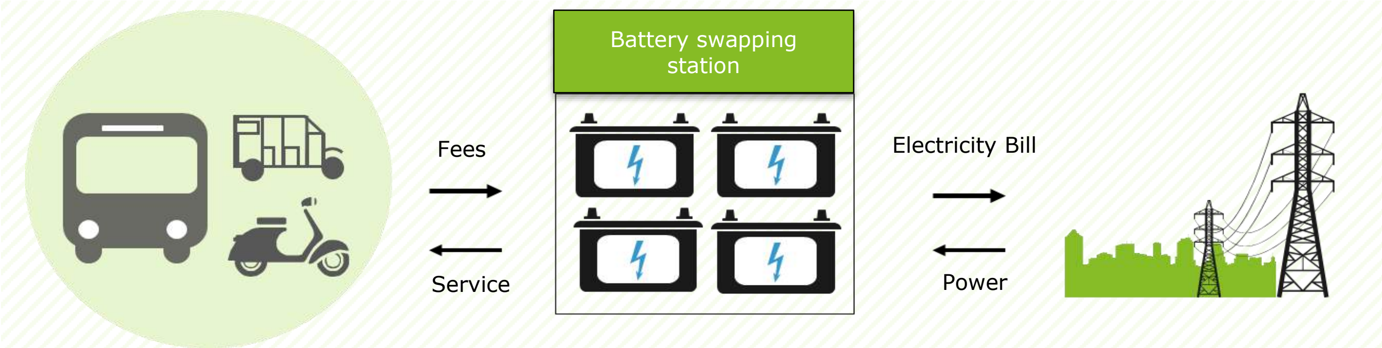
Battery constitutes approximately 40% of the upfront cost of an EV. The high upfront cost of EV is a key barrier to its widespread adoption. Removing the battery from the vehicle and providing the same through a service can lower the cost of an EV and offer a better value proposition to users. Such a model can ensure that upfront prices of EVs are at par or even lower than the ICE vehicles. Battery swapping provides such a method of decoupling of batteries from EVs and reducing their upfront costs. It also ensures reduced waiting / charging time for vehicles and offers a promising alternative to increase the adoption of EVs in commercial segment.

Figure 83 Value promosition for battery swapping



In battery swapping, a third party takes the ownership of the battery and is liable for replacing the drained batteries with fresh / charged batteries. The third party also needs to ensure standardization in batteries. Battery Swapping Stations act as a battery aggregator and charge batteries by availing electricity connection from either power distribution companies or through open access.

Figure 84 Typical arrangement at Battery swapping station (BSS)



Battery swapping provides multiple advantages to all stakeholders in the value chain:

Table 14 Advantages of battery swapping stations to the stakeholders

EV Owner	BSS operator	Discoms
• Reduced cost of ownership • Fast refuelling – reduced downtime/ charge time • Reduced range anxiety (in presence of wide network of BSS) • Relieving the concern of battery lifetime	• Reduced cost of real estate (no need for large parking space) • Can minimize electricity cost (in ToU scenario) • Can have other revenue stream by participating in electricity market	• Planned development of infrastructure • BSS can be treated as flexible load • Increased predictability of load, which otherwise would be difficult to have in high EV penetration scenario

3W (predominantly e-rickshaw and some share of e-auto) is by far the largest adopter of EVs in India at the moment. In a typical charging cycle these commercial vehicle faces downtime of 3-4 hours that have significant impact on their earning potential.

To overcome such challenge, battery swapping is emerging as promising business model for this segment of vehicles with many companies entering into this arena (Sun Mobility, Lithion, E-Chargeup Solution, ACME, Amara Raja, Panasonic etc.)

Figure 85 Private players in battery swapping space

SUNMOBILITY	Buses, 2W and 3W (IOT enabled keychain to access the dock to place the drained battery, pay for energy consumed and pick up a charged battery)	Lithion Lithium-ion battery recycling	2W and 3W (Swapping takes less than 5 mins.)
charge-up	3W (e-rickshaw) (Provides IoT enabled solutions for battery swapping)	Panasonic	2W and 3W (Conducting pilot programmes on battery swaps in Delhi NCR)

OLA	2W and 3W (e-rickshaw) (Having operational battery swapping station in Delhi and NCR)	AMARA RAJA Gotta be a better way	3W (e-auto) (Established battery swapping stations for fleet of e- Autos in Tirupati city)
ACME	4W (Launched EcoCharge station as India's 1st Battery Swapping and Charging Station for Ola Electric in Nagpur)		

Even with significant benefits offered by battery swapping to the associated players, this model is still at a nascent stage in India. Key factors hindering the adoption of battery swapping are provided below:

Figure 86 Reasons for low adoption of battery swapping in India

Reasons for lack of adoption of battery swapping by the industry

1. **Standardization** is the biggest bottleneck in the large-scale adoption of battery swapping in India. Without standardization of EV batteries, the battery swapping business model cannot be a success.
2. There is risk of **brand reputation** for the OEMs from battery swapping. OEMs have concerns that any fire or other fatal accident caused as a result of plugging in faulty/ sub-standard battery with their vehicle, may severely tarnish their brand reputation.
3. **Proprietary technology** of battery is a strong selling proposition for any OEMs. As standardization would mean sharing the same battery characteristics as their competitor leading to losing value in their product.

Reduction in upfront cost of EV is an important advantage of battery swapping. However, OEMs such as Renault have come–up with battery leasing option to their customers which reduces the high upfront cost of the EV for the customer, and also at the same time ensures use of verified batteries in their vehicles.

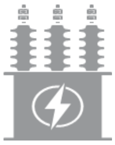
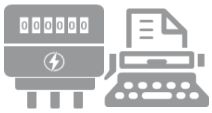
2.4 Distribution utility – market landscape

2.4.1 Role of Distribution utility in EV marketplace

A well-developed and robust charging network is vital for increased offtake of EVs and vice-versa. Development of charging infrastructure and increased adoption rate of electric vehicles is a classic case of chicken-egg problem. Discom could play a vital role in providing a solution to this problem. Discoms are aptly placed in the EV ecosystem to catalyse the development of charging infrastructure by leveraging its business synergies and technical capabilities. Following excerpts highlight the unique positions that discoms possess in in development of charging infrastructure:

Grid infrastructure

Discoms have existing grid infrastructure that could be suitably augmented to cater to EV charging load. Further, discoms have the visibility of optimal locations which can absorb the EV charging load and can help stakeholders in determining such optimal locations.

 **Distribution transformer loading**	Discoms have better visibility of the DT loading and line capacities that could be utilized in optimal siting analysis. Zones could be earmarked for near-term, medium-term and long-term suitability for charging infra development, matching with the Discom's DT/ grid augmentation plan. This would provide visibility to the charging infra developer of the adequacy of network infrastructure before investing in development of charging infra at a particular location/zone.
 **Metering and Billing system**	Discoms have existing well-established system of metering, billing and collection system. This includes smart metering infrastructure, billing software etc., which could be leveraged for invoicing energy usage by EV owner/Charging Point Operator/ Commercial Institution.
 **Access to suitable locations**	State owned Discoms have access to land allotted to them by State Government, for existing as well as future development of grid sub-stations. Discoms can use such land for development of charging infrastructure, in case, they don't have any near to medium term plan for utilizing it for other purposes. Further, being a government owned entity, it is expected that discoms can acquire suitable land with minimum administrative hurdles.
 **Technical expertise**	Technical expertise of discoms puts them in an unmatched position for developing charging infrastructure. CEA Regulations mandates Discoms to have Safety Officers that could play an important role of inspection and safety audit in development of charging infrastructure.

Distribution Utilities worldwide have played an active role in laying out and scaling up charging infrastructure installations. The roles and responsibilities range from coming out with a prioritized set of locations for setting up charging infrastructure within their respective license areas, offer new tariffs and incentives as a part of demand response (DR) program for the EV users, extend distribution operations and integrate EVSE operations through advanced telemetry and communication protocols, etc. Involvement of utilities can range from being a mere network infrastructure provider to the EV charging stations to providing the full depth of consumer services starting from network development, owning and operating the stations, and rolling out DR programs. For instance,

- Discom could invest in "**make-ready**" infrastructure, which include the electrical infrastructure required up to, but not including, the actual EV charging equipment.
- Discom could **Build, Own and Operate** installations, which would include the make-ready components as well as the charging equipment itself, resulting in a single regulated entity building out and owning the electric infrastructure and vehicle charging equipment.
- Discom could leverage their technical capabilities in **inspection and auditing** of charging infrastructure.

2.4.2 Discom role in providing "make-ready" infrastructure

Utilities are adopting a range of approaches while undertaking investments in network upgrades necessary for facilitating EV charging services. Supported by regulators, utilities in the US have taken an approach of investing in "make-ready" infrastructure where utilities set up the necessary infrastructure required for EV charging services providers to install charging stations. "Make-ready" infrastructure may include components such as necessary transformer and transformer pads, new service meter, new service panel, associated conduit and conductor necessary to connect each piece of equipment, and it can also include Smart Grid

Devices. While the "make-ready" infrastructure is owned by utilities, the EVSE is owned by charging service providers.

Box 12: Charge Ready Program

Through the Charge Ready Program, South California Edison (SCE) provides the requisite grid infrastructure at an SCE consumers' premises (also known as the site host) for installing the EVSE. Charge Ready was developed to reduce barriers to EV adoption by deploying electric infrastructure to serve EV charging stations (EV supply equipment, or EVSE) at long dwell-time locations where EVs are usually parked for at least four hours. These locations provide adequate time for most EV drivers to fully recharge their vehicles.

The Pilot is open to eligible non-residential customers in the following long dwell-time location market segments:

- Workplaces
- Multi-Unit Dwellings (MUDs), such as apartment buildings
- Fleets
- Destination centers, such as sports arenas or malls

Through Charge Ready, SCE installed, owned, maintained, and paid all related costs for make-ready stubs serving EVSE, including:

- Electric distribution infrastructure, such as transformers, service lines, and meters dedicated to EV charging equipment deployed under the Pilot.
- Customer-side infrastructure, such as panels, step-down transformers, wiring and conduits, and stub outs, to allow for EVSE installations.

Participating customers were responsible for procuring, installing, and maintaining qualified EVSE, including electrical energy and networking costs, but received rebates applicable against some or all of the EVSE and installation costs.

The participant of this program has to enrol themselves on SCE Charge Ready Enrolment Portal. Once SCE confirm that the applicant meet the initial qualifications of the program, an Account Manager (SCE representative) provide a program overview and discuss deployment considerations and options with the applicant. The following support is provided by SCE:

- **Evaluation of the site,** requirement of the actual number of charging stations based on several criteria, including current and near-term EV adoption and the number of parking spaces available at applicant site.
- Provide approved list of vendors and charging stations to applicant to **assist them in procurement process and installation of charging stations.** Rebate in the cost of installation by procuring through SCE approved vendors
- **All permit and inspection** are obtained by SCE or Charge Ready vendor, on behalf of applicant
- On signing of the Agreement between SCE and Applicant, the **SCE deploy the necessary electrical infrastructure** suitable for the agreed number of charging stations to be developed by the applicant.

The above-mentioned case study provides an exemplary mechanism to fast-track the EV Charging Infrastructure, however it ***requires Electricity Regulators in India to explore mechanism/design for distribution utilities to allow recovery of cost associated with "make-ready" infrastructure in their Annual Revenue Requirement (ARR) filings.*** States such as Andhra Pradesh and Madhya Pradesh have already recognized these issues and allowed recovery of expenses incurred by Discoms in developing of charging stations through ARR and tariff determination.

In the US, such practice of recovering investment cost of developing charging infrastructure is known as "**rate-basing**". Rate-basing investments add only a small amount to customer electricity bills, and regulatory agencies may encourage these investments due to their potential to increase utilization of the electric grid and incentivize wider adoption of EVs and drive down rates for all ratepayers.

There are several reasons why rate-basing upgrade costs (if any) – at least for an initial period – make sense.

- Rate-basing costs is much simpler than trying to ascertain individual customer responsibility for an upgrade
- Imposing distribution facility upgrade costs on specific consumers may discourage them from purchasing an EV or "smart charging" equipment that could actually benefit the grid by facilitating off-peak load and improving grid utilization.
- Impact of EV charging on the distribution system has been minimal and hence the investments if spread across all consumers will also have minimal impact.

The state of California issued the state policy goals under Assembly Bill (AB 32) to reduce greenhouse gas emissions and the related ARB Scoping plan which includes a comprehensive strategy to reducing greenhouse gas emissions from the transportation sector. Electrification of vehicles is a critical component of the ARB's 2008 Scoping Plan. Electric Tariff Rules-Rule 15 (Distribution Line Extensions) and Rule 16 (Service Line Extensions) pertain to grid equipment used by multiple customers, for example, a transformer serving multiple homes and network equipment used by just one customer respectively.

As per California Public Utilities Commission (CPUC), the rationale for adoption of rate basing of EVSE is highlighted below:

Figure 87 Rationale for adoption for rate basing in California

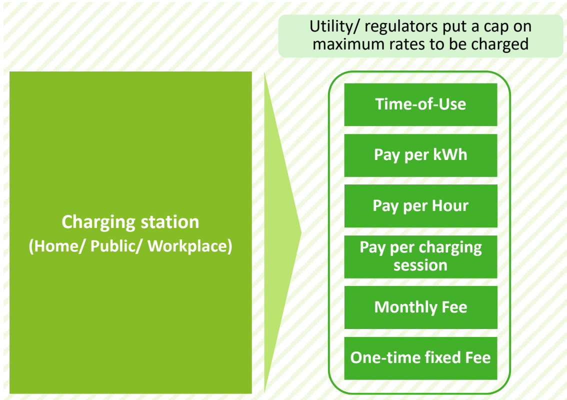
Particulars	Rationale
Utility expenses vs customer expenses	An upgrade to equipment which has the potential to serve multiple customers is generally considered a utility expense and the associated cost is borne by the general body of ratepayers and not just by the EV customer or just by the group of neighbours being served by the transformer.
Upgrade as a system asset and Rule 16 provisions	The cost to replace a shared distribution transformer, due to projected impact of additional loading by EVs, would be considered a total system asset and, as a result, should be included in rate base. On the other hand, the cost to replace an existing customer-specific service transformer would be at the customer's expense. A commercial or public charging station is hence considered as a system wide asset.
EV as a new and permanent load	The load profile created by EVs is similar to that created by other large residential appliances, such as large portable air conditioners and hence it cannot be considered as a temporary load created by specific customers.
Improved system utilization and reduced losses for managed charging	• Incremental EV load on a larger scale has the potential to yield improved electricity system asset utilization in the long-term. Benefits of the same would accrue to all customers of the utilities • On a large scale EV charging occurring during off-peak periods could actually reduce the price of energy for all ratepayers which would have otherwise been incurred by utilizing expensive peaker plants in on-peak periods. The benefits of the same would be realized by all customers
Residential level upgrades	Any expenses incurred over and above the standard residential allowances, if any given to EV owners, would be rate based provided that the additional expenditure pertains to only basic and necessary investments
Adherence to overall state goals	Adoption of EVs is based on California State's goal to reduce greenhouse gas emissions through the electrification of the transportation sector and hence any investments in achieving the same is as per the state goals.

Source: 70 Deloitte analysis

2.4.2.1 Discom role in Building, Owning and Operating of Charging Station

Discom may further extend their role from developing of make-ready infrastructure to owning and operating of Charging Station. It is a classic case of forward integration, whereby Discom would embark into the business of their prospective consumers (EVSE operators). Several regulators in US allow utilities to own charging stations in-order to avoid stifling of market competition except in particular cases where provisioning of charging service is an issue such as in disadvantaged communities. In cases where there is no restriction on utilities to own charging infrastructure, utilities have set-up charging stations along with the necessary grid facing infrastructure. In this case, utilities are allowed to recover the cost of "make-ready" infrastructure and EVSE through rate-basing.

For example, the CPUC allows "PG&E to include the EVSE it owns in its rate-base, because it will be utility property that is used and useful in rendering utility service". Similarly, in **"Power Your Drive program"**, SDG&E is responsible for owning, operating and maintaining the installed chargers. The program is open to existing SDG&E consumers who have dedicated parking spaces (minimum 5 for Multi Dwelling Units and 10 for businesses). The eligible property owners have to apply to the program through the SDG&E website and complete a similar evaluation process as in the case of SCE (explained in case study above).



In India, similar model could be adopted with necessary approvals from regulators. Utilities can decide to recover the full cost of EVSE infrastructure through an increase in fixed charges; a mix of fixed and variable charges from EV charging services; or fully from EV charging services. In all cases, regulatory approval is required. A range of options can be considered for tariff rate structure design as shown in alongside.

There could be several business model possible under this approach. Discom may consider to develop the entire infrastructure under this model and may **bid-out the operation of charging station to third-party** under regulator approved commercial arrangements.

2.4.3 Discom role in inspection and auditing of charging infrastructure

By leveraging its technical capabilities, Discom can facilitate in the inspection and auditing of the charging stations. As per CEA (Measures relating to Safety and Electric Supply) Regulation, 2010, Electrical Inspector and Chartered Electrical Safety Engineer (CESE) are made responsible for providing permission to electrical installation before connected it with the electricity grid. The Discom could play a supervisory role during construction of charging/ battery swapping stations. Suitable Regulatory provisions needs to be done to waive-off the requirement of permission of Electrical inspector/CESE in case Discom provides undertaking that the entire charging infrastructure has been developed under their supervision. As the electrical installation could be expected to be constructed under the supervision of technical experts of Discom, the Electrical Inspector/ CESE could be allowed to provide permission to connect charging infrastructure with electricity grid without any detailed testing and inspection against the undertaking provided by the Discom. This would lead to reduction in number of administrative approvals required in setting up of charging infrastructure as well reduce the overall time from commissioning to electrification of the charging infrastructure.

Discoms can also play a role in specifying and standardizing the technical requirement of the equipment, used at charging stations and, as a step further, in specifying/developing communication protocol for communicating with the Discom, charging station, captive generators (built for EV charging only) etc. Discoms can also render assistance on understanding requirements for enabling demand response and implementation of V2G in near future.

Box 13: ElaadNL

ElaadNL is owned by the Distribution System Operators (DSO) in the Netherlands. Since its establishment in 2009, ***ElaadNL provides the coordination for the connections of public charging stations to the electricity grid on behalf of the involved DSO's*** (until 2018). ElaadNL is the knowledge and innovation centre in the field of smart charging infrastructure in the Netherlands. Through their mutual involvement via ElaadNL, the grid operators prepare for a future with electric mobility and sustainable charging.

Through ***ElaadNL DSOs helped in developing the Open Charge Point Protocol (OCPP)*** which is a de-facto global standard for connecting different charge stations with different management systems which now is managed by the 'Open Charge Alliance'.

ElaadNL also facilitate inspection of the public charging stations. Network operators are responsible for the quality, reliability and safety of the electricity grid. Even when charging stations for electric vehicles are connected to the grid, it is important that these parameters remain guaranteed. That is why every new type of public charging station must be inspected by the network operators before it can be connected to the electricity network. Grid Operator Inspection is facilitated by ElaadNL in collaboration with all participating grid operators - Coteq Netbeheer, Enexis, Liander, Rendo Networks, Stedin and Westland Infra. The applicant needs to apply for inspection by sending email or calling at designated number provided by ElaadNL.

In addition to the above, Distribution utilities / companies, in association with technology start-ups, are reinventing the experience of EV charging through the electricity network. In London, start-ups such as Ubitricity, in collaboration with municipal corporations and grid operators is offering on-street electrical vehicle charging services by installing smart socket in street light lamp post. Overview of the Ubitricity model is provided below:

Box 14: Ubitricity model – street lamp post charging station

The Problem: Requirement of planning permission for designated EV charging spaces. No affordable solution available for residents with electric vehicles without off-street parking.

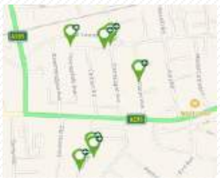
The Solution: Ubitricity, a German company, developed a hardware & software solution to enable electric charging points to be more ubiquitous. It uses a 'SimpleSocket', installed at lamp post, capable to communicate with 'SmartCable' provided to EV owner on subscription of Ubitricity plan. Each SimpleSocket and SmartCable has unique identity that is used to charge EV owner on monthly basis against energy usage by them anywhere within the permitted EV charging points.

The Business Model: Ubitricity tied up with Municipal Corporation for setting up of SimpleSocket in street lamp posts. It provides SmartCable to EV owner against payment of one-time hardware cost. SmartCable is equipped with communication and smart metering device that logs the electricity consumption and communicates with the Ubitricity server to transmit energy usage data, location and ID of SimpleSocket etc. At the end of a month, Ubitricity sends monthly energy usage bill to its consumer having details of energy consumption and parking charges, if any. It charges nominal monthly subscription charges in providing its services to the EV owner. Ubitricity reimburses the energy charges and parking charges to grid operator and Municipal Corporation respectively and retain the subscription charges as its revenue.
At present Ubitricity provide cable compatible for Type 1 and Type 2 charging:


SmartCable


Charging Point

Signage


App based charging point locator

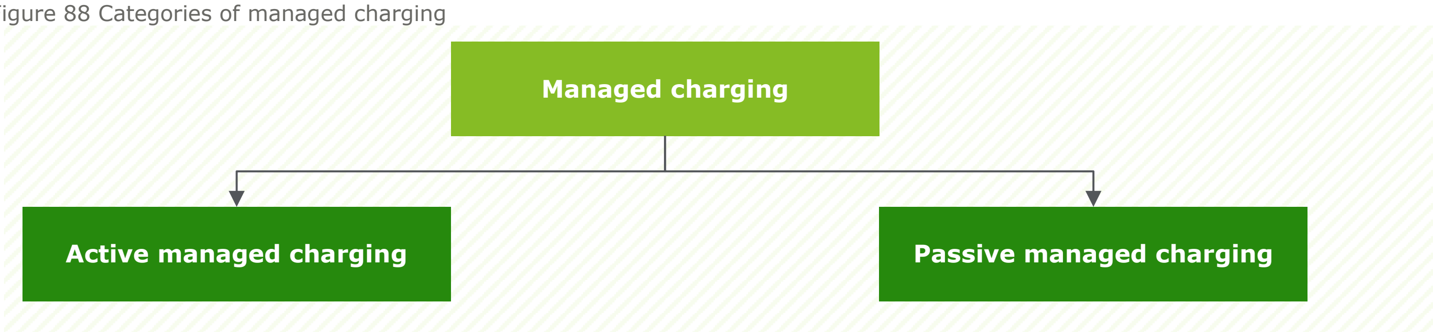
2.4.4 Discom role in managed charging

A major concern associated with the high uptake of EVs is the risk of "unmanaged charging". Unmanaged charging refers to random charging of electric vehicles at any time suitable to the EV owner which can possibly lead to simultaneous charging of many vehicles in a concentrated region thereby increasing the stress on the distribution grid. This situation could be further aggravated by coincidence of peak EV charging with peak electricity demand.

With high share of EVs, the unmanaged charging may lead to substantial increase in the peak load, fluctuation in voltage, overloading of distribution equipment etc. to address the challenge of unmanaged charging, the concept of 'Managed charging' has been introduced in many advanced jurisdictions throughout the world. In managed charging, the utility or a third-party will remotely control the vehicle charging by either disconnecting it from the grid, connecting it at a time when the stress on the grid is the least or even throttle / alter the charging speed to better correspond to the real-time needs of the grid[39].

Managed charging is categorised into following two types:

Figure 88 Categories of managed charging



In **active managed charging**, utilities will be able to control vehicle charging schedule. This is done by using algorithms based on certain grid conditions related to load, voltage, feeder capacity etc. The active managed charging therefore can help in ensuring that vehicles do not cause excess strain on the network. Customers also benefit lower electricity rates during active managed charging and thereby lowering the operational cost of owning an EV.

Whereas, the **passive managed charging** focuses on load control through behavioural changes in consumers. In this form of managed charging, utilities try to influence the EV charging behaviour by incentivizing certain behaviour patterns through time-of-use tariffs for charging or other such incentivizing programs.

Below are some of the advantages of managed charging:

Figure 89 Advantages of managed charging

Advantages	Particulars
Improve grid economics	By modulating/varying the charging levels to reflect the grid conditions, managed charging can achieve higher utilization rates, and therefore capacity factor of generation assets (increased charging rates during off-peak period and reduced rates during peak load/overload conditions)
Reduction in emissions	Managed charging can reduce emissions by aligning charging with surplus renewable generation, thereby creating a scenario where excess renewable capacity can be absorbed in the system, such as photovoltaic (PV) production during peak solar hours and wind spikes during off-peak hours.

[39] Beyond load growth: The EV managed charging opportunity for utilities (access here)

Advantages	Particulars
Reduced stress on the grid	Managed charging can reduce grid stress and maintain grid stability by minimizing charging ramp rates and reducing the strain on local distribution transformers which tend to be overloaded during peak period.
Capex deferral	Managed charging can reduce the need for new peak generation and distribution capacity resulting from EVs charging during peak hours.
Reduction in T&D losses	Modulating the amperes flowing through the charging station can also result in reduction of technical losses in the distribution system
New market opportunities	Capacity and ancillary market services such as frequency regulation and spinning reserves.
Benefits to EV consumer	Economic returns to EV owners by reducing the cost of charging through dynamic rates and potential payments for the supply of ancillary services.

Box 15: International experience in managed charging

1. Los Angeles Department of Water and Power (LADWP)

The Los Angeles Department of Water and Power (LADWP), through its "Charge Up L.A.!" program, offers up to $500 for Level 2 residential chargers or $4,000 for commercial chargers. As a condition of the rebate program, recipients must agree to participate in LADWP's demand response program for the life of the installation in the event the utility needs to curtail that load. Further, LADWP can disconnect the load from the EV charger for the duration of the event without notice.

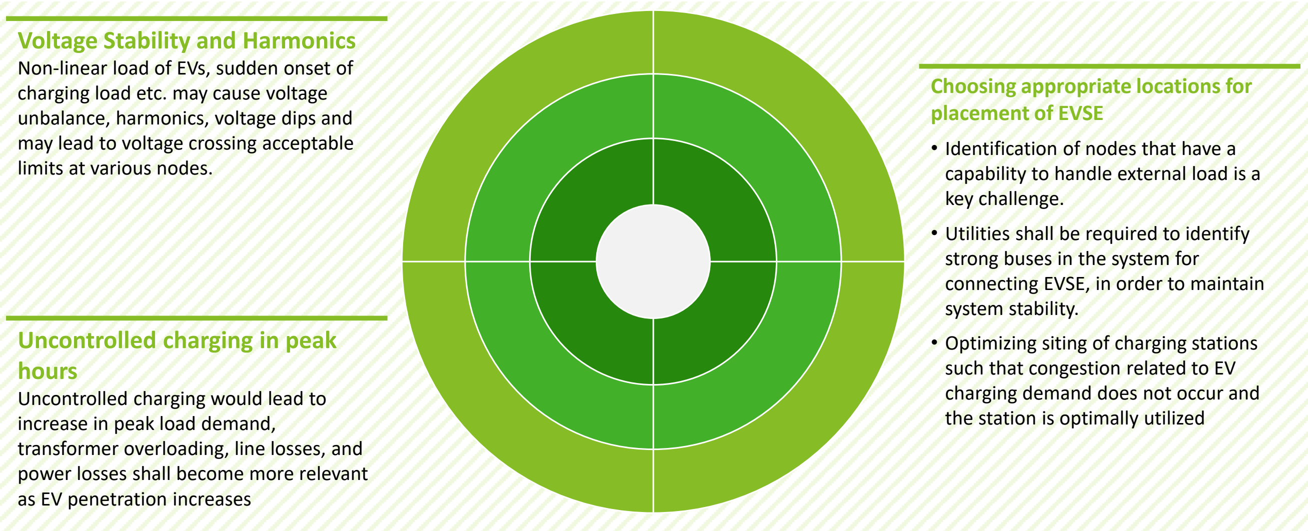
2. Managed charging for bidding in CAISO

eMotorWerks, which developed a Vehicle Grid Integration platform called JuiceNet, has its own smart grid enabled JuiceBox EV charger, and provides JuiceNet platform capabilities to five other Electric Vehicle Supply Equipment (EVSE) manufacturers. Additionally, eMotorWerks has started deploying its platform to control vehicle charging directly over the telematics link with select OEMs. By controlling how and when large quantities of EVs charge throughout the day, eMotorWerks can bid that capacity into wholesale power markets such as the California Independent System Operator (CAISO), use it to balance renewable generation, or provide traditional DR services to the utilities, while observing driver behaviors and allowing driver override to avoid customer dissatisfaction.

2.4.5 Challenges

The key challenges which discoms could face with high penetration of EVs is summarized in the figure below.

Figure 90 Key challenges for Discoms with high EV penetration



Distribution utilities should proactively conduct adequate technical analysis to understand the impact of EV penetration under different scenarios and devise a mechanism for optimal integration of the same in the grid.

2.5 Consumers – market landscape

Although, there have been significant developments in the electric mobility space, the perception of consumers is still not in favour of electric vehicles. Deloitte, through its Automobile Consumer Study 2020, surveyed 3022 consumers in India to understand opinions regarding critical issues in automobile sector.

- Over past few years, there has been decline in 2-3% of consumers who are unwilling to pay any more for either autonomous technologies or alternative engine technologies.
- Around 40% consumers preferred Electric vehicles (Battery/ hybrid) for their next vehicles. However, decision of buying an EV is dependent upon the price of fuel for ICE vehicle. Only when the fuel prices rise by an additional 40%-50% from the present level, it is expected that majority consumers will prefer electric vehicles over ICE.

Figure 91 Consumer preference for their next vehicle purchase

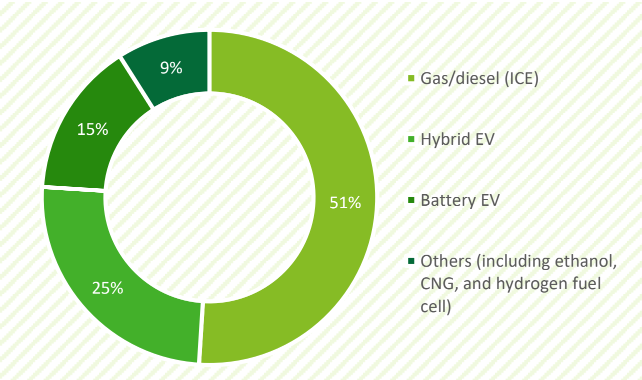
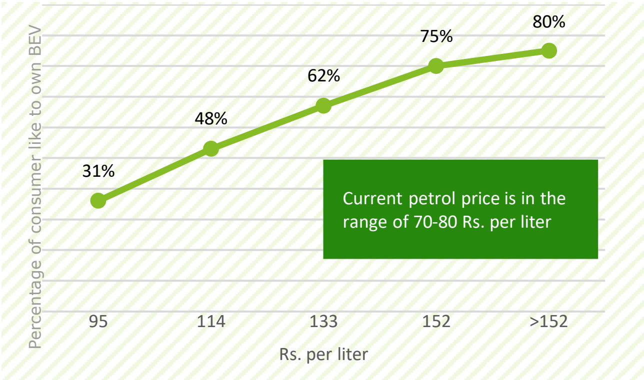


Figure 92 Consumer preference to own BEVs with change in petrol prices



Source: 71 2020 Deloitte Automobile consumer Study

Conventional vehicles are still the preferred choice for the Indian vehicle user

Majority of consumers stated that lower emission from EVs is their primary reason for purchase. However, only 14% of consumers are willing to pay an additional Rs 3 Lakh for an electric vehicle in comparison to a similar conventional vehicle.

Figure 93 Reasons consumers consider hybrids or BEVs

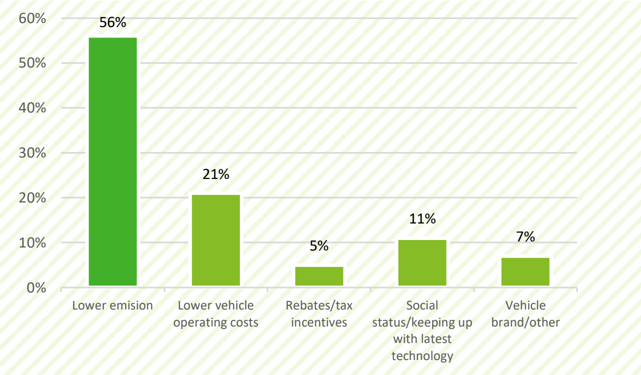
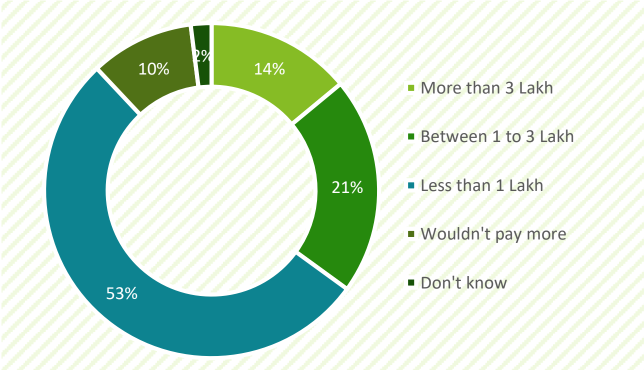


Figure 94 Consumer willingness to pay extra for an EV



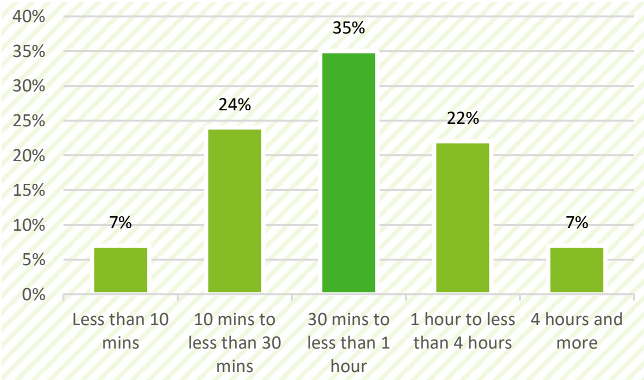
Source: 72 2020 Deloitte Automobile consumer Study

Even though consumers prefers EVs due to their low emission capability, they are not willing to pay extra for EVs.

Majority of consumers expect the range of an EV to be more than 340 kms for buying. Around 64% of consumers are willing to wait for at least 30 minutes to fully recharge a battery electric vehicles.

Figure 95 Minimum driving range consumers are expecting from a BEV (km)

Figure 96 Amount of time consumers are willing to wait for full EV charging



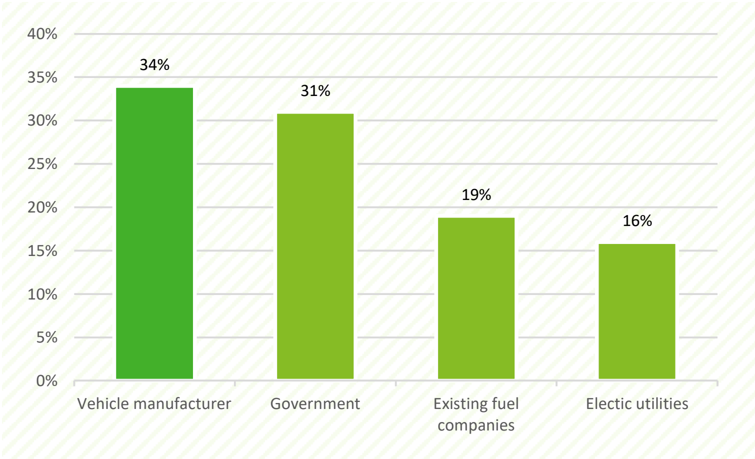
Source: 73 2020 Deloitte Automobile consumer Study

Indian consumers prefers EVs with high travel range and charging infrastructure supporting fast charging

Around 65% of consumers think that it is either the responsibility for vehicle manufacturers or government to build publicly accessible EV charging stations and other infrastructure.

Majority of consumers believe that the vehicle manufacturers should install and operate EV charging infrastructure

Figure 97 Responsibility of building accessible EV public charging infrastructure



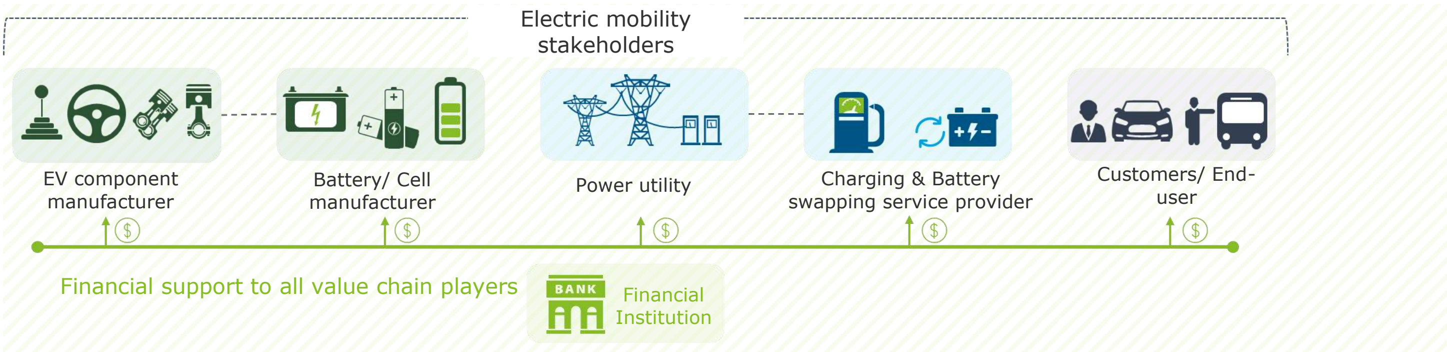
ICE vehicles are still the preferred vehicle option among Indian consumers and expected to remain the same unless fuel prices jumps 40%-50% from their existing level.

High vehicle prices is one of the major bottleneck in adoption of EVs as Indian consumers are not willing to pay extra for EVs.

2.6 Financial institutions – market landscape

Financial institutions are one of the vital stakeholders that can catalyse uptake of electric mobility. They enable stakeholders in realizing their electric mobility plan by helping them in financing various activities such as developing of manufacturing units, upgrading/ augmenting distribution network, setting up EV charging infrastructure or for purchasing electric vehicle.

Figure 98 Role of financial institution in uptake of electric mobility



There is no proactive participation of financial institutions in promoting electric mobility in India. Among all nationalized banks, only State Bank of India has come up with the loan facility for electric car buyers at reduced interest rate.

State Bank of India introduced country's first "Green Car Loan" (Electric Car) to encourage customers to buy electric vehicles. The scheme offers a 20 basis points smaller interest rate than on the existing car loan schemes.

Further, access to debt capital by the small and medium manufacturers of auto ancillary part and start-ups venturing into EV manufacturing, is very difficult, as the financial institutions still consider EV as a nascent market with a high technological risk perception. New entrants in the EV market have limited financial muscle as their business models are still evolving and they do not have substantial financial backing. Therefore, it is very difficult for such players to raise capital from lending institutions. However, the established OEMs are relatively in comfortable position to raise debt fund, based on the strength of their balance sheet.

The industry needs the support of financial institutions in bridging the gap to access finance for increased offtake of EVs. There is an increasing need to consider electric mobility as a priority sector for lending, so as to catalyse large scale uptake of EVs in the country.

2.7. Summary

Summary of electric mobility landscape analysis:

01

Commitment towards GHG reduction, huge dependency on imported crude oil, high urbanization, and growing population are the key drivers that could propel the transition from conventional mobility to electric mobility. Policy makers and regulators have taken collective effort to promote electric mobility in India. DHI introduced FAME schemes (I & II) to spur the EV demand whereas MoP notified guidelines on installation of charging infrastructure. Electricity regulatory commissions have also brought out special tariffs for EV charging, and ARAI has introduced standards for AC & DC charging. MoHUA has amended Building Bye-laws and Urban and Regional Development Plans Formulation and Implementation Guidelines to make charging infrastructure development as an integral part of urban planning, development and construction.

Along with the policy efforts by the Govt. of India, states have also come out with their independent EV policies to help uptake of electric mobility.

02

Although central government and state government are putting substantial efforts to drive the EV adoption in India, traction can only be seen in 3W and 2W segments. The 3W segment, particularly e-rickshaws, is driving the high adoption rate of EVs. For 2W the major drivers are lower operational cost, ease of charging at home with available infrastructure. However, EVs still need to achieve cost parity with ICE vehicle for large offtake by consumers, especially in the2W segment. High cost of EVs is identified as the biggest bottleneck in adoption of electric vehicles in the country.

Exclusion of 4W private vehicle from FAME – II eligibility for demand incentive along with multiple issues related to high cost, unavailability of adequate charging infrastructure, range anxiety etc. is causing this segment to witness lesser adoption of EVs.

E-buses have not witnessed the required level of traction as envisaged under various policies. Even after allocating more than 40% of total incentive pie for e-buses under FAME – II, no significant traction has been observed. Mandatory requirement of procuring e-buses on GCC model needs to be re-looked with consideration for relaxing requirement of huge bank guarantees as security to increase uptake of e-buses.

03

From supply-side point of view, there are several constraints. For battery manufacturing, India lacks in access to raw materials (mineral resources). EV auto ancillary in India is also at nascent stage with limited manufacturing capabilities. Huge dependency on imported auto component (mainly electronic and electrical) acts as a barrier in attaining price parity with ICE vehicle. Phased Manufacturing Program, Aatma Nirbhar Bharat, and incentives announced by several states in their EV policy is expected to strengthen the supply-side scenario in medium to long run.

04

FAME II scheme allotted 10% of its overall outlay for EV charging however, there has been no significant growth in development of EV charging infrastructure. Administrative procedures of land acquisition and electricity connection, lower utilization of charging infrastructure, absence of provisions for recovery of expenditure through tariffs, absence of regulatory provision for participating in ancillary market etc. are some of the challenges industry is currently facing.

Discoms have not been mandated to actively participate in the development of charging infrastructure. Further, as highlighted above, There exists no regulatory clarity on allowing capex for charging-infra development as pass-through in tariffs.

05

With their inherited capability of existing infrastructure, existing consumer base and superior technical skills, the role of distribution utilities will be crucial for uptake of EV charging.

Discoms need to actively participate in planning for EV charging infrastructure. Random charging of EVs may put strain in the grid. Harmonics from EV charging stations will also impact the power quality of the system. There is need to carry out analysis and determine the need for strengthening the distribution network in order to integrate EV charging stations.

06

Battery constitutes approximately 25 - 40% of the vehicle cost. Battery swapping model allows to take out of the cost of battery from the upfront cost of EVs. The cost can be reduced, and a better value proposition could be offered to consumer for adoption of EVs with prices at par or lower than the ICE vehicle. However, lack of policy guidance on standardization of battery for EVs, and huge upfront capital requirement is posing challenge in massive uptake of battery swapping business model.

07

To incentivize charging infrastructure development, regulatory commission needs to play an active role. This can include the following:-

- Devising mechanism for recovery of investment made by discoms as part of tariff.
- Incentivizing charging infrastructure developers by allowing them to participate in real-time and ancillary power market
- Developing framework to promote managed charging

08

Although there are still challenges across EV landscape, private players are betting heavily on success story of EVs in India. Many start-ups have entered into manufacturing of EVs in past 5-7 years and conventional vehicle manufacturers, both domestic and global, are also launching EVs in Indian marketplace.

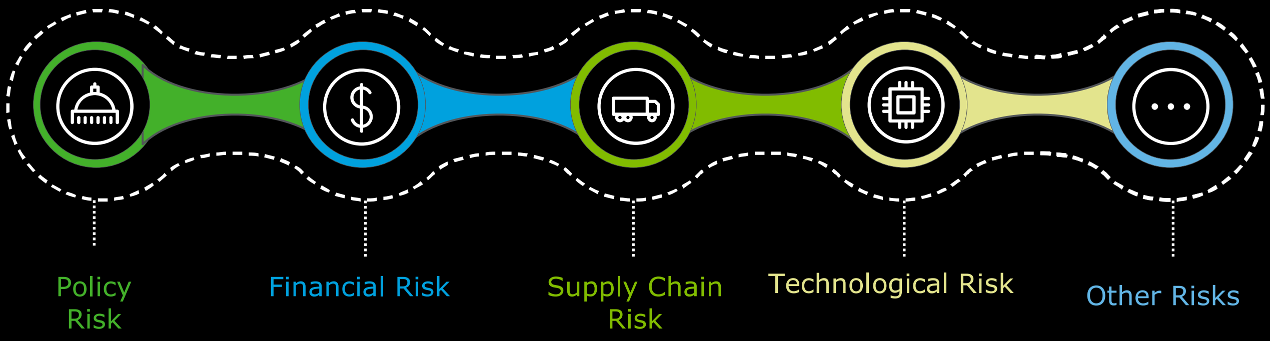
Similarly, several players have ventured into development of charging stations and have substantial plans for developing charging stations as well as battery swapping station across India in the future.

2.8. Gaps in EV landscape

Stakeholder	Gaps
Policymaker and Regulator	No mandate for EV adoption in FAME/ State EV policies; Regulatory uncertainty in allowing capex investment for developing charging infrastructure as pass-through; Too many riders put in FAME scheme to avail subsidy – localization, re-certification, max. speed
EV Component OEMs + Battery OEMs	Lack of strictness in implementation of localization targets; Availability of limited suppliers; Lack of focus on skill development on battery technologies; Availability of limited financing options
Distribution companies	Lack of support for conducting system modeling studies; No mandate for Discom to develop charging infrastructure. Lack of regulatory guidance on investment approval
EVSE and battery swapping	Lack of standardization; Lack of support for promotion of workplace charging; Delay in providing connectivity to charging infrastructure
Consumers	Lack of awareness; Limited travel range of EVs; Limited availability of charging infrastructure; High charging time; Availability of limited financing options
Financial institute	No mandate for Financial Institution to providing funding for electric mobility (as priority sector lending)

2.9. Risks & challenges to EV stakeholders

Risks & challenges for EV stakeholders in the existing market are categorized into five categories:



	Policy risk	Financial risk	Supply chain risk	Technological risk	Other risks
EV Component OEMs + Battery OEMs	- Non – implementation of policy measures after announcement - Phasing-out of subsidy support/ posing stiffer norms for availing incentives - Policy risk associated with import-export of automobile component - Introduction of any policy mandating investment in recycling of battery	- High cost of funding due to perceived high technology risk by FIs - Exchange-rate risk due to import dependency for auto components - Investment recovery risk - evolving business models, limited charging infrastructure	- Insufficient access to mineral resources for manufacturing critical components indigenously - Quality of indigenously manufactured auto ancillary component - Demand-supply issue of indigenous auto ancillary component due to limited manufacturing capacity - Geo-political risk -unstable relationship with China (import dependency on China)	- Fast evolution of technology (especially in Battery) – risk of obsolesce - Battery prices may not go down as predicted (may be due to demand-supply mismatch) - Interoperability - Price versus performance - risk of technology preference	- Uncertain consumer preference - High wage rate of skilled manpower/ shortage of skilled manpower - Evolving safety standards and their compliance related risk - Environmental concern – battery scrappage or recycling issues
Distribution companies	- Uncertainty around government funding support for network upgradation	- High cost of supply than approved EV tariff (accrual of EV tariff subsidy	- Risk associated with new vendor performance (EVSE vendors), in case it enters into business of	- Unpredictable EV demand – technological limitation in managing charging	- Shortage of manpower within Discom for doing core business, while obligating

	Policy risk	Financial risk	Supply chain risk	Technological risk	Other risks
	- Regulatory disallowance for recovery of Capex - Tariff increase across consumer category, if pass-through is allowed for CAPEX done for network upgradation – reduction in electricity demand from price-sensitive consumer categories	committed by government) - No regulatory guidance on approving of Capex to upgrade network to cater EV load - Difficulty in raising cost-effective funds to finance network upgradation due to poor financial performance of discoms	development of EVCS - Inventory stock-out risk – unpredictable requirement of network upgrade (due to limited network load flow studies conducted)	demand on real-time basis - New technology (say Hydrogen) replaces EV technology leading to stranded asset - Cyber security threat in sharing Discom data interface with EVCS owned and operated by third-party - Network behaviour with high EV penetration – power quality/ safety	additional role as SNAs/ facilitator for development of EVCI - Operational risk in providing charging service (in case discom enter into such business) – payback may be calculated considering EV demand assessment, traffic density, city planning, urbanization etc.
EVSE and battery swapping	- No roadmap for EV adoption. Uptake of EVSEs and increase in EV adoption posing a chicken-egg problem - Policy risk associated with import-export of EVSEs - Government procurement policy related risk - Uncertainty around participation of EVCI provider in real-time and ancillary power market	- Unpredictable real-estate cost with increase in demand for suitable location for developing EVCI - EV tariff and electricity demand charges for sanctioned load - Evolving business model, lower utilization of assets – banks reluctance to fund, high cost of funds - Capping on service charges may pose significant risk on investment recovery	- Availability of local supply chain for EVSE – cost and quality concerns - Suitability of imported EVSE chargers Indian weather conditions - Pace of development of Indian power electronic market - Overall performance of Indian MSME especially in Power electronics - Software integration issues, due to presence of	- Change in technical specification – risk of obsolescence - New technology (say Hydrogen) replaces EV technology - Battery technology change which may make existing charging stations obsolete - Evolution of interoperability measures/ mandates	- Regulatory compliance for power purchase (say RPO/HPO compliance) - Operational risk - payback may be calculated considering EV demand assessment, traffic density, city planning, urbanization etc., leading to investment recovery risk - Consumers preferring home charging

	Policy risk	Financial risk	Supply chain risk	Technological risk	Other risks
			multiple operators		
Consumers	- Phasing-out of subsidy support/ posing stiffer norms for availing incentive - NGT guidance on mandatory disposal of battery after certain time may change the cost economics of EVs	- Huge bank guarantees for e-buses under GCC model - High upfront cost of EV (for similar performance ICE equivalent) - EV tariff and service charges offers significant risk on operational cost	- Limited availability of EV models - Limited availability of charging infrastructure - Newer manufacturing unit of EV auto component may poses quality concern	- Longer duration of charging (fast DC charging is not supported by existing batteries used in 2W and 3W - New technology (say hydrogen) may replace EV technology – risk of obsolescence	- Risk associated with battery quality and safety -
Financial institute	- Non – implementation of policy measures after announcement - Certainty of EV and associated businesses are difficult to predict (in absence of any adoption mandate) - Lack of clarity on government efforts for enabling sustainability of EV business – no regulatory framework for participation of EVCI provider in real-time and ancillary power market	- Uncertainty around life of the asset, end-of-life value, and resale value - Uncertainty around picking-up of EV demand. Investors are concerned about the viability of EV business considering consumer preference and issues around range-anxiety, lack of development of EVCI - Capacity utilization of EVCI is very low, risk of investment recovery	- No observed risk	- EV technology is still evolving and it is true with other technology as well, such as Hydrogen Fuel Cell. In case Hydrogen based technology establishes itself earlier than EV technology, then investor would come at risk of recovery of investment - Rapidly changing technological environment	- No observed risk

2.10. Recommendations

Recommendations for uptake of electric mobility in India:

01 National / State level policy should be formulated for incentivizing Distribution Utilities on investing in development of EV charging infrastructure

02 In line of international case-studies, a Charge-ready infrastructure programme to be launched mandating Discoms to spearhead the development of charging infrastructure by leveraging their technical capabilities, international case studies shall be capitalized to align Discom role in charging infrastructure ecosystem

03 Electricity Regulator to be mandated to provide mechanism for approval for Rate-basing of utility investments in building EV charging infrastructure

04 Electricity Regulator should design and implement TOU tariffs for EV charging

05 Technical standards for charging equipment in the case of Managed charging should be designed and approved

06 Designing electricity market structures for participation of EVs. Electricity regulators shall be mandated to devise mechanism for allowing charging infra developer in demand response market.

07 Policy consideration to be deliberated for workers in ICE Auto Ancillary industry (primary mechanical) to skill them suitably for working in EV auto ancillary industry (primary electrical and electronics)

08 Standardization of battery should be done to enable battery swapping a plausible business model catering primarily to commercial vehicle

09 Financial Institutions should be encouraged to extend their lending facility to electric mobility sector.

10 Existing scheme/policies designed for promoting electric mobility needs to be fine-tuned, based on the scheme/policy performance and market expectations. For examples, riders are availing subsides could be re-examined.

11 Many of the new technology related to managed charging of EV has been introduced first using a pilot platform. The results for these pilots are then used to carry out large scale deployment of technology. While standards and guidelines introduced in India do provide provisions for communication protocol between EVSE and other stakeholders, there has been no pilot initiative on large-scale managed charging pilots. Utilities and regulators across India need to take initiative on introducing pilot projects which can demonstrate the benefits of managed charging of EVs.

12 It has been observed that having dedicated tariffs and incentives for EV encourages adoption. While few states in India have taken EV policy initiatives, a large number of states are yet to introduce EV specific tariffs for public and home charging as well as incentives under state policies for purchasing EVs and setting up home and public charging stations.

13 National level policy for Urban Local bodies / municipalities, etc. to issue Charger Deployment plans and undertake investments in PCS through loans from Central government. The same could be converted to grants on timely achievement of milestones subject to the local authorities tying up with designated government agencies for implementing the roll out plan.

14 Adopt a framework for state level / city level authorities to undertake competitive bidding for allotment of zones for PCS installations.

Develop frameworks for public private partnerships / franchisee agreements for developing EVCS.

Explore innovative business models for development of charging stations.

15 For EV users, interoperability, or “e-roaming,” means that users can charge at any station with a single identification or payment method, and that all charging stations can communicate equally with vehicles. For this to work seamlessly, common standards for charging network operators must also be established

16 A key enabler for smart charging and other vehicle-grid integration aspects is collaboration among various stakeholders. There is a need to create a common platform which can bring together expertise of all stakeholders.

3. Review of policy, regulation and technical standards for electric mobility and LCPRT

Conducive policies and regulations play a vital role in unleashing the potential of new technology and opening corridors for new opportunities. Similarly, technical standards play a major role in streamlining of technological development, compatibility of various systems and components used in value chain. It also ensures safety and reliability of new technologies which in turn increases consumer confidence. This chapter will focus on highlighting various policy and regulatory measures taken collaboratively by several ministries under Central/State government to expand the uptake of electric mobility and clean fuel based automobile market in India. It also covers the review and analysis of CEA regulations for electrical safety standards and grid interconnection.

3.1 Policy initiatives

3.1.1 Electric mobility

3.1.1.1 Central policies

As EVs are at nascent stage, policy and regulatory measures are crucial to provide push to the development of the electric mobility ecosystem. Globally, the policy and regulatory measures have focused on providing various fiscal and non-fiscal incentives for adoption of EVs and charging infrastructure. Realising the need of the transition to cleaner technology, the government has been leapfrogging in developing various policies and support structures for increased adoption of EVs. There have been several policies issued at different stages of the journey of Indian automotive sector which are aimed at adoption of clean fuel and electric mobility. These policies and interventions are highlighted subsequently.

3.1.1.1.1 National Electric Mobility Mission Plan (NEMMP)

Adopted in 2013, the National Electric Mobility Mission Plan (NEMMP) 2020 laid down the vision and roadmap for EV penetration in India. NEMPP outlines incentives along four priority areas for EVs viz. demand incentives, manufacturing of EVs, charging infrastructure development, and research and development.

The Mission aims to achieve 6 to 7 million on road electric vehicles by 2020.

In terms of the assessment made by the joint Government-Industry study, the total investment requirement envisaged in the mission document for setting up the required infrastructure to achieve the target (both power and charging infrastructure), is summarized in following table:

Table 15 NEMMP Targets

Area	4W	2W	3W	Buses	LCV	Total
Additional generation Capacity (MW)	150-225	600	10-15	<5	10-20	775-865
Power Infrastructure (Rs Crore)	1,200-1,300	3,300-3,400	75-85	20-30	90-100	4,685-4,915
Charging Infrastructure (Rs Crore)	950-1000	-	70-80	10-20	115-125	1,145-1,225

Source: Department of Heavy Industries. 2013. "National Electric Mobility Mission Plan 2020"

It was expected that GoI will support the development of electric vehicle charging infrastructure in the initial stages of development when the pilot projects will be rolled out for cities and during the phase when the business model will be at a nascent stage. Subsequently, private sector participation will be required to set up country wide charging infrastructure. Moreover, roll out of the EV charging infrastructure was planned in a phased manner as follows:

Phase I (first year)	This will involve detailed and in-depth evaluation of various options, prioritization and putting in place the required frameworks and models for EVSE adoption, enabling policies, charging infrastructure standards, laws and undertaking detailed studies that will facilitate the roll out of the optimum EV infrastructure.
Phase II (Year 1 - 3)	The activities in the medium time frame would build on the initial basic work done and include deeper impact assessment studies and programs, pilot projects in various cities, EV infrastructure consortium building activities, development of possible business models, etc.
Phase III (Year 3 to 2020)	This will include the following activities:- i. Ensuring availability of reliable and regular electricity supply, ii. Making available adequate recharging facilities with convenient access, iii. Development of EV charging as a viable business entity, iv. Well established and synergic linkage between EV charging infrastructure with renewable energy generation infrastructure, v. Development of public recharging infrastructure that includes opportunities for rapid recharging through either setting up of optimal number of fast recharging centres or by use of batteries swapping stations that allows quick replacement of discharged battery packs with charged ones.

There were several provisions listed under the policy, however the same were not effectively implemented.

i. **Permissive legislations:** Legislations to allow usage of electric vehicles in various areas

ii. **Operational regulations:** Use of legislation framework and regulations aimed at setting safety regulations, emission regulations, vehicle performance standards, charging infrastructure standards, etc.

iii. **Fiscal policy measures:** Trade related policies for shaping the market, imports and exports

iv. **Manufacturing policies** aimed at encouraging investments. Specific policies aimed at incentivizing manufacturing and early adoption of electric vehicles through demand creation initiatives

v. Schemes and **pilot projects** for facilitating infrastructure creation

vi. Policy for facilitating **research and development**

The Government of India has taken considerable measures to keep efforts aligned to the provisions laid down under NEMPP, however the EV sales penetration stands nowhere near to the planned target level. In all likelihood the EV penetration target of 14%-16% by 2020 as envisaged under NEMMP is unlikely to be achieved. (In Chapter 1, we observed that the yearly sales penetration of EVs in last five years has been less than 1%)

Failure in achieving EV penetration targets envisaged under NEMMP, indicates that the policy measures undertaken to promote electric

mobility were not sufficient. Nevertheless, the actions taken as per the provision of NEMMP has provided the initial boost for uptake of EVs and increased the awareness level among consumers and industry players FAME Scheme

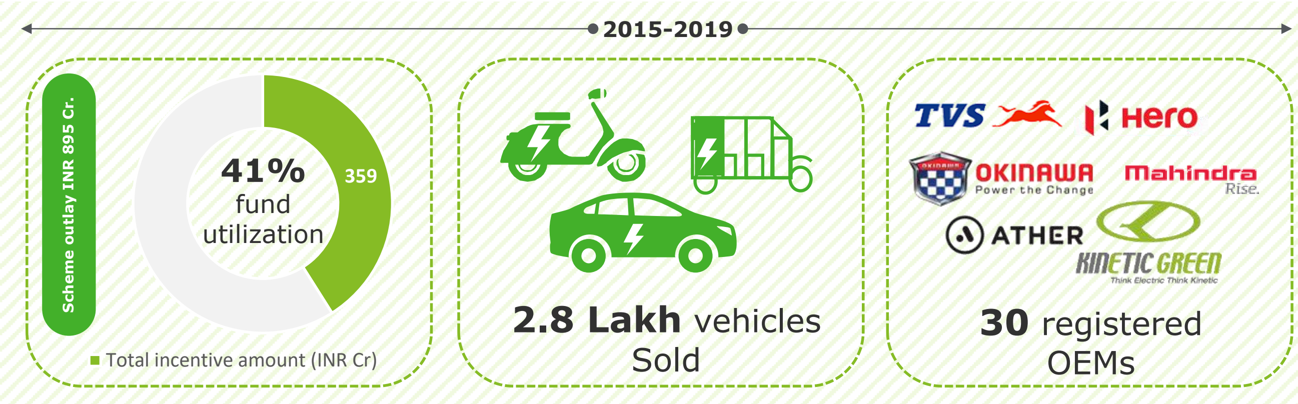
The FAME (Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles) scheme was first launched in 2015 as a flagship scheme under NEMMP 2020 mission plan of Central government to enhance hybrid and electric technologies in India. The overall scheme is proposed till FY22 to support market development of EVs.

FAME Phase I

Phase 1 of the scheme was initially launched for over a two-year period starting from FY 2015-16 to FY 2016-17 with an overall outlay of INR 795 Cr. The scheme was later extended four times for six months each with additional outlay of INR 100 Cr.

The funds were used to provide direct subsidy to the EV buyers. Along with direct subsidy, grants for specific projects under pilot projects were sanctioned, also, R&D/technology development, and public charging infrastructure components were also sanctioned under the scheme. 465 buses were sanctioned to various cities/states under this FAME I.

Figure 99 Snapshot of FAME I scheme



The FAME I scheme failed in utilizing complete allocated fund in four years of its period. Only 41% of its overall outlay of INR 895 Cr was utilized.

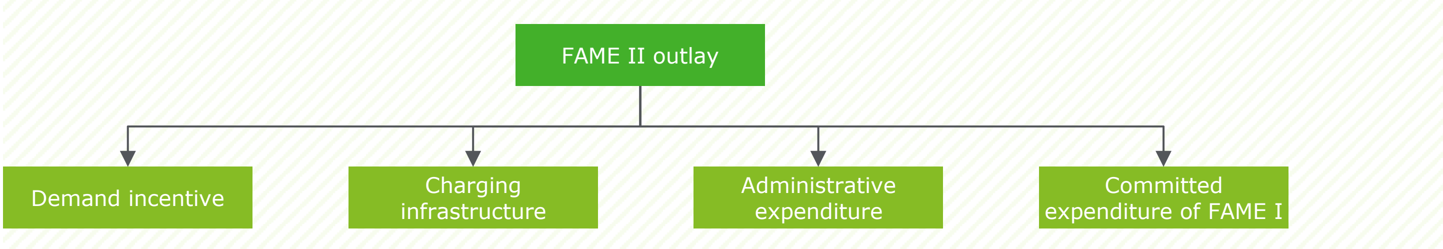
Although the FAME I scheme failed to utilize sanctioned funds, it has provided the stepping stone for uptake of electric mobility in Indian market. The scheme was successful in creating awareness and momentum for electric mobility in the market.

FAME Phase II

In March 2019, the MoHI&PE notified FAME –II scheme with increased layout of Rs 10,000/- crores, which includes a spill over from FAME-I of Rs 366 Cr. Period for Phase 2 of the FAME scheme was from FY 2019-20 till FY 2021-22.

FAME II aims to leverage the buzz created by FAME I to create a platform for the EV industry to take off in the country. The scheme is focused on promoting demand as 86% of the scheme outlay is reserved for demand incentive. The overall outlay is segregated into four categories:

Figure 100 Outlay break-up under FAME II



As far as subsidization of vehicle goes, the scheme is supporting sale of close to 1.56 Mn vehicles (all categories). Breakup of this provided in below figure.

Figure 101 Category-wise no. of vehicles to be subsidized under FAME II

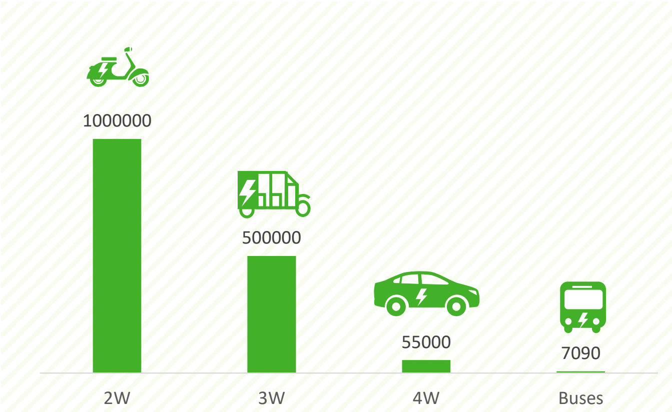
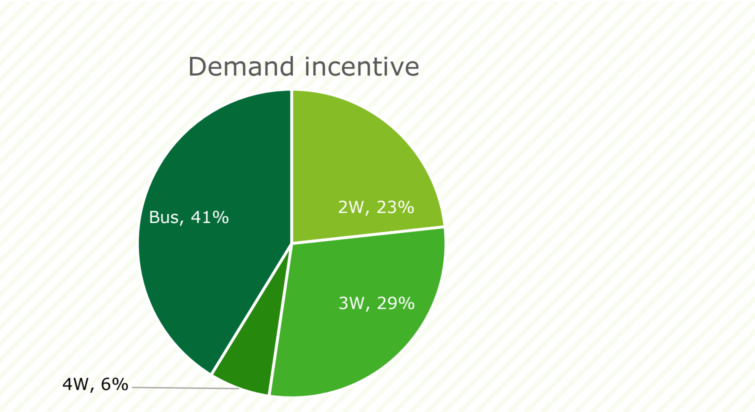


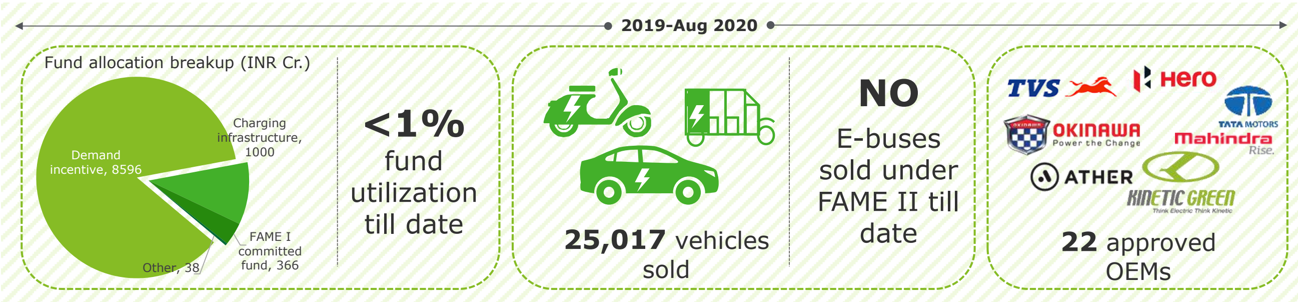
Figure 102 Demand incentive category-wise distribution in FAME II



Source: 74 FAME II scheme

Subsidies under FAME II are limited to EVs using advanced Li-battery and newer technologies only

Figure 103 Snapshot of FAME II and progress till date



Key policy gaps in FAME II scheme:

Gap 1	**No incentive for vehicle scrappage/ Retro fitment allowance**	The incentives under the policy are for purchase of new EV only, however it does not provide for any scrappage incentive, to encourage ICE vehicle owners to scrap their vehicle for EVs. Further, it does not talk about any retro-fitment allowance for converting existing ICE vehicle to EV.
Gap 2	**No mandate for EV adoption**	Unlike China and California, there is no EV mandate provided under the scheme that led to following issues: 1. **Insufficient development of charging infrastructure**: In China, State Owned Grid Utilities are investing hugely in development of charging infrastructure; EV mandate in the country provides assurance to investors in terms of business continuity, higher utilization of assets and early payback. 2. **Investment dilemma among automobile manufacturer**: Currently, automobile manufacturers have hugely invested in ICE technology. India is transitioning towards BS IV to BS VI standard and EV at the same time. In the absence of clarity on certain uptake of EV (through mandate) it will be very difficult for the automobile industry to do parallel investment in two technologies simultaneously as limited resources are available with industry.
Gap 3	**No provision for fee-bate concept**	ICE vehicles have been in use since decades and therefore users are comfortable in using it. A huge inertia has been developed among consumers that restricts them to switch to EVs. Presently, there is no concept of fee-bate being used in the policy that allows to put huge fees/ penalty /cess/surcharge in using ICE vehicle that may reduce the inertia carried by ICE technology. (Sweden has increased taxes on cars that create pollution, thereby dissuading consumers from buying vehicles with internal combustion engines as they contribute significantly to noise and air pollution)
Gap 4	**Additional riders for availing subsidy**	Under FAME I, two-wheelers with top speed of up to 25km/hr were qualified for incentives of up to INR 17,000 and INR 22,000 for high speed ones. However, riders put under FAME II mandated to have a minimum range of 80 km per charge and minimum top speed of 40 kmph to qualify an electric two-wheeler for an incentive of INR 20,000. The higher performance parameters comes at a higher cost that have excluded the large section of society that are price-sensitive from EV purchase. Ather's 450X model (Top speed: 80 km/hr), Revolt's RE400 (Top speed: 80 km/hr), Bajaj's Chetal (Top speed: 80 km/hr) all priced at more than Rs. 1.15

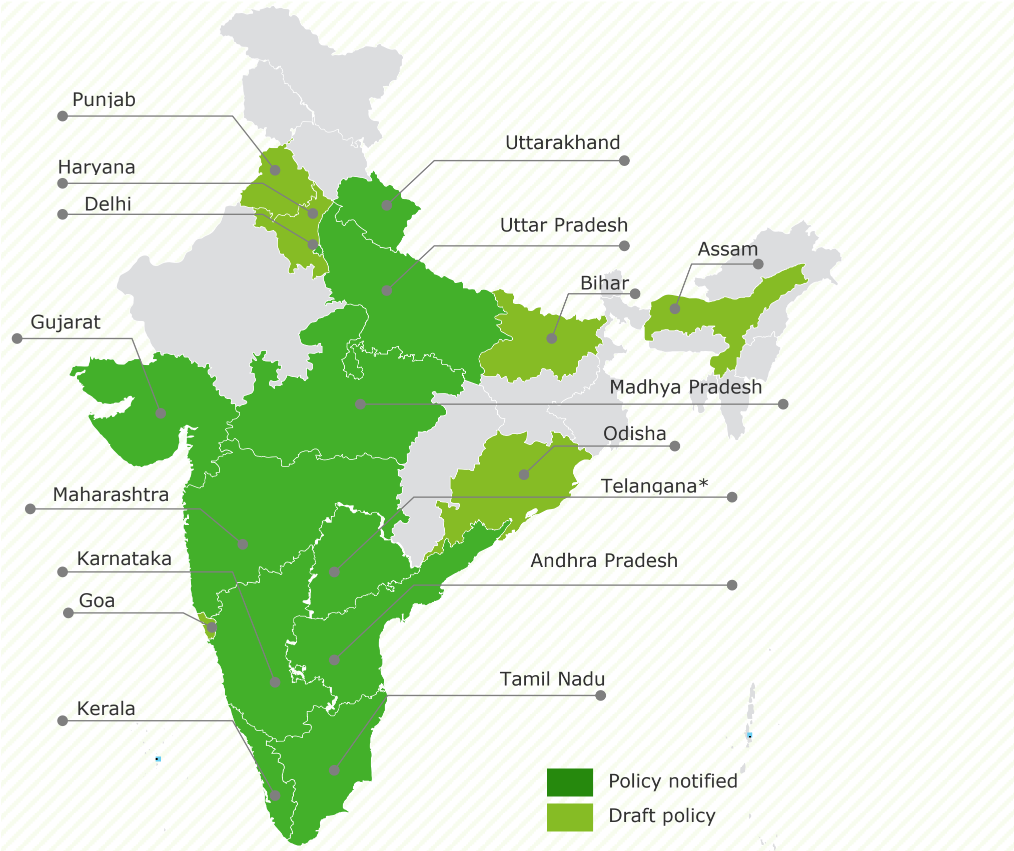
		Lakh. Avon E Star (range 65km/charge, top speed less than 50kmph comes at Rs. 60,000)
Gap 5	**No subsidy for private 4W**	With growing per capita income of the country, it was expected that there would be an increase in purchase of private 4Ws. However, the FAME II is providing subsidy only for public 4Ws.
Gap 6	**Requirement of re-certification**	To be eligible for demand incentive OEMs are mandated to undergo re-certification process for conformity check to obtain certificate of 'FAME II India Phase II eligibility fulfilment' from approved testing agencies in India. Further, the OEMs need to get the certificate in each year to claim the subsidy. This creates and unnecessary administrative bottleneck for OEMs
Gap 7	**Requirement of indigenous component**	FAME –II guideline requires OEMs to use certain percentage of indigenous components to be eligible for availing subsidy. However, the Auto ancillary industry for EVs is at a nascent stage. To have a large number of EVs on road, there is a need for well-developed supply chain of auto components. In absence of the same, the requirement of indigenous components acts as a barrier in realizing the incentives. . Further, limited number of indigenous manufacturers of EV components leads to import of such components thereby driving up the prices of EVs.
Gap 8	**No institution is assigned with responsibility of developing charging Infrastructure**	Uptake of EV and setting-up of charging infrastructure is a chicken and egg problem. FAME-II allocated Rs. 1000 crore as incentive for developing charging infrastructure. However, presently there is no centralised institution which is assigned the responsibility of development of country wide charging infrastructure. In China, the guidance for developing electric vehicle charging infrastructure for 2015–2020 was developed as focused policy document to develop charging infrastructure across country. It has established clear goals for national and regional electric charging infrastructure layout and identified strategic regions for development of charging infrastructure. State Grid Corporation of China, a State-owned electric utility is investing hugely in development of charging infrastructure across country.

3.1.1.2 State policies

Several states have notified their EV policies aimed at promoting manufacturing and increasing demand of electric vehicles in their respective states. Karnataka was the first state to release its EV policy. Till date, a total of eleven states have notified their EV policies viz. Delhi, Uttarakhand, Uttar Pradesh, Madhya Pradesh, Maharashtra, Telangana, Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, and Gujarat.

In the sections below, we will analyse the state policies in detail. Each State policy has been assessed across three levels:

Figure 104 States with notified and draft EV policy



** State Government of Telangana & Gujarat have approved their EV policies, however the final policy is not available in public domain*

Draft EV Policy: Punjab, Bihar, Goa, Odisha, Assam, and Haryana have either published their Draft policies or are in process of drafting

Figure 105 State EV policy analysis framework

3.1.1.2.1 Delhi

Key highlights of "Delhi Electric Vehicles Policy, 2020"

Policy notified: 07 August 2020

Table 16 Key policy guidelines of Delhi EV policy

Key Policy guidelines	
Institutional setup	• Setting-up of **EV Cell** within the transport department for monitoring of effective day-to-day implementation of EV policy • Creation of **State EV Board**, an apex body to implement EV policy
Govt. departments	• Within 1 year **all 4W fleet** of government departments will be **transitioned to EV**
Discoms	• **Facilitate** consumer to **purchase and install** of a Private Charging Point

Key policy targets:

- 25% of new vehicles to be EV by 2024
- Induction of 1000 e-buses by 2020
- Delivery Service provider to go 100% electric by 2025

The EV policy of Delhi focuses primarily on creating demand for EVs. There are no promotional measures taken to provide thrust to supply side actors.

Delhi announced additional incentives (over and above FAME II incentives) on purchase of 2W, 3W and 4W EVs

Snapshot of promotional measures in Delhi's EV policy for EV value chain players is given in Figure 106.

Figure 106 Snapshot of promotional measures for EV value chain players

Category	Value chain players → / Key policy measures	Battery OEMs	Component manufacturers	EV OEMs	Individual/ institutional buyers	EV Charging station	Battery swapping stations
Infrastructure	Allotment of land ★						
	Land at concessional rate ★					Included	Included
	Logistics support ★						
	Plug & Play facility ★						
Fiscal & Non-fiscal incentives	Capital subsidy ★				Included	Included	Included
	Interest subvention ★				Included		
	SGST rebate ★					Included	Included
	Stamp duty exemption						
	Electricity Duty exemption						
	Road tax exemption				Included		
	Subsidized electricity						
	Subsidized water						
	Other fiscal incentives						
	Other non-fiscal incentives				Included		

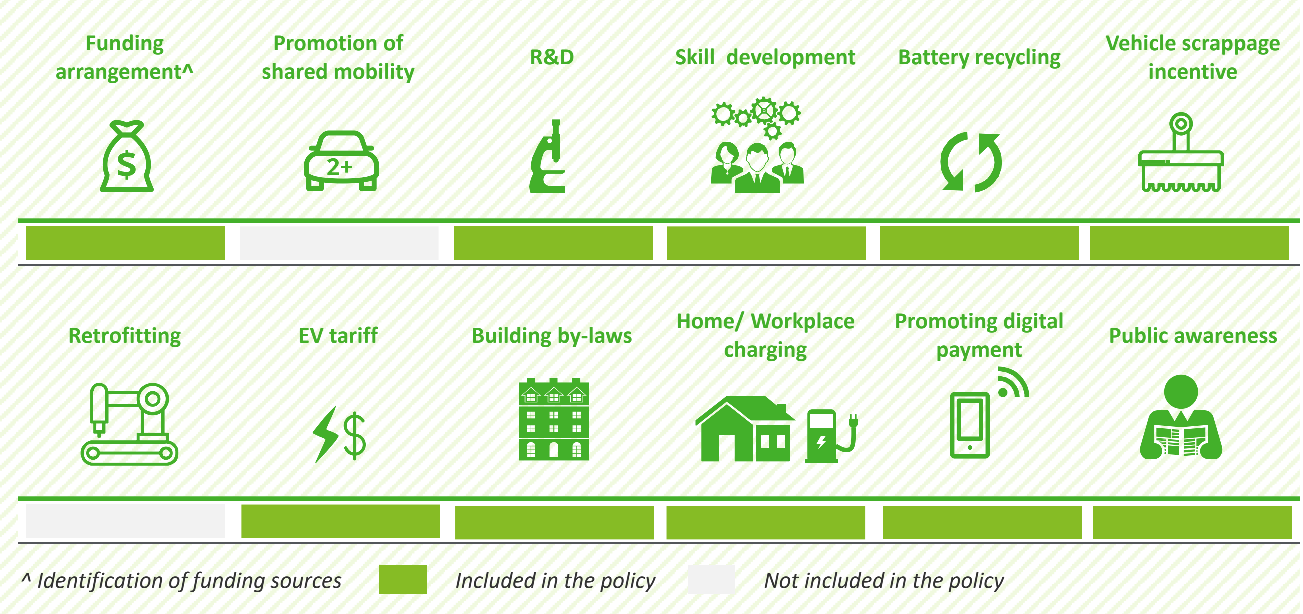
★ *High impact policy measures* ▪ *Included in the policy* ▪ *Not included in the policy*

Source: 75 Note: Non-fiscal incentive is provided to only 3W vehicles in the form of open permit

The EV policy of Delhi is offering purchase incentive to all E-rickshaw or E-cart including models with lead acid batteries as well.

There are several other key promotional measures notified in Delhi's EV policy such as incentives for scrapping, skill development initiatives, battery recycling provisions etc. which is expected to enable creation of the requisite ecosystem for larger uptake of electric mobility.

Figure 107 Other key measures taken by Delhi for uptake of electric mobility



Summary:

- Addressed the gaps of FAME-II, extended **purchase incentive support to private vehicle** owners as well
- **Interest subvention** on loan amount to individual buyer
- **Scrappage incentive**
- Incentive for purchasing equipment for **home/ workplace charging**
- Extended incentives to **e- Carriers**
- Identified **avenues to arrange funds for policy implementation**

- **No definition of roles, responsibilities and powers** of institutions set-up under EV policy
- **Discoms are not mandated** to invest in development of charging infrastructure
- **No support** provided to Charging Infrastructure developer, in expediting administrative approval process such as **single window clearance** system/dedicated help desk
- No focus on **power system upgradation** and augmentation to cater to **EV load**
- **Purchase incentive** to **lead acid battery** based 3W vehicles
- Target to adopt EVs in **one govt. department**
- **Very short policy tenure** which may not be sufficient to provide confidence of business community / consumers
- **Lack of clarity** on **reimbursement procedure** and **time interval** for installation of EV charging stations

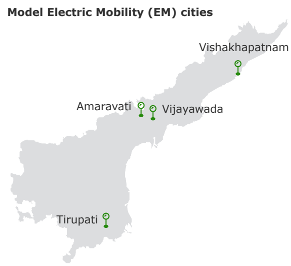
3.1.1.2.2 Andhra Pradesh

Key highlights of Andhra Pradesh "Electric Mobility Policy 2018-23"

Policy notified: 08 June 2018

Table 17 Key policy guidelines of Andhra Pradesh EV policy

Key policy guidelines	
Institutional setup	• Creation of **Smart Mobility Corporation** to coordinate all necessary activities for promoting futuristic needs of transportation
EV adoption for Model cities	• **Model Electric Mobility (EM) cities** to **convert 100%** of all commercial and logistics fleets to electric fleet by 2024
Govt. departments	• **All** government departments' **vehicles** to be converted into **EV** by 2024
Discoms	• To release **connection** to Private Charging Infrastructure (PCI) within **48 hours of application** • To set-up **100 DC charging station** each in 4 Model Electric Mobility (EM) cities - Vijayawada, Vishakhapatnam, Amaravati and Tirupati
Transport Department	• To develop **charging stations** at **depots**, bus **terminals** and **bus stops**

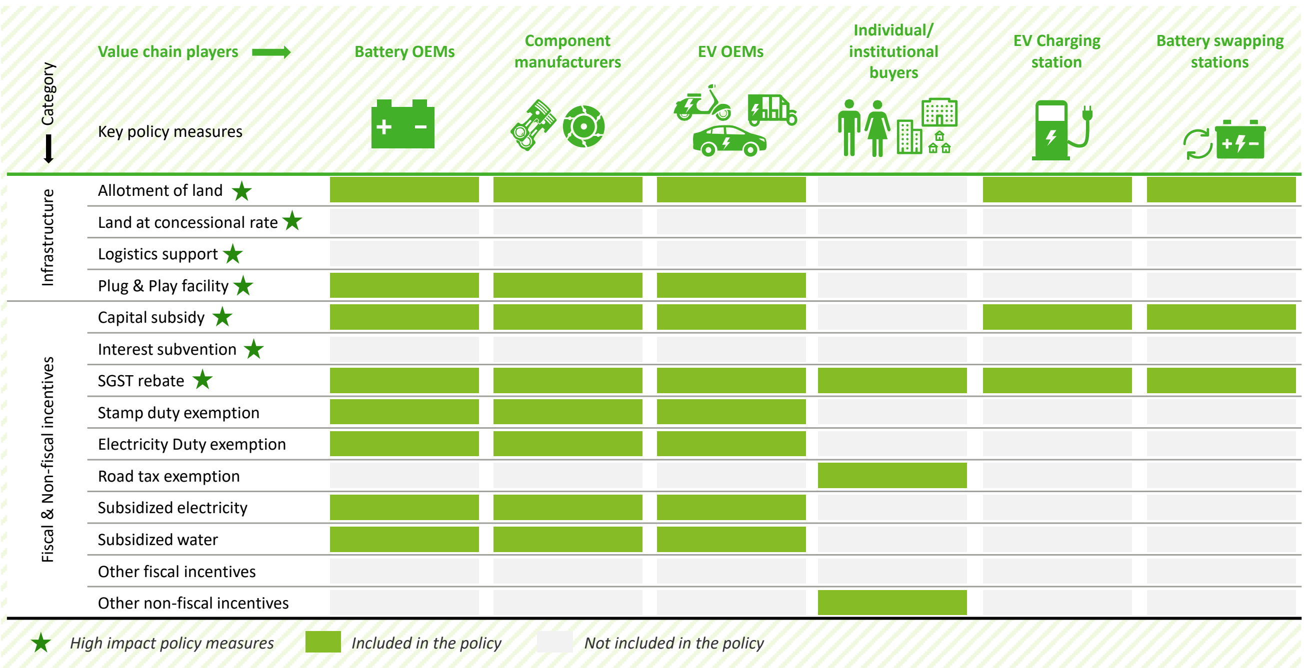


Key policy targets:

- State bus fleet all electric by 2029
- Phasing out of all ICE based commercial fleets and logistic vehicles by 2030

The EV policy of Andhra Pradesh is highly focused in promoting supply (manufacturing) and EV charging stations/ battery swapping stations. The policy does not envisage any subsidy or incentives to the EV buyers.

Figure 108 Snapshot of promotional measures for EV value chain players

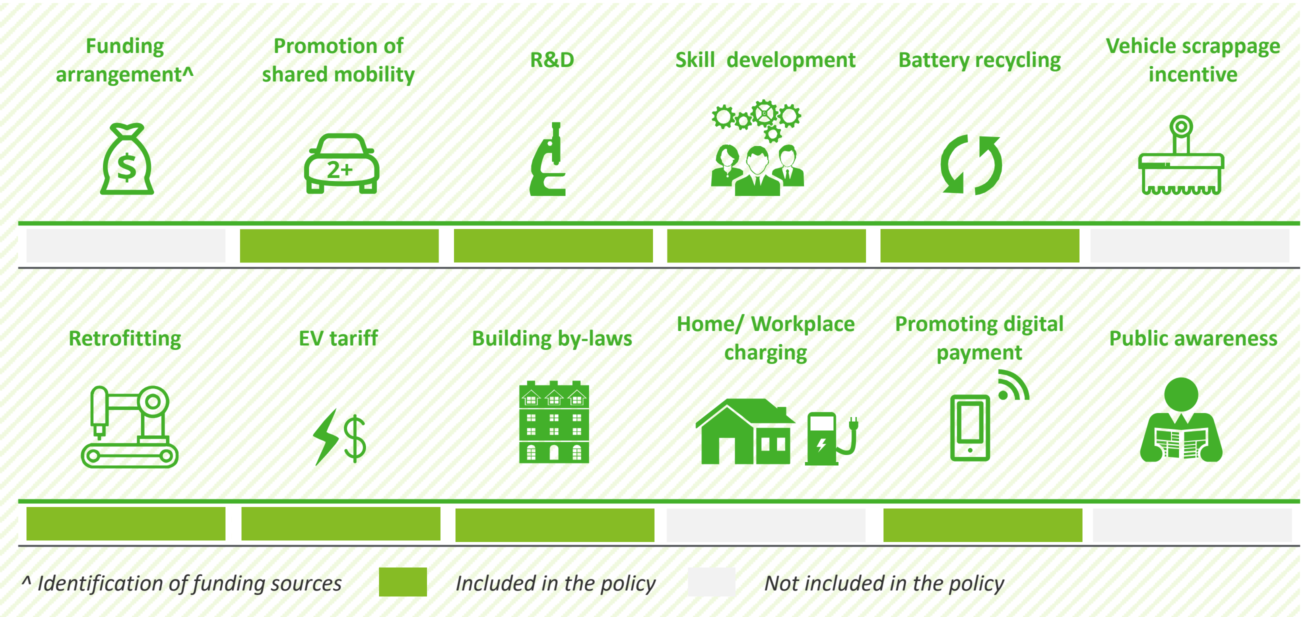


The state of Andhra Pradesh has also promoted V2G (Vehicle-to-grid) for sale of power from EVs and battery swapping stations.

V2G will allow EV owners and battery swapping stations to realize additional revenue by selling power from the batteries to the grid. The policy has directed Electricity Regulatory Commission (APERC) to issue regulations on V2G.

To further promote uptake of electric mobility, Andhra Pradesh has provided for special tariffs for EV charging and has introduced TOU tariffs.

Figure 109 Other key measures taken by Andhra Pradesh for uptake of electric mobility



Summary:

- **Discoms are mandated** to develop charging stations. They are allowed cost recovery through tariffs
- Allocation to the extent of **Rs. 500 Cr.** for R&D has been done
- 4 cities to be developed as Model Electric mobility City with provision to have "**Green Zone**", "**EV only zone**"
- Battery Swapping Stations can provide **ancillary service**
- **EV parks** with plug and play facility to be developed
- Efforts taken to **ease out administrative approval** procedures
- **Stipend** to employees for upskilling on EV related issues

- **No purchase incentive** has been provided (except road tax/registration fees reimbursement)
- **No support** provided to home charging/ workplace charging
- **Doesn't identify** avenues to arrange funds for policy implementation
- **No focus** on public awareness
- No focus on **power system upgradation** and augmentation to cater to **EV load**
- No provision of **single window clearance** system
- Lack of clarity on **reimbursement procedure**, **installation timeline** etc.

3.1.1.2.3 Uttar Pradesh

Key highlights of "Uttar Pradesh Electric Vehicle Manufacturing and Mobility Policy 2019"

Policy notified: 7 August 2019

Table 18 Key policy guidelines of Uttar Pradesh EV policy

Key policy guidelines	
Institutional setup	• Provision of **single window clearance** system and single sanction of reimbursement, subsidies, etc. under the policy
Space for EV charging	• **Public parking spaces** mandated to have charging stations • New commercial complexes, housing societies and residential townships will be **mandated** to have **EV charging**
Govt. departments	• All forms of **government vehicles** to be converted to **electric vehicles** by 2024
Discoms	• **Discom** to **release supply** to charging/battery swapping stations **within 15 days** of application • **Discom** to **invest** in **setting up** both **slow and fast charging** networks in government buildings and other public places (to **setup 100 DC** public charging stations)
Transport Department	• State **bus depots**, bus **terminals** and bus **stops** will have charging stations

Model Electric Mobility (EM) cities

Key policy targets:

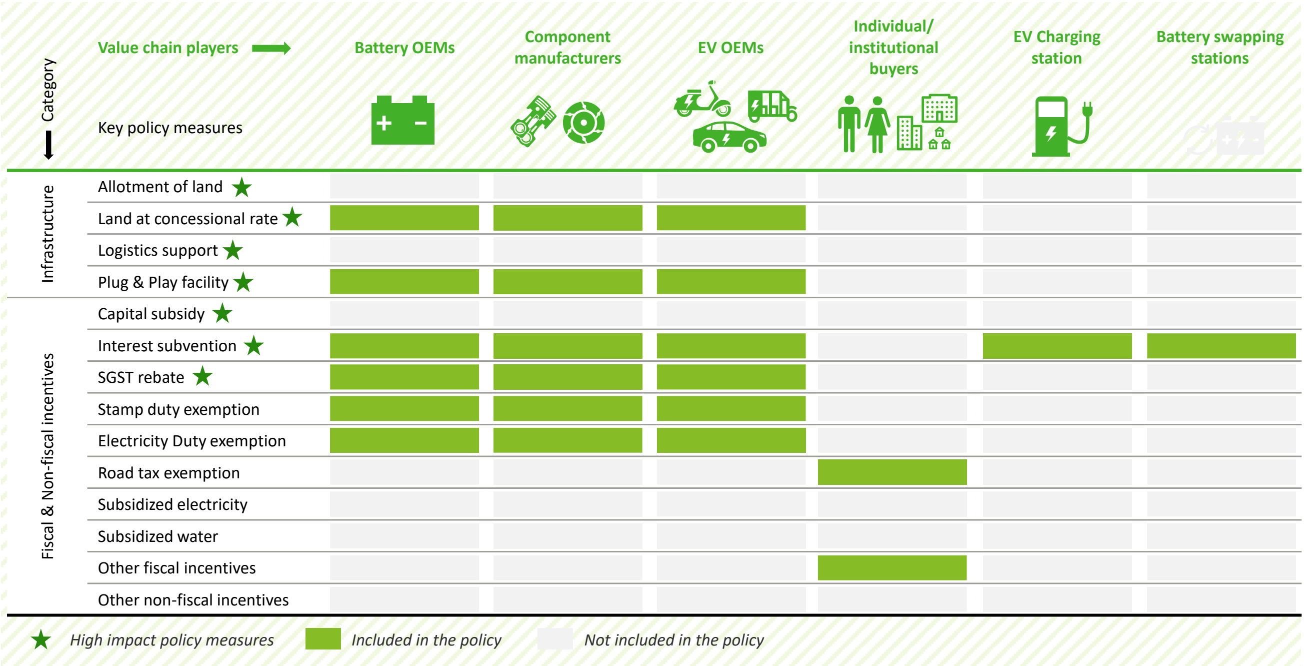
- 10 Lakh EVs by 2024
- 5 GWh storage manufacturing in next 5 years
- 2 lakh EV charging and swapping stations by 2024
- Induction of 1000 e-buses by 2030

The State policy provides multiple supporting measures for manufacturing of EVs and other associated components. For charging infrastructure, the policy offers capital subsidy of up to 25% which excludes the cost of land.

Uttar Pradesh EV policy provides exemption from registration fees and road tax for EV buyers, however it is only applicable to the vehicles which are manufactured in the state itself

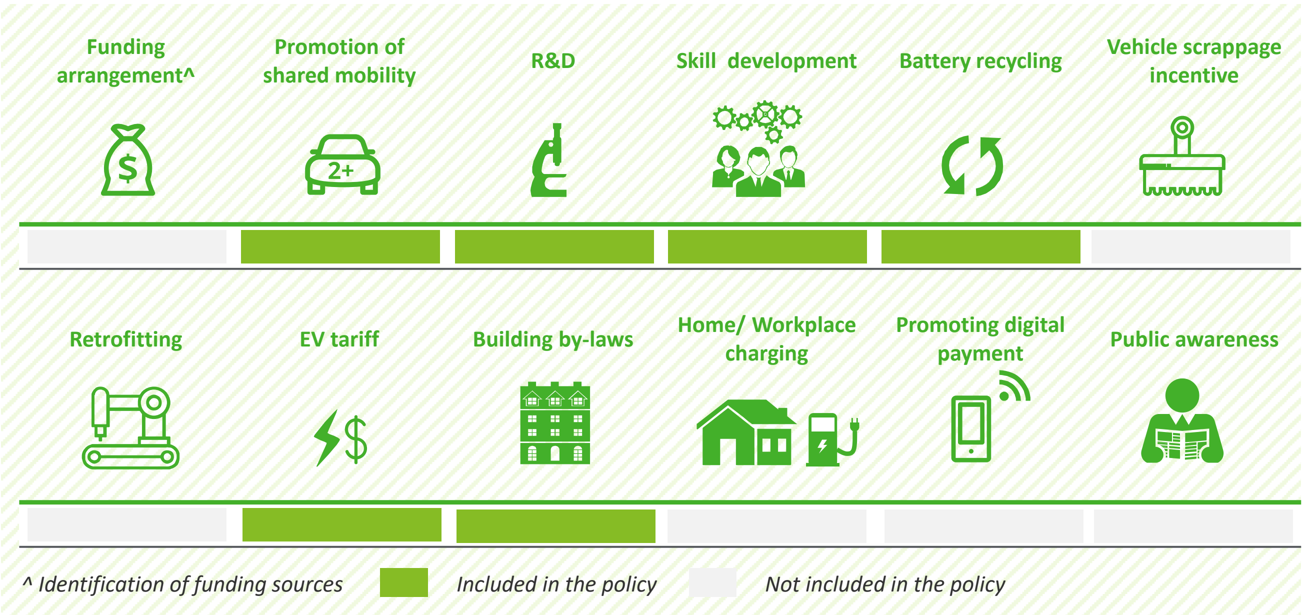
The state also aims to promote development and use of **Hydrogen powered fuel cells**. Under the policy, the state aims at incentivising manufacturing of Hydrogen-powered fuel cells and would allow private developers to setup hydrogen stations. Such developers will receive 50% capital subsidy (excluding land) to setup refuelling infrastructure.

Figure 110 Snapshot of promotional measures for EV value chain players



In addition to the above measures, Uttar Pradesh has announced to introduce Special Power Tariff Policy to facilitate low-cost EV charging along with TOU tariff for vehicle charging. The state also envisages to focus on upskilling its manpower on EV technology and promote R&D on next generation battery chemistries, fuel cell systems, powertrains, automotive electronics and electrical road systems (ERS).

Figure 111 Other key measures taken by Uttar Pradesh for uptake of electric mobility



Summary:

- **25% Capital subsidy** on development of EV charging infrastructure

- Vehicle registration and road tax exemption is only provided to vehicles **manufactured in the state** of Uttar Pradesh

- **Parking spaces** are **mandated** to install charging stations
- Discom to **release connection** for supply to charging/ battery swapping station within **15 days** of installation
- New EV enabling **building codes** for 10 EM cities
- **Interest subvention** to EV and associated component manufacturers
- **Incentives** to **battery recycling** units

- **No capital subsidy** in addition to FAME II scheme for buyers
- No policy incentive for **scrapping** or provision for **retrofitting**
- No promotion of **home/workplace charging**
- No focus on **power system upgradation** and augmentation to cater **EV load** (through network flow study)

3.1.1.2.4 Maharashtra

Key highlights of "Maharashtra's Electric Vehicle Policy - 2018"

Policy notified: 14 February 2018

Table 19 Key policy guidelines of Maharashtra EV policy

Key policy guidelines	
Institutional setup	• **High powered committee** to be constituted at the state level to **monitor the implementation of policy**, and develop procedures and modalities where required (Committee composition is provided)
Location of charging infrastructure	• **Common charging points** in residential areas, societies, bus depots, public parking areas, and fuel pumps is allowed as per the policy
Govt. departments	• **Development Control Rules (DCR)** of local self-government and special planning authorities to be suitably modified in order to allow setting up of public charging infrastructure
Discoms	• Discoms to **grant permission** to the charging station within **15 days**

Key policy targets:

- 5 Lakh EVs in the state by the end of policy period
- Employment to 1 Lakh people
- INR 25,000 Cr investment in electric mobility space

The EV policy proposes to setup a high powered committee which will further decide the fiscal and non-fiscal incentives applicable for EVs and associated component manufacturers.

Figure 112 Snapshot of promotional measures for EV value chain players

Category	Value chain players → / Key policy measures	Battery OEMs	Component manufacturers	EV OEMs	Individual/ institutional buyers	EV Charging station	Battery swapping stations
Infrastructure	Allotment of land ★	Not included	Not included	Not included	Not included	Not included	Not included
	Land at concessional rate ★	Not included	Not included	Not included	Not included	Not included	Not included
	Logistics support ★	Not included	Not included	Not included	Not included	Not included	Not included
	Plug & Play facility ★	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Capital subsidy ★	Not included	Not included	Not included	Included	Included	Not included
	Interest subvention ★	Included	Included	Included	Not included	Not included	Not included
	SGST rebate ★	Not included	Not included	Not included	Not included	Not included	Not included
	Stamp duty exemption	Included	Included	Included	Not included	Not included	Not included
	Electricity Duty exemption	Included	Included	Included	Not included	Not included	Not included
	Road tax exemption	Not included	Not included	Not included	Included	Not included	Not included
	Subsidized electricity	Included	Included	Included	Not included	Not included	Not included
	Subsidized water	Not included	Not included	Not included	Not included	Not included	Not included
	Other fiscal incentives	Included	Included	Included	Included	Not included	Not included
	Other non-fiscal incentives	Not included	Not included	Not included	Not included	Not included	Not included

★ *High impact policy measures* *Included in the policy* *Not included in the policy*

Note: The fiscal and non-fiscal incentives to the manufacturers will be on approval from High Power Committee

Maharashtra's EV policy, however, lacks in addressing support towards scrappage activities, battery recycling, home or workplace charging, etc. Also, no special tariff for EVs has been mentioned in the policy.

Figure 113 Other key measures taken by Maharashtra for uptake of electric mobility

Funding arrangement^	Promotion of shared mobility	R&D	Skill development	Battery recycling	Vehicle scrappage incentive
Not included	Included	Included	Included	Not included	Not included

Retrofitting	EV tariff	Building by-laws	Home/ Workplace charging	Promoting digital payment	Public awareness
Not included	Not included	Not included	Not included	Not included	Not included

^ *Identification of funding sources* *Included in the policy* *Not included in the policy*

Summary:

- **Interest subsidy** for EV and associated component manufacturers
- **Capital subsidy** on purchase of EVs

- No provision of **public awareness**
- No policy incentive for **scrapping** or provision for **retrofitting**

- **25% capital subsidy** on development of **charging infrastructure**
- **Training-based certification** and placement programmes for skill development
- **Establishment of center** of excellence for R&D

- No promotion of **home/workplace charging**
- No focus on **power system upgradation** and augmentation to cater **EV load**
- No provision of **land allotment** for charging infrastructure business
- No provision of **single window clearance** system
- Lack of clarity on **reimbursement procedure**, **installation timeline** etc.

3.1.1.2.5 Uttarakhand

Key highlights of Uttarakhand EV Policy 2019

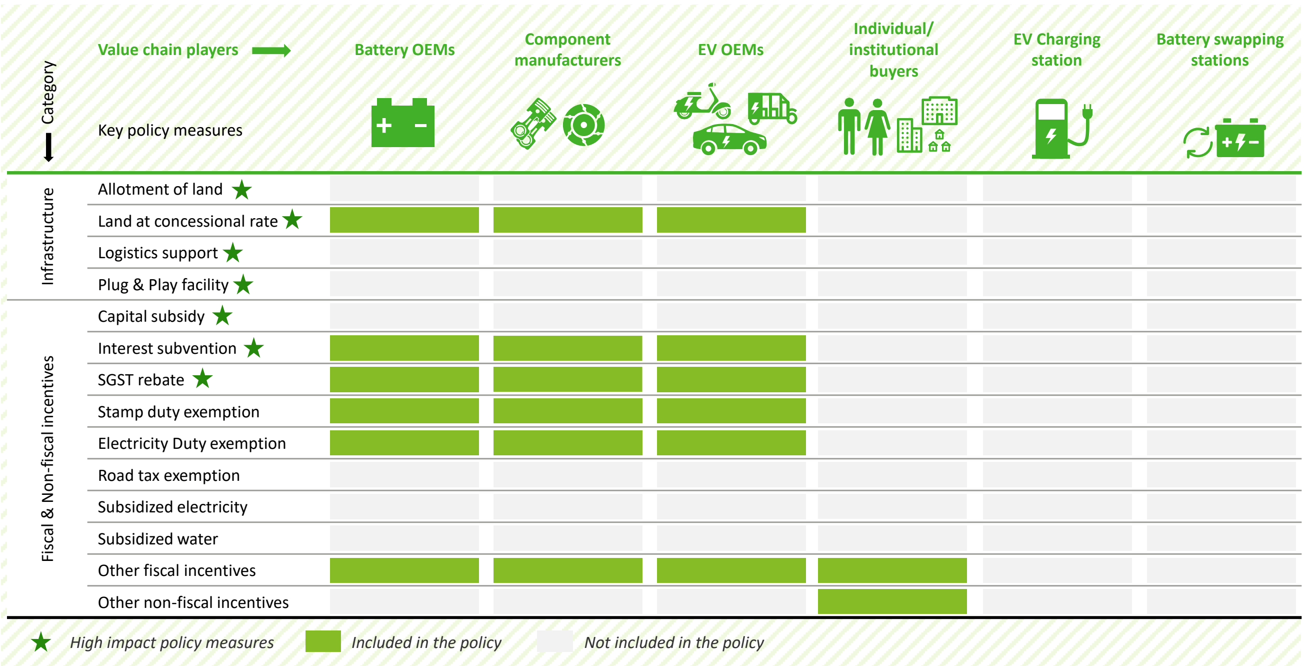
Policy notified: 02 December 2019

Table 20 Key policy guidelines of Uttarakhand EV policy

Key policy guidelines	
Institutional setup	• **Nodal agency** for the policy will be Industries Department, Uttarakhand and State Infrastructure & Industrial Development Corporation of Uttarakhand (SIIDCUL)

Uttarakhand state policy offers significant support to manufacturing of EV components in the state. Along with this, buyers will also receive exemption from Motor Yan tax and commercial vehicles will receive exemption from carriage permit.

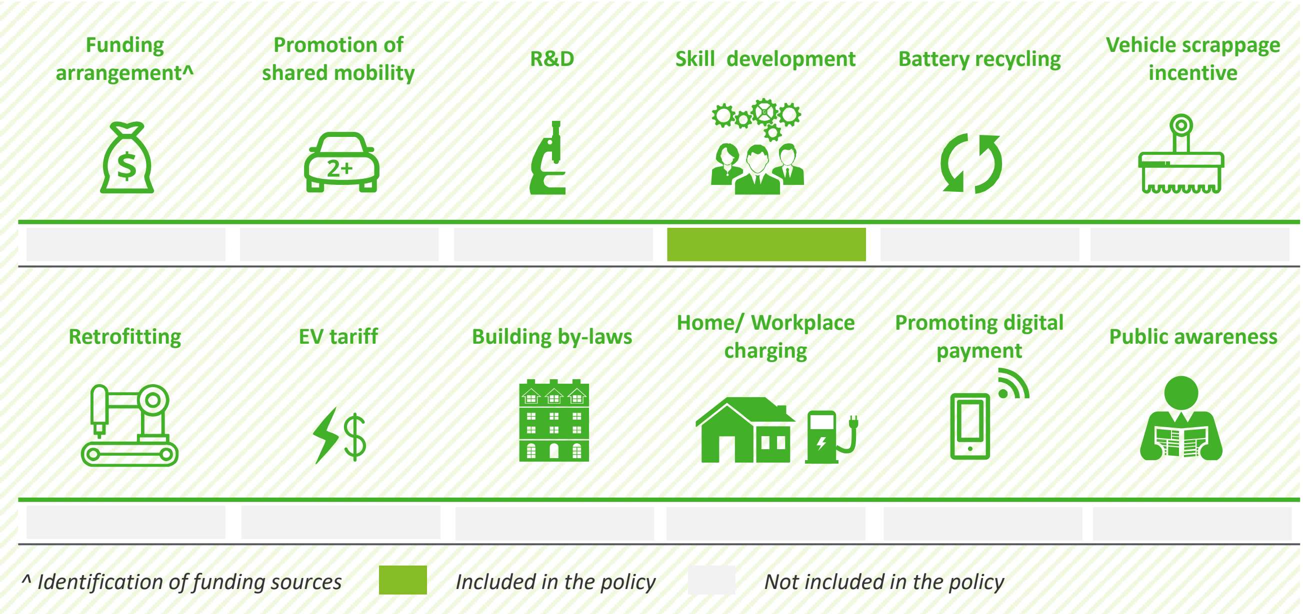
Figure 114 Snapshot of promotional measures for EV value chain players



Note: Other fiscal incentive for manufacturers is EPF reimbursement; for buyers it is exemption from paying Motor Yan tax; Other non-fiscal incentive for buyers is receiving priority is attaining route permit

Along with supporting manufacturing of EVs, the state would also provide financial support to the organizations who wish to upskill their manpower on EV related aspects.

Figure 115 Other key measures taken by Uttarakhand for uptake of electric mobility



Summary:

- **Land at concessional rate** for EV or component manufacturers
- Provision for **interest subvention** for manufacturers
- **Stamp duty and electricity duty exemption** for manufacturers
- **Training reimbursement** for organizations involved in upskilling workers
- **50% EPF reimbursement** for 10 years for employing 100+ skilled/semi-skilled workers

- No focus on **power system upgradation** and augmentation to cater **EV load**
- No provision for **incentivizing EV charging stations** or battery swapping stations
- No EV **purchase subsidy**
- No incentives for **scrapping** or provision for **retrofitting**
- No provision for **battery recycling**
- No provision for **R&D** in electric mobility

3.1.1.2.6 Karnataka

Key highlights of "Karnataka Electric Vehicle & Energy Storage Policy 2017"

Policy notified: 25 September 2017

Table 21 Key policy guidelines of Karnataka EV policy

Key policy guidelines	
Institutional setup	• **Karnataka Udyog Mitra** to facilitate EV/Battery/Charging Equipment manufacturer in taking clearances from environment, labour and other departments • **Technical committee** to be set-up to **certify the EV component** manufacturer including EV Li-ion battery supplier claiming incentive and concession under the policy
Discoms	• To examine **permitting use of renewable energy** at low connection cost and offer zero wheeling charges by EV charging station
Transport Department	• Selected **state transport corporations** to **introduce 1,000 EV buses** during the policy period

Key policy targets:

100% fleet and commercial electric mobility in Bangalore by 2030

To set Fast charging station/Battery swapping station at every 50 km on highways

The EV policy of Karnataka aims to offer fiscal support towards manufacturing of EV charging stations, however, there are not adequate demand-side incentives to boost sales of EVs.

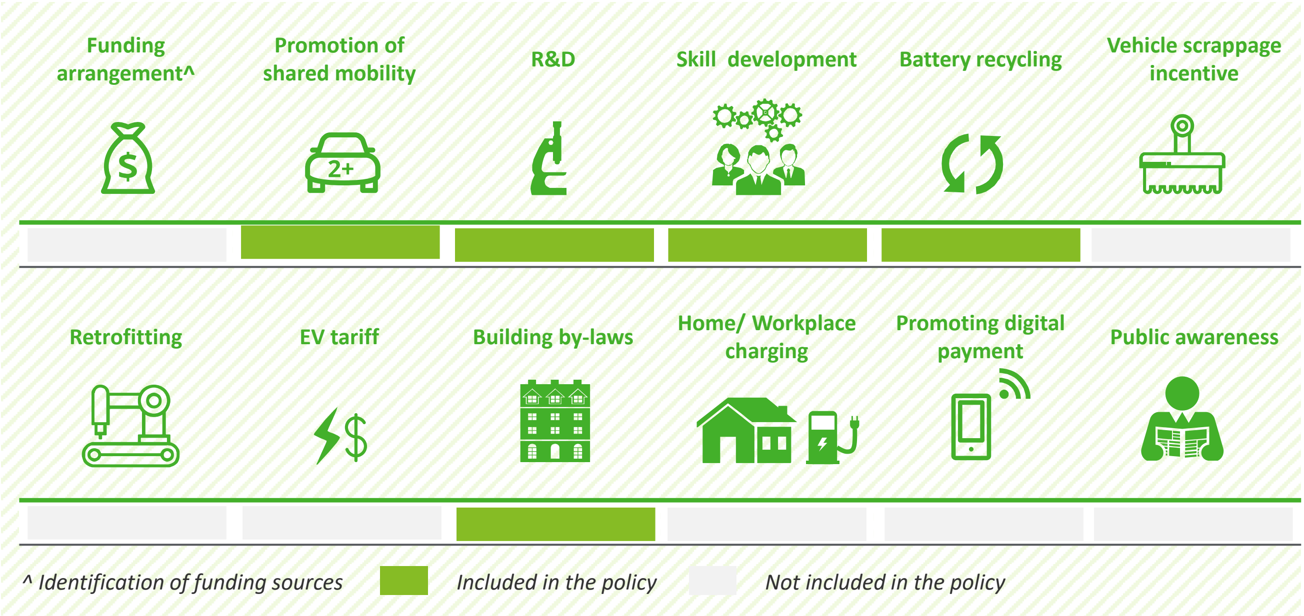
Figure 116 Snapshot of promotional measures for EV value chain players

Category	Key policy measures	Battery OEMs	Component manufacturers	EV OEMs	Individual/ institutional buyers	EV Charging station	Battery swapping stations
Infrastructure	Allotment of land ★					Included	Included
Infrastructure	Land at concessional rate ★						
Infrastructure	Logistics support ★						
Infrastructure	Plug & Play facility ★	Included	Included	Included			
Fiscal & Non-fiscal incentives	Capital subsidy ★	Included	Included	Included		Included	Included
Fiscal & Non-fiscal incentives	Interest subvention ★						
Fiscal & Non-fiscal incentives	SGST rebate ★					Included	Included
Fiscal & Non-fiscal incentives	Stamp duty exemption	Included	Included	Included		Included	Included
Fiscal & Non-fiscal incentives	Electricity Duty exemption	Included	Included	Included		Included	Included
Fiscal & Non-fiscal incentives	Road tax exemption						
Fiscal & Non-fiscal incentives	Subsidized electricity						
Fiscal & Non-fiscal incentives	Subsidized water						
Fiscal & Non-fiscal incentives	Other fiscal incentives	Included	Included	Included	Included		
Fiscal & Non-fiscal incentives	Other non-fiscal incentives						

★ *High impact policy measures*   *Included in the policy*   *Not included in the policy*

The state policy also focuses on promoting shared mobility and mandates parking spaces under its building by-laws. It also envisages focus on upskilling its manpower and promoting R&D in electric mobility space.

Figure 117 Other key measures taken by Karnataka for uptake of electric mobility



Summary:

- **Zero wheeling charges** for EV charging station procuring renewable power
- **EV parks** with plug and play facility
- Setting-up **Udyog Mitra** to **ease out administrative approval** procedures
- Provides **clarity on incentive disbursement mechanism** to manufacturer through **Technical Committee**
- **SPV** of municipal corporation, discom, transport company, industrial board and renewable energy company to develop charging infrastructure **(improved coordination process)**
- Plan to deploy used EV batteries for solar application **(clarity on battery lifecycle management)**
- **Stipend and in-plant training** for upskilling

- **No purchase incentive** has been provided for EV purchase (except reimbursement of vehicle taxes)
- **No support** provided to home charging/ workplace charging
- **Doesn't identify** avenues to arrange funds for policy implementation
- **No focus** on public awareness
- **No mandate** for inducting EVs in government offices/departments
- **No focus** to develop slow charging stations
- No focus on **power system upgradation** and augmentation to cater to **EV load**

3.1.1.2.7 Madhya Pradesh

Key highlights of "Madhya Pradesh Electric Vehicle (EV) Policy 2019"

Policy notified: 01 November 2019

Table 22 Key policy guidelines of Madhya Pradesh EV policy

Key policy guidelines	
Institutional setup	• Madhya Pradesh Urban Development & Housing Department (UDHD) will be the **nodal department** for the implementation of the policy • Government of Madhya Pradesh (GoMP) will **setup** a **high level committee** consisting of stakeholders from all concerned departments • **State Electric Mobility Board** (Madhya Pradesh Electric Mobility Board "MPEMB") shall be constituted as the apex body for **effective implementation of the policy**
Govt. department	• All forms of **Government vehicles**, including vehicles under Government Corporations, Boards and Government Ambulances etc. will be **converted to electric vehicles by 2028**
Electricity regulator	• MPERC to issue **regulations**, defining **tariff** and related terms and conditions, for **Vehicle-to-Grid (V2G)** sale of power to meet the requirements of real time and ancillary services for DISCOM • Sale of power from **battery swapping stations** to the grid will also be considered as **V2G** sale of power
Discoms	• Discoms to **invest** in **setting up both slow and fast charging networks** in government buildings and other public places • Discoms allowed to **recover expenses** done in setting-up of **charging infrastructure** as part of ARR • Discoms shall **release supply** to charging/battery swapping stations within **48 hours of application**
Transport Department	• Inter State Bus Terminals (ISBT), bus terminals and bus stops will have **charging stations**
Space for EV charging	• Municipal Corporations Public parking spaces will be mandated to have charging stations. • All **new permits** for **commercial complexes**, housing societies and residential townships with a built-up area 5,000 sq.mt and above will **mandatorily** have a **charging stations**

Key policy targets:

- 25% of all new public transport vehicles registrations by 2026
- Convert 100% of all commercial and logistics fleets to electric fleet by 2028
- Convert 100% of public transport bus fleet into electric buses

MP's EV policy does not provide adequate push at the supply as well as demand side of EVs. However, it provides for land at concessional rates to manufacturing facilities along with providing grants for R&D. EV buyers are not provided with any subsidy.

Figure 118 Snapshot of promotional measures for EV value chain players

Category	Key policy measures	Battery OEMs	Component manufacturers	EV OEMs	Individual/ institutional buyers	EV Charging station	Battery swapping stations
Infrastructure	Allotment of land ★	Not included	Not included	Not included	Not included	Included	Included
Infrastructure	Land at concessional rate ★	Included	Included	Included	Not included	Not included	Not included
Infrastructure	Logistics support ★	Not included	Not included	Not included	Not included	Not included	Not included
Infrastructure	Plug & Play facility ★	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Capital subsidy ★	Not included	Not included	Not included	Not included	Included	Included
Fiscal & Non-fiscal incentives	Interest subvention ★	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	SGST rebate ★	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Stamp duty exemption	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Electricity Duty exemption	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Road tax exemption	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Subsidized electricity	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Subsidized water	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Other fiscal incentives	Included	Included	Included	Included	Not included	Not included
Fiscal & Non-fiscal incentives	Other non-fiscal incentives	Not included	Not included	Not included	Included	Not included	Not included

★ *High impact policy measures* | *Included in the policy* | *Not included in the policy*

Madhya Pradesh included the provision of Electric Mobility Bonds by ULBs to ensure sufficient funding in the electric mobility sector. The state is also promoting recycling of batteries and provides incentives for vehicle scrappage.

Figure 119 Other key measures taken by Madhya Pradesh for uptake of electric mobility

Funding arrangement^	Included
Promotion of shared mobility	Included
R&D	Included
Skill development	Included
Battery recycling	Included
Vehicle scrappage incentive	Included
Retrofitting	Not included
EV tariff	Included
Building by-laws	Included
Home/ Workplace charging	Not included
Promoting digital payment	Included
Public awareness	Not included

^ *Identification of funding sources* | *Included in the policy* | *Not included in the policy*

Summary:

- **Online portal** for applying for EV related incentives
- Battery Swapping Station can provide **real time and ancillary service** to have additional revenue stream

- **No purchase incentive** has been provided for EV purchase (except road tax/registration fees reimbursement/parking fees waiver)

- **Net Metering** for Energy Operators (EOs) and Battery Swapping Operators (BSOs) who set up captive renewable energy facilities
- State Electric Mobility Board having **cross-department representations** for effective implementation of policy
- **Mandate** for govt. department for EV adoption
- **Discoms are mandated** to develop charging stations and are allowed to recover expenses through tariff
- **Allowed to establish and run public amenities** like cafeteria, public toilets and outdoor media devices at **charging station**
- Identified avenues to arrange funds for policy implementation **(Electric Mobility Bonds)**
- "**E-Zones**" with entry only to non-fossil fuel based vehicles in Smart Cities
- **Plan to stop registering new Auto** (ICE vehicles) in a phased manner
- **Re-skilling of ICE vehicle mechanics/ Job fairs** at skilling center

- **No support** provided to home charging/ workplace charging
- **Vehicle scrappage incentive limited to buses**
- **No plan to provide plug and facility to** attract EV manufacturer and component manufacturer
- No focus on **power system upgradation** and augmentation to cater **EV load**

3.1.1.2.8 Kerala

Key highlights of "Policy on Electric Vehicles for the State of Kerala"

Policy notified: 10 March 2019

Table 23 Key policy guidelines of Kerala EV policy

Key policy guidelines	
Institutional setup	• **Technical Advisory committee** - Mobility State Level Task Force (e-MobSLTF) will be set up by Government. Committee shall define and **strategize** the policy for development of sector. Committee shall **scrutinize** the technology adoption and manufacturing proposal and **recommend** the Government for its adoption
Discoms	• Discom to **set-up fast charging station** and **battery swapping station** in PPP mode • Discom to **set-up slow AC charging station** on street and parking lots with Standard 15A outlet for slow charging (Charging station 20 each in Trivandrum, Ernakulum and Kozhikode) • Discom to **set-up Battery Swapping Station**, swapping operation to be done by independent player selected through transparent bidding process (150 battery

Key policy targets:

- 1 million EVs on road by 2022
- Replacing existing 6000+ buses with e-buses by 2025

	swapping station in Trivandrum, Ernakulum and Kozhikode)

The policy extends support to EV manufacturers and buyers, however no fiscal or non-fiscal support is provided to the EV charging or battery swapping operators.

Figure 120 Snapshot of promotional measures for EV value chain players

Category	Key policy measures (Value chain players →)	Battery OEMs	Component manufacturers	EV OEMs	Individual/ institutional buyers	EV Charging station	Battery swapping stations
Infrastructure	Allotment of land ★	Not included	Not included	Not included	Not included	Not included	Not included
Infrastructure	Land at concessional rate ★	Not included	Not included	Not included	Not included	Not included	Not included
Infrastructure	Logistics support ★	Not included	Not included	Not included	Not included	Not included	Not included
Infrastructure	Plug & Play facility ★	Included	Included	Included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Capital subsidy ★	Included	Included	Included	Included	Not included	Not included
Fiscal & Non-fiscal incentives	Interest subvention ★	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	SGST rebate ★	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Stamp duty exemption	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Electricity Duty exemption	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Road tax exemption	Not included	Not included	Not included	Included	Not included	Not included
Fiscal & Non-fiscal incentives	Subsidized electricity	Included	Included	Included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Subsidized water	Not included	Not included	Not included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Other fiscal incentives	Included	Included	Included	Not included	Not included	Not included
Fiscal & Non-fiscal incentives	Other non-fiscal incentives	Not included	Not included	Not included	Included	Not included	Not included

★ *High impact policy measures* | *Included in the policy* | *Not included in the policy*

Note: Capital subsidy is only given to 3W only

The state policy includes provision for special tariff for EVs including promotion of home or workplace charging. The state is also promoting skill development and R&D in EV space. Along with these, Kerala announced no new registration of ICE vehicles in certain cities of the state.

Figure 121 Other key measures taken by Kerala for uptake of electric mobility

Funding arrangement^	Promotion of shared mobility	R&D	Skill development	Battery recycling	Vehicle scrappage incentive
Not included	Not included	Included	Included	Not included	Not included

Retrofitting	EV tariff	Building by-laws	Home/ Workplace charging	Promoting digital payment	Public awareness
Not included	Included	Not included	Included	Included	Not included

^ Identification of funding sources | *Included in the policy* | *Not included in the policy*

Summary:

- Plan for mandating certain cities to convert all 4W as EV by enforcing them as '**Pollution free Zone'**
- **Mandate for Discom** to set-up charging station and battery swapping station in PPP mode
- Plan to set-up **fund for technology acquisition**
- **EV parks** with plug and facility
- **'electric mobility zone'** in certain pilot region such as tourist villages/spots, technology hubs
- **Plan to stop registering new Auto** (ICE vehicles) in certain cities

- **No clarity on recovery of expense made by Discoms** in developing of charging infrastructure
- **Purchase incentive** is **limited to only 3W**
- **Interest subvention** on loan **is limited to Government employees** only
- **No support** provided to home charging/ workplace charging
- **Doesn't identified** avenues to arrange funds for policy implementation
- **No focus** on public awareness
- **No mandate** for inducting EVs in government offices/departments
- **No vehicle scrappage policy**
- **No provision to have single window clearance system/dedicated help desk** to expedite Administrative approval
- **No plan to amend building bye-laws** to enable home/workplace charging
- No focus on **power system upgradation** and augmentation to cater **EV load** (through network flow study)

3.1.1.2.9 Tamil Nadu

Key highlights of "Tamil Nadu Electric Vehicle Policy 2019"

Policy notified: 16 September 2019

Table 24 Key policy guidelines of Tamil Nadu EV policy

Key policy guidelines	
Institutional setup	• **Tamil Nadu Industrial Guidance and Export Promotion Bureau** will be set-up for **sanctioning** of incentives provided by Government to Industries • All investment proposals under the EV sector will be provided the **necessary facilitation** through the **Single Window Clearance** facility • Created a **high-level Steering Committee** formed to monitor the implementation of the policy
Industries Department	• The Industries Department will be the **nodal department** for the implementation of all manufacturing related incentives

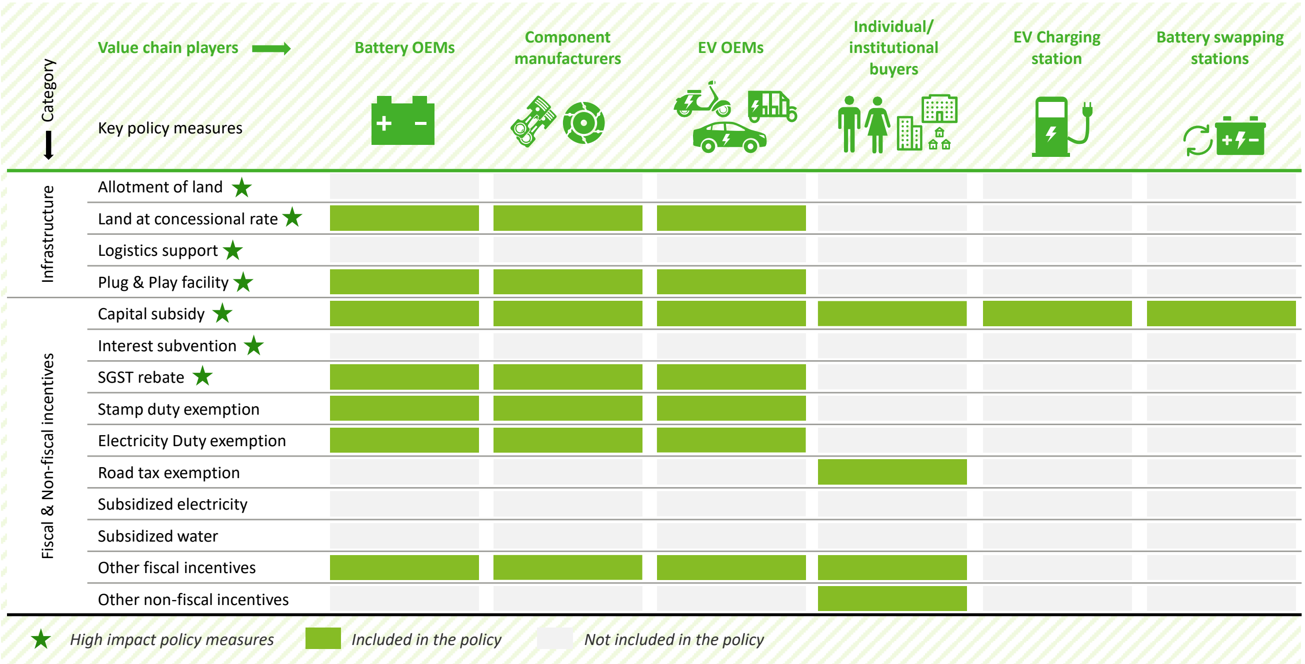
Key policy targets:

- Commercial fleets are encouraged to convert into EV
- Introduce 1000 new e-buses every year

Energy department	• The Energy Department will ensure that **public and private charging station** are provided with all **necessary facilitation** and incentive
Discoms	• State Discom to invest in **setting up both Slow and fast charging networks** in Government buildings and other public places
Transport Department	• Shall act as **nodal department** for **issuing guidelines** to achieve the other objective of EV policy

Tamil Nadu's EV policy greatly supports EVs and component manufacturers and provides various incentives to EV buyers. The EV charging station owners would receive capital subsidy on setting up of charging stations.

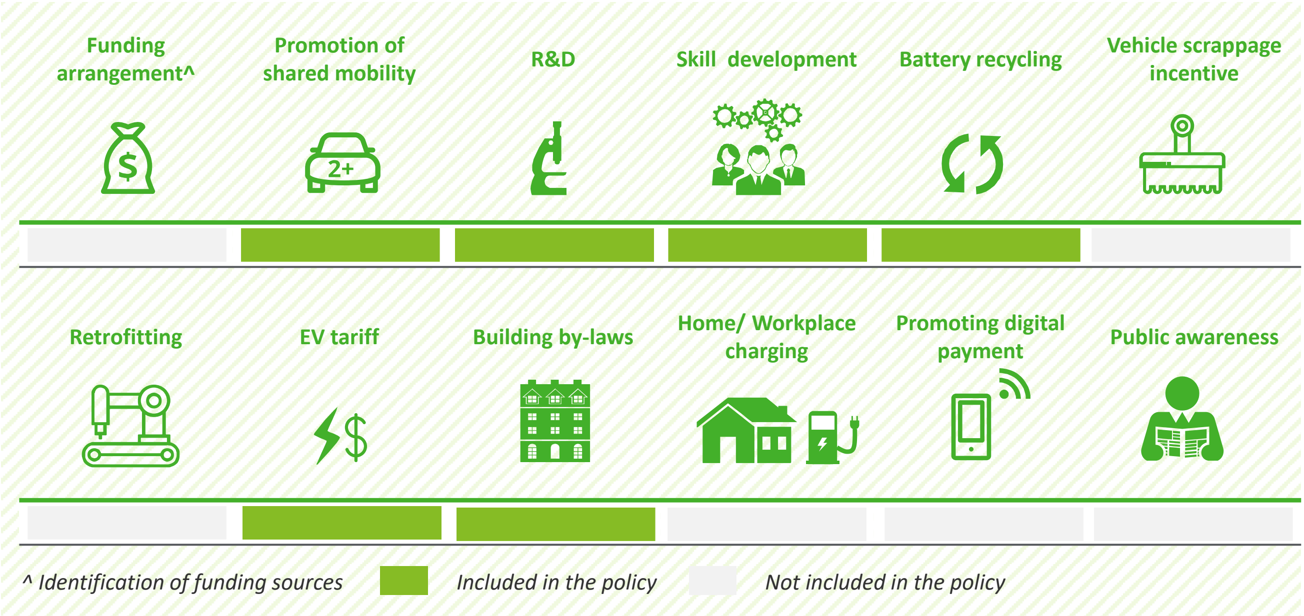
Figure 122 Snapshot of promotional measures for EV value chain players



Note: Capital subsidy is given only on purchase of e-buses

Tamil Nadu is also promoting shared mobility in the state. The policy has provided for special tariff for charging of EVs and its building by-laws have made it mandatory to allow adequate space for EV chargers. The state also aims to focus on R&D and skill development in electric mobility space.

Figure 123 Other key measures taken by Tamil Nadu for uptake of electric mobility



Summary:

- **Single Window Clearance** facility for all investment proposals under the EV sector
- **Discoms are mandated** to develop charging stations
- High-level Steering Committee having **cross-department representations** for effective implementation of policy
- **Responsibility division among department** (separate nodal Department for charging infra development, manufacturing facilitation and EV policy implementation)
- Plan to provide **capital subsidy** for development of **Public Charging Stations**
- **Interest subvention on loan** for Medium Industries. Additional **capital subsidy** for MSME
- **Reimbursement of employer's contribution to the EPF** for all new jobs created till 2025
- **One-time Re-skilling allowance** for existing employees
- **Logistic Parks** and Free Trade/Warehousing Zones for better inventory management
- **EV parks** with plug and facility
- EV **Venture Capital Fund** to offer financial support to EV start-ups
- **Long policy tenure** (10 years), help in providing long term stability of policy terms and building confidence among investors

- **No clarity on recovery of expense made by Discoms** in developing of charging infrastructure
- **Purchase incentive** is **limited to only buses**
- **Commercial tariff** applicability for EV charging
- **No vehicle scrappage incentive**
- **No support** provided to home charging/ workplace charging
- **Doesn't identify** avenues to arrange funds for policy implementation
- **No focus** on public awareness
- No focus on **power system upgradation** and augmentation to cater **EV load** (through network flow study)

3.1.1.2.10 Bihar

Key highlights of "Draft Bihar Electric Vehicle Policy 2019"

Draft policy issued: 08 March 2019

Bihar has issued a draft EV policy on March 2019 with a tenure of five years. The policy does not have any guidelines for institutional setup or any mandate for any government department to promote electric mobility.

Key policy targets:

- 100% electric mobility by 2030
- 100% e-rickshaw by 2022

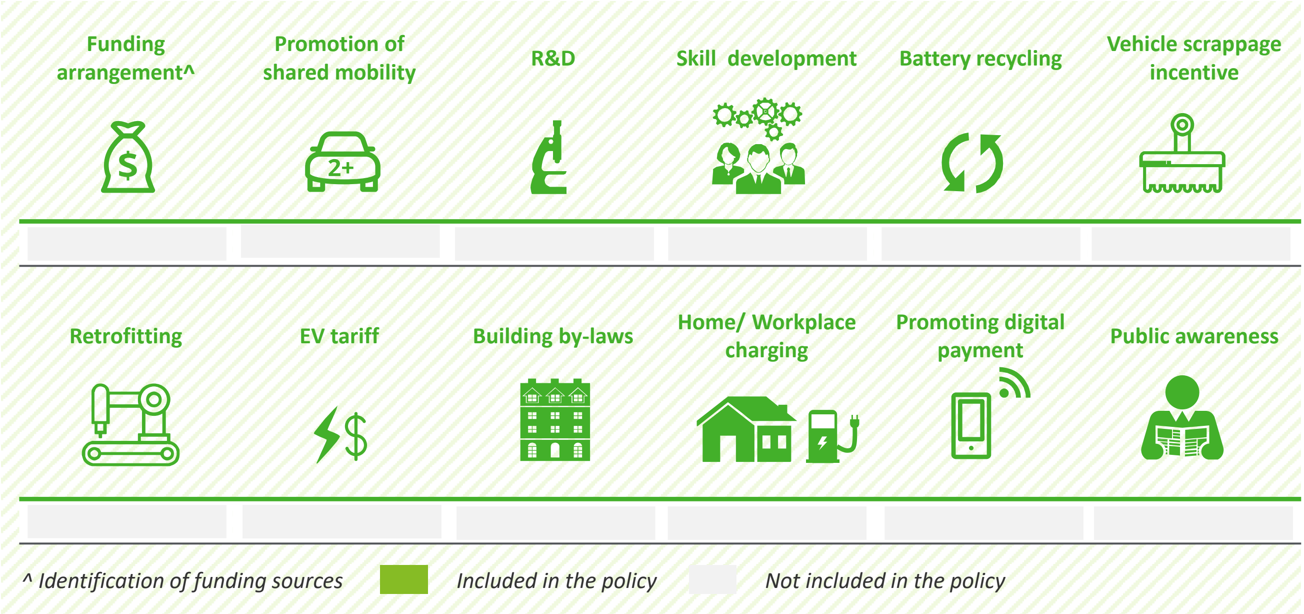
However, the state policy provides several fiscal and non-fiscal incentives to EV OEMs, component manufacturers, EV buyers and charging station operators.

Figure 124 Snapshot of promotional measures for EV value chain players

Category	Key policy measures	Battery OEMs	Component manufacturers	EV OEMs	Individual/ institutional buyers	EV Charging station	Battery swapping stations
Infrastructure	Allotment of land ★						
	Land at concessional rate ★						
	Logistics support ★						
	Plug & Play facility ★	■	■	■			
Fiscal & Non-fiscal incentives	Capital subsidy ★				■	■	■
	Interest subvention ★	■	■	■		■	■
	SGST rebate ★	■	■	■		■	■
	Stamp duty exemption	■	■	■		■	■
	Electricity Duty exemption	■	■	■			
	Road tax exemption				■		
	Subsidized electricity						
	Subsidized water						
	Other fiscal incentives	■	■	■	■	■	■
	Other non-fiscal incentives						

★ High impact policy measures ■ Included in the policy (blank) Not included in the policy

Figure 125 Other key measures taken by Bihar for uptake of electric mobility



Summary:

- Addressed the gaps of FAME-II, extended **purchase incentive support to private vehicle** owners as well
- **Private investors are encouraged** to set-up Industrial park/EV Parks
- **Interest subvention** on loan for development of Charging Infrastructure and setting-up of EV parks by private investors
- Plan to set-up EV Park by government with plug and play facilities
- **Special incentive package** for women/ differently abled persons/ SC/ ST etc. for setting up of manufacturing unit or development of charging infrastructure

- Primary focus on replacing of '**Paddled rickshaw' with EV**
- **No institutional mechanism** proposed for implementation of EV Policy
- **No support** provided to home charging/ workplace charging
- Plan for setting public charging infra is **limited to cater Rickshaw-pullers only**
- **Doesn't identify** avenues to arrange funds for policy implementation
- **No focus** on public awareness
- **No mandate** for inducting EVs in government offices/departments
- **No vehicle scrappage policy**
- **No provision to have single window clearance system/dedicated help desk** to expedite Administrative approval
- No separate EV tariff, **industrial tariff for EV charging station**
- No focus on **power system upgradation** and augmentation to cater **EV load**

3.1.1.2.11 Punjab

Key highlights of Draft "Punjab Electric Vehicle Policy (PEVP) 2019"

Draft policy issued: 15 November 2019

Table 25 Key policy guidelines of Punjab draft EV policy

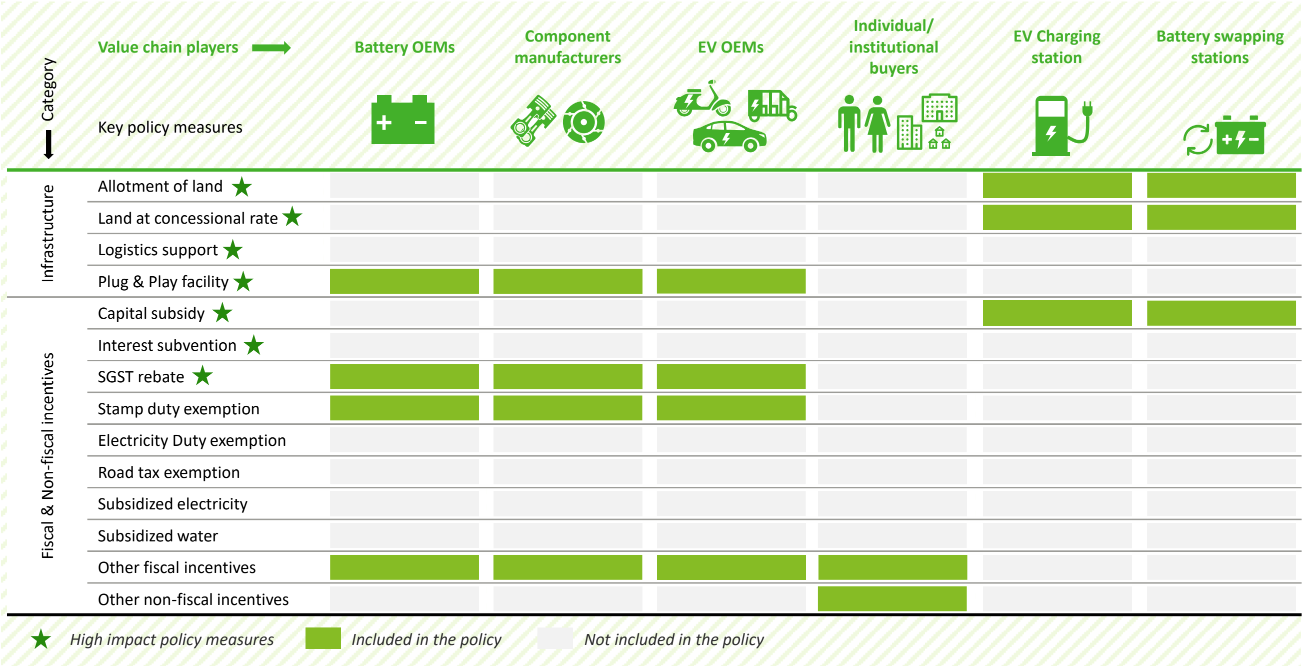
Key policy guidelines	
Institutional setup	• **EV Cell** to be established within the Transport Department for **effective day-to-day implementation** of the EV Policy • **State EV Committee** to act as the apex body for effective **implementation** of the State EV Policy. • **Discom has been designated as the State Nodal Agency** for development of EV Charging Infra • **District Level Implementation Committee (DLIC)** shall be responsible for creation/approval of charging infrastructure.
Govt. departments	• **100% transition** of public vehicle fleet to electric in a phased manner (used in offices)
Discoms	• Discom is the **State Level Nodal Agency (SLNA)** for implementation of Charging Infra. It would be **responsible for setting up charging infra** on State Highways in co-ordination with PWD and also aggregate procurement at the State Level • **Discom and District Level Implementation Committee (DLIC)** responsible for providing permit and inspection of charging infra (would develop detailed guidelines for the same to simplify the approval, renewal and inspection process to be completed in a time bound manner.) • Discom is **designated as SLNA** for implementation of EV Charging Infra
Transport Department	• Policy **interpretation and coordination** with state EV Cell. Enable implementation of incentives related to the department

Key policy targets:

- 100% transition towards electric in "target cities" in a phased manner
- Replace 25% of bus fleet under Department of Transport to e-buses
- 2W/3W sales to reach 25% penetration during the policy period

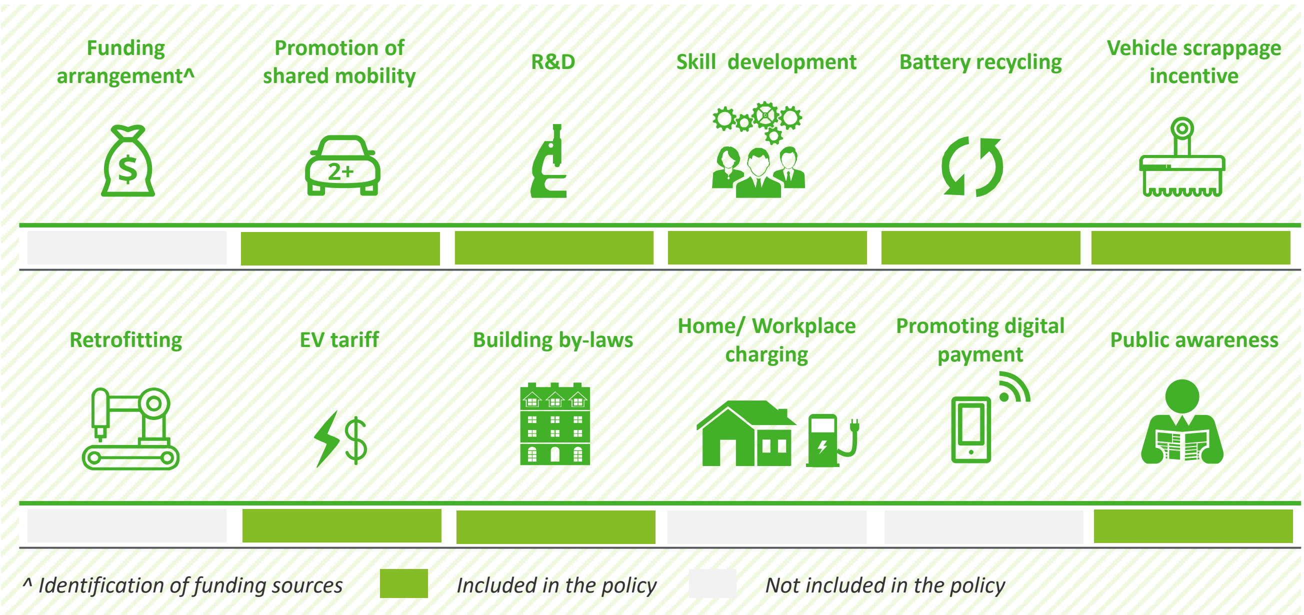
The state policy provides several fiscal and non-fiscal support to EV value chain players such as concessional allotment of land, capital subsidy, tax rebate etc.

Figure 126 Snapshot of promotional measures for EV value chain players



The state promotes shared mobility in the state along with R&D and skill development. The policy also supports battery recycling and vehicle scrapping.

Figure 127 Other key measures taken by Punjab for uptake of electric mobility



Summary:

- **District Level Implementation Committee** (DLIC) chaired by District Collector responsible for monitoring of policy implementation and **easing out administrative approval** process.

- **No purchase incentive** has been provided for EV purchase (except waiver of Motor Vehicle Tax)
- **No support** provided to home charging/ workplace charging

- **Well established institutional mechanism**. DLIC to report State EV Committee, apex body for implementation of EV policy
- Cross-department representation in EV Committee for policy implementation
- **e-marketplace for resale of used batteries**
- **Discom is mandated** to develop charging stations across highways and to aggregate demand at State level
- **Dedicated inspection and approval desk** to be set-up by discom for **quick and easy approval** for charging infra development
- **Vehicle Scrappage incentive**
- **Special vehicle tax waiver** for EVs manufactured in Punjab State
- 5 cities to have "**Special Green Zone**" and "**Green Transportation Corridor**"
- **EV parks** with plug and facility
- Efforts taken to **ease out administrative approval** procedures
- **Stipend** to employees for upskilling
- **Employment generation subsidy** to EV/ component manufacturer
- **100% Electricity Duty Exemption** on using electricity for EV charging purpose
- **Plan to stop registering new Auto** (ICE vehicles) in certain cities

- **Doesn't identify** avenues to arrange funds for policy implementation
- **No clarity on recovery of expense made by Discoms** in developing of charging infrastructure
- **Interest subvention** on loan for EV owner or manufacturer is not considered
- No focus on **power system upgradation** and augmentation to cater **EV load** (through network flow study)

3.1.1.2.12 Telangana

Key highlights of "Telangana Electric Vehicle Policy – Draft"

Draft policy issued: 27 September 2017

Note: Final EV policy of Telangana has been approved by state cabinet on 5th August 2020; policy not available in public domain

Table 26 Key policy guidelines of Telangana draft EV policy

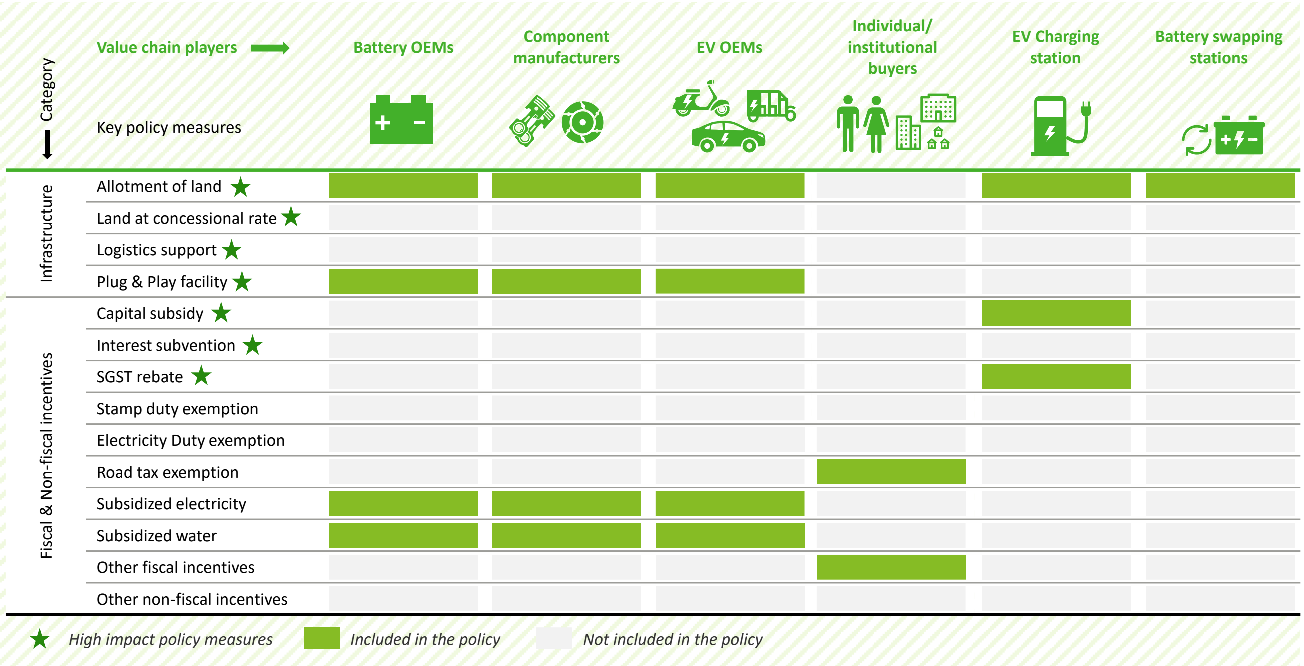
Key policy guidelines	
Institutional setup	• **Steering Committee for EV Charging Infrastructure**: Responsible for time bound implementation of charging station network • **Telangana State EV Advisory council**: To advise the Government on remedial measures required to address any concern as well as course corrections at policy level. Council will have representatives from Industry, Academia and Research • **Single-Window System** - An escort officer will be appointed at Commissioner of Industries and TSIIC office to ensure fast track clearance and grievance redressal for applications received from EV vehicle/component manufacturers • **Change in Labour laws** - permission to the Electric Vehicle and components industry for 24x7, employment of women in night shifts, flexibility in employment conditions, • EV industry will be declared a **'Public Utility'**
Govt. departments	• **Government vehicles** (owned and contractual) to switch to **all electric by 2025**, in phased manner
Discoms	• **Encourage** to set-up **charging infrastructure**
Transport Department	• **Target** for **phased adoption** of e-buses (25% by 2022, 50% by 2025 and 100% by 2030)

Key policy targets:

- 100% EV migration by 2030
- Intra-city goods delivery services to switch to EVs by 2030
- 2W/3W sales to reach 25% penetration during the policy period

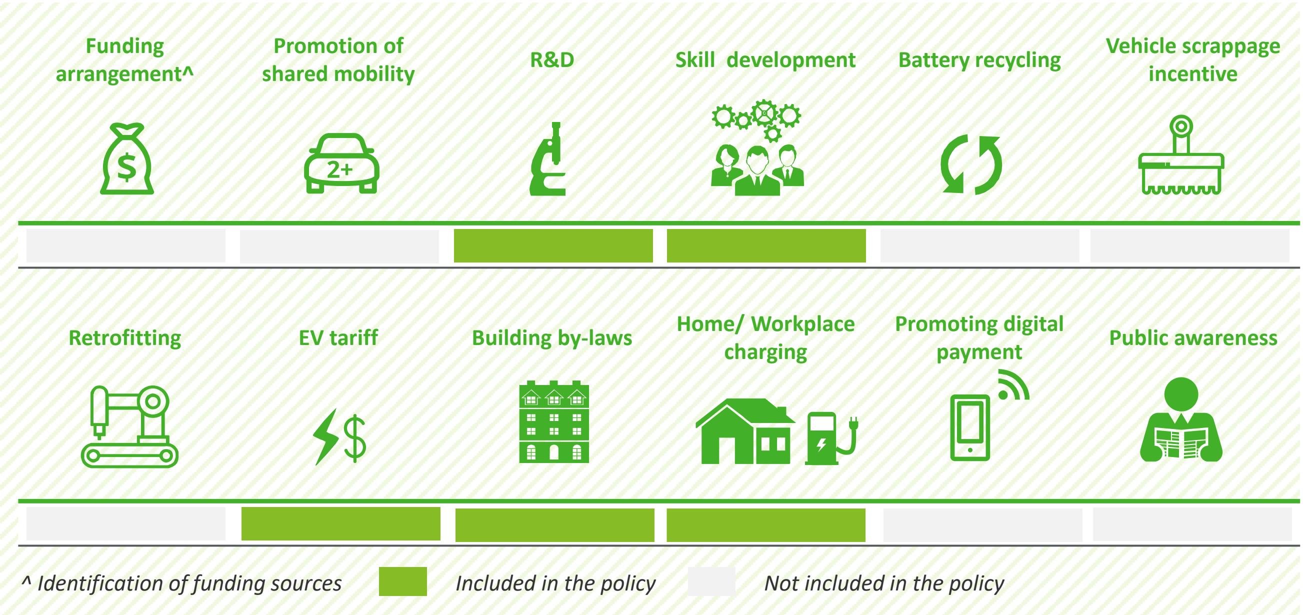
Telangana EV policy provides balanced support to all EV value chain players. It encourages EV manufacturers to setup plants in the state by providing them land and plug and play facility. The EV buyers in the state are exempt from giving road tax, and the charging infrastructure receives land, capital subsidy and SGST rebate from the state.

Figure 128 Snapshot of promotional measures for EV value chain players



Telangana focuses on promoting R&D and skill development in the state. It includes provision for special tariff for EV charging. The state also promotes adoption of EV charging station by providing capital subsidy to home chargers and mandates commercial complexes, housing societies etc. to have an EV charging station.

Figure 129 Other key measures taken by Telangana for uptake of electric mobility



Summary:

- **Single-Window System -** An escort officer be appointed at Commissioner of Industries and TSIIC

- **No purchase incentive** has been provided for EV purchase (except road tax exemption) office to ensure fast tracked clearance and grievance redressal

- **Mandate for EV adoption**
- **Mandate** for govt. department for EV adoption
- **Electricity Duty Exemption** on using electricity for EV charging purpose
- **EV parks** with plug and facility
- Plan to have **mandatory provision** for having Charging points in all commercial buildings
- Mandate for Transport Department to have 100% fleet of e-buses by 2030

- **Interest subvention** on loan for purchase of EV is **limited to Government employees only**
- **No support** provided to home charging/ workplace charging
- No mandate for Discom to set-up charging infrastructure
- Plan to set-up charging infra for Government employees only
- **No vehicle scrappage incentive**
- **Doesn't identified** avenues to arrange funds for policy implementation
- **No focus** on public awareness
- **No plan for battery recycling**
- No focus on **power system upgradation** and augmentation to cater **EV load** (through network flow study)

3.1.1.3 Summary of state policies

Tabular summary of state policies briefed in Section 3.1.1.2:

Table 27 Tabular comparison of state EV policies

Parameter	DL	AP	UP	MH	UK	KA	MP	KL	TN	BR*	PB*	TS*
Institutional Mechanism and Target												
EV target	✓	✓	✓	✓		✓	✓	✓	✓		✓	
Institutional setup	✓	✓		✓		✓	✓	✓	✓		✓	✓
Model EM cities		✓	✓									
Policy Mandates												
EV adoption mandate to institutions		✓										✓
Plan for induction of EVs in government department	✓	✓					✓				✓	✓
Mandate for Discoms	✓	✓	✓	✓		✓	✓	✓	✓		✓	
Mandate for Transport Department		✓				✓						✓
Demand Incentives												
Fiscal Incentives -2 W	✓		✓	✓			✓		✓	✓	✓	✓
Fiscal Incentives -3 W (e-auto, e-rickshaw and e-cart)	✓		✓	✓			✓	✓	✓	✓	✓	
Fiscal Incentives -4 W	✓		✓	✓			✓		✓	✓	✓	✓
Fiscal Incentives -2W fleet/ 4 W (Fleets)		✓					✓		✓		✓	
Fiscal Incentives - Bus				✓			✓		✓	✓	✓	
Fiscal Incentives - Goods carrier	✓				✓		✓		✓		✓	
EV Charging infrastructure												
Incentive for public charging deployment	✓		✓	✓			✓		✓		✓	✓
Incentive for Energy Operator/Battery Swapping station	✓		✓			✓	✓			✓	✓	✓

Parameter	DL	AP	UP	MH	UK	KA	MP	KL	TN	BR*	PB*	TS*
Incentive for Home/Workplace charging	✓		✓					✓				✓
Manufacturing												
Incentive to manufacturer		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Focus on promotion of auto-ancillary manufacturer		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Provision for Industrial Parks and Clusters for EV/Ancillary manufacturing		✓	✓			✓		✓	✓	✓	✓	✓
Battery OEM			✓	✓	✓	✓	✓	✓	✓	✓	✓	
Scrapping and recycling												
Vehicle scrappage incentive	✓						✓				✓	
Battery recycling related provision	✓	✓	✓		✓	✓	✓		✓		✓	
Miscellaneous												
Payment system and information exchange	✓	✓					✓	✓				
Identification of source of funding for various incentives declared in policy	✓						✓					
Skill Development/Job creation	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
R&D	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Public awareness	✓						✓				✓	
Changes in building bye-laws	✓	✓	✓			✓	✓					✓

Note: *Draft; DL: Delhi; AP: Andhra Pradesh; UP: Uttar Pradesh; MH: Maharashtra; UK: Uttarakhand; KA: Karnataka; MP: Madhya Pradesh; KL: Kerala; TN: Tamil Nadu; BR: Bihar; PB: Punjab; TS: Telangana

Promotion of electric mobility by California (USA) and China

California and China have set an example in promoting electric mobility, in their respective regions. While California has the maximum penetration of electric vehicles across United States, China is the global leader in EV sales. One common aspect of such successful adoption of electric mobility in these regions is favourable policy and regulatory support to encourage use of EVs.

Below tables list some of the key supporting measures adopted by California and China:

CALIFORNIA

EV OEMs

- ✓ Manufacturers with annual sales greater than 60,000 vehicles must sell 14% sales from zero emission vehicle

EVSE and battery swapping

- ✓ Utilities are mandated to file transportation electrification proposals (plan to set-up charging Stations) with commission
- ✓ California Energy Commission (CEC) provides funding (loan) to the EV charging stations
- ✓ Institutional set-up for assessment of EVSE requirement to support on road EVs
- ✓ Mandatory Electric Vehicle Supply Equipment (EVSE) Building Standards for EVSE installation in parking spaces
- ✓ State agencies are directed to actively identify and pursue opportunities to install EVSE, and accommodate future EVSE demand, at state employee parking facilities in new and existing agency buildings
- ✓ Commission allows investor-owned utilities to own and operate charging stations

Consumers

- ✓ EV owners earn Low Carbon Fuel Standard (LCFS) credit which is used to receive rebate in energy charges
- ✓ Electricity used to charge PEVs at a state-owned parking facility is exempt
- ✓ EV purchase incentive up to $7,000 under Clean Vehicle Rebate Project (CVRP)
- ✓ EV owner receive exemption for High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) late
- ✓ Incentive Programs for Alternative Fuel Vehicle (AFV) parking

Legend: Measures that can be adopted by India

CHINA

EV OEMs

- ✓ Vehicle manufacturers to meet 10% and 12% new energy vehicle credit targets in 2019 and 2020

EVSE and battery swapping

Central level initiatives

- ✓ Purchase incentives are provided based on electric drive range and other technical parameters
- ✓ Plan to develop huge network of Charging Infrastructure; Incentives for charging infrastructure development
- ✓ Support for electric car-sharing pilots

Consumers

State level initiatives

- ✓ Cities are providing subsidy over and above the central government subsidies
- ✓ EVs are exempted from the annual Vehicle and Vessel Tax in China
- ✓ Reduction in parking fees for EVs
- ✓ License plate fee waived for EVs
- ✓ Maximum cap on EV charging fees
- ✓ Capital subsidy on home chargers
- ✓ Exemption on road toll
- ✓ Dedicated parking space for EV owners
- ✓ Road access privilege – In congested cities EVs are exempted from odd-even restriction

Legend: Measures that can be adopted by India

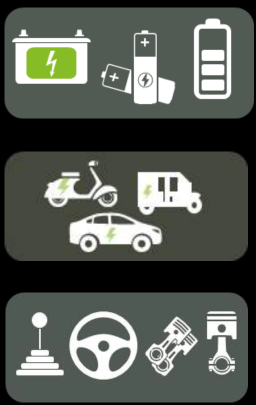
Key recommendations for state policies

Best policy practices for promotion of electric mobility value-chain:

Key policy recommendations

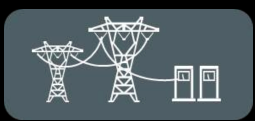
Institutional setup

- ✓ Formulate a cross-department apex committee constituting members from at least the Transport Department, Energy Department, Industrial Development, and Housing and Urban Development for better co-ordination, policy implementation and effective monitoring.
- ✓ Set-up a District Level Implementation Committee headed by District Collector for field level monitoring and implementation of EV policy; and to smooth out administrative approval processes



OEMs

- ✓ Online portal and single window clearance system for availing clearances and subsidies/rebate in transparent manner
- ✓ Provision for interest subvention on loan
- ✓ Provision for State Guarantee on loan for Micro and Small Industries
- ✓ State support in knowledge and technology transfer (Technology transfer fund could be created as proposed in Kerala policy)
- ✓ Longer policy tenure to develop confidence among industrialist in sustainability of rebates and subsidies for longer horizon
- ✓ Employment generation subsidy to be included as part of state policy (Punjab is providing employment generation subsidy to industrialist in EV domain, Rs. 36,000 per male employee and Rs. 48,000/ per employee per year in case of females and SC/ST/OBC employee)
- ✓ Reimbursement of employer's contribution to the EPF for all new jobs created in EV industry (Tamil Nadu have similar policy provision)
- ✓ Stipend to individual taking in-plant training in manufacturing units



Network operators

- ✓ Discoms to mandatorily file transportation electrification proposal (plan to set-up charging stations)
- ✓ Targets to discoms on installation of EV charging infrastructure
- ✓ Policy should encourage conducting network flow study to assess the need of power system upgradation and augmentation due to EV charging and provide capital subsidy for development of infrastructure
- ✓ Allow recovery of network investment cost through regulatory provisions of ARR and Tariff Determination

EVSE and battery swapping

- ✓ Online portal and single window clearance system for availing clearances and subsidies/rebate in transparent manner
- ✓ Allow Charging Infra Developer to use certain percentage of allotted land to open public amenities such as cafeteria/food zone etc. to have additional revenue stream to ensure sustainability of business (Madhya Pradesh EV policy has made similar provision)
- ✓ Provide opportunity to Battery Swapping Stations to participate in real time market and ancillary service market
- ✓ Discoms to be mandated to provide connectivity within a limited time frame under State Guaranteed Delivery of Service Act

	Key policy recommendations
	✓ Electrical Inspectorate Department/ Discoms to be mandated to set-up express helpdesk for expediting inspection and clearance in respect of CEA Regulations for electrical safety and grid interconnection
Consumers	✓ EV Purchase subsidy over and above FAME II subsidy ✓ Interest subvention on loan amount taken for EV purchase ✓ Creation of non-financial incentives such as priority lanes, reserved parking for EV only vehicle in commercial/shopping complexes etc. ✓ Incentives for vehicle scrapping
Financing	✓ Include EVs and associated business in priority lending sector ✓ State backed loan guarantees for EV and associated component manufacturers ✓ Electric Mobility Bonds (Madhya Pradesh have similar provision) ✓ Use of fee-bate concept for funding of policy provisions (Delhi policy have similar provision), whereby additional taxes to be levied on conventional fuel vehicle
Miscellaneous	✓ Green Zone to be demarcated within cities that permit only EVs and charge heavy taxes on conventional fuel vehicle ✓ Green Corridors to be earmarked on which only e-buses are provided permit to operate ✓ Provision for providing training in electric mobility, upskilling of existing ICE mechanics needs to be focused in State policies ✓ Disseminate public awareness through launching test drives, competitions, celebrating Electric mobility day etc.

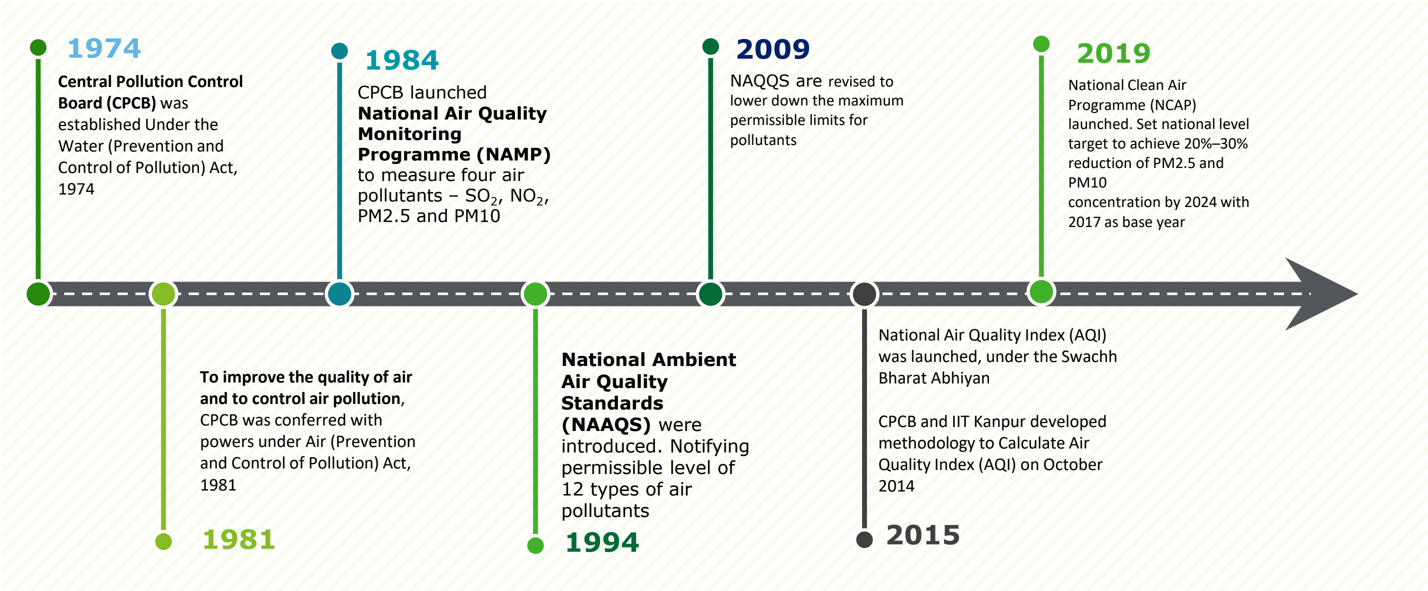
3.1.2 Clean fuel

3.1.2.1 Initiatives for monitoring and control of air pollution in India

From the early 1970s, factors such as rapid industrialization and urbanization led to increased pollution levels. This led to rising concerns among environmentalists and government authorities which drove the need for creation of an institution for overseeing efforts on curbing such pollution levels. This led to the establishment of Central Pollution Control Board (CPCB) on 22nd September 1974 under the Water (Prevention and Control of Pollution) Act, 1974. CPCB along with SPCBs act as the key machinery of the Government for planning and execution of nation-wide programme for the prevention, control, or abatement of water and air pollution.

Post the formation of CPCB, several initiatives have been taken for curbing pollution. Some of the key initiatives taken by the government in area of monitoring and control of air pollution are provided below:

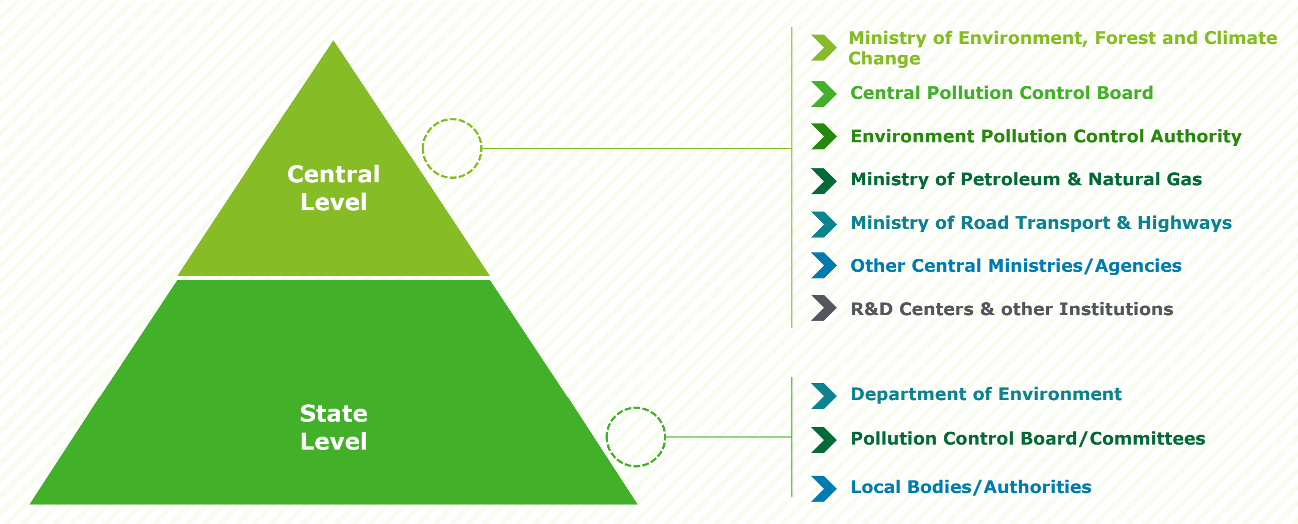
Figure 130 India's initiatives for monitoring and control of air pollution – Timeline



Source: 76 Deloitte analysis

The Air (Prevention and Control) Act 1981 introduced the concept of Air Quality Management (AQM) to safeguard the environment. MoEF&CC (previously MoEF), constituted in 1985, is the nodal agency in the administrative structure of the Central Government responsible for AQM. Along with MoEF&CC, there are several other ministries, departments and institutions who play important role in effective operation of AQM mechanism. The overall institutional mechanism of AQM in India is provided in Figure 131.

Figure 131 Institutional mechanism of AQM



Source: 77 Strategies to reduce air pollution in India (access here)

3.1.2.1.1 National Air Quality Monitoring Programme (NAMP)

NAMP embarked the journey for air quality monitoring in India with establishment of air quality monitoring stations. In 1984, the programme was originally called as the National Ambient Air Quality Monitoring (NAAQM) and started at Agra and Anpara with 7 stations, the programme has since been substantially expanded.

Major objectives of NAMP are to:

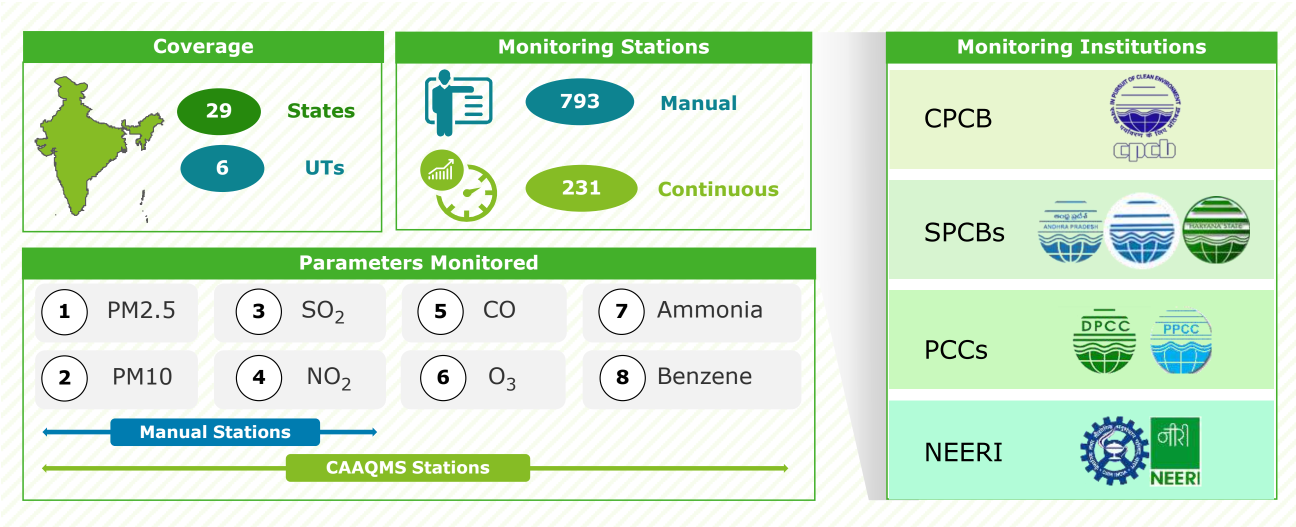
1.	Determine the status and trends of ambient air quality
2.	Ascertain whether the prescribed ambient air quality standards are violated;
3.	Identify non-attainment cities;
4.	Obtain the knowledge and understanding necessary for developing preventive and corrective measures
5.	Understand the natural cleansing process undergoing in the environment through pollution dilution, dispersion, wind-based movement, dry deposition, precipitation, and chemical transformation of the pollutants generated

At present, there are 793 manual operating stations across India[40] in 344 cities and towns, monitoring air pollutants such as SO_2, NO_2, PM10, and PM2.5[41]

The monitoring of pollutants at manual station is carried out by taking 4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter (during 24 hours) with a frequency of twice a week, to have one hundred and four (104) observations in a year.

[40] CPCB Monitoring Network (access here)
[41] PM10: Suspended particulate matter; PM2.5: Fine particulate matter

Figure 132 Snapshot of air pollution monitoring and institutional mechanism



In addition to above, there are 231 Continuous Ambient Air Quality Monitoring Stations (CAAQMS) established to monitor live air quality data on 8 parameters - PM10, PM2.5, SO2, NO2, ammonia (NH3), CO, ozone (O3), and benzene.

CPCB: Central Pollution Control Board; **SPCBs**: State Pollution Control Boards; **PCCs:** Pollution Control Committees; **NEERI**: National Environmental Engineering Research Institute

The monitoring is carried out with the help of Central Pollution Control Board; State Pollution Control Boards; Pollution Control Committees; National Environmental Engineering Research Institute (NEERI), Nagpur. The monitoring of meteorological parameters, such as wind speed and wind direction, relative humidity (RH), and temperature are also integrated with the monitoring of the air quality.

3.1.2.1.2 National Ambient Air Quality Standards (NAAQS)

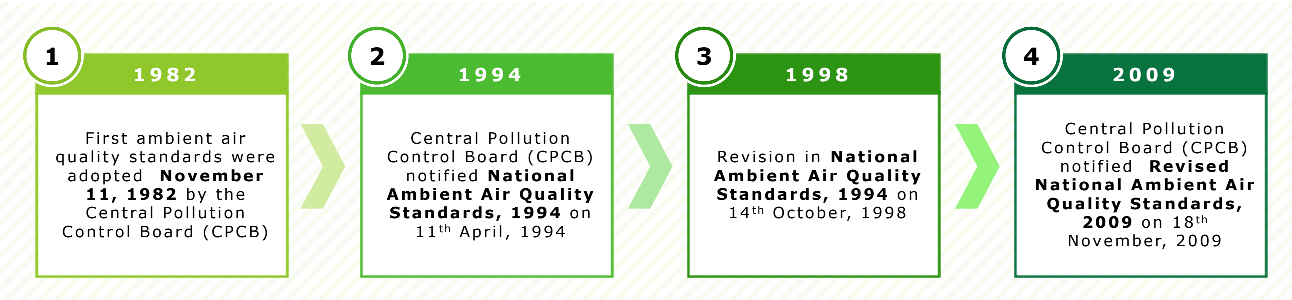
India's first ever ambient air quality standard was adopted by CPCB on November 11, 1982. The CPCB later notified National Ambient Air Quality Standards in April 1994 by exercising its powers conferred to it by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981). The standard was further revised in October 1998.

Major objectives of NAAQS are to:

1.	Indicate necessary air quality levels and appropriate margins required to ensure the protection of vegetation, health, and property
2.	Provide a uniform yardstick for the assessment of air quality at the national level
3.	Indicate the extent and need of the monitoring programme

In November 2009, CPCB suppressed all its previous notifications issued in relation to NAAQS and issued stringent norms for air quality standards. Further, it has recognized and specified permissible norms for new set of pollutants that includes – PM2.5, Benzene, Benzo (a) Pyrene, Arsenic and Nickle.

Figure 133 Timeline of air quality standards adopted by India



Source: 78 CPCB

Although the NAAQS specified in 2009 are stringent than norms specified in 1998, but these are still higher than the norms specified by World Health Organization (WHO) in 2005. The comparison of norms specified under NAAQS and WHO guidelines is provided in Annexure – 6.3 (Table 70).

3.1.2.1.3 National Air Quality Index (AQI)

On 6th of April 2015, Prime Minister of India has launched the National Air Quality Index, for monitoring the quality of air in major cities across the country on a real-time basis and enhancing public awareness for taking appropriate action to reduce air pollution. The AQI is promoted as 'one number, one colour and one description[42]' to inform the public about air quality in a simple and easily understandable format. There were 14 cities covered under AQI monitoring at the time of launch, however it has been expanded to 224 cities[43] till date. CPCB and IIT Kanpur jointly developed the methodology[44] for calculation of AQI. The AQI categorization is provided in Table 28.

Table 28 AQI categorization and associated health impacts

AQI	Associated Health Impacts
Good (0-50)	Minimal Impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people
Moderate (101-200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease with short exposure.
Very Poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity.

Source: 79 CPCB – National Air Quality Index portal (access here)

[42] Launch of National AQI (access here)
[43] National Air Quality Index portal (access here)
[44] AQI Methodology (access here)

Box 16: Graded Response Action Plan for Delhi & NCR

In 2016, Central Pollution Control Board (CPCB) enforced "Graded Response Action Plan for Delhi & NCR" to tackle degrading air quality in the region of Delhi & NCR. The Graded Response Action Plan was prepared for implementation under different Air Quality Index (AQI) categories as per National Air Quality Index. Also, a new category of "Severe+ or Emergency" has been added in the Action Plan.

Some of key action plans is provided below:

✓	Stopping **entry of truck traffic** into Delhi (except essential commodities)	✓	Stopping **construction activities**
✓	Introducing **odd and even scheme** for private vehicles based on license plate numbers and minimize exemptions	✓	Shutting down brick **kilns**, Hot Mix **plants**, Stone **Crushers**
✓	Shutting down **Badarpur power plant** and maximize generation of power from existing natural gas based plants to reduce operation of coal based power plants in the NCR	✓	Intensifying **public transport services**; introducing **differential rates** to encourage off-peak travel
✓	Increasing frequency of **mechanized cleaning of road** and sprinkling of water on roads; identifying road stretches with high dust generation	✓	Stopping the use of **diesel generator sets**
✓	Enhancing **parking fee** by 3-4 times	✓	Increasing **bus and metro services** by augmenting contract buses and increasing frequency of service
✓	Stopping the **use of coal/firewood** in hotels and open eateries	✓	**Alerting in newspapers/TV/radio** to advise people with respiratory and cardiac patients to avoid polluted areas and restrict outdoor movement

Source: 80 Image: CNN; CPCB - Graded Response Action Plan for Delhi and NCR (access here)

3.1.2.1.4 National Clean Air Programme

The reference standards for various pollutants contributing towards air pollution and mechanism for monitoring of such pollutants were established through various initiatives taken by CPCB and Central/State Government before the launch of National Clean Air Programme. However, in the absence of any nation-wide effort to curb the level of pollutants, the quality of air continued to deteriorate over the years. In 2019, India was ranked 5th in world's most polluted countries and 6 of the world's 10 most polluted cities were from India.

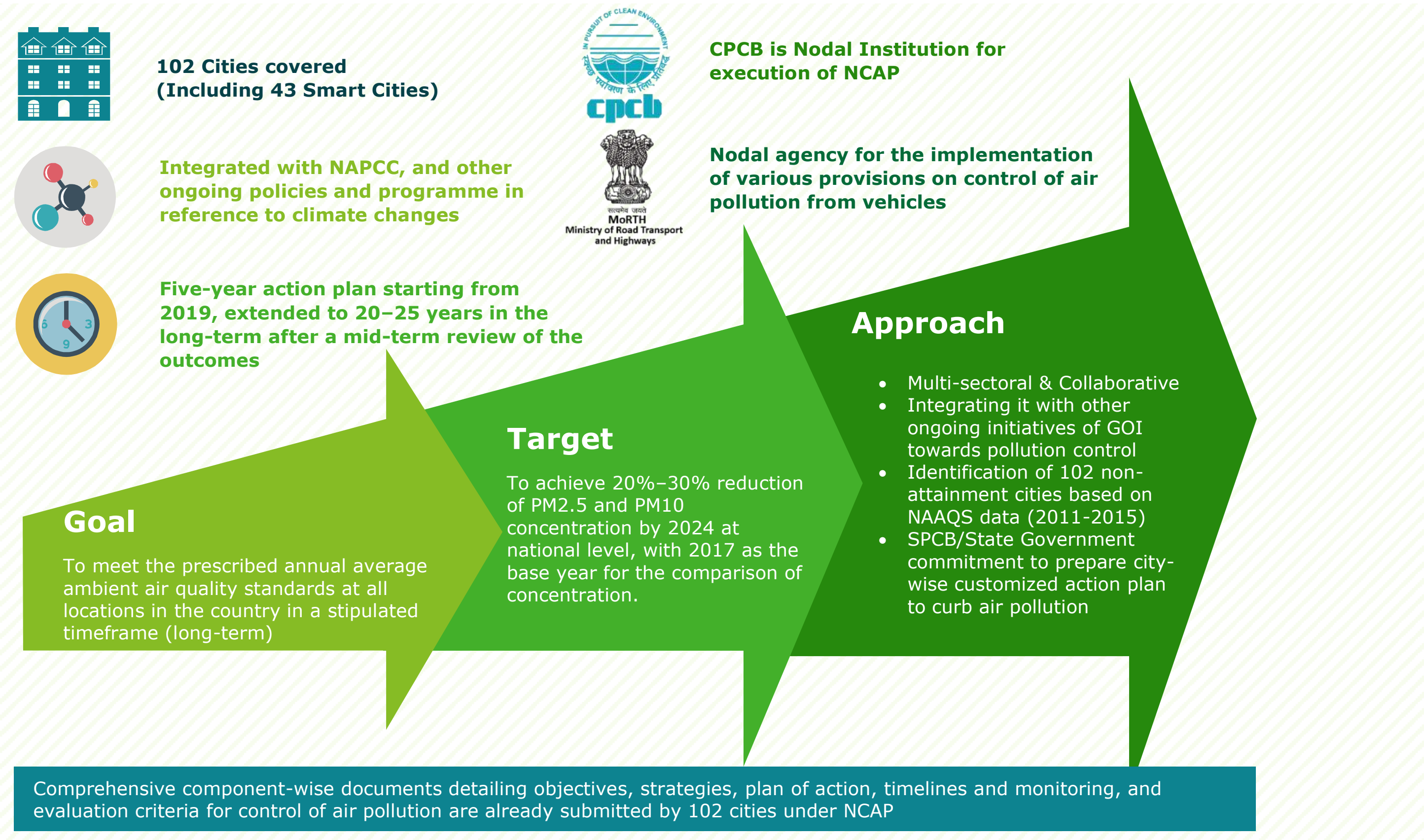
Figure 134 India: Problems with pollution

Source: 81 IQ Air

Air pollution led to 1.24 million or 12.5% of the total deaths recorded in the country during 2017 alone. With the alarming air pollution levels across India the urgency of a national level action plan was therefore inevitable.

In response to the same, the National Clean Air Programme (NCAP) was launched in January 2019, by MoEF&CC, with the primary objective of implementing mitigation measures for prevention, control and abatement of air pollution, expanding the national air quality monitoring network, building capacity for air pollution management, and strengthening public awareness about the dangers of air pollution.

Figure 135 Snapshot of National Clean Air Programme

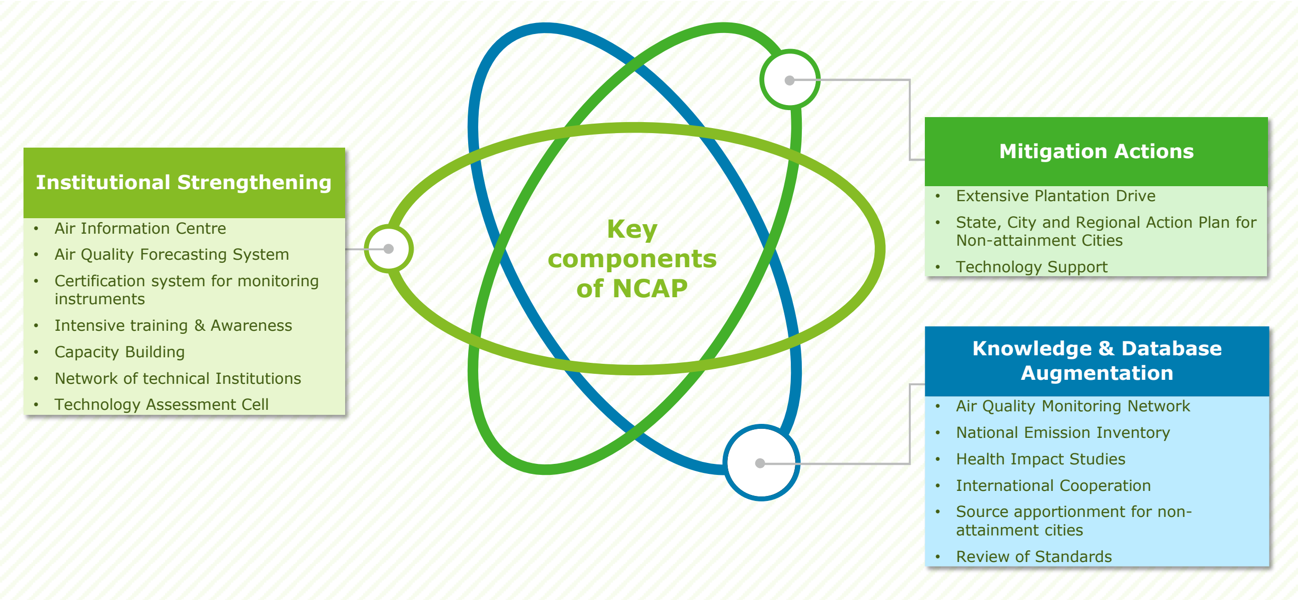


With the launch of NCAP, the Central Government aims to cut the concentration of coarse (particulate matter of diameter 10 micro meter or less, or PM10) and fine particles (particulate matter of diameter 2.5 micro meter or less, or PM2.5) by at least 20% in the next five years, with 2017 as the base year for comparison.

The key components of NCAP are segregated across three broad categories – Knowledge and Database Augmentation, Mitigation Actions and Institutional Strengthening.

Figure 137 provides the snapshot of NCAP key components as outlined under the policy document. The list of action-points/ steps suggested for Knowledge and Database Augmentation, Mitigation Actions and Institutional Strengthening are placed at Annexure 6.3.

Figure 136 Key components of NCAP



Under NCAP eight sectoral interventions have been identified around which the identified cities (102 non-attainment cities) have been directed, under Section 31A of the Air (Prevention and Control of Pollution) Act, 1981, to develop action plan for maintaining air quality within the prescribed norms. The various interventions as identified under NCAP, cover the pollution caused due to re-suspended road dust control, construction and demolition related dust, power sector and industrial emissions, transport sector emissions, agricultural emissions and emissions from unsustainable waste management practices.

Figure 137 Key sectoral interventions under NCAP

Action-points for each of the above, as shown in the figure, are detailed in the NCAP. For the purpose and coverage of this report, the Actions-Points pertaining to Transportation sector and Power sector are reproduced as below:

Figure 138 Action points for transport and power sector under NCAP

Action points for Transport Sector

In-use vehicles

01 Stringent implementation of BS VI norms all over India by April 2020

Green Mobility

01 Stringent implementation of National Biofuel Policy with respect to ethanol and biodiesel blending target of 20% and 5%, respectively by 2030

02 City action plans to review the extension of MRT in cities/towns

03 Improvement and strengthening of inspection and maintenance system for vehicles through extension of I&C centers

04 Stringent implementation of PUC certificate through regular inspection and monitoring.

05 Fleet modernization and retro-fitment programmes with control devices

06 Reducing real-world emissions by congestion management

07 Review the Green Corridor Project and feasibility of its extension with reference to 102 cities

08 To review the scaling up of Pilot project of MoPNG for introducing CNG in 2W and ensure timely implementation

09 Scaling up of R&D on use of Hydrogen as transport fuel

E-Mobility

01 Formulation of a national-, state-, and city-specific action plan for e-mobility

02 Rapid augmentation of charging infrastructure in the country focusing on 102 cities

03 Central government offices fleets older than 15 years to be shifted to electric vehicles

04 Government-run buses for public transport, private buses, and 3-wheelers to be converted to EVs

05 Gradual transition to e-mobility in the 2-wheeler sector

06 Specific allocations for creating a venture capital fund

07 Investment in R&D and pilots focusing on the indigenization of battery manufacturing, cheap alternate resource to lithium and cobalt, resource efficiency associated with a circular economy, re-use and recycling for lithium batteries, etc.

Action points for Power Sector

01 Stringent compliance by all TPPs with respect to the emission norms according to the timelines up to December 2022 and as per the action plan prescribed in the direction dated December 2017 issued under EPA 1986

02 There is need for optimizing the use of the existing power plants by prioritizing capacity utilization of natural gas/ clean fuel-based thermal power plants

03 CGD network distribution shall be taken up on priority within the country, emphasizing on 102 non-attainment cities

04 Phasing out older coal-based power plants and converting specific coal-based power plants to natural gas

05 Emphasis on improved power reliability in urban areas to eliminate the operation of DG sets

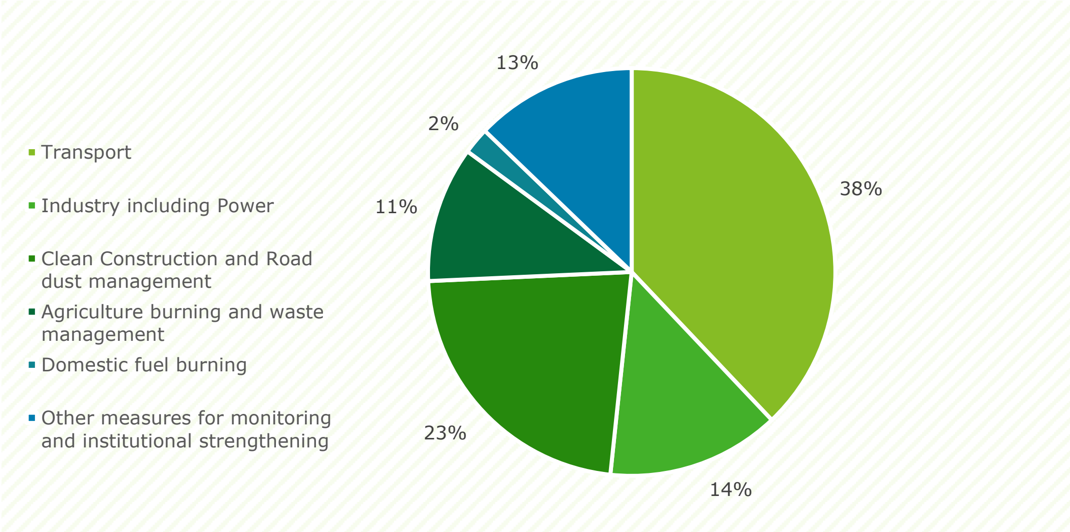
06 Need to explore the possibility of Fly-ash utilization in extensive way in 102 non-attainment cities

07 Emphasizing the expansion of renewable power initiatives prioritizing the use of existing framework of NAPCC in non-attainment cities

Note: Action-points for each sector are placed at Annexure 6.3

The state-wise break-up of non-attainment cities is provided at Annexure 6.3. Nearly, one-third of total cities lie in only two states – Maharashtra and Uttar Pradesh, having 17 and 15 non-attainment cities respectively. As per CPCB, all 102 attainment cities have submitted their action plan to control air pollution. The sector-wise break-up of action-plan for each State is provided at Annexure 6.3. Transport emission has been considered as one of the major contributor toward air pollution and therefore nearly 38% of the total action plan submitted by all States are focused on this sector alone.

Figure 139 Segregation of action plans across identified sectors under NCAP



Source: 82 Deloitte Analysis, Central Pollution Control Board

Note: Action Plan for few sectors are combined to have better representability of data in chart. For detailed break-up please refer to Annexure 6.3

Although, the transport sector has been kept at the centre stage of the action plan, limited focus has been provided for transition to and adoption of electric mobility. However, there has been increasing focus on measures such as fuel-quality checks, monitoring of vehicle fitness, widening of roads to avoid traffic congestions, retro-fitment of particulate filter in diesel vehicles, increased amount of penalization on vehicle emitting visible smoke, increase in public transportation system, phasing out of diesel vehicles which are 15 years old, programs for public awareness on air pollution control etc. The State-wise comparison of extent of focus on electric mobility /alternate fuel based mobility is provided below:

Table 29 State-wise focus area on electric mobility and alternate fuel

State	Focus Area		
	Electric mobility	CNG/LPG/Biofuel	Charging Infra development
Andhra Pradesh	🟢	🟢	🔴
Assam	🟢	🟢	🟠
Chandigarh	🟠	🔴	🔴
Chhattisgarh	🟠	🟠	🔴
Delhi	🟢	🟢	🟢
Gujarat	🟠	🟢	🔴
Himachal Pradesh	🟠	🔴	🔴
Jammu and Kashmir	🟠	🟢	🔴
Jharkhand	🟠	🔴	🔴
Karnataka	🟢	🟠	🔴
Madhya Pradesh	🟠	🟠	🔴

State	Focus Area		
	Electric mobility	**CNG/LPG/Biofuel**	**Charging Infra development**
Maharashtra	Green	Green	Red
Meghalaya	Orange	Red	Red
Nagaland	Orange	Orange	Red
Orissa	Green	Green	Green
Punjab	Orange	Green	Orange
Rajasthan	Orange	Orange	Red
Tamil Nadu	Orange	Orange	Red
Telangana	Green	Green	Red
Uttar Pradesh	Green	Orange	Green
Uttarakhand	Orange	Orange	Red
West Bengal	Green	Green	Orange
Bihar	Green	Green	Green

Green: Sufficient focus – Coverage across vehicle category such as 2W, 3W, 4W and Buses with time bound action plans

Orange: Limited focus – Coverage mainly across e-rickshaw category with limited time bound actions plans

Red: No focus – Not covered in action plan

Source: 83 Deloitte analysis and Central Pollution Control Board

The action plan submitted under NCAP shows that most of the states have limited focus on EV adoptability, and wherever the same is focused on, the same is confined to vehicle segments such as E-rickshaw, E-Auto, and/or E-buses. States such as Andhra Pradesh, Maharashtra, Telangana have, however, set ambitious plans for EV/CNG/LPG adoption but have not adequately planned for development of the refuelling infrastructure.

In terms of planning adequacy, states such as Delhi, Orissa, Bihar, West Bengal and Assam have taken a balanced EV/Clean Fuel technology transition strategy. These states have taken a prudent approach by focusing on developing peripheral and supporting infrastructure as well as complementary policy support (such as phasing of diesel vehicles), for smoother transition towards EV/Clean Fuel mobility alternatives.

3.1.2.1.5 National Biofuel Mission (NBM)

The National Biofuel Mission (NBM), launched in 2003 under the aegis of the Planning Commission, GOI, was a pioneering effort towards the adoption of 1G biofuels. It envisaged the phased expansion of area under biofuel feedstock crops (Jatropha and Pongamia) and several missions aimed at promoting large-scale plantation of feedstock crops in forests and wastelands, procurement of seeds, oil extraction, transesterification, blending, trade, and R&D.

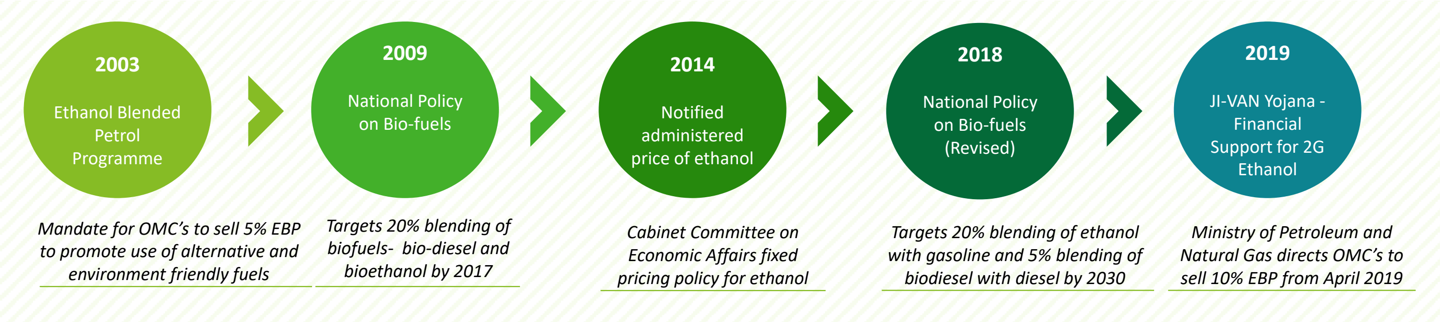


Figure 140 Timeline for promotion of use of biofuels in India

Source: 84 Deloitte analysis

In 2003, the Indian Ministry of Petroleum and Natural Gas (MoPNG), in a bid to make biofuel blending a binding obligation on the states, made 5 percent ethanol blending in petrol mandatory in 9 states and across 5 union territories. Unavailability of ethanol (attributable to low sugarcane yield), however, was a huge impediment to the adoption of this mandate. The blending mandate was further extended to cover 21 states and 4 union territories in 2006. However, the mandate could not be fulfilled on account of insufficient availability of ethanol at the prevailing market prices.

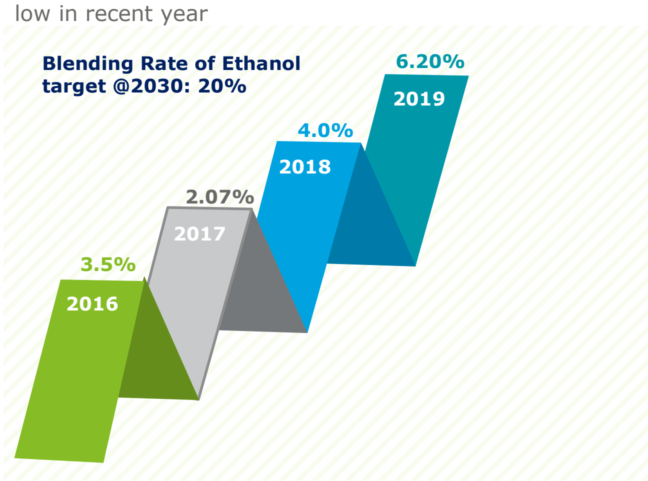
In 2007, along with the mandated 5 percent ethanol blending across the country and 10 percent where feasible, the "National Biofuel Policy" was formulated by the Ministry of New and Renewable Energy (MNRE) in September 2008. Biofuels as a potential means to rural development and employment generation was envisioned as part of this policy. The NBP laid out R&D, capacity building, purchase policy, and registration for enabling biofuel use, including second-generation biofuels. While the policy was not feedstock specific, it maintained the government's position that energy crops should not have any adverse impact on the food sector.

Government of India in 2014, took multiple interventions including, reintroduction of administered price mechanism, opening of alternate route for ethanol production, exclusive control of denatured ethanol by the Central Government, reduction in Goods and Service Tax (GST) on ethanol from 18% to 5%.

The Ethanol Blended Petrol Program (EBPP) and Biodiesel Blending Program (BDBP) both of which were integral parts of the NBM were aimed at initiating the blending of biofuels with transport fuels such as petrol and high-speed diesel on a commercial scale.

However, there were several issues that created hurdles in attaining the desired level of production of ethanol and biodiesel fuel.

Figure 141 Blending rate of ethanol has been low in recent year



India had faced severe sourcing issues with Ethanol and Biodiesel which has contained their growth in blending.

Issues with production/ sourcing of ethanol and biodiesel:

1. Poor grade of domestic sugarcanes

India produces "C grade" canes which yields very low amount of biofuel (1 litre of biofuel from about 0.004 tonnes of molasses).

2. Better price markets for sugarcanes

Farmers receive better prices for sugarcanes from alcohol and pharmaceutical industries. This leads them away from producing biofuel.

3. High cost of biofuel

Most of India's agricultural residue is repurposed as manure. If the residue is purchased for biofuel then the price will be paid for the residue as well as for the pesticides (as the farmer is not producing manure). This increase the overall cost of production of biofuel

4. Low food security

India is a net importer of edible oil. Therefore, with limited available land for agriculture, production of non-edible oil seeds based biodiesel would lead to lower food security of the country.

Later in 2018, government of India notified the Bio Fuel Policy 2018. The policy addressed some of the key sourcing issues as it expanded the scope of raw material for ethanol production by allowing use of various agro-waste products. Below are few key measures undertaking by the policy to increase the production of biofuel fuels in total blending:

- reinforcing ethanol/biodiesel supplies through increasing domestic production
- setting up Second Generation (2G) bio refineries
- development of new feedstock for biofuels
- development of new technologies for conversion to biofuels
- creating suitable environment for biofuels and its integration with the main fuels

On February 2019, the Government of India launched "Pradhan Mantri JI-VAN (Jaiv Indhan- Vatavaran Anukool fasal awashesh Nivaran) Yojana" for providing financial support to Integrated Bioethanol Projects using lignocellulosic biomass and other renewable feedstock. The scheme was designed as a tool to create 2G Ethanol capacity in the country and attract investments in this new sector.

Under the scheme, 12 Commercial Scale and 10 demonstration scale Second Generation (2G) ethanol projects will be provided a Viability Gap Funding (VGF) support in two phases. The ethanol produced under the scheme will be mandatorily supplied to Oil Marketing Companies (OMCs) to improve the blending percentage under EBP Programme.

Although there have been numerous efforts from the government to boost the production of biofuels, shortage of supply and high cost of fuel are still the biggest bottlenecks in adoption of biofuels.

3.1.2.1.6 Auto Fuel Vision and Policy 2025

The Ministry of Petroleum and Natural Gas, Government of India notified first Auto Fuel Policy in October 2003. It addressed measures to cover various areas in which action was required viz. vehicular emission norms, fuel quality and standard of CNG/LPG kits, measures to reduce emissions from in-use vehicles, vehicle technology, air quality data and Research and Development. It also covered air quality data and health effects of air pollution.

The Auto Fuel Policy 2003 had envisaged that due to technological and other changes which take place over time, the Policy needs to have periodic revisions. In this backdrop, Ministry of Petroleum and Natural Gas, in 2012, felt necessary to initiate a process to develop an Auto Fuel Vision and Policy for the country which would lay a clear roadmap for the future, till 2025.

Auto Fuel Vision Committee was set up in 2013 to recommend the future roadmap on advancement of fuel quality and vehicular emission standards up to 2025. The committee published its report in May 2014. It had more stringent fuel and emissions standards requirement as compared with the provisions of the National Auto Fuel Policy 2003.

Figure 142 Key observation of the Auto Fuel Vision Committee

Key observation of the committee

1. There were differential norms on emission standards were made applicable in metros and in the rest of the country because of limited domestic availability of higher quality automotive fuel in the country
2. India was consuming proportionately more diesel relative to gasoline that could be normally derived from crude oil. This results in a need to maximize diesel production
3. It was expected that about half of gasoline and one third of diesel will be equivalent to Euro V by 2020
4. There was different tax treatment on imports of crude petroleum (import duty - NIL) & LNG (import duty – 5%)
5. There is need to deregulate the retail prices of diesel such that the refineries are able to fully recover their costs and service the huge capital investments

Key recommendations of the Auto Fuel Vision and Policy 2025:

✓ Implementation of next stage of Bharat emission norms (BS norms):

2017	2020	2024
BS IV	BS V	BS VI

✓ To levy a "special fuel upgradation cess" of 75 paise per litre on all gasoline and diesel sold in the country for seven years up to 2021

✓ To rationalize the rates of Central Excise Duty for gasoline and diesel

✓ To establish an Empowered Monitoring and Evaluation Committee with the Secretariat being provided by CPCB and with members drawn from all the stakeholders as well as independent experts knowledgeable in the various aspects (including technical, financial, health, social, environmental and institutional), to define the studies and analyses that would be undertaken for effective implementation of the Auto Fuel Vision and Policy 2025

✓ Creation of a Centralized I&M (Inspection and Maintenance) system where inspection and maintenance are carried out independently

✓ Creation of a policy for the phasing out of older commercial vehicles

✓ To set mandate for commercial vehicles to get the retro-fitting of catalytic converters and particulate filters done within a period of two years for the extension of their operating licence under the Motor Vehicles rules.

✓ OMCs to implement vapour recovery system for gasoline to minimise benzene emission in larger cities

Shortcomings of the Auto Fuel Vision and Policy 2025:

BS VI implementation was proposed from 2024 which was almost 10 years later than its equivalent EURO VI	BS VI standards were not fully defined	Durability requirement for emission under BS V (120,000 Kms) was less than Euro V (160,000 Kms)

3.2 Regulations and technical standards

3.2.1 Electric mobility

3.2.1.1 CEA regulation on grid interconnection and electrical safety standards

CEA introduced two amendments related to connectivity and safety of EV charging stations:

- 01 Technical Standards for Connectivity of the Distributed Generation Resources Amendment Regulations, 2019
- 02 Measures relating to Safety and Electric Supply Regulations, 2019

CEA notified Technical Standards for Connectivity of the Distributed Generation Resources, Amendment Regulations in February 2019 that laid down guidelines for connectivity of EV charging station with the electricity system below 33 kV voltage level. Key provisions under the regulation are summarized below:

Table 30 Key provisions of grid connectivity of DER regulation by CEA for EV charging operators

Sr. No.	Particulars	Key provisions
1	Standard	• EV charging station operator needs to provide a reliable protection system to detect various faults and abnormal conditions and provide an appropriate means to isolate the faulty equipment or system automatically. • It would be the responsibility of the charging operator that fault in the EV charging infrastructure equipment or system does not affect the grid adversely. • Discom (distribution licensee) should carry out adequacy and stability study of the network before permitting connection with its electricity system. • Discom to continuously measure and meter the harmonics with power quality meters complying with the provisions of IEC 61000-4-30 Class A. • Charging operator needs to install power quality meters and share the recorded data with the Discom • Discom should periodically measure the voltage sag, swell, flicker, disruptions as per relevant IEC standard

In order to safeguard the Charging Infrastructure from electrical accidents, CEA amended the "Measures relating to Safety and Electric Supply) (Amendment) Regulations" in June 2019. It laid down several safety provisions for EV charging infrastructure connected with the grid. Some of the key provisions under the regulation are summarized in below table:

Table 31 Safety Provisions for Electric Vehicle Charging Stations as per Safety and Electric Supply Regulations, 2019

Sr. No.	Particulars	Key provisions
1	General safety requirements	• All electric vehicle charging stations are required to provide protection against the overload of input supply and output supply fittings • All electric vehicle charging points should have socket-outlet of supply at least 800 millimeter above the finished ground level • Suitable lightning protection system needs to be provided as per Indian Standards Code IS/ IEC 62305

Sr. No.	Particulars	Key provisions
2	Earth protection system	• All residual current devices used for the protection of supplies to electric vehicle needs to be permanently marked to identify their function and the location of the charging station or socket outlet they protect. • Each electric vehicle charging points needs to be supplied individually by a dedicated final sub-circuit protected by an overcurrent protective device complying with IEC 60947-2, IEC 60947-6-2 or the IEC 60269 series and the overcurrent protective device should be part of a switchboard.
3	Fire hazard prevention	• Enclosure of charging stations should be made of fire retardant material with self-extinguishing property and free from Halogen • Power supply cables used in charging station or charging points should conform to IEC 62893-1 and its relevant parts
4	Charging station testing	• All apparatus of charging stations should have the insulation resistance value as stipulated in the relevant IEC 61851-1
5	Inspection and assessment	• The owner of the charging station needs to establish and implement a safety assessment programme for regular periodic assessment of the electrical safety of charging station. Electrical inspectors and/or Chartered Electrical Safety Engineers are entrusted with the responsibility of testing and inspection of charging infrastructure
6	Record maintenance	• The owner of the charging station needs to keep records of the results of every inspection, testing and periodic assessment and details of any issues observed during the assessment and any actions required to be taken in relation to those issues
7	International standards	• The safety provisions of all Alternating Current charging stations should be in accordance with IEC 61851-1, IEC 61851-21 and IEC 61851-22. • The safety provisions of all Direct Current charging stations should be in accordance with IEC 61851-1, IEC 61851-21, IEC 61851-23 and IEC 61851-24.

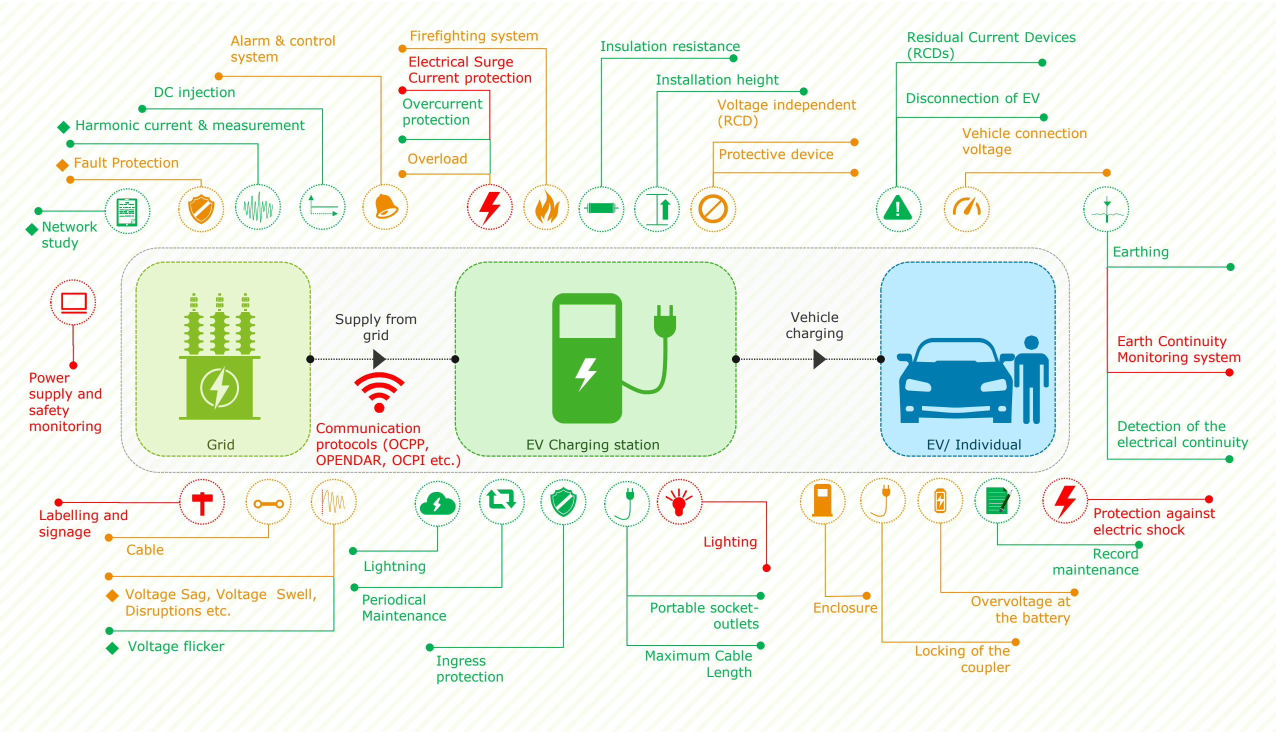
3.2.1.1.1 Analysis and recommendations

The CEA safety and interconnection regulations were evaluated and compared with similar regulations and standards prevalent globally. It was identified that there are three key considerations that are taken care of while drafting safety and interconnection regulation (shown in Figure 143).

Figure 143 Key safety considerations

A literature review of parameters which are considered critical for safety of charging infrastructures was carried out and have been mapped in the schematic below. The assessment showed that although CEA standards have adequately covered safety requirements, however the same could be improved further by (i) specifying the reference standard (IS/IEC/IEEE/Other) for few parameters specified in the existing regulation and; (ii) including additional parameters from the view point of enhancing electrical safety.

Figure 144 Key parameters for grid, equipment and life safety in EV charging, and mapping with CEA specified guidelines



Legend:

included in CEA regulations for interconnection and electrical safety; and CEA specified the reference standards

included in CEA regulations for interconnection and electrical safety; and CEA doesn't specify the reference standards

not included in CEA regulation

legends with diamond shape ◆ indicates parameters from CEA's Connectivity of the Distributed Generation Regulation

Source: 85 Deloitte analysis

The mapping of key parameters is carried out under three categories viz.

- parameters included in CEA regulations and for which CEA has specified the reference standards
- parameters included in CEA regulations but for which CEA has not specified the reference standards and
- parameters which are not covered in CEA regulation.

Following additional provisions can be included in the safety regulation by CEA.

Table 32 Additional provisions for EV charging station adopted globally

Sr. No.	Provision	Country	Description
1	Provision for Labelling and signage	USA, Abu Dhabi, Hong Kong, Netherlands	• Signage posted in EV station helps drivers to understand appropriate use of charging infrastructure
2	Provision for site lighting	China, USA	• The charging station should have adequate lighting facility especially during night time. Adequate lighting avoids instances of accident.
3	Requirement of monitoring system (Power supply and safety protection)	China	• Monitoring of power supply will include switch status, protection signal, voltage, current, active power, reactive power, power factor etc.

Sr. No.	Provision	Country	Description
			and safety protection such as alarm, entrance, exit control etc.
4	Provision for protection against electric shock	China, Abu Dhabi	• Charging stations to have anti-electric shock protection in order to ensure risk to life during any hazard

Source: 86 Deloitte analysis

Along with the provisions, there are several international standards on EV charging station that CEA could adopt to strengthen the safety and interconnection regulations and make it future ready. Some of these key standards are listed in below table:

Table 33 Key international standards on EV charging safety and grid interconnection

Sr. No.	Standard	Description
1.	IEC 61980	• The standard provides a standard for Wireless Power Transfer (WPT) system and is applicable for a supply voltage up to 1000 V AC and 1500 V DC
2.	IEC62196	• The standard provides a standard for plugs, socket outlets, vehicle connectors, and vehicle inlets that are used for conductive charging of EVs
3.	IEEE1547	• Standards for interconnecting distributed resources with electric power systems. The standard covers requirements relevant to the performance, operation, testing, safety and maintenance for interconnection of DER with grid. It is applicable for DERs with a collective capacity of 10MVA or less.
4.	GB/T 36278-2018	• Technical code for electric vehicle charging/battery swap infrastructure interconnecting to distribution network
5.	SAEJ2293	• The standard establishes the requirement of on and off-board charging equipment. It has two sections: J2293-1 discusses the power requirements and system architecture for three operating conditions (conductive AC, conductive DC and inductive charging), and J2293-2 discusses the communication requirement and network architecture for EV charging
6.	SAEJ1772	• The standard discusses all the equipment ratings for EV charging including circuit breaker current rating, charging voltage rating and so on
7.	SAEJ1773	• This standard specifies the minimum requirements of inductively coupled charging scheme for EVs. It also establishes explicitly the requirement for manually connected inductive charging systems and elaborates the requirements of software interface for inductive charging
8.	SAEJ2847 and SAEJ2836	• Both the standards along with SAEJ1772 specify the communication requirements between an EV and the charging infrastructure. SAEJ2847 specifies the communication requirements and SAEJ2836 defines the use cases and provides the testing infrastructure.
9.	SAEJ2931	• This standard establishes the requirements for digital communication between EVs, EVSE, utility, energy service interface, advanced metering infrastructure, and home area network

Sr. No.	Standard	Description
10.	NFPA3	• Standard for Commissioning of Fire Protection and Life Safety Systems (National Fire Protection Association (NFPA))
11.	NFPA 551	• Guide for the Evaluation of Fire Risk Assessments (National Fire Protection Association (NFPA))
12.	IS 1646:1997	• Code for practice for fire safety of Building (general) Electrical installation
13.	IS 2189	• Selection, installation and maintenance of automatic fire detection and alarm system
14.	IEC 61439-7:2018	• Low-voltage switchgear and control gear assemblies - Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations
15.	IEC 61140:2016	• Protection against electric shock - Common aspects for installation and equipment
16.	IEC 60364-7-722:2018	• Low-voltage electrical installations - Part 7-722. Requirements for special installations or locations - Supplies for electric vehicles

Source: 87 Deloitte analysis

Along with the above mentioned interconnection and safety standards, CEA may also provide direction on communication protocol followed between the charging station/ network service provider and the utility. Some of such protocols are mentioned below:

Table 34 Standards on communication between Utility and EV charging station

Sr. No.	Standard	Description
1	OSCP 1.0, OCPP 1.5, OCPP 1.6, OCPP 2.0	• The Open Charge Point Protocol (OCPP) and the Open Smart Charging Protocol (OSCP) were developed by the members of the Open Charge Alliance and are an open protocol for communications between charging points and the EV charging network administrator. These protocols provide charging station owners the option of changing EV charging network administrators without stranding equipment assets. The OSCP acts between the charging station and the energy management system, can provide 24-hour prediction for local available capacity, and fits charging profiles to grid capacity. OCPP 1.6 includes smart charging support for load balancing. The most recent version, OCPP 2.0, includes support for ISO/IEC 15118 (among other things). Although not yet formalized as a standard and managed by a recognized SDO, there is significant adoption of the OCPP protocol and efforts are underway to develop it into a full standard within the IEC.
2	OpenADR 2.0	• The Open Automated Demand Response (OpenADR 2.0b is the most updated version) standard is currently managed by the OpenADR Alliance and provides an open and standardized way for Virtual Top Nodes (e.g., electricity providers and system operators) to communicate with various Virtual End Nodes (e.g., aggregators, EV charging network operators, etc.) using a common language over any existing IP-based communications network. Originally developed as a peak load management tool, it has since expanded to include other DERs. Messaging protocols such as OpenADR can also be used in combination with other protocols, such as those used to communicate between a charging station and a network operator (e.g., OCPP76, IEEE 2030.5, etc.).

Source: 88 Deloitte analysis

3.2.2 Clean fuel

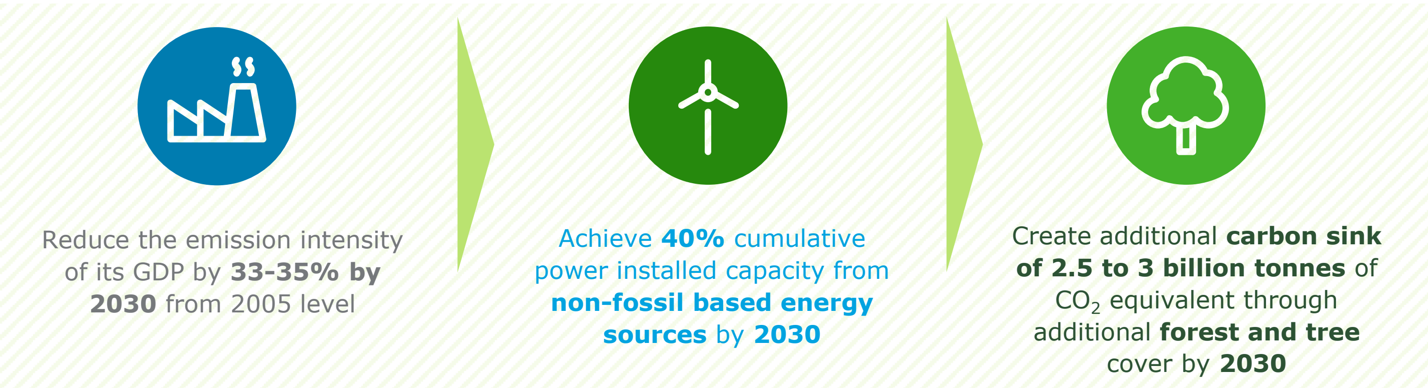
India took its first big step towards climate change in the year 2008 when it released its National Action Plan on Climate Change (NAPCC). The plan outlined existing and future policies and programs aimed at addressing climate change and adapting to the same. The action plan identified several measures that would support the development objectives along with ensuring that climate change risks are mitigated. The action plan identified eight core "national missions" running through 2017 which represents a multi-pronged, long-term and integrated approach for achieving key goals in the context of climate change.

Figure 145 Eight missions identified under National Action Plan on Climate Change (NAPCC)

Source: 89 India: National action plan on climate change (NAPCC) (access here)

Thereafter, in the year 2015, ahead of COP 21, India submitted its Intended Nationally Determined Contribution (INDC) to United Nations Framework Convention on Climate Change (UNFCCC). Limiting the global warming levels was at the center stage of India's INDC commitments with an increasing focus on containing emission levels, increasing renewable power generation, and undertaking afforestation measures.

Figure 146 India's key Intended Nationally Determined Contribution (INDC) targets for the period 2021 to 2030

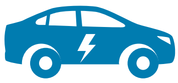


Under the core missions identified by NAPCC and to achieve the INDC target, India took several major initiatives in order to curb its overall emission level and promote adoption of clean technologies. Some of the major initiative towards clean fuel promotion are provided below:

Table 35 Measures adopted by India to curb emission level

	Promotion of renewable energy generation	• In 2015, India set an ambitious target to install 175 GW of renewable energy by year 2022. The target was in line with its COP21 target to achieve 40% power generation from non-fossil fuel based sources by 2030. Further to 175 GW target by 2022, India announced its intention to reach a target of 450 GW of renewables by 2030 at the Secretary General's summit in New York[45].
	Stringent emission norms for thermal power plants and shutting of inefficient power plants	• In Union Budget 2020, India proposed to shut down inefficient thermal power plants that have exceeded their useful life[46] • On December 2015, Ministry of Environment, Forest and Climate Change brought out new norms for coal-based power stations to cut down emissions of particulate matter (PM10), sulphur dioxide (SO2) and oxides of nitrogen (NOx) to improve the air quality around power plants.[47] • The Central Pollution Control Board (CPCB) had directed inefficient thermal power plants to install flue-gas desulfurisation (FGD) in order to reduce SO2 emission, failing which, they would be shut down.[48]
	Replacing polluting means of cooking with clean LPG (Pradhan Mantri Ujjwala Yojana (PMUY))	• India launched Pradhan Mantri Ujjwala Yojana (PMUY) on 01 May 2016 with the aim to safeguard the health of women and children. The primary goal was to replace carbon emitting cooking methods such as firewood, coal, dung – cakes etc. with cleaner LPG. Under the scheme, deposit-free LPG connection is provided to the woman member of a Below Poverty Line (BPL) family.[49]
	Improving the fuel quality in transportation	• India announced migration from Bharat Stage IV norms to more stringent Bharat Stage VI norms by skipping Bharat Stage V norms. While European countries experienced this transition in almost 10 years, India envisioned it to accomplish in three years. • India is also expanding its bio-fuel mixing program to reduce the share of crude oil used in India. The country targets 20% blend of bioethanol and 5% of biodiesel into diesel and petrol mix by 2030
	Decarbonising the transport sector	• In January 2014, India set CO_2 emission targets for Light Duty Vehicles (LDVs) at the equivalent of 130 gm of CO_2 per kilometre (gCO2/km) in 2017 and 113 gCO2/km in 2022 • In August 2017, India published fuel efficiency standards for commercial heavy-duty vehicles and

[45] Report of the Secretary-General on the 2019 Climate Action Summit (access here)
[46] India Union Budget 2020-2021 (access here)
[47] CEA -Brief review of the new MOEF&CC Environmental Rule (access here)
[48] CPCB threatens to shut down 14 coal-fired power plants which failed to limit emissions (access here)
[49] About PMUY (access here)

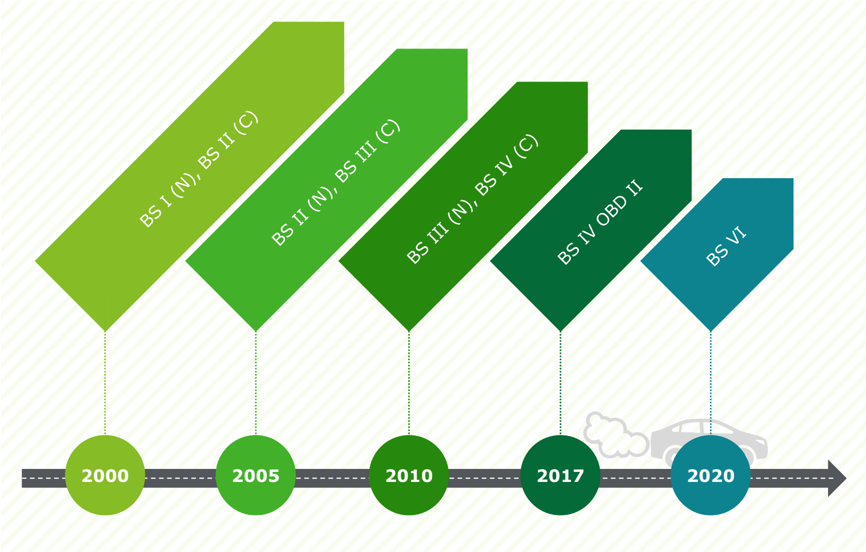
		became one of the first countries in the world to do so.
	Promoting adoption of electric mobility	• India launched FAME India Scheme (Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles in India) in 2015 to promote demand for electric vehicles in the country. It subsequently launched FAME II scheme in 2019 which aimed at continuing the incentives offered to electric vehicles.
	Curbing CO2 emission through energy efficiency	• The Perform, Achieve and Trade (PAT) scheme was one of the four initiatives launched under National Mission for Enhanced Energy Efficiency (NMEEE). The scheme focused on improving the efficiency of energy intensive sectors. Till date, the PAT scheme has helped in avoiding more 62 million tonnes of CO2[50].
	Reducing emission in agriculture	• Under National Mission for Sustainable Agriculture (NMSA), India took several initiatives including promotion of lower methane emission rice production, crop diversification, chemical-free farming and soil health pilot projects. • In 2005, government made neem coating mandatory for urea in order reduce nitrous oxide emissions.[51]
	Odd-even transportation policy	• The Government of NCT of Delhi implemented odd-even scheme with the objective of reducing air pollution in Delhi. The policy was first introduced for five days in November 2015. • Under the policy, odd numbered vehicles were allowed to move on odd numbered days, while even numbered vehicles would move on even numbered days.

3.2.2.1 Emission standards in India

India's journey of adopting emission standards started in the year 1991[52] when India notified the first stage of mass emission norms for petrol vehicles followed by mass emission norms for diesel vehicles in 1992. However, it was only in 2000 when India notified its first emission standard i.e. BS I, in line with European standards. The BS I (India 2000) norm was implemented pan India in year 2000. During this period, BS II norm was implemented in the National Capital Region (NCR). In 2005, the BS II was finally adopted nationwide, and BS III norm was introduced in thirteen major cities of the country. Similarly BS IV, implemented in 2010, was initially rolled out in select cities until 2017, post which it was adopted nationwide. The latest BS standard prevalent nationwide is BS VI which has been made effective w.e.f. April 2020. The overall timeline for adoption of BS norms in India is provided in Figure 147:

[50] PAT (access here)
[51] Neem Coated Urea(access here)
[52] SIAM - Emission norms (access here)

Figure 147 Adoption of emission norms by India - Timeline



Since the beginning of Bharat Stage (BS), India always implemented BS in major cities first before implementing it nationwide. BS VI norm, however, implemented nationwide directly.

Source: 90 ARAI; BS: Bharat Stage, OBD: On-Board Diagnostic, N: Nationwide, C: Major Cities

Note: From April 2023, phase II of BS VI standards is proposed

The BS VI norms are the sixth stage for vehicular emissions in India and are equivalent to Euro VI standard with slightly relaxed limits.

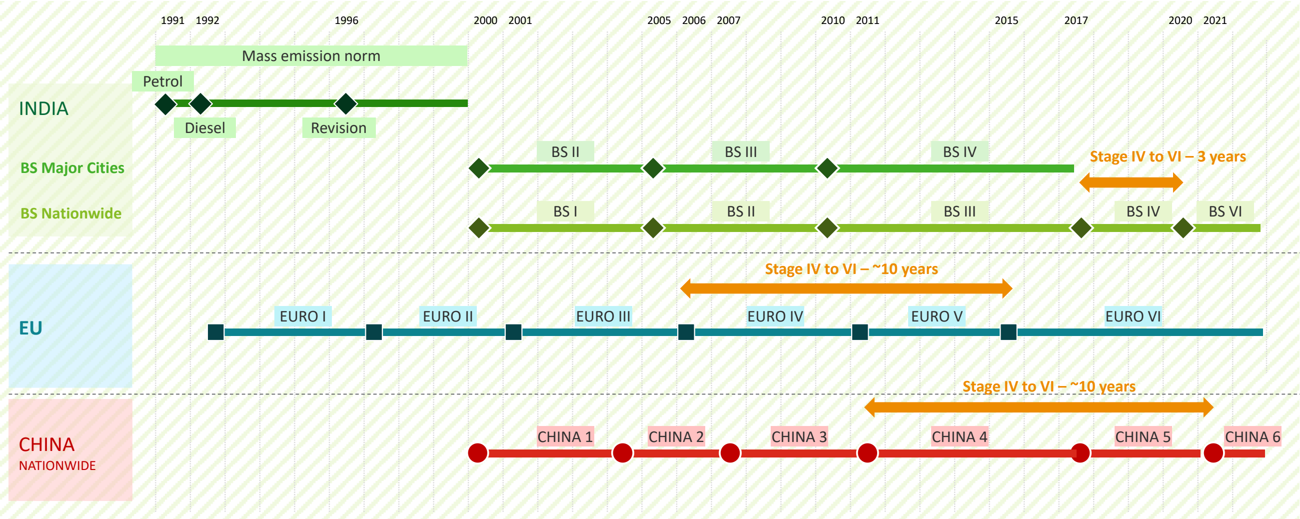
Table 36 Similarity in fuel specification for gaoline and diesel in BS VI and Euro 6

Sr. No.	Fuel Parameter (Gasoline)	BS VI	Euro 6	Fuel Parameter (Diesel)	BS VI	Euro 6
1	Sulfur, ppm, max.	10	10	Sulfur, ppm, max.	10	10
2	Research Octane (RON), min.	91/95	95	Cetane Number (CN), min	51	51
3	Olefins, vol%, max.	21/18	18	PAH, mass %, max	11	8

Source: 91 Technical Background on India BS VI Fuel Specifications (access here); PAH: Polycylic Aromatic Hydrocarbon

Although BS VI is adopted from EURO 6, it is still almost five years delayed, as the EURO 6 norm was enforced in year 2015. Figure 148 showcases the adoption timeline of fuel emission norms in India, EU and China.

Figure 148 Timeline adoption of emission standards by India, EU and China



Source: 92 SIAM, ARAI, ACEA, DieselNet; For EURO registration date is considered

It can be observed from the above figure that EU was the first adopter of the latest EURO 6 norms, which was implemented in year 2015. India, by skipping BS V and implementing BS VI from 2020 is now at part with the EURO 6 norms. China on the other hand has planned the implementation of its CHINA 6 norm (equivalent to EURO 6) from year 2021 onwards.

From the above timeline, it can be observed that India migrated to BS VI directly from BS IV in only **three years**, whereas, EU and China adopted stage 5 norms and took almost **ten years** in this migration.

Although India had to skip BS V and implement BS VI in very short timeline, this leapfrog from BS IV to BS VI was vital for India due to following reasons:

- ✓ First, it aligned Indian emission standards with Euro 6/VI regulations applicable in the European Union; and,
- ✓ Second, the fuel emission had direct impact on health of general public; delaying in adoption of BS VI would put lives of many citizens at risk. For a diesel engine, Particulate matter (PM) limit in BS VI is 82 to 93 per cent lower than the BS IV level[53].

In the next section, we will analyse the emission norms under BS VI its comparison with BS IV.

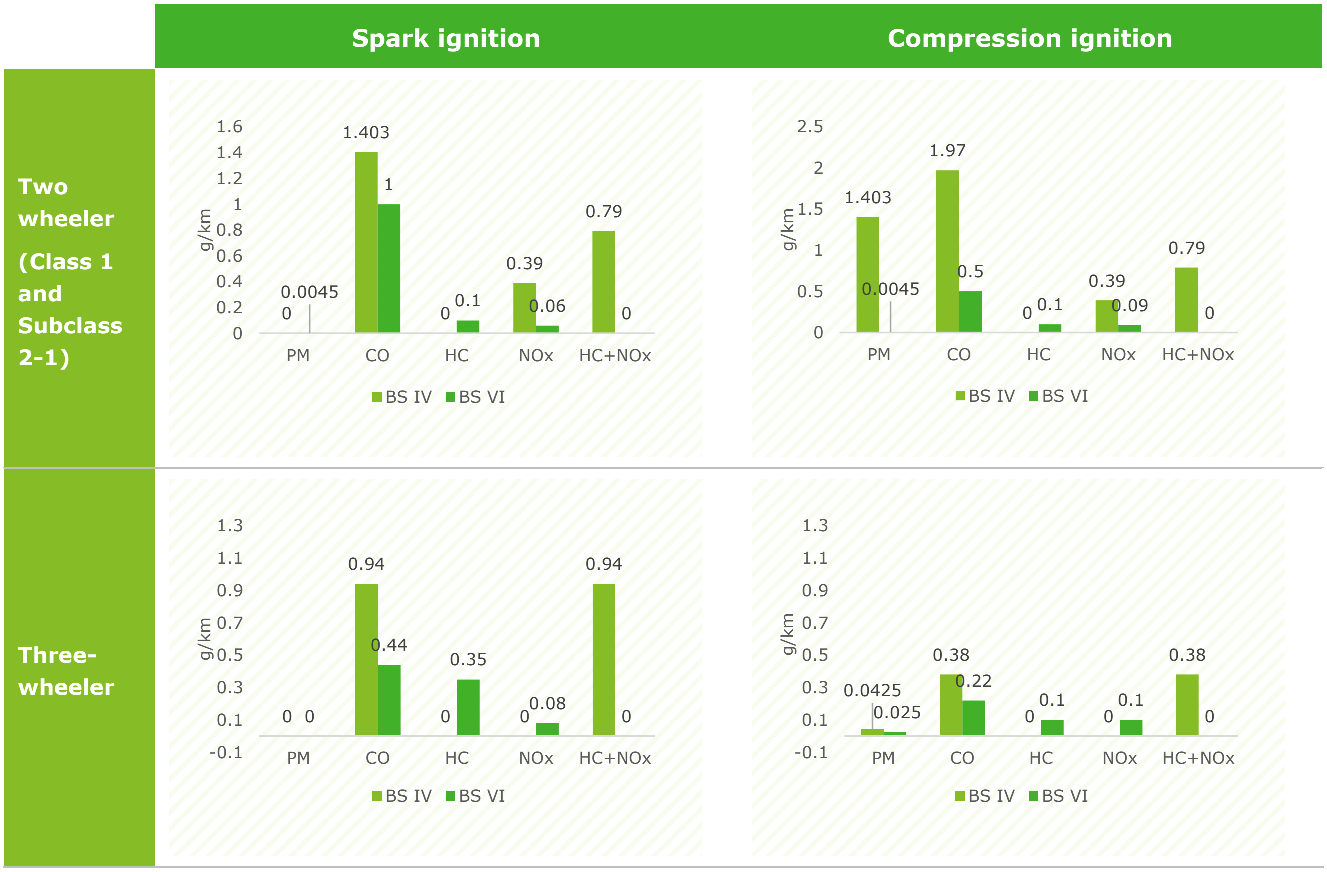
3.2.2.1.1 Emission limits in BS VI

The main pollutants emitted from conventional vehicles are: PM (Particulate Matter), CO (Carbon Monoxide), HC (Hydrocarbon), NO_x (Nitrogen Oxides), and HC along with NOx. In the figures provided below, we would illustrate as to how the implementation of BS VI has effectively led to tightening of emission standards.

The initial comparison was conducted for 2W and 3W vehicles. These vehicles are further categorized into spark ignition and compression ignition.

[53] Bharat Stage VI: India leapfrogs today and it is no Fool's day (access here)

Figure 149 Comparision in emission norms for 2W and 3W under BS IV and BS VI



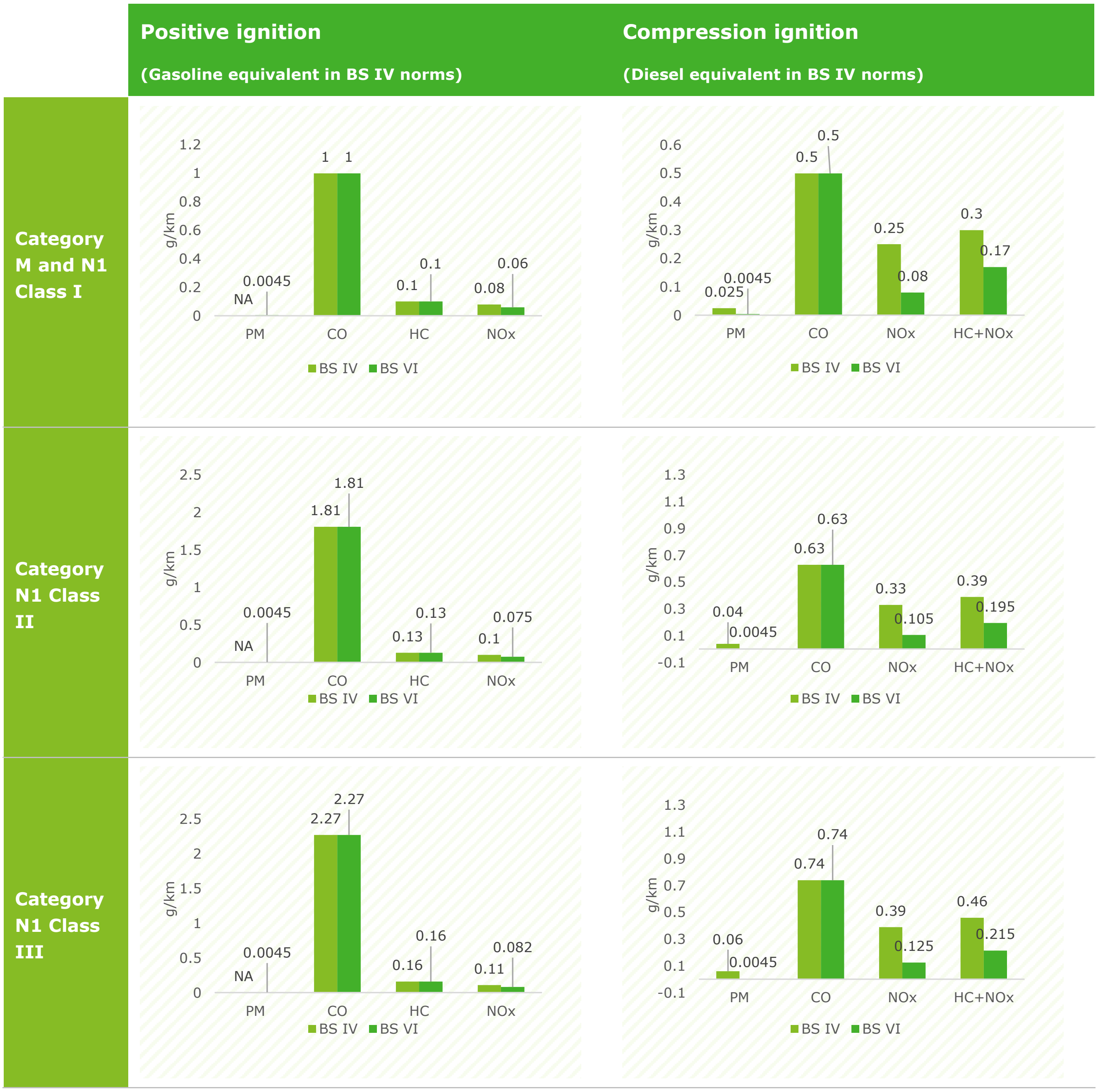
Source: 93 Indian Emission Regulation Booklet – ARAI (access here)

Note: Class 1- 50cc<D<150cc and Vmax≤50km/h, or D<150cc and 50<Vmax<100km/h Subclass 2-1-D<150cc and /100≤Vmax<115km/h, or D≥150cc and Vx<115 km/h

BS VI has tightened the acceptable limit for Particulate Matter, Carbon Monoxide, Nitrogen Oxides (for 2W) and Hydrocarbon-Nitrogen Oxide

For assessing the changes in emission limits for a light-duty vehicle with gross vehicle weight (GVW) ≤ 3,500 kg, it is further categorized into vehicle categories of M and N where, category M are motor vehicles having at least four wheels and are meant for the passenger transport, whereas category N are the Power-driven vehicles having at least four wheels and are meant for goods carriage.

Figure 150 Comparision in emission norms for light duty vehicles under BS IV and BS VI



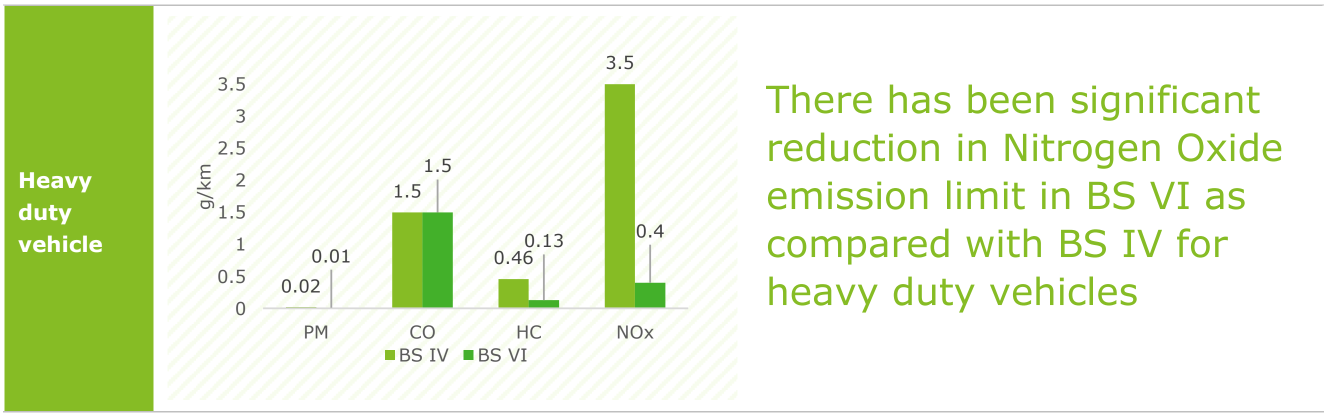
Source: 94 Indian Emission Regulation Booklet – ARAI (access here)

Note: N1- Vehicles for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes; Class I- RW ≤ 1305 kg; Class II- 1305 kg < RW ≤ 1760 kg; Class III- 1760 kg < RW

There aren't considerable changes in the emission limit for light duty vehicles as compared to 2W and 3W vehicles in BS VI

For vehicles with Gross Vehicle Weight (GVW) > 3,500 kg which includes commercial trucks, buses, and on-road vocational vehicles such as refuse haulers and cement mixers, comparison is given in below figure

Figure 151 Comparision in emission norms for heavy duty vehicles under BS IV and BS VI



Source: 95 Indian Emission Regulation Booklet – ARAI (access here)

3.2.2.2 Fuel quality standard

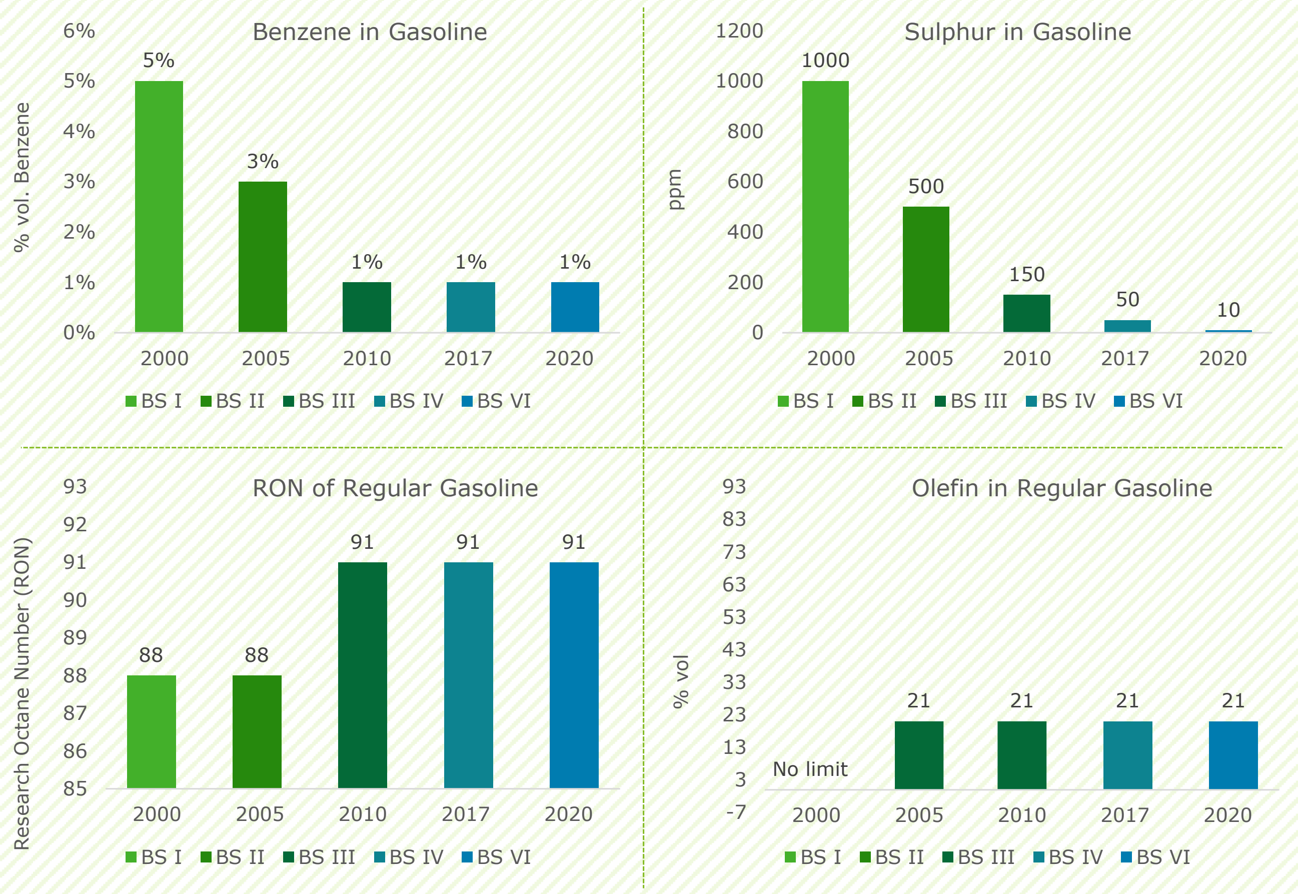
The BS VI also regulates the quality of fuel used for transportation i.e. Gasoline (Petrol) and Diesel:

Gasoline

For gasoline, the fuel quality is primarily identified by below four contents:

Benzene Content	Benzene is highly dangerous for human health. It is a substance capable of causing cancer. In early 2000s, acceptable benzene content was 5% volume max. This limit has now been reduced to 1% volume max under BS VI.
Sulphur Content	Sulphur is a form of impurity present in gasoline. The BS VI standard has limited sulphur content to 10 ppm in the gasoline fuel.
Octane Number	The Octane number of gasoline fuel provides a measure of the fuel's ability to resist the process of auto-ignition, which can mainly cause engine damage.
Olefin Content	High olefin content in the fuel helps to improve the combustion efficiency, that leads to reduction in the hydrocarbon emissions (HC) but increase the nitrogen oxide emissions (NOx).

Figure 152 Trend in permissible limit for gasoline contents in different BS standards



Source: 96 Centre for High Technology (CHT) (MoP&NG)

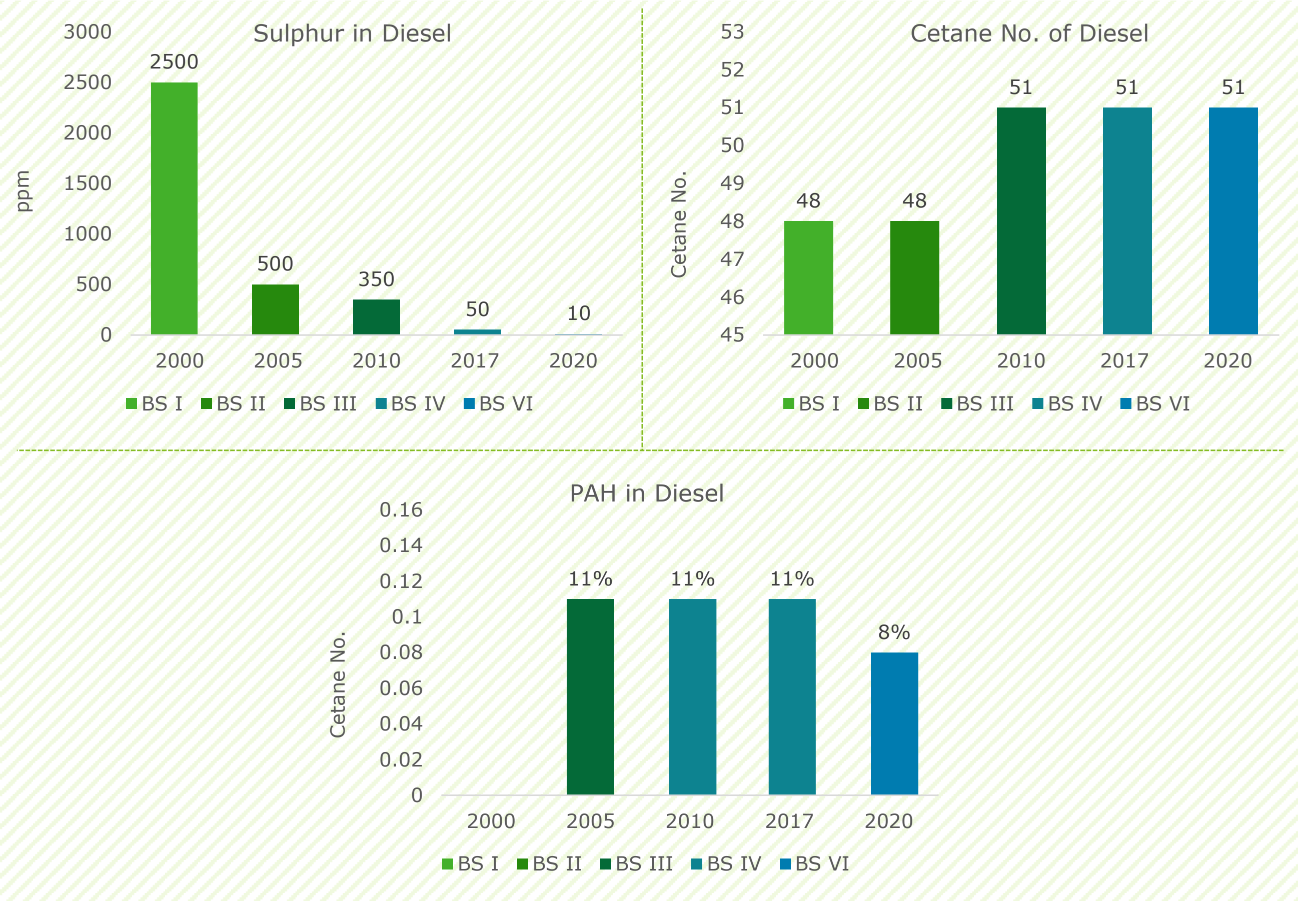
There is significant reduction in acceptable sulphur content in Gasoline under BS VI

Diesel

For diesel the quality is primarily identified by below three contents:

Sulphur Content	Sulphur is a form of impurity present in gasoline. The BS VI standard has limited sulphur content to 10 ppm in the gasoline fuel.
Cetane Number	The Cetane number is a measure of compression ignition quality of diesel fuel and influences cold start-ability, exhaust emissions and combustion noise.
Polycyclic Aromatic Hydrocarbon (PAH) Content	Polycyclic aromatic hydrocarbons (PAHs) are a group of more than 100 chemicals that are also called polynuclear aromatic hydrocarbons. Exposure to PAH can lead to irritation of the eyes and breathing passages and also can be a cause for cancer.

Figure 153 Trend in permissible limit for diesel contents in different BS standards



Source: 97 Centre for High Technology (CHT) (MoP&NG)

Similar to gasoline, BS VI reduced the limit of sulphur content in diesel. Sulphur content quantity is now at the same level for both gasoline and diesel.

3.2.2.2.1 Technology upgrade in BS VI

The BS VI standard is applicable for vehicles such as two-wheelers, three-wheelers; Light-duty vehicles (category M and N vehicles with gross vehicle weight (GVW) ≤ 3,500 kg)[54] and Heavy-duty vehicles (category M and N vehicles with gross vehicle weight (GVW) > 3,500 kg). It is expected that adequate technological upgrades will be required in such vehicles to ensure that the vehicle emissions remain within the limits as specified in BS VI.

It is expected that the following upgrades would have to be carried out to the engine of an ICE vehicle:-

[54] Category M: A Motor vehicle with at least four wheels used for carrying passengers; Category N: A motor vehicle with at least four wheels used for carrying goods. These vehicles can carry persons in addition to the goods. Please Refer Annexure 6.3 for details on vehicle categories

Table 37 Engine technological upgrades from BS IV to BS VI

 **Petrol Engine**	 **Diesel Engine**
Port and exhaust system redesign Re-design of ports and improvement in the exhaust system to achieve more effective scavenging and reduce mixture short-circuiting	**Additional devices to include in the engine** In BS IV, a catalytic convertor was part of the engine. However, with migration to BS VI, two additional devices i.e. Diesel Particulate Filter (DPF) and Selective Catalytic Reduction (SCR) are required to be fit in series (in case of four wheeler)
Redesigning combustion chamber Redesigning of combustion chamber and sparkplug re-location in order to reduce knocking with higher compression ratios	
Improved Piston-design Improving the piston-design to minimize crevice volumes and friction losses. Also, adopting microprocessor based electronic control, and enhancing the don-board diagnostic system	
Use of controlled auto ignition Charge stratification having controlled auto ignition along with variable ignition timing. This will help in improved combustion of fuel.	

Source: 98 Technical Challenges in Shifting from BS IV to BS-VI Automotive Emissions Norms by 2020 in India (access here)

In case of two and three-wheeler vehicles under the BS VI norms, conventional carburettor was to be replaced with fuel injection, under BS VI. Now, Air Assisted Direct Injection (AADI), and High Pressure Direct Injection (HPDI) are used in spark ignition (SI) vehicles for fuel injection.

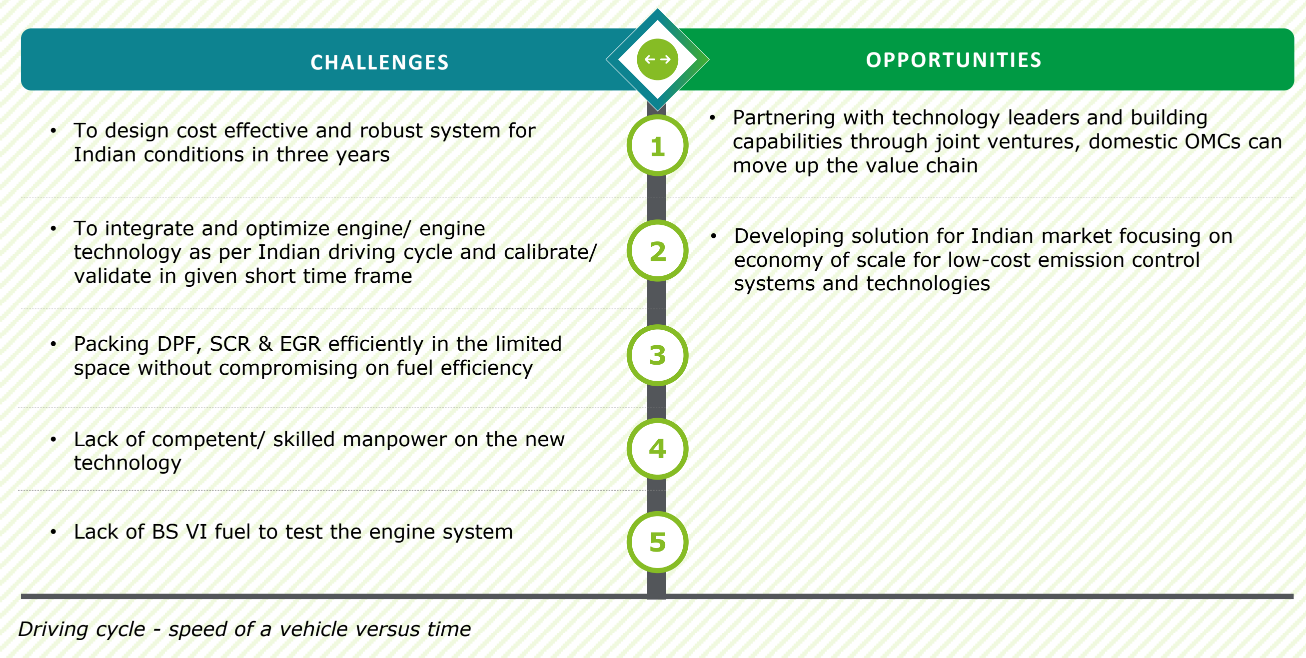
3.2.2.2.2 Challenges and opportunity from BS IV to BS VI transition

The transition from BS IV to BS VI required introduction of advanced technologies to limit pollutants emitted by the vehicles. This transition required changes in the existing engine system and incorporation of diesel particulate filter (DPF), selective catalytic reduction (SCR) and exhaust gas re-circulation (EGR) technologies. BS IV required the use of either DPF or SCR. However, BS VI now requires both the technologies to be present. To develop DPF, the equipment needs 5,000 hours on the test bed and at least 700 tests on the chassis dynamometer[55], whereas SCR requires 4,000 hours on the test bed. With such short timeline for migration (3 years), testing of DPF and SCR itself required close to six months.

Some of the major challenges and opportunities arising from BS IV to BS VI transition are given in below figure:

[55] Chassis dynamometer is a device for measurement and testing to simulate the road on a roller in a controlled environment

Figure 154 BS IV to BS VI transition – Challenges and opportunities



3.2.2.3 Average fuel consumption standard

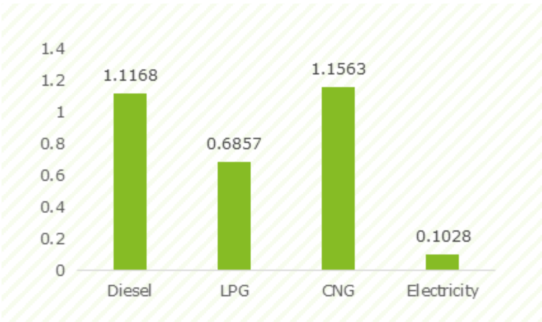
In April 2015, MoP issued the fuel consumption standards for cars. The standard was applicable for petrol, diesel, LPG or CNG based passenger vehicles with gross vehicle weight of up to 3,500 kilograms. The formula for calculation of average fuel consumption standard is provided below:

$$Average\ Fuel\ Consumption\ Standard = a \times (W - b) + c$$

Where: a is the Constant Multiplier
b = Fixed Constant;
c = Fixed Constant;
W = Weighted average of unladen mass in kilogram (kg) of all new said motor vehicle, manufactured or imported for sale by the manufacture

Average Fuel Consumption Standard is the fuel consumption in petrol equivalent liter per 100 kilometer by the manufacturer

Figure 155 Conversion factor of different fuel types to petrol equivalent



Values of constants a, b and c along with calculation formula is provided in below table:

Table 38 Formula for calculation of Average Fuel Consumption Standard for Manufacturer

Parameter	FY18-FY22	FY23 Onwards
a	0.0024	0.002
b	1037	1145
c	5.4922	4.7694
Average Fuel Consumption Standard for Manufacturer	= 0.0024 x (W – **1037**) + **5.4922**	= 0.002 x (W – **1145**) + **4.7694**

As shown in Table 38, the average weight of all cars is expected to be **1037 kg** for FY18-FY22 with Average Fuel Consumption Standard of less than **5.49 km/100 liters**. From FY23 onward, the standard assumes an average car weight of **1145 kg**, and requires the average fuel consumption to be less than **4.77 l/100km**.

Table 39 Average fuel consumption standard for passenger cars in India

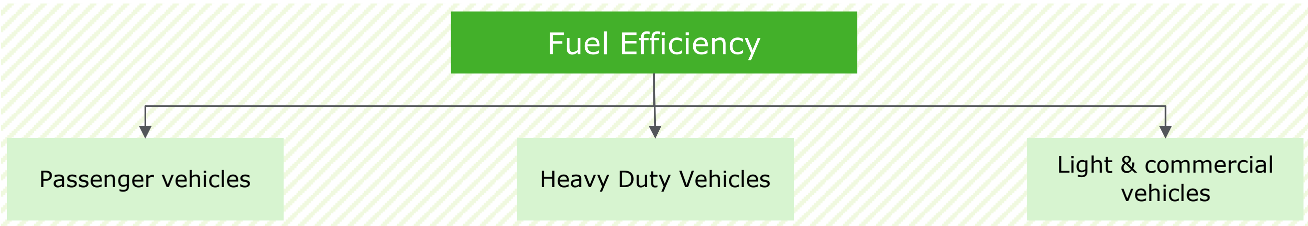
Standard	2017-18 to 2021-22	2022-23 Onwards
Expected weight (Kg)	1037 kg	1145 kg
Average fuel consumption (l/100 km)	5.49 l/100km	4.77 l/100km

As per GoI estimates, there is a scope of reduction in fuel consumption to the extent of **22.97 million tons** by 2025 through this standard[56].

3.2.2.4 Fuel Efficiency

To ensure efficient consumption of fuel, India has notified fuel efficiency standards for passenger vehicles, heavy duty vehicles (HDV) and light and commercial vehicles (LCV).

Figure 156 Fuel efficiency for vehicles in India



In the below sections, fuel efficiency details on various vehicle categories is elaborated:

3.2.2.4.1 CAFE (Corporate Average Fuel Efficiency) regulations for passenger vehicles

Implemented first in 1970s by USA[57], the purpose of CAFÉ regulations was to enhance the fuel efficiency of passenger vehicles in the country. The CAFE regulations require each car manufacturer to meet a standard for the sales-weighted fuel economy (mpg)[58] for the entire fleet of vehicles sold in each model year.

The CAFE standard prescribes the minimum average mileage per gallon (mpg) a vehicle class must meet.

In **USA**, CAFE standards are regulated by US Department of Transportation's (DOT) National Highway Traffic and Safety Administration (NHTSA). NHTSA sets and enforces the CAFE standards, while the Environmental Protection Agency (EPA) calculates average fuel economy levels for manufacturers, and also sets related GHG standards[59]. Some of the salient features of CAFÉ norms are given below:

- Reduces the overall fuel consumption of the economy;
- Increase the availability of alternate fuel vehicles;
- Promotes advancements in innovative technologies;
- Reduces in overall GHG emission of the country and improve air quality;
- Provides credit to the auto manufacturers for exceeding the standard requirement;
- Penalize the manufacturers for not meeting the minimum standard requirement

In **India**, the CAFÉ norms were proposed by Ministry of Power in collaboration with Bureau of Energy Efficiency (BEE) which set the fuel consumption targets for every automaker in the country and aims to

[56] Corporate Average Fuel Economy Norms for Passenger Cars (access here)
[57] The New CAFE Standards: Are They Enough on Their Own? (access here)
[58] Fuel economy is the average **m**ileage a vehicle can travel **p**er **g**allon of fuel (mpg)
[59] Corporate Average Fuel Economy (CAFE) Standards (access here)

improve the overall fuel efficiency of automobiles. The timeline for notification of CAFÉ norms for different vehicle categories is provided below:

Table 40 Timeline for notification of CAFÉ norms for different vehicle category

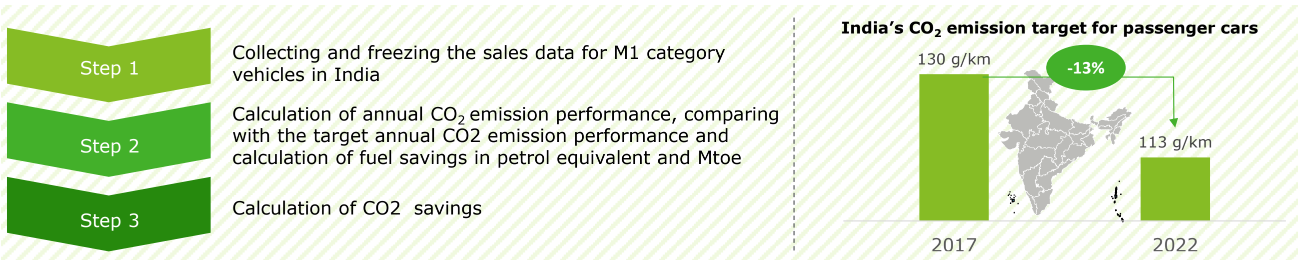
2015	2017	2019
CAFC^ Norms established for passenger cars	CAFÉ Norms established for Heavy Duty Vehicles (HDV)	CAFÉ Norms established for light commercial vehicles

Source: 99 CAFC: Corporate Average Fuel Consumption

The CAFÉ norm was established with two-phase targets for FY 2017–2018 and for FY 2022–2023.

In CAFÉ norms, vehicle manufacturer receives a target in gasoline-equivalent **liters per 100 kilometers** (L/100 km) based on vehicle curb weight. However, the actual fuel consumption for compliance is measured as grams of CO2 emissions per kilometer (g/km) during vehicle type approval. The calculation of CO_2 savings along with India's target is provided in below figure:

Figure 157 Methodology to calculate CO_2 savings under CAFE norms and India's emission target for passenger cars

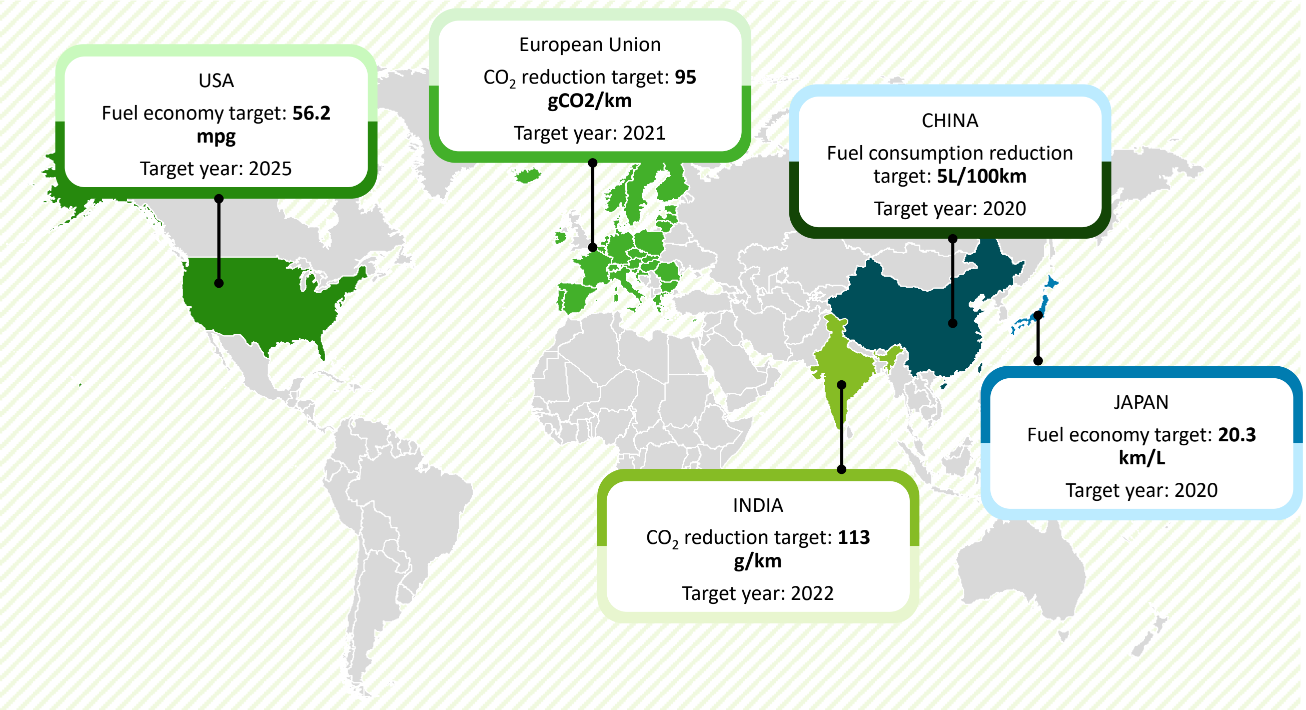


Source: 100 BEE - Impact of energy efficiency measures FY19

The regulation also provides super credits to manufacturers producing electric vehicles thereby encouraging the shift towards electric mobility. India targets cars to be become 30% or more fuel-efficient from 2022, while 10% or more by 2021.

India has set the target for **113 gm/km** of CO_2 emissions from passenger cars. An overview of the target of CO_2 emissions from passenger cars, as set by select countries, is provided in Figure 158. It can be observed that India, China and Japan have CO_2 emission targets for year 2020/22, whereas, European Union and United States of America has emission target for year 2021 and 2025 respectively.

Figure 158 Global emission targets from passenger vehicles by leading countries



Source: 101 ICCT - Global Comparison of Passenger Car and Light-commercial Vehicle Fuel Economy/GHG Emissions Standards (access here)

3.2.2.4.2 Fuel Economy Norms for Heavy Duty Vehicles (Constant Speed Fuel Consumption (CSFC) standard)[60]

In August 2017, India published the fuel efficiency standards for commercial heavy-duty vehicles (HDVs). By doing so, India became one of the first countries in the world to publish a fuel efficiency standard for HDVs.

Standard applicability: This standards are applicable for Heavy duty commercial vehicles of category M3 and N3 with gross vehicle weight exceeding twelve tonnes.

Category M3: A vehicle used for the carriage of passengers, comprising nine or more seats in addition to the driver's seat and having a GVW exceeding 5 ton

Category N2: A vehicle used for the carriage of goods and having a GVW exceeding 3.5 ton but not exceeding 12 ton

As per this standard, manufacturers need to demonstrate compliance by testing their vehicles over the constant speed fuel consumption (CSFC) test procedure. Under this procedure, trucks are tested at constant speed on a test track at 40 and 60 kmph, whereas, buses are tested at 50 kmph.

The first phase of the standard (Phase 1) came in effect in April 2018, while Phase 2 is scheduled to be effective from April 2021. Under the standard, the fuel consumption of each vehicle of a given category must be less than the fuel consumption value derived from the equation provided in the standard.

The standard, however, is applicable for vehicles complying with BS-IV standards.

[60] Fuel Economy Norms for Heavy Duty Vehicles (access here)

The target fuel consumption is calculated from the formula:

$$Y = a \times X + b$$

Where: Y: Normalized value (fuel consumption) in litres/100kms
a and b = Fixed Constants;
X: Gross vehicle weight in tonnes

The standard has provided target fuel consumption formula for M3 and N3 categories at constant speed of 40 kmph and 60 kmph. Target fuel consumption for N3 vehicle at 40 Km/h is provided in below tables:

Table 41 Phase I - Category N3- Rigid vehicles at 40 km/h

N3 Rigid vehicles at 40 km/h		
Gross vehicle weight range	Axle configuration	Equation for deriving target fuel consumption (1/100km)
12.0-16.2	4x2	Y=0.362X+10.327
16.2-25.0	6x2	Y=0.603X+6.415
16.2-25.0	6x4	Y=0.723X+4.482
25.0-31.0	8x2	Y=0.527X+8.333
25.0-31.0	8x4	Y=0.928X-0.658
31.0-37.0	10x2	Y=0.960X-5.100

Table 42 Phase II - Category N3– Rigid vehicles at 40 km/h

N3 Rigid vehicles at 40 km/h		
Gross vehicle weight range	Axle configuration	Equation for deriving target fuel consumption (l/100km)
12.0-16.2	4x2	Y=0.329X+9.607
16.2-25.0	6x2	Y=0.523X+6.462
16.2-25.0	6x4	Y=0.673X+4.032
25.0-31.0	8x2	Y=0.430X+8.780
25.0-31.0	8x4	Y=0.732X+2.558
31.0-37.0	10x2	Y=0.963X-7.753

Similarly, equations for each vehicle category at different speed for calculating target fuel consumption is provided in Annexure 6.3 section**.**

3.2.2.4.3 Fuel Economy Norms for Light and Commercial Vehicles (Constant Speed Fuel Consumption (CSFC) standard)[61]

In July 2019, India published its fuel efficiency standards for light and commercial vehicles.

Standard applicability: This standard is applicable for Light and Medium commercial vehicles of category M2, M3 and N2 with gross vehicle weight between three and a half tonnes to twelve tonnes.

Category M2: A vehicle used for carriage of passengers, comprising nine or more seats in addition to the driver's seat, and having a maximum Gross Vehicle Weight (GVW) not exceeding 5 ton

Category M3: A vehicle used for the carriage of passengers, comprising nine or more seats in addition to the driver's seat and having a GVW exceeding 5 ton

Category N2: A vehicle used for the carriage of goods and having a GVW exceeding 3.5 ton but not exceeding 12 ton

[61] Fuel Economy Norms for Light & Commercial Vehicles (access here)

Unlike FE norm for HDVs, fuel economy norm for light and commercial vehicles are applicable to both, BS-IV and BS-VI compliant vehicles.

The target fuel consumption is calculated from the formula:

$$Fuel\ Consumption = a\ + W \times b$$

Where: Fuel Consumption is the normalized value (fuel consumption) in litres/100kms;
a and b = Fixed Constants;
W: Gross vehicle weight in tonnes

The fuel consumption of each vehicle of a particular category must be **less than** the fuel consumption value derived from the equation.

For each category and different vehicle weight and testing speed, values of a and b have been provided. Below table represents the formula for fuel consumption for different vehicle categories and testing speed.

Table 43 Fuel consumption calculation for N2 category vehicles

Gross Vehicle Weight	Range Testing Speed (Kilometres per Hour)	Equation for Deriving Target Fuel Consumption (litre per 100km.)
3.5 T to 7.5 T	50	Fuel Consumption = 1.038*W+3.372
7.5 T to 12.0 T	40	Fuel Consumption = 1.080*W+1.708
7.5 T to 12.0 T	60	Fuel Consumption = 1.038*W+6.008

Table 44 Fuel consumption calculation for M2 and M3 category vehicles

Gross Vehicle Weight	Range Testing Speed (Kilometres per Hour)	Equation for Deriving Target Fuel Consumption (litre per 100km.)
3.5 T to 7.5 T	50	Fuel Consumption = 1.293*W+2.806
7.5 T to 12.0 T	40	Fuel Consumption = 1.399*W+0.381
7.5 T to 12.0 T	60	Fuel Consumption = 1.768*W+0.509

Other than the fuel efficiency norms, Govt. of India has also planned for **star labelling** of the vehicles. However, the same is currently under review and pending formal approval.

4. Review of Services and Business Models in electric mobility

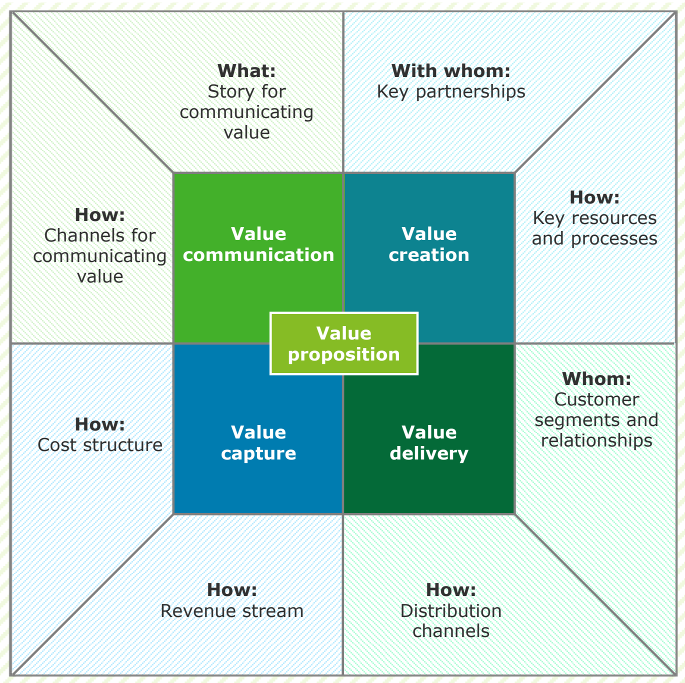
Multiple business models for uptake of EVs have evolved in past few years and several are also in the process of evolving to respond to the emerging needs at the EV marketplace. An optimal and sound business model would play a vital role in ensuring long-term sustainability and growth of EVs in the country.

4.1 Framework for assessment of business models

To assess the electric mobility business model, a framework is provided in Figure 159. Parameters selected in the framework are adopted from Osterwalder's business model canvas[62].

A business model describes how the company communicates, creates, delivers, and captures value out of a value proposition.

Figure 159 Business model framework



Source: 102 Adopted from Osterwalder business model canvas and business ecosystem approaches; N. Abdelkafi, S. Makhotin & T. Posselt, 2013, "Business Model Innovations for Electric Mobility"

Value proposition denotes an overall view of company's offerings (products and services) that are of value to the customer. **Value creation** signifies transforming resources into products and services. **Value communication** denotes delivery of the value proposition as a message to the target groups. **Value capture** describes the ability of the value proposition to transform into revenue stream. **Value delivery** defines the means by which enterprises establish interactions with the customer in order to provide the value.

The report will assess existing business models in electric mobility space using the above-mentioned framework.

4.2 Key business models promoting uptake of electric mobility

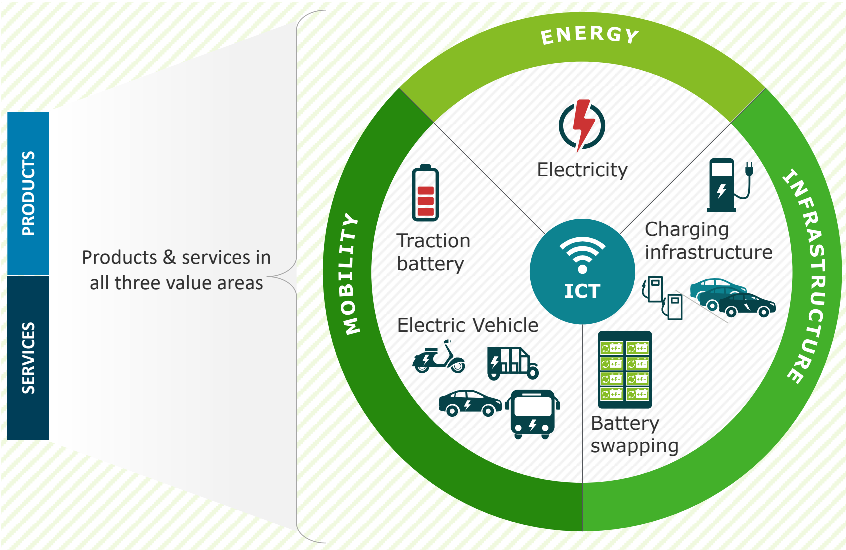
An overview of potential areas for business, within electric mobility value chain is provided in Figure 218. However, for the purpose of this report, primarily, only those business models have been assessed that can potentially promote uptake of EVs among end-consumer (B2C businesses).

[62] Business model canvas (access here)

Katja Laurischkat, Arne Viertelhausen, and Daniel Jandt, in their paper "Business Models for Electric Mobility", identified essential business areas where substantial value can be delivered to the customer, within the electric mobility space. These business areas are considered as essential for large scale uptake of EVs Such areas are provided in Figure 160.

Businesses need to invest and build offerings around: mobility; infrastructure; and, energy

Figure 160 Value-wheel for businesses to promote uptake of electric mobility among customers



Source: 103 Katja Laurischkat, Arne Viertelhausen, Daniel Jandt, 2016, "Business Models for Electric Mobility" (access here); Deloitte analysis; ICT: Information and Communications Technology

The value-wheel consist of three major areas – Mobility, Infrastructure, and Energy. Mobility segment includes electric vehicle and traction battery; infrastructure segment includes charging infrastructure and battery swapping stations; and energy segment includes electricity used for charging vehicles and storing in EV batteries.

Information and Communications Technology (ICT) will remain at the core of the value proposition of any business concept and will act as an enabler for any business model.

In the sections provided below, we will assess global and Indian business models around the identified areas for each segment of the value-wheel.

4.2.1 Mobility

Mobility is essentially the most significant area where actual uptake of electric vehicles will take place. This value area focuses on business models that use EVs or batteries to provide a set of service to the customers. It focuses on how introduction of EVs or battery services will add value to the customers, and eventually encourage businesses and customers to adopt EVs. In line with this, the mobility segment is divided into two categories: electric vehicles, and traction battery. Each section will evaluate how business models under both the categories would creating value for customers.

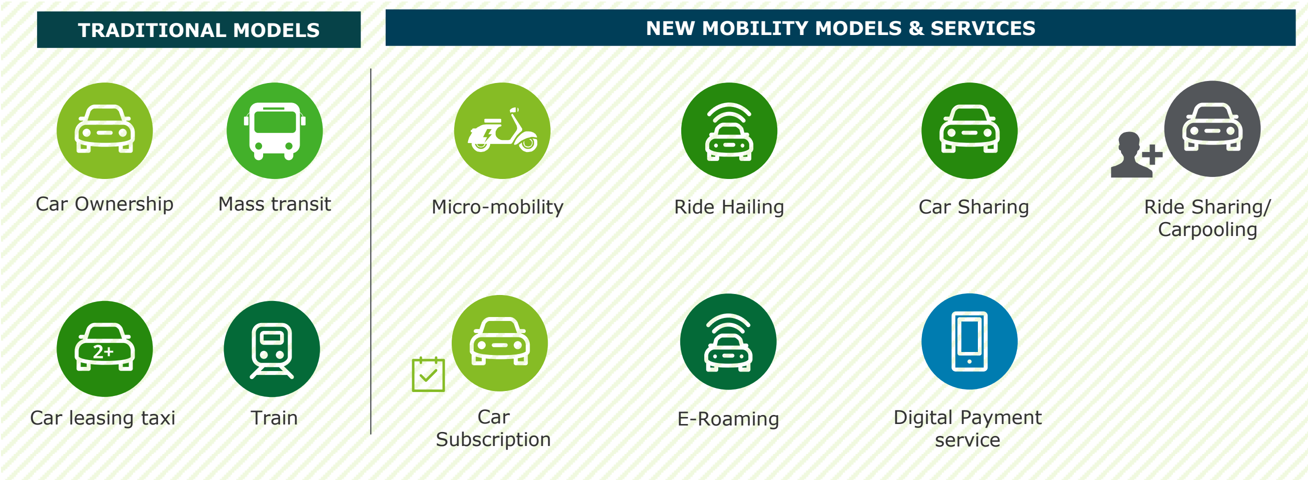
4.2.1.1 Electric vehicles

Public perception on shared economy (such as goods, mobility, properties etc.) has changed substantially in past few years. Customers are increasingly preferring shared/ on-demand vehicles that are highly cost effective as against personal ownership of vehicles. Customers have shown interest towards business models and services that offers them an alternative for owning a vehicle along with providing all the facilities/ luxury of vehicle ownership.

New mobility business models is effectively changing the way people move.

Overview of this shift from traditional business models to new mobility models and services is presented in Figure 161.

Figure 161 Evolution of models and services in mobility



Source: 104 Marsh & McLennan Advantage Insights; Marsh; Oliver Wyman; Center for Automotive Research (CAR); Deloitte analysis

Sections provided below discuss the new mobility business models in detail, along with its footprint in India.

4.2.1.1.1 Micro-mobility

Micro-mobility provides travelling solutions for short distances to one or two passengers at a time, usually to cover the first or last mile of a journey. Micro-mobility includes vehicles such as bicycles, skateboards, electric bicycles, electric scooters, Segway[63] etc. However, worldwide, electric scooters have emerged as a preferred choice among all vehicle types that facilitate micro-mobility. Characteristics of electric scooters which enable it to be a preferred choice includes its ease of use, acting as a faster alternative to public transportation, and easier to use than conventional bicycles[64].

In micro-mobility, bike sharing has evolved as a prominent business model that has been widely adopted across many countries. Bike sharing provides affordable access to users for short-distance trips, mostly in urban areas. Some bike sharing services uses docking stations for drop-off and pickup (e-bike can be picked-up from and returned to any station or kiosk), while others use smartphone apps to provide a dock-less option (e-bike can be picked up and left to any location).

There are various companies operating in bike sharing model with different ownership structure such as: Zypp (India), owned and maintained privately; Capital Bikeshare (Washington), owned and maintained publicly; CitiBike (New York), publicly owned but privately maintained by the company called Motivate.

Some of the emerging micro-mobility companies in India are:

BOUNCE | ZYPP | yulu | VOGO

Business model review of few of the above mentioned bike sharing companies is provided below:

a) ZYPP

Started as Mobycy, Zypp was India's first e-bike / e-scooter sharing platform that does not utilize a docking station. The company allows users to book an e-bike with upfront fare estimate based on origin and destination coordinates.

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[63] A Segway is a two-wheeled, self-balancing personal transporter (more details)
[64] Mobility Revolution: Challenges and Potentials (access here)

Zypp is a dockless platform and it requires customer to park the bike anywhere after use[65]. The company provides services such as bike rentals to end-users, delivery of grocery by commercial users as well as delivery of food items, etc. The company currently operates in Gurugram, Delhi and Noida.

Zypp offers e-scooter renting at Rs. 109 per day and offers battery swapping at Rs. 10[66]

Value proposition		• Station less e-bikes; Fully electric fleet; owns battery swapping station; low speed vehicles (top speed 25 kmph) exempted from license requirement; customized plans for customer; maintenance support
Value creation	**Key partnerships:**	• Spencer's Retail for last mile delivery • Partnered with Zomato and Swiggy • DMRC and local authorities for parking of e-scooters
	Key resources:	• E-bikes • Battery swapping station • Technology
	Key processes:	• Fleet management • Battery swapping station management • Mobile application management
Value communication	**Story/ Channel for communicating value:**	• Social media • Mobile application based booking and payment
Value capture	**Cost structure:**	• Bike and battery cost • Bike maintenance cost • Maintenance of battery swapping station
	Revenue stream:	• Rental fees from every ride • Revenue from last mile delivery • Revenue from battery swapping
Value Delivery	**Distribution channels:**	• Customers to locate nearest pickup point of the ride
	Customer segments:	• Short distance, on-the-go customers • Food and grocery delivery business

b) Yulu

Yulu is a Bengaluru-based electric bike sharing platform having partnership with Uber. The company has over 3,000 electric bikes on its platform that operates through clusters. The company has demarcated "Yulu zones" from where the customers can pick up and drop their vehicles. It has partnered with the government bodies and other infrastructure units like Bruhat Bengaluru Mahanagara Palike (BBMP), Directorate of Urban Land Transport (DULT) and Bengaluru Metro, to access parking space for their vehicles. Yulu offers their electric vehicle under the name "Yulu Miracle" [67].

[65] Mobycy (access here)
[66] Zypp eyes Rs 100 cr in next round (access here)
[67] India's electric bike rental start-up Yulu inks strategic partnership with Bajaj Auto, raises $8M (access here)

Yulu Miracle pricing: Rs. 10 to unlock the vehicle; Rs. 10 for every 10 minutes; Rs. 5 as pause charges for every 10 minutes

Value proposition		• Fully electric; affordable; convenient commuting; free battery swapping; no license required
Value creation	**Key partnerships:**	• With Bajaj Auto for micro-mobility revolution • With Uber for eBike trial
	Key resources:	• E-bikes • Technology
	Key processes:	• Management of rental zones • Bike maintenance • Online support to customers
Value communication	**Story/ Channel for communicating value:**	• Social media • Company website • Yulu mobile app
Value capture	**Cost structure:**	• Bike and battery cost • Maintenance of e-bikes • Maintenance of battery swapping station
	Revenue stream:	• Per booking revenue • Revenue from long term rentals
Value Delivery	**Distribution channels:**	• Bikes kept unattended at Yulu zone; Customer to locate and start the ride
	Customer segments:	• Daily short-distance riders

Micro-mobility offers economical solution to cover the distances that are neither walkable nor long enough to hire expensive taxi ride. This mode of transportation will thus prove to be highly effective in areas where public transport is either expensive or distance to be traversed is substantial. Moreover, in a country like India where traffic density is very high, EV enabled micro-mobility has the potential to become the preferred choice for last mile connectivity as it has the potential to save substantial commuting time.

To provide the adequate boost for increased uptake of EVs in the micro-mobility space, India needs to provide special infrastructure such as, dedicated EV lanes, common parking lots to the micro-mobility vehicles, etc. Existing Smart-city missions could embrace the micro-mobility concept and provide the requisite infrastructure by earmarking dedicated lanes, EV zones etc.

EVs would be key in growth of micro-mobility, as it provides cheaper and faster alternative for transportation. However, focus on building complementing infrastructure is equally important for this business segment to grow.

4.2.1.1.2 Ride Hailing

Similar to Uber or AirBnb, ride hailing business model revolves around creating a two-sided market that connects the end user with the service provider over a technology enabled platform. On the one hand, it facilitates a customer to book a cab at his / her own convenience, and on the other hand, it provides a source of earning to drivers of private 4Ws. Such business models would also discourage private car ownership and provide an additional source of income for drivers of private vehicles.

These services rely on smartphone apps to connect willing passengers with drivers who provide rides (for a fee) in their private vehicles. Transportation Network Companies (TNCs) design and operate these online platforms. Most TNCs function as digital marketplaces linking self-employed drivers with customers, while collecting a fee for making the connection. Key examples of the same are Ola, Uber, Lyft, Didi, Get etc.

a) OLA

Ola's business model revolves around facilitating cab-booking services to the customers through their app. It integrates city transportation for customers and driver-partners onto the mobile technology platform, thus, ensuring convenient, transparent, and quick fulfilment of services.

Value proposition	• Affordable pricing scheme; Minimum waiting time; Eco-friendly mode of transportation; certified drivers	
Value creation	**Key partnerships:**	Financing of e-rickshaws in NCR: Bhartiya Micro Credit (BMC)
	Key resources:	• Technology • Driver partners • Engaged community
	Key processes:	• Establishing charging infrastructure • Fleet management
Value communication	**Story/ Channel for communicating value:**	• Partner channel • Social media • Mobile application based booking and payment
Value capture	**Cost structure:**	• Platform cost • Sales & Marketing • Operational cost • Assets cost
	Revenue stream:	• Commission based model • OLA money • In-cab promotion and advertisement • Cab leasing • OLA credit card • Corporate accounts • OLA prime play
Value Delivery	**Distribution channels:**	• Online booking
	Customer segments:	• Fixed point to point commute on fixed routes • Corporates

b) SmartE

SmartE is a 3W—all electric—mobility service provider, which offers services to commuters to meet their requirement of first & last mile connectivity. Currently, SmartE is providing its commuting services in major urban cities of India.

Value proposition	• Affordable pricing scheme; Minimum waiting time; Eco-friendly mode of transportation	SMARTE™ 0% Pollution, 100% Electric
Value creation	**Key partnerships:**	**Charging infrastructure:** Exicom; Power Grid; NTPC **Battery swapping infrastructure:** SUN mobility **Land for parking:** Delhi Metro; Rapid Metro Gurgaon
	Key resources:	• Vehicle (3W) fleet size of 600 in Delhi NCR region • Pilot of battery swapping model
	Key processes:	• Fleet management
Value communication	**Story/ Channel for communicating value:**	• Social media • Mobile application based booking and payment
Value capture	**Cost structure:**	• Fleet management • Maintenance of charging infrastructure • Vehicle parking
	Revenue stream:	• Rs. 10 for its first pit stop (fixed cost for first 2 km) and Rs. 5 per km thereafter • Initially started on a commission based model where it was charging operating commission from drivers. Now, it owns and manages vehicles. • Smart ads: Revenue generation from hyperlocal advertising on vehicles
Value Delivery	**Distribution channels:**	• Online booking; operates on route within range of 5 km
	Customer segments:	• **Fixed point to point commute:** Service to and from metro, bus stations, residential colonies, corporate hubs, shopping areas

Ride hailing business reduces the cost of owning a vehicle and at the same time ensures convenience to customers. Inclusion of options for hassle free online payment also increases its adoption by customers.

However, due to the unprecedented COVID-19 outbreak, ride hailing businesses have been severely impacted, as consumers have been wary of resorting to such services on the backdrop of increased risks of infection. This has led to disruption in the operations of ride hailing businesses in several cities of India[68]. During April and May 2020, OLA's revenue declined by almost 95%[69]. Customers have now shifted to the traditional method of using own vehicles for commuting.

[68] Covid-19 impact: Indian consumers may move away from ride-hailing services (access here)
[69] How the pandemic has hit Ola, Uber hard in India (access here)

Deloitte study has shown that more than 70% customers wish to limit their usage of ride-hailing service post COVID outbreak[70]

However, it is too early to comment on the future prospects of the ride hailing business in the wake of COVID. It is expected that with the gradual decrease in infection rate and arrival of immunization / vaccination, the risk perception of ride hailing services would gradually reduce. This puts additional consideration for service providers to take into account increased safety precautions in their operations.[71]

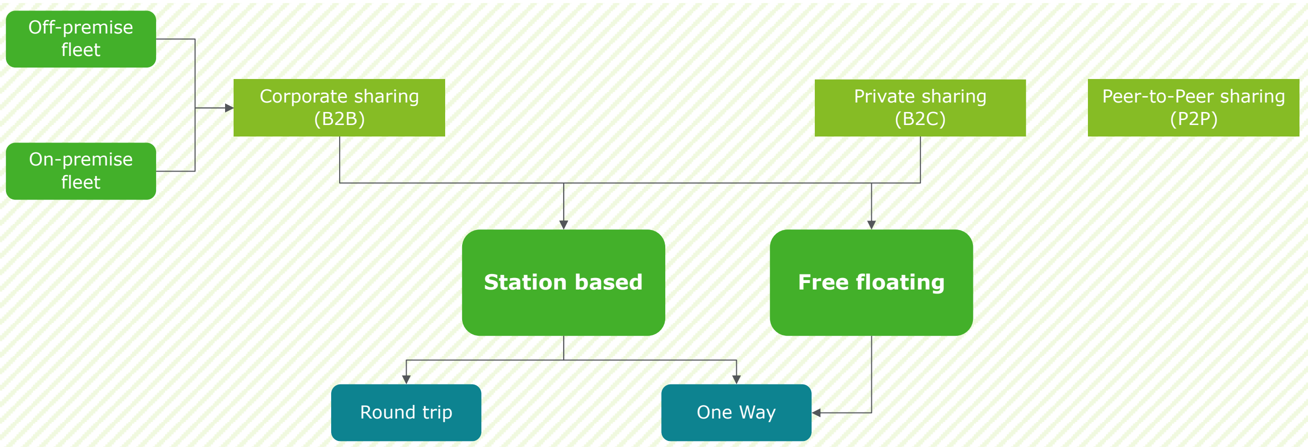
4.2.1.1.3 Car Sharing

Car sharing follows similar concept as bike sharing, however it is preferred for longer distances. It is a short-term car rental, hired on either hourly basis or per kilometre basis or hybrid of both. In this type of service, an electronic systems allow unattended access to the vehicles with fuel and insurance charges bundled into the rental charges. Car sharing can be round-trip, one-way, free-floating or station-based.

In round trip, user is required return the vehicles to their original pick-up stations after use, whereas, in one-way system, user can pick-up and park the vehicle at any authorized parking spot. In station-based car sharing model, user could pick up and return the vehicle at designated rental stations only. Whereas, in free-floating, user locates the nearest available car using the mobile app, uses it, and then drop-off it at any location.

Car sharing is enabled through three types of common business models based on the relationship of the service provider and consumer. These business models include: 1) business to consumer (B2C); 2) business to business (B2B); and 3) peer-to-peer (P2P).

Figure 162 Car sharing business models based on service provider and consumer relationship



Source: 105 eMaaS – electric Mobility as a Service - eMaaS Consortium – June 2020, Deloitte analysis

Business-to-Consumer (B2C): In a B2C model, the service operator offers individual consumer an access to a fleet of vehicles through memberships, subscriptions, user fees, or combination of pricing models. Examples of B2C include Zipcar and Enterprise CarShare (roundtrip); and SHARE NOW (free-floating one-way).

Business-to-Business (B2B): In a B2B model, the service operators offers access to their vehicles to employees of a company with which it has entered into a contract for a fixed period of time. The service operator bills the company through a fee-for-service or usage fees,. Such business models serve the need of offering convenience to employees in completing work-related trips. Owing to similarity in services between B2B and B2C models, it is found that the same service operators exist in both B2B and B2C market

[70] Deloitte - Global State of the Consumer Tracker - Global Automotive Industry (access here)
[71] Deloitte - Last mile delivery after COVID-19: A world of things to solve (access here)

segment. However, companies such as Lithium Urban operate only in B2B segment by positioning itself as premier service operator for businesses.

Peer-to-Peer (P2P): The P2P model (sometimes referred to as personal vehicle sharing) is similar to round trip car sharing. In this model, the vehicle usually consists of private car owners who are willing to rent out their vehicles when they are not using it. This model offers an additional revenue stream for the vehicle owners. Drivezy is an example of a car sharing company which offers P2P sharing facility in India.

Some of the major players in car sharing are:

Lithium	Zipcar	Car2go	Enterprise CarShare

a) Lithium Urban Technology

Lithium Urban Technologies owns fleet of Electric Vehicles (EVs) and associated charging infrastructure, backed by strong technology platform for telemetry, GIS, employee transport management, scheduling, rostering and analytics based optimisation. The company positioned itself as a premier B2B service operator. The company operates its fleet through trained and certified drivers.

Value proposition	Eco-friendly mode of transportation; Safe, secure and hassle-free option for corporate commutation; 24X7 service	
Value creation	**Key partnerships:**	• Collaboration with Mahindra & Mahindra for procurement of EVs • Fourth Partner Energy and Lithium Urban Technologies entered into a partnership to build solar-powered charging infrastructure
	Key resources:	• Over 100 charging stations • Fleet of 500 cabs
	Key processes:	• Establishing charging infrastructure at corporate office complexes • Fleet management
Value communication	**Story/Channel for communicating value:**	• Social media • Mobile application based booking
Value capture	**Cost structure:**	• Cost of vehicle • Fleet management • Charging infrastructure maintenance
	Revenue stream:	• Corporates invoiced on monthly basis for the numbers of cars contracted, irrespective of the miles driven. Corporates are separately charged for electricity bills of charging stations
	Distribution channels:	• Mobile application based booking

Value Delivery	**Customer segments:**	• Fixed point to point commute: B2B with Tesco, Unisys, Accenture, Adobe Systems, VMware

b) Zipcar

Zipcar focuses on urban areas and college campuses across Europe and North America. The company strives to offers a wide selection of cars that serve multiple purposes, including moving apartments or hauling office supplies.

The company has several partners with which it works, to enhance its value proposition. For example, Zipcar works with local authorities to secure free parking on public streets for its members; it works with city councils to set up electrification bays for the EV portion of its fleet; it provides its members with discounts to local businesses that it partners with and it integrates its network with public transport.

Depending on the subscribed package, members pay a monthly subscription fee. In addition, subscribers pay for trip fees based on the car usage (time duration for total trips in a month) and overcharge fees, if any. The company does not require subscriber to pay any upfront security deposits.

Value proposition	Discounts to local business partners; Free street parking; Offers electric cars; Fuel, city congestion chargers, insurance & 60 miles/ day included in membership; No deposit required	zipcar
Value creation	**Key partnerships:**	• Local authorities; city council; local businesses; academic researchers
	Key resources:	• Vehicle • Chip card technology • Strategic parking on public streets
	Key processes:	• Maintaining fleet • Service provision (unlocking cars remotely) • Platform management
Value communication	**Story/ Channel for communicating value:**	• Social media • Website • Smartphone app
Value capture	**Cost structure:**	• Purchase & maintenance of fleet • Fuel *(as customers don't pay for the fuel)*/ Electricity charges
	Revenue stream:	• Monthly subscription fee • High-risk driver & rule-breaking charges • Usage fees (minute, hourly & daily rates; per km if over 60 km)
Value Delivery	**Distribution channels:**	• Online booking
	Customer segments:	• Services can be availed by anyone having smartphone and valid licence • Businesses • University students • On-the-go customers (last minute booking)

c) Car2Go

Launched in Germany in 2009, Car2Go is the world's first free-floating car sharing service operating across 26 locations in eight countries.

The free-floating business model allows Car2Go members to take one-way trips and park the cars within specified zones. The company aims at attracting customers who want to drive premium car models including Businesses/corporates. The organisation has some electric cars available in its fleet as well.

Car2Go's real-time reservation system allows customer to book cars just 20 minutes in advance. Its value proposition also provides drivers with free parking in public car lots and awards them with free minutes for refuelling or recharging cars. Customers pay a small subscription fee plus rates based on both the time and kilometres driven. The company does not require subscriber to pay any upfront security deposits.

Value proposition	Free parking in public car lots; no deposit required; no insurance, fuel, electricity cost; 24x7 availability; credit given for refuelling or recharging the car	
Value creation	**Key partnerships:**	• Public transport operators for digital integration • Local governments • Social services for cleaning & maintenance • Businesses • Universities • Car manufacturers
	Key resources:	• IT platform • Premium vehicles • Free parking spaces
	Key processes:	• Fleet maintenance • Platform management • Customer service
Value communication	**Story/ Channel for communicating value:**	• Social media • Website • Mobile app • Customer service shop
Value capture	**Cost structure:**	• Vehicle purchase cost • Fleet maintenance
	Revenue stream:	• Subscription fees • Pick-up & drop charges • Usage fees (minute, hourly, and daily rates, plus per km)
Value Delivery	**Distribution channels:**	• Online booking
	Customer segments:	• People on the go with last-minute reservations • One-way travellers, including drivers headed to/from the airport • Businesses • Eco-conscious individuals

4.2.1.1.4 Ride sharing

Rides sharing is a type of carpooling that allows private non-commercial vehicle owners to pool their ride with travellers having their destination in the same route. The online platform provided by the service providers merely acts as a tool to match demand and supply on a particular travel route. However, absence of any check and balances for safety and security of travellers using such platform is a concern. Instead of such issues, this business model has been gaining traction among price sensitive travellers.

Some of the companies in ride sharing business are:

BlaBlaCar vRide® Getaround

a) BlaBlaCar

BlaBlaCar claims to be the world's leading long-distance carpooling platform provider. Its platform connects people looking to travel long distances.

Value proposition	• Connects drivers and passengers who travel to the same destination; economical means of transport; revenue for drivers/ vehicle owners	BlaBlaCar
Value creation	**Key partnerships:**	• Vehicle drivers • Car insurance players • Hosting/ architecture providers
	Key resources:	• Driver community and their cars • Web based platform and apps
	Key processes:	• Product development • Marketing and promotion
Value communication	**Story/ Channel for communicating value:**	• Website • Social Media platforms
Value capture	**Cost structure:**	• Cost of hosting (servers) • Marketing
	Revenue stream:	• Fixed commission from drivers • Monetizing through implementing Internet payment system
Value Delivery	**Distribution channels:**	• Online apps
	Customer segments:	• Drivers; Vendors; Passenger

Ride sharing promotes the concept of increased asset utilization, mostly among private vehicle owners. It is an attractive business model that leverage shared mobility to reduce the cost of travel for both, the vehicle owner/driver and the co-traveller. As ride sharing is offered by non-corporate entity (vehicle owner), it has minimum overheads involved compared to car sharing or ride hailing, which is managed and operated by corporate firms.

Typical cost of using BlaBla from Delhi to Jaipur (~280 kms) cost INR 450-650, however it cost more than INR 2500 (Uber/Ola multi-city travel rate) in using ride hailing service.

4.2.1.1.5 Car subscription

Car subscription has gained a lot of traction in last few years, as the behavioural shift has been observed in personal mobility (consumers are shifting away from owning a vehicle). Traditional subscription models included personal contracts and long-term leasing arrangement. Now, customers are preferring flexible monthly contracts inclusive of bundling insurance, maintenance and other costs. Car subscription model provides customers with an experience of a private vehicle but saves them from paying the heavy upfront cost for owning the vehicle.

Businesses in car subscription are offering customers wide range of vehicle options suitable to their requirement with the flexibility of selecting desired period.

Many OEMs such as Volvo, Porsche and BMW[72], and other independent platform providers are introducing new subscription schemes to attract and encourage the customers to experience the personal mobility under car subscription.

Some of the businesses operating in car subscription are:

Zoomcar Never Stop Living | DROVER | MYLES DRIVE YOURSELF | CLUTCH

a) Zoomcar

Founded in 2013, Zoomcar is India's first 100% self-drive car rental company. It allows the user to rent cars on hourly, daily, weekly or monthly basis. Zoomcar uses Zap app to help customers to list their car on the company platform. As per Zoomcar's business model, the vehicle owner is responsible for service, maintenance and related expenses of the car. For monitoring, Zoomcar uses its proprietary IOT devices to determine the health of a car on real-time basis.

Value proposition	• Fuel cost covered by ZoomCar; Flexi pricing packages; 24x7 roadside assistance; damage insurance	
Value creation	**Key partnerships:**	• Partnership with Mahindra Electric and Ford
	Key resources:	• Private car fleet offered • Data and inventory • Online platform
	Key processes:	• Procurement • Vehicle maintenance • IT operation/ platform development • Marketing
Value communication	**Story/ Channel for communicating value:**	• Website • Social Media platforms
	Cost structure:	• Fleet maintenance • Park location rental • Fuel cost

[72] OEMs' Subscription Plans Could Revolutionize Auto Industry (access here)

Value capture		• Insurance
	Revenue stream:	• Subscription fees (6, 12, 24 months) • Rental fees per hour
Value Delivery	**Distribution channels:**	• Pickup service
	Customer segments:	• Drivers, travellers

Car subscription offers economical alternative to long-term car leasing. The car subscription offerings are highly flexible and economical for the customer. Customers now have the option of accessing the cars even for their hourly need. This business model will be benefitted from the adoption of EVs, as the reduced operating cost (vehicle charging cost) would enhance the value proposition of this business model.

Following the COVID outbreak, car subscription business is expected to increase as it allows customer to lease the vehicle for personal use without the need of paying hefty amount for the purchase of vehicle, at the same time it minimizes the risk of sharing vehicles with anyone (during the contract period).

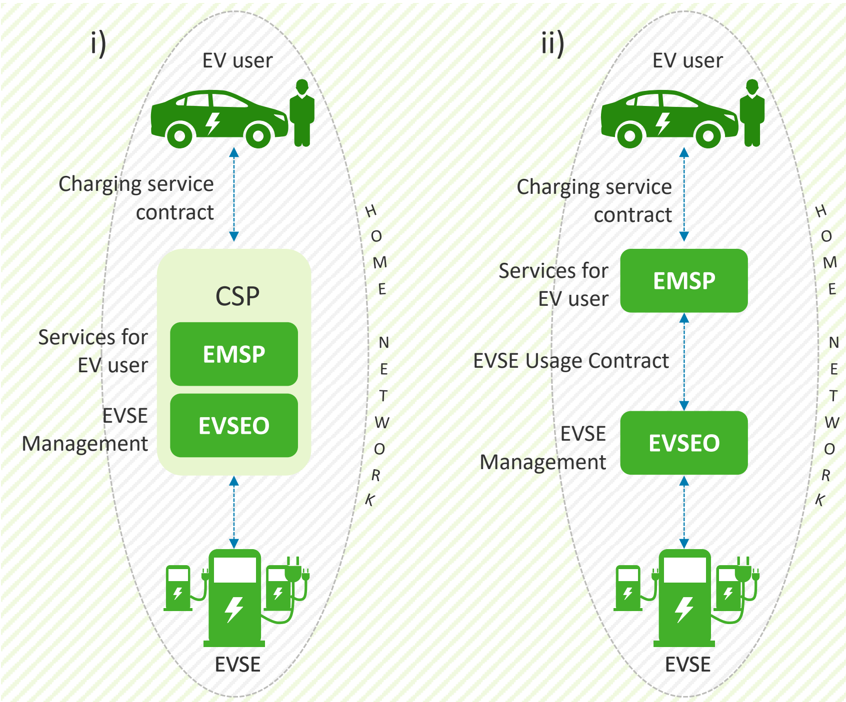
4.2.1.1.6 E-Roaming

In an EV charging process, the EV user have direct contact with the Electro Mobility Service Provider (EMSP) and Electric Vehicle Supply Equipment Operators (EVSEO). Each individual EMSP has an "EVSE usage contract" with one dedicated EVSEO. The EVSEO enables the use of its charging infrastructure by the EMSP's client (i.e. EV user) while the EMSP ensures the payment of charging service fee to the EVSEO (illustrated in Figure 163 (ii)).

In some cases, role of EMSP and EVSEO is played by a single entity; termed as Charging Service Provider (CSP) (illustrated in Figure 163 (i)).

Entire charging infrastructure managed by the CSP/ EMSP with which EV user has entered into contract, is considered as "home network" for the contracted EV user.

Figure 163 Home network illustration for an EV user



Source: 106 Jure Ratej, Borut Mehle, Miha Kocbek, 2013, "Global Service Provider for Electric Vehicle Roaming" (access here)

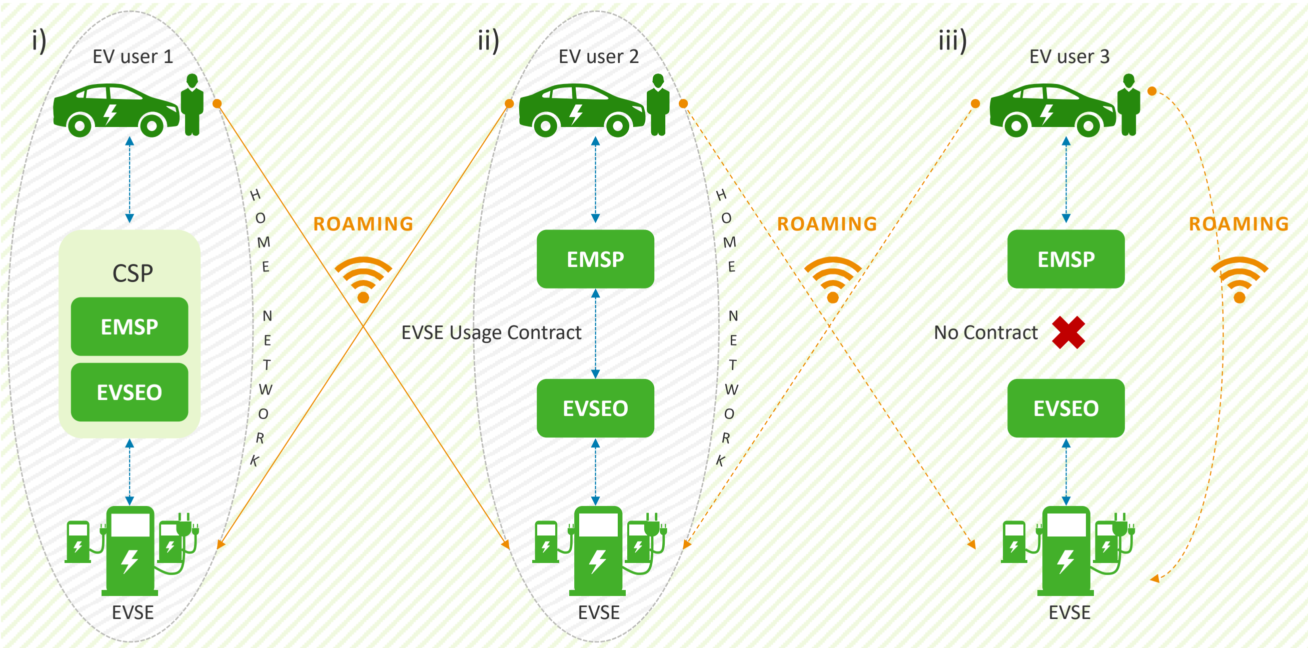
As illustrated in Figure 163, EV users generally sign a contract with the different CSP/EMSP. Under this arrangement, EV user is allowed to charge his/her vehicles from those charging station only that are managed by CSP/EMSP they have contracted with.

However, the challenge arises when the customer (EV user) needs to charge vehicle in area where infrastructure of contracted CSP does not exist. In such cases, the customer needs to sign additional charging service contracts with multiple CSPs, leading to customer receiving multiple monthly bills. This also requires the customer to maintain multiple RFID cards for each geographical location/area.

Interoperability appears as an ideal solution for such challenges. In interoperability, service providers engage in B2B contract with each other, eliminating the need for customer to enter into contract with each service provider. Such arrangement allows customers to charge their vehicles with any CSP/EMSP (network partner), eliminating constraints in charging across different geographies. This approach of providing seamless charging experience to users in their "home network" as well as in "visited networks" (location where contracted CSP does not own charging infrastructure) is known as **e-roaming**.

As presented in Figure 7 (i & ii), e-roaming enabled EV users to charge their vehicle from charging stations that does not belong to their home network. In case the EMSP does not have any usage contract with EVSEO, all the charging session will be done via roaming (Figure 164 (iii)).

Figure 164 Roaming in EV charging



Source: 107 Jure Ratej, Borut Mehle, Miha Kocbek, 2013, "Global Service Provider for Electric Vehicle Roaming" (access here)

Some of the companies working in e-roaming space are:

a) E-clearing

E-clearing is one of the largest e-roaming platform in Europe, with more than 1,06,000 connected charge points and 8,80,000 active drivers. The company was setup in October 2014 as a joint venture of Dutch foundation ElaadNL and smartlab Innovationsgesellschaft mbH from Germany. E-clearing offers an open B2B-platform to all market players in electric mobility. It enables cross-network interoperability in charging of electric vehicles and related value added services. Through the offered platform, electric mobility players can share the data necessary for user authentication, billing, real-time information and other continually expanding use cases.

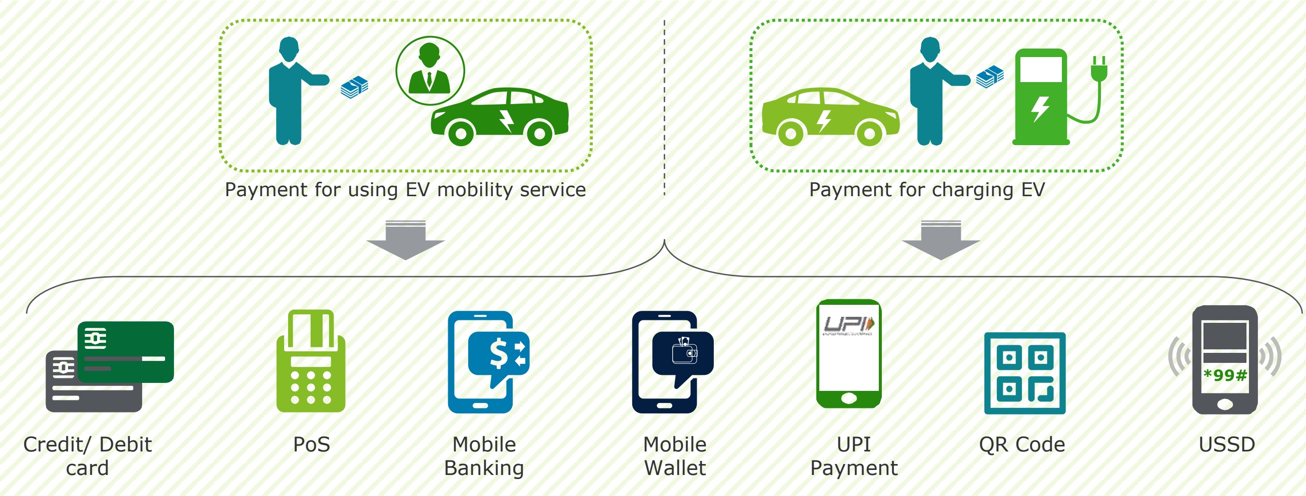
Value proposition	• Full autonomy to connect; open business model (no third parties); open protocol	e-clearing.net
Value creation	**Key partnerships:**	• JV of ElaadNL and smartlab nnovationsgesellschaft mbH • Financial support by the Federal Ministry for Economic Affairs and Energy (BMWi) and the Dutch Ministry of Economics (EZ)
	Key resources:	• Open B2B-platform
	Key processes:	• Enable communication between parties
Value communication	**Story/ Channel for communicating value:**	• Website • Social Media platforms
Value capture	**Cost structure:**	• Platform maintenance
	Revenue stream:	• Fixed, yearly membership fee
Value Delivery	**Distribution channels:**	• Online apps
	Customer segments:	• Charge Point Operators, Parking spot operators, Electric Mobility Providers, Navigation Service Providers

E-roaming makes electric mobility convenient as the EV user do not have to worry about finding home network stations for EV charging.

4.2.1.1.7 Payments services

Cash has been the traditional mode of payment for many decades. However, growth in e-commerce and widespread use of mobile devices have opened up new avenues for payments via digital means. Mobility service providers in general, are tying up with payment gateways to offer hassle-free cashless services. Mobility service providers such as OLA have their own mobile wallet – OLA Money, that allow deduction of ride charges directly from OLA Money account on availing OLA services. With the increase in shared-mobility, payment gateways are finding increased significance and usage. With respect to EVs, the payment services will be used predominantly for two purposes: for utilizing EV mobility service from an operator, and for charging EV. Potential payment methods used in these two purposes are illustrated in Figure 165.

Figure 165 Payment methods for enabling electric mobility services



Source: 108 Cashless India, Deloitte analysis; **Note:** PoS: Point of Sale; UPI: Unified Payment Interface; USSD: Unstructured Supplementary Service Data

Overview of all the payment methods mentioned in Figure 165 is provided in Annexure 6.4.

4.2.1.2 Traction battery

Batteries contribute to ~40% in overall cost of EV (Chapter 1), therefore, businesses providing service in battery segment, and delivering value in terms of reducing overall cost of EV, can play huge role in promoting uptake of EVs. In this section, we will discuss potential services/ processes related to battery that a business can take up and help in reducing the overall cost of ownership for EV buyers.

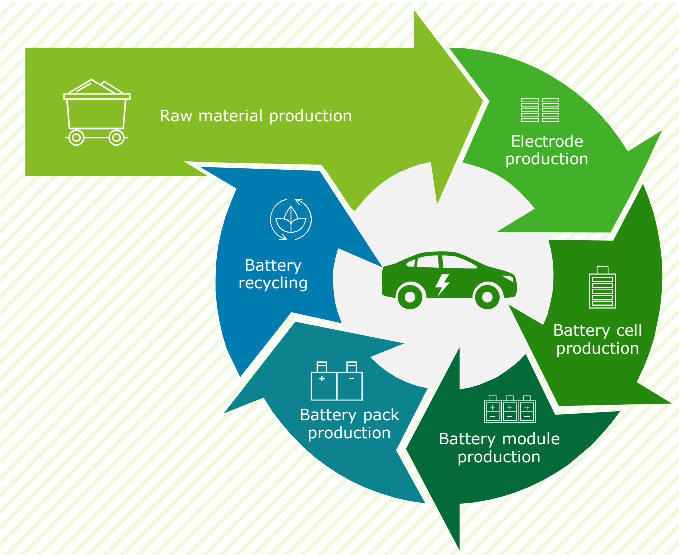
4.2.1.2.1 Battery recycling

Technology such as lithium ion, is predominantly used in EV batteries worldwide. The lithium ion batteries mainly comprise of rare elements such as Lithium, Nickel, and Cobalt. With growth in EV industry, use of these rare elements are expected to increase, and therefore could lead to supply chain issues in future as availability of these rare elements is concentrated in few countries only.

Battery recycling is an effective way to ensure optimal utilization of such rare elements along with meeting the rising demand.

Recycling of batteries reduces negative environmental impact as well as has the potential to reduce the overall cost of a battery (and therefore EVs'). Battery recycling provides strategic benefit to the manufacturer as it uses materials that are readily available. It is also understood that, at times, the raw material from the recycled battery is of higher quality than original raw materials as they already have gone through refining processes, and therefore need

Figure 166 Overview of a battery life-cycle with recycling



Source: 109 Sourcing resources: How efficient battery recycling helps reduce costs and emissions (access here) less pre-processing.[73] This in-turn helps the manufacturer to produce a cheaper battery and consequentially increase affordability of EVs.

World Economic Forum (WEF), in their report suggests that battery recycling holds the potential to provide 13% of the global battery demand for cobalt, 5% of nickel and 9% of lithium in 2030.[74]

However, the major challenge faced in battery recycling is the "high cost of recycling". The economic viability of battery recycling process depends upon factors such as costs of collecting, handling and disassembling the batteries. Once the recycling process is completed, the viability also depends upon scale of reliability and material value of batteries recycled.

Policy makers may consider providing financial assistance/ incentives to the high-quality recycling processes, and promote creation of battery recycling industry in the country

Promotion of battery recycling will encourage evolution of new business models such as, trading of recycled raw materials in the exchange market, or physical reuse of aged batteries in other applications (e.g., as energy storage systems).

India, acknowledging the importance of battery recycling, released a draft "Battery Waste Management Rules, 2020" which laid guidelines on effective recycling of batteries along with responsibility of all value chain players.

Box 17: Battery Waste Management Rules, 2020 (Draft)

On February 2020, Ministry of Environment, Forest and Climate Change issued a draft rule on Battery Waste Management, superseding Batteries (Management and Handling) Rules, 2001. The draft rule aimed to create an ecosystem for handling and disposal of batteries in India and ensure safety of the public as well as of the environment. It covers all types of batteries (rechargeable and non-rechargeable) along with the appliances where batteries are used.

The rule laid guidelines on recycling of batteries through formal channels in safe manner and seek accountability from every value chain player including central/ state pollution control boards. The amendment mentioned development of a computerized system for keeping track of all the activities such as sale, distribution, collection auction, processing etc. of batteries in the country. The rule also mandated manufacturer, importer, assembler and re-conditioner to setup collection centers (either individually or jointly) at various places for collection of used batteries from consumers or dealers.

The rule has directed State Pollution Control Boards (SPCBs) to periodically monitor battery recycling facilities. It also directed Central Pollution Control Boards (CPCB) to prepare guidelines/ SOPs for battery recycling facilities, standardization of technologies for all types of battery recycling, and establishment of R&D cell for battery recycling.

Source: 110 Battery Waste Management Rules, 2020 (access here)

4.2.1.2.1.1 Battery subscription

Battery Subscription is key to reduce the upfront cost of the electric vehicles (especially e-buses). In Battery Subscription, batteries are provided to vehicle operators on subscription basis, charging for use on daily or per kilometre rates.

[73] Sourcing resources: How efficient battery recycling helps reduce costs and emissions (access here)
[74] A Vision for a Sustainable Battery Value Chain in 2030 (access here)

A business model concept on battery subscription is prepared by Climate Finance Lab ("The Lab") where barriers such as high upfront costs of electric buses and lack of access to suitable financing were tried to address.[75]

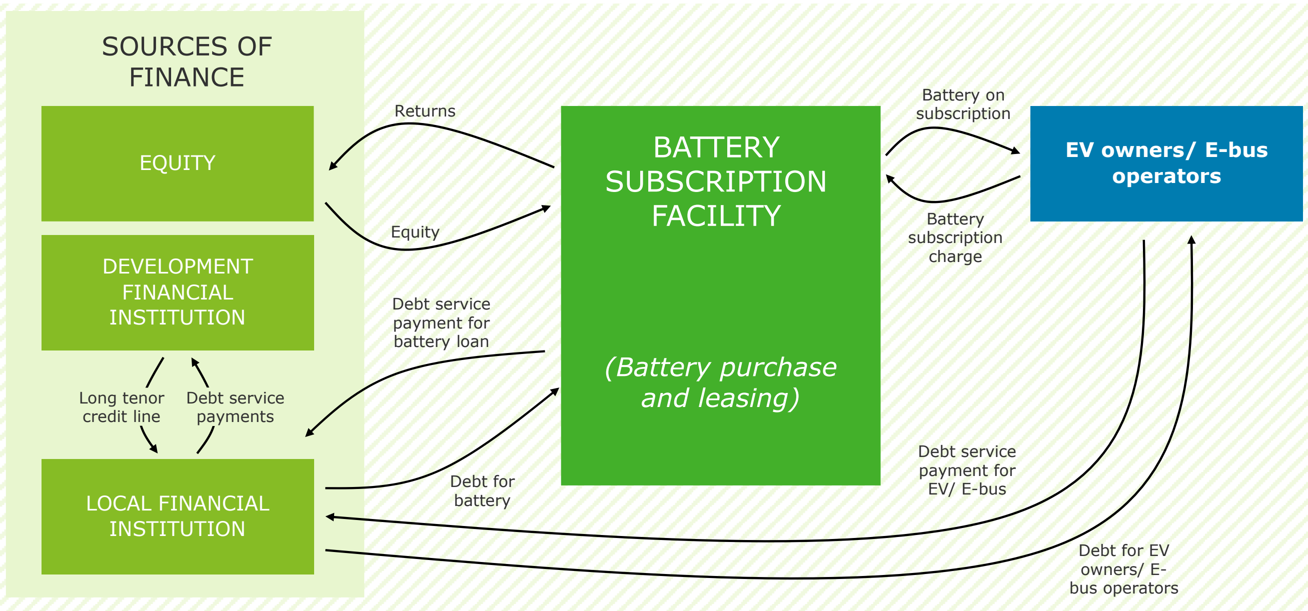
E-buses are 1.5 to 2 times more expensive than conventional diesel buses

In the proposed subscription based business model, the battery subscription facility will setup as a third party battery service provider, which purchases the battery, and provides them to the bus owners while charging on a daily or per kilometer basis.

To lease the battery, the subscription facility and the bus operator will jointly purchase the battery and e-bus from the manufacturer. The ownership of the battery will remain with the subscription facility, and ownership for the bus will be with the bus operator.

The agreement between the subscription facility and the bus operator was custom designed to ensure viability to both the parties.

Figure 167 Sample design of a battery subscription service arrangement



Source: 111 Battery Subscription Facility - Lab Instrument Analysis (access here)

From this business model, the subscription facility will obtain ensured revenue, whereas the bus operator will enjoy low cost of operation against fluctuating diesel/CNG prices.

The battery subscription model supports the adoption of EV by reducing the upfront cost of EV acquisition. On 12th August 2020, the Ministry of Road and Transport Highways allowed the sale and registration of electric vehicles without batteries in an effort to delink the cost of battery with the EVs.

[75] Battery Subscription Facility - Lab Instrument Analysis (access here)

4.2.1.2.1.2 Battery-as-a-Service (BaaS)

Battery-as-a-Service (BaaS) is an effective business model to maximize the value of a battery. As per report by Ronald Berger[76], Battery-as-a-Service (BaaS) make use of circular economy model in order to maximize asset utilization, and at the same time connects the transport and energy sector.

Manufactured batteries (new) are leased to end-users such as vehicle owners, energy storage project etc. for usage. Once the battery reaches to near its end-of-life (EoL), the BaaS service provider either refurbishes the batteries and make them suitable to be used in applications such as energy storage or behind the meter usage; or, recycles the batteries by extracting the raw material from them to manufacture new batteries. The process is provided in Table 45.

Table 45 Integrated value chain - BaaS

Battery leasing	Refurbishment	Energy storage systems	Recycling
✓ Battery leasing option on a monthly fees ✓ Battery returns to OEM after leasing	✓ Refurbish used batteries by replacing modules with insufficient capacity	✓ Integrate used batteries in industrial and residential energy storage systems	✓ Recycle batteries to extract raw materials as well as precursor material

Source: 112 Ronald Berger

Box 18: Nio—Battery-as-a-Service (BaaS) with CATL

In 2020, Nio, a Chinese car manufacturer partnered with CATL, a leading battery manufacturer, targets to separate the costs of battery from the purchase price of its vehicles through "Battery as a Service (BaaS)" business model. The Baas enabled Nio to reduce its vehicle prices by 70,000 yuan (~ 8,530 euros).

To implement the Battery-as-a-Service, Nio, CATL and two other partners, founded a Battery Asset Company. Each partner had invested 200 million yuan (~ 25 million euros) in the company. The Battery Asset Company is proposed to purchase the batteries, and lease those using concepts of BaaS business model, with CATL supplying the cells.

Source: 113 Nio launches Battery-as-a-Service (BaaS) with CATL (access here)

4.2.2 Infrastructure

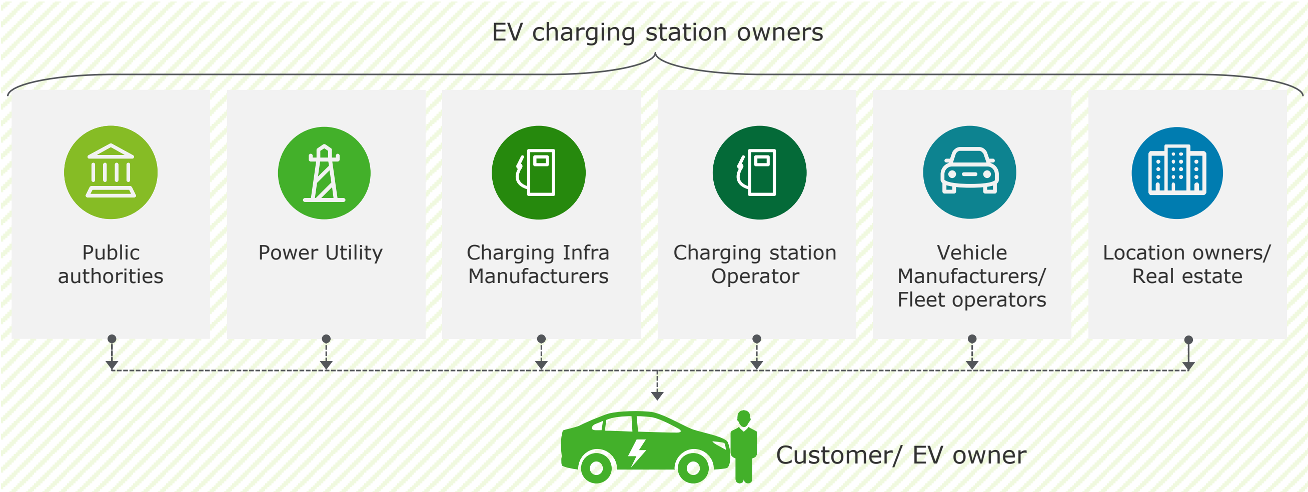
Lack of public charging infrastructure has been one of the key barriers in large scale adoption of electric mobility in India. Therefore, it is important for India to have a robust backbone of charging infrastructure, across the length and breadth of the country with due consideration to traffic and population density. In the following sections, we will assess players responsible for setting up charging stations and business models adopted by them.

4.2.2.1 EV charging infrastructure

With growth in adoption of EVs, the charging business have also evolved, globally. International experience suggests that various stakeholders / institutions have engaged themselves in planning and development of EV charging infrastructure. The various stakeholder / participants are provided below:

[76] E-mobility index 2019 (access here)

Figure 168 Players involved in charging infrastructure business



Source: 114 Deloitte analysis

Among all players listed in Figure 168, charging infrastructure manufacturer and charging station operators have and the most important role in developing and operating EV charging stations. The following section provides details on these two players only. For other players, brief note is provided in Annexure 6.4.

a) Charging infrastructure manufacturers

The major revenue of a charging infrastructure manufacturer is generated from manufacturing and selling EV charging equipment. These players provides EV infra hardware solutions in two ways: first, standalone delivery – to install at home, workplace or for public charging; and, second, in partnership with vehicle manufacturers, offering the hardware as a part of vehicle

The charging infrastructure manufacturer provides complete charging points solution for public and private charging and including the hardware and software installation. These players also provides services such as maintenance of the hardware as well as additional support services. Some of the major charging infrastructure manufacturers are:

ALFEN | chargepoint | EVBOX | heliox

i. Alfen

Alfen is an Electrical & Electronic Manufacturing company which offers a range of 3.7-22KW smart charge points for home, work and public areas. Along with the product, the company also provides services around your charging points, ranging from smart charging to back-end management and remote control of charge points.

Value proposition

- EV charging with renewable energy; intelligent charging solutions

ALFEN

Value creation

Key partnerships:	• **Innovators:** supplying smart charging equipment to Vandebron, a company who is working on an EV blockchain project. • **Governments & municipalities:** delivering equipment to the European Commission in Brussels and hundreds of municipalities.

	Key resources:	• **Skilled employees:** retention and attraction to keep up with growth. • **In house production:** resulting in maximum flexibility and rapid adaption to a highly innovative and potentially disruptive EV market.
	Key processes:	• Charging station management • **R&D:** Grid system and EV charging equipment development are key to maintain the strong market position Alfen has in the EV market.
Value communication	**Story/ Channel for communicating value:**	• Social media • Company website
Value capture	**Cost structure:**	• **Scalable factories:** as rapid growth is anticipated, investments to keep up with future demand are made. • **Material cost:** cost of c.a. 68% of revenues in 2017, material cost have a large impact on profits.
	Revenue stream:	• **Individual charging equipment sale:** offering smart and connected EV chargers for use at home, office and public locations. • **Projects:** Offering turnkey solutions. Example: The Hague stadium; Alfen delivered a fully integrated energy solution for the stadium consisting of an EV charging hub, energy storage system and local smart grid.
Value Delivery	**Distribution channels:**	• Alfen has authorized dealers; customer can find the nearest dealer to install the charging station

b) Charging station operators

Charging station operators (CSO) generate revenue by operating a network of chargers. They provide variety of services such as EV charging, customer support, network solution (standalone or in partnership with a Network Service Provider) etc.

The CSO adopts pricing mechanism such as Time-based fees, Energy-based fees, fixed fees, Membership fees etc. to charge EV users. The CSO sometimes partner with NSPs that provides services such as software solution, user interface, user solution etc. The CSO offers different solution for home charging, workplace charging, and public charging.

Some of the companies working as CSO are:

FASTNED allego anwb newmotion A Member of the Shell Group

i. Fastned

Founded in 2012, Fastned is a Dutch company that owns and operates EV charging stations in Netherlands, Germany, and the United Kingdom.

FASTNED

Value proposition		• Payment software; Country presence (Netherlands); Tesla compatibility
Value creation	**Key partnerships:**	• **Albert Heijn:** a large supermarket chain who agreed to cooperate with Fastned to place chargers in front of their stores. • **Governments & Municipalities:** in an attempt to bring down air pollution in cities and to decrease CO2 emission, they have granted subsidies and "cheap" land to promote EV's.
	Key resources:	• **Scalable high traffic locations:** to be able to scale up when EV sales increase, without having to reinvest in property in the same area. • **Property:** strategic plots of land are key to further expand the charging network.
	Key processes:	• Creating a European network that allows for fast charging for both commercial and professional usage, like truck and taxi.
Value communication	**Story/ Channel for communicating value:**	• Social media • Mobile App • Company website
Value capture	**Cost structure:**	• **Acquiring new plots of land:** mostly near cities and busy highways making it costly. • **Developing software:** new charging and payment software development requires substantial investments.
	Revenue stream:	• **Guests:** individual payments, no additional services (€0.59 per kWh). • **Members:** with registration, plus extra service, like auto charge and charge history (€0.59 per kWh) • **Gold members:** with registration and subscription (€0.35 per kWh & €11.99 per month).
Value Delivery	**Distribution channels:**	• Drivers to navigate and reach to the nearest Fastned charging station to charge their vehicles
	Customer segments:	• Households; Real estates; EV owners; Fleet operators

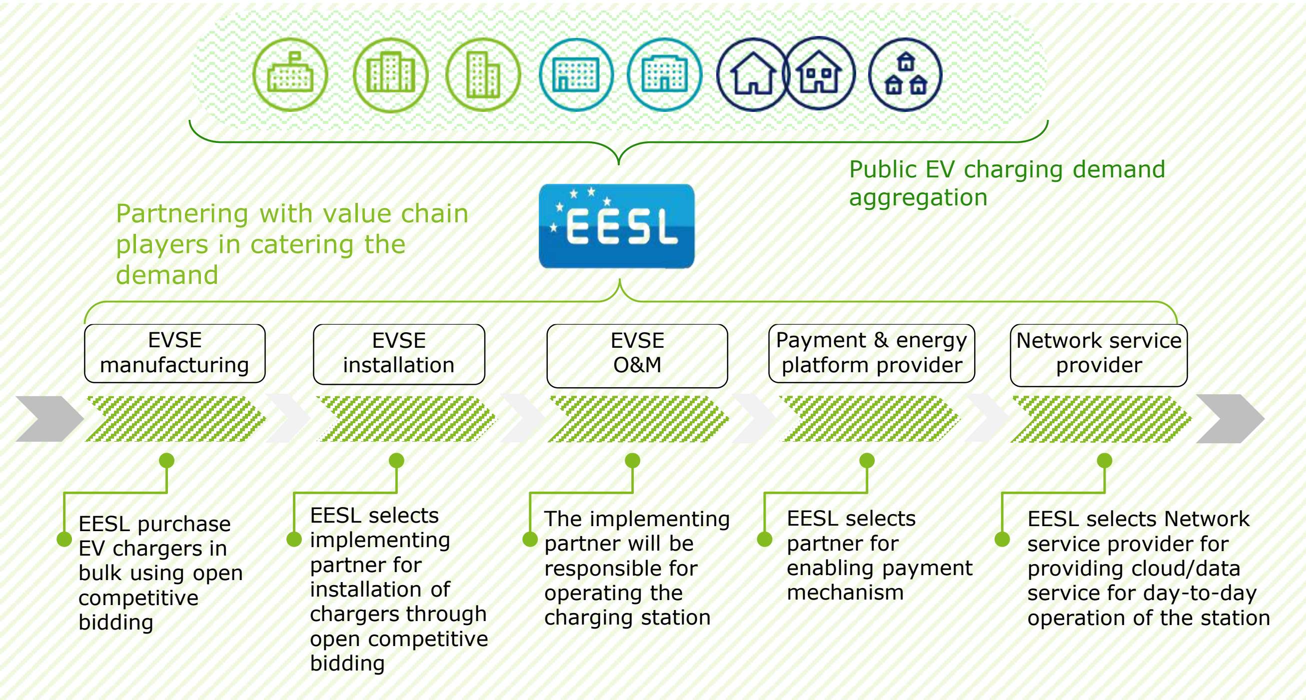
In India, EESL is the one of the prominent players in EV charging development. The company acts as an aggregator and partners with multiple value chain players to develop EV charging infrastructure. Business model review of EESL is provided below.

a) EESL (Energy Efficiency Services Limited)

EESL is the largest EV charging station aggregator in India. Till date, the company has installed 92 public charging stations along with 488 captive chargers across India[77]. The company also deployed India's first public charging plaza at Chelmsford Club, New Delhi.

EESL works on demand aggregation model where it purchases EV chargers in bulk through open competitive bidding. The selected contractor/vendor is responsible for providing end-to-end support (from planning, to commissioning) for the charging station. The vendor is also responsible for operation and maintenance of the charging station for a definite period of time.

Figure 169 EESL business model



Source: 115 Deloitte analysis

Value proposition		• Large network, low system cost
Value creation	**Key partnerships:**	• In partnership multiple municipalities, DISCOMs, Metro Corporations, Government departments
	Key resources:	• EV charging stations
	Key processes:	• Demand aggregation • Floating tenders for public procurement
Value communication	**Story/ Channel for communicating value:**	• Public procurement • Advertisements
	Cost structure:	• Purchase of EVSE through public procurement • Operation & Maintenance

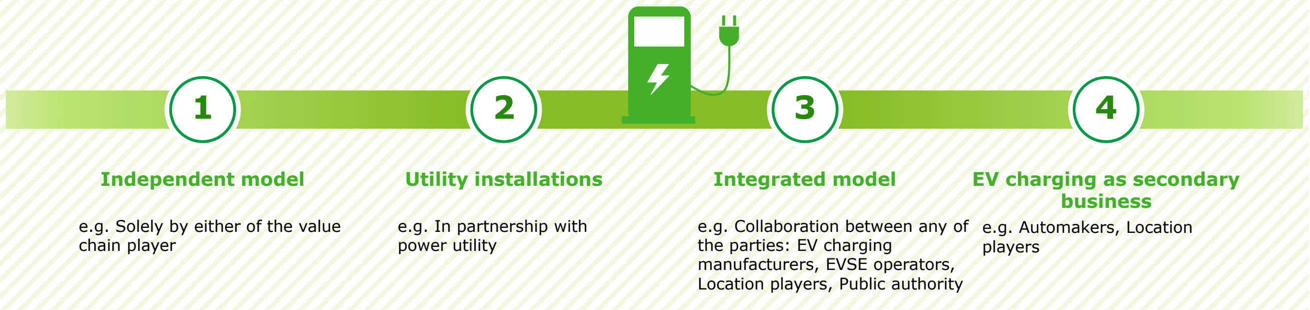
[77] EESL – EV Charging (access here)

Value capture	**Revenue stream:**	• Fixed payment in case of ESCo model • Payment from EV charging service
Value Delivery	**Distribution channels:**	• Customer needs to locate EESL public charging station to charge their vehicle
	Customer segments:	• Government organizations, EV users

Note: *To understand the feasibility of charging infrastructure business in India, financial analysis on a single charger project is done for 10 year project life. Project assumptions, outputs and sensitivity is provided in Annexure 6.4*

Based on the route of deployment of EV charging station, business models in EV infrastructure business can be classified into four categories:

Figure 170 Business models in deployment and operation of EV infrastructure



Source: 116 Deloitte analysis

Independent model	▪ Private players set up EVSE by taking licenses from governments or municipalities. They may appoint EV service providers for charging operations and payment settlements who ensure certain level of interoperability amongst different NSE network owners. Major countries which are using this model are UK and Netherlands.
Utility Installations - Own & through PPP	▪ In China, the State Grid Corporation of China and China Southern Power Grid in partnership with many OEMS have opened charging stations, largely limiting their role to power supply only. ▪ In Germany, power companies, including RWE, Vattenfall, EON and EnBW, account for of all public charging Stations (Hall and 2017)
Integrated Model	▪ Utility owns the EV Charging infrastructure, operate it either Own or through their third party Contractors. ▪ EVSE assets forms part of the assets of utility, who are responsible for distribution of as well as operation and maintenance of the EVSE. Major country that run this model is Canada. ▪ Advantage of model is that utility need not to worry about the low volume of business in Starting phase, as assets are created under regulated capex route.
Charging infrastructure as secondary business	▪ By own installations , Tesla has built a network of fast-charging Superchargers along highways throughout North America, Europe, and Asia, which Roadster, Model S and Model X owners for free. In addition, the company has built over 9,000 destination charging connectors similar to Tesla Wall Connectors. 400 kWh supercharger credits are awarded annually to the car owners, after which they are charged based on either per kWh or per minute.

- The leading automobile companies' viz. BMW, Daimler, Ford, Volkswagen have created a JV to develop ultra-fast, high-power charging stations in Europe. The JV sets an initial target of ~400 charging stations by partnering with service providers, for e.g. BMW partnered with ChargePoint, to allow its users to access the ChargePoint's network through a smart card. Similarly, Nissan partnered with EVGo to provide two years of complimentary access to its vehicle to participating stations of EVGo for public DC fast and Level 2 charging.

Business models in EV charging infrastructure segments are limited. However, with growth in the industry, more business models in EV charging space are expected to evolve. Details about potential future business models in electric mobility are provided in the section below.

4.2.2.2 Future EV charging business models

The commercial development phase of EV charging industry can be segregated into three phases: introductory phase, growth phase and maturity phase

Figure 171 Business innovation in EV charging vis-à-vis market development stages

Source: 117 FSR - charging up India's Electric vehicles (access here); Deloitte analysis

Introductory stage is the initial stage of the product *(here "charging infrastructure")* when it is deployed in the market. The product during the introductory stage is under continuous R&D while the market/ customers are still gaining awareness/ knowledge about it. During this stage, the sales/ deployment of the charging infrastructure is slow, and the players invest significant capital to bring the product to the market (particularly with the interest to take first-mover advantage).

The next stage is the **growth stage when** the market is fully aware and is adopting the product rapidly. During this stage, the market share of the products starts to grow, and several new players start entering into the market. Profits/ margins of the product in this stage is very high as compared to the introductory phase. Players with strong market share in the introductory phase enjoys early entrant advantage and earns high profits.

At **maturity stage,** the rate of adoption of technology starts becomes either stagnant or declining. The market share of the company stabilizes. There are very few innovations took place during this stage and companies target to earn constant revenue from the product.

India's EV charging market is currently at introductory phase where limited players with limited business models are serving the market. In the above sections, we have reviewed existing state of India's EV industry, business models, players etc. However, as the electric mobility industry grow, there will be change in existing business processes to adapt concurrent changes in EV landscape.

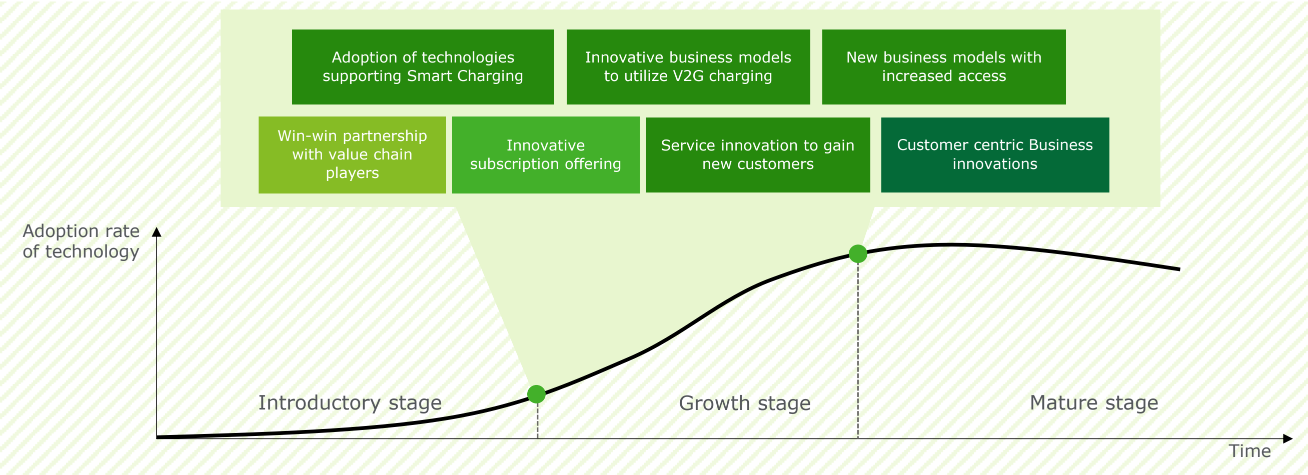
Table 46 lists expected changes in electric mobility industry and it's probable impact on EV charging businesses when it transit from introductory phase to growth or maturity stage.

Table 46 Shape of EV charging industry - Present and future

Present	Future (2025 & beyond)	Business impact
Low EV Penetration	High EV penetration	More charging stations; need for fast charging
Less competition	High competition	Innovative business model to retain customer, cost competitive business model, bundled model – product with services
Focus on urban areas	EV charging expanding to Tier 2 & Tier 3 cities	Suitable business model for price sensitive customers in semi-urban and local areas, high volume and low prices based business models, e-roaming
More focus on product	Service will be key in attracting customer	Need for innovative services, co-located charging, bundled services
Short range vehicle/ less distance travel	Long range vehicle/ long distance capable batteries	Need for fast charging facility; charging zone
Conventional vehicles	Smart, autonomous, connected vehicles	Need for smart charging
"Charging" is the only service	Energy feed back to the grid during from vehicle during unused hours	Need for Vehicle-to-Grid (V2G) facility, participation in demand response, Virtual power plants
No managed charging facility	Active and passive managed charging in place	Increased role of DISCOMs and third party service providers in managing the grid, smart charging
Less cyber threat	High cyber threat	More investment in data security, secure data communication
Single business-led	Partnership-led	Win-win partnership collaboration, co-located charging stations, charging zones with public amenities such as food zone, recreational activities

With the change in the market dynamics, business models will transform when we proceed to the growth-stage. For the purpose of this report, business models that may evolve at maturity stage are not covered as it would be too early to predict the market forces that may shape up the business models as maturity stage. The likely business models that may evolve in growth-stage in a response to change in operating business environment are highlighted below:

Figure 172 Business innovation in EV charging in the growth stages



Source: 118 FSR - charging up India's Electric vehicles (access here); Deloitte analysis

Details about business innovations in the growth stage is mentioned below:

Smart charging	• Smart charging is considered as a charging technology that along with charging the vehicle, communicates with external entities such as utility, charging operator etc. This technology will help in active managed charging by utilities.
V2G charging	• V2G charging will allow feeding power back to the grid from EV battery. This will help in providing power to the grid in case of shortage and also allow EV owner to earn revenue by selling the EV power.
Business model with increased access	• As the electric mobility industry is growing, charging infrastructure will expand to Tier-2 & Tier-3 cities. Operators will need to ensure that EV users have access to charging even in places outside their home-network. Business models around e-roaming system will be key for providing access to the EV user.
New partnership with value chain players	• As electric mobility grows, it will not be possible for a single business to maintain a competitive edge. Partnership with other players in the value chain will help offering a complete solution to the consumer.
Innovative subscription offering	• To overcome acquisition cost hurdle, new form of subscription models may evolve, offering electrical vehicle ownership by paying monthly rental. Tata Motor for its Nexon model have already launched such offer to generate volume for business by reducing price barriers. Similarly, battery subscription models would also be evolved with standardization of technical standards and battery parameters compatible with wide range of electric vehicle.
Service innovations	• During the growth stage, as the competition will increase, profit margin would shrink. Focus would shift from product offering to service offering as a bundle of product and service. It could be lifetime free maintenance, unlimited/limited battery changes, free access to range of charging station etc. Revolt a Gurugram based start-up has already launched such scheme at nominal additional prices for limited time period.
Business innovation	• With the increase in electric vehicles on road, new business concepts would evolve as a response to problems that may emerge with increase in vehicle volume. For example, to avoid waiting time at charging stations concept of anywhere-charging may evolve. Ubitricity in UK are offering smart cable and smart meter to enable consumer to charge from electricity poles of any DSO and send monthly bill as energy charge with nominal subscription fee (Please refer to Box – 14 for detailed case study on Ubitricity business model).

4.2.3 Energy

A private vehicle stands idle for an estimated 95% of its lifetime[78]

The premise for energy as a value area comes from the above stated fact on level of underutilization of private vehicles for transportation purpose. Battery in EVs stores electricity, and when not in use for commuting, EV owners can trade/ sell/ utilize the stored power and can earn additional revenues. In the sections provided below we will understand how energy stored in the EV batteries can provide value to its owner, and areas where business can evolve in utilizing power from EV batteries.

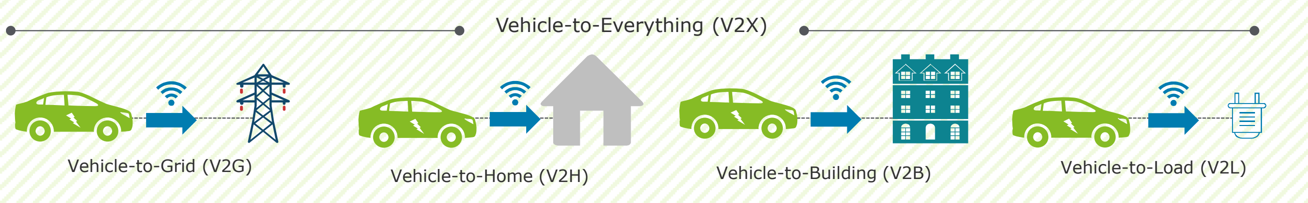
Interconnection of EVs with grid is conducted using two main technologies: V1G and V2G.

Vehicle-to-Grid (V1G) is also known as smart charging or managed charging technology. This type of charging provides feature such as dynamic modification of the charge rate or the charge time of the vehicle. V1G is highly effective with grids that follow Time-of-use (ToU) tariffs. Modification in charging rate and time allows power utilities to decrease peak loads or smooth frequency deviations.

Other than V1G, there are other advanced interconnection technologies for transfer of power. Some of these technologies are given in Figure 173.

[78] Moving Forward Together – Enabling Shared Mobility in India (access here)

Figure 173 Electric vehicle connection technologies to end-user



Source: 119 Deloitte analysis

A step further than V1G, in a **Vehicle-to-Grid (V2G)** system, additional power in the vehicle can be fed back to the grid (bidirectional). With V2G technology, it is possible to control the time, magnitude and direction of charging/ discharging power. Using this technology, an electric vehicle can feed power to the home (V2H) or building (V2B) as well. V2G technology helps in applications such as short-term storage for renewables, higher capacity for frequency regulation, and for off-grid applications.

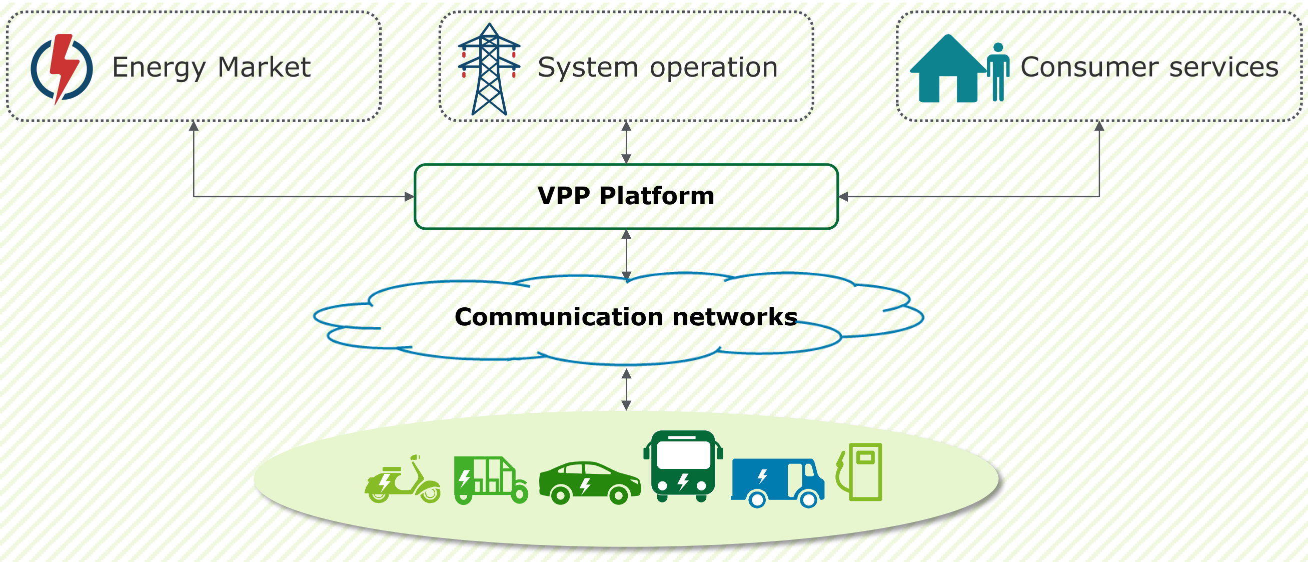
Vehicle-to-home (V2H) and **Vehicle-to-building (V2B)** are the subsets of V2G and operates in a similar manner. However, it is to note that V2H caters to a home power need, whereas V2B operates at a much larger scale such as for buildings or commercial places. In both the technologies, home owner or building owner uses the bi-directional power flow capability in order to optimize energy consumption in the home or building, provide emergency backup power or supplement grid electricity supply in extreme cases. The key difference between V2G and V2H or V2B technologies is that utility may not be directly involved in the bi-directional electricity flow in case of V2H/ V2B.

Vehicle-to-Load (V2L) is used to provide emergency backup in event of electricity outage or power to rural areas with limited energy availability. V2L is also used in providing energy to critical equipment in hospitals, research centers etc.

4.2.3.1 Virtual Power Plant (VPP)

A virtual power plant is a cloud-based distributed power plant that aggregates the capacities of heterogeneous distributed energy resources (DER) such as solar power equipment, batteries, EVs etc., Figure 174 illustrates basic outline of a virtual power plant aggregating powers of electric vehicles.

Figure 174 Virtual power plant for aggregating power from EVs



Source: 120 Virtual Power Plant (TOPMOST) - Durham University (access here)

Virtual power plant provides an efficient way of utilizing power from electric vehicles in grid balancing or trading in the electricity market (at peak time for energy arbitrage). This concept has opened up a new avenue for revenue generation for fleet operators, bus operators etc. that can play a role in VPP architecture.

Virtual power plant, however, will require a power network integrated with secured communication network, protocols for data sharing and cyber security etc. to operate, which, with reference to India, could be possible in a medium to long term horizon.

Box 19: Toyota Tsusho – Nuvve – Virtual Power Plant partnership

In 2017, Toyota appointed Nuvve to support in expansion of the virtual power plant (VPP). Nuvve operates a V2G system that controls the charge and discharge of the batteries in EVs connected to charging stations based on the electrical supply-and-demand balance of electrical grids.

"The V2G technology that Nuvve offers allows parked EVs to become part of an electric grid while connected to the charger. Depending on the supply-demand balance in the grid, the company's platform can control the charge and discharge of multiple parked EVs - becoming a virtual power plant."

Source: 121 Promoting Virtual Power Plants (VPPs) Using Electric Vehicles (EVs) While Adding Value to EV Ownership (access here)

4.2.4 E-Buses

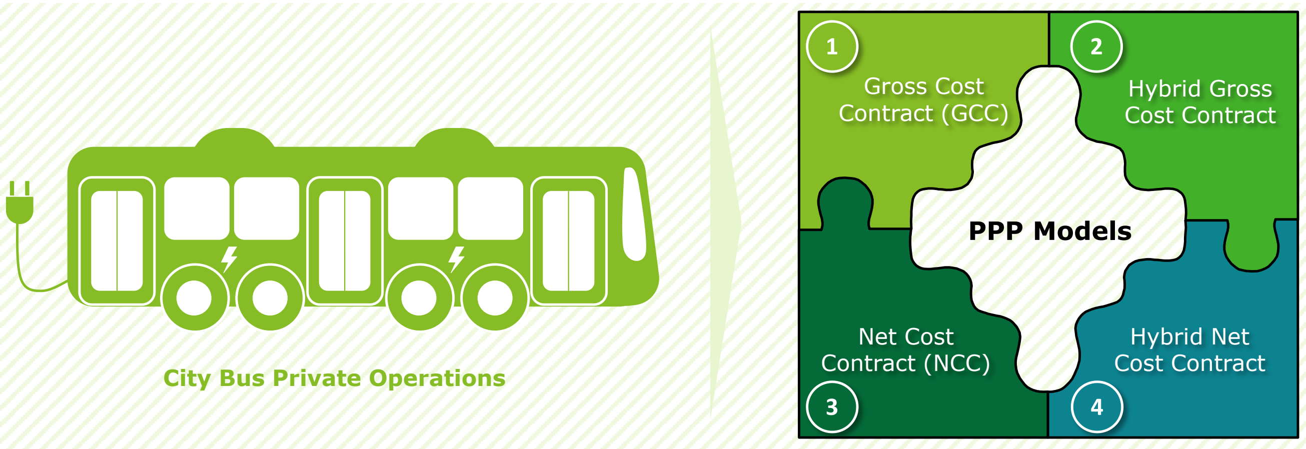
4.2.4.1 Procurement model for E-buses

Procurement and operation of buses in India is largely done through PPP (Public Private Partnership) framework. There are multiple models available under PPP framework that differs in terms of degree of operational control, allocation of risk and investment contribution.

For procurement of conventional buses, Gross Cost Contract (GCC) and Net Cost Contract (NCC) have been commonly adopted by several Indian cities. Ahmedabad (AMTS and BRTS bus services), Surat (BRTS bus services) Delhi (DIMTS bus services)[79] have adopted GCC contracting, whereas Rajkot, Vadodara, Indore and Delhi Metro Feeder Buses[80] operate their buses on NCC basis.

For e-buses also, the similar approach of GCC and NCC has been widely adopted. In addition to these models, hybrid GCC and hybrid NCC contracts are also used in several countries to address the shortcomings of conventional GCC & NCC contracts.

Figure 175 PPP models in city bus private operations



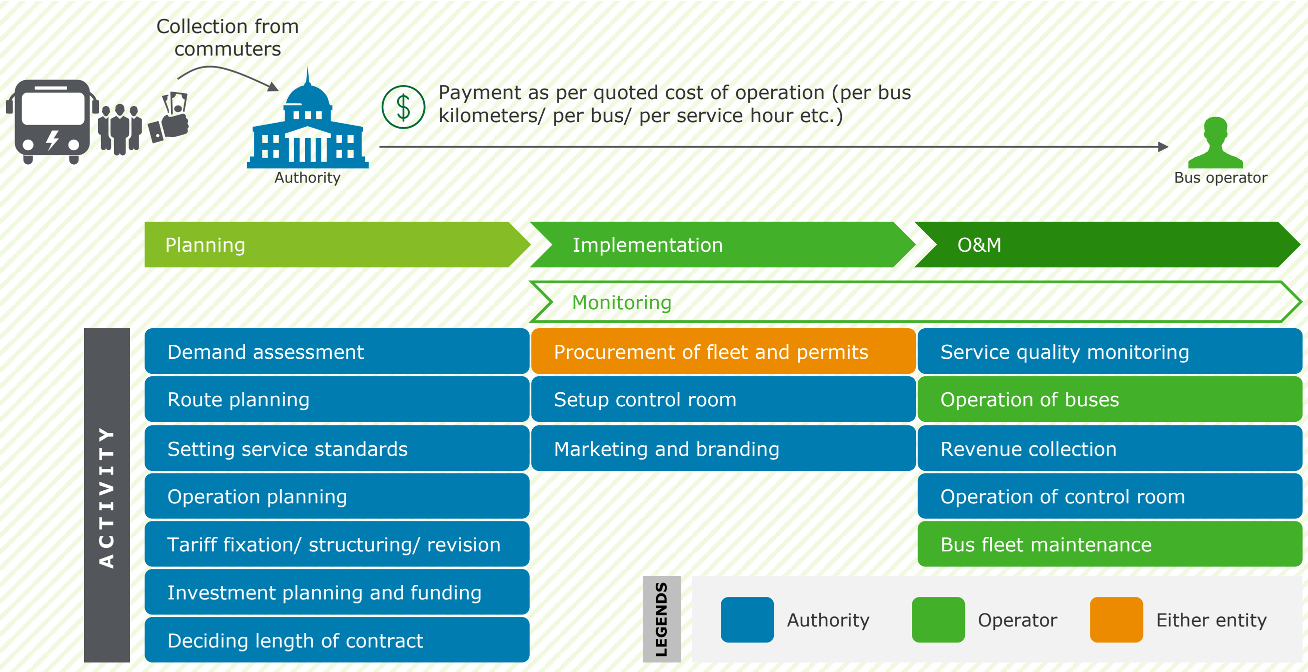
[79] Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here)
[80] Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here)

4.2.4.1.1 Gross Cost Contract (GCC)

In GCC contractual structure, the authority takes a major role in managing the network whereas the operations & maintenance is carried out by the private player (bus operator). The authority makes payments to the bus operator on kilometerage[81] cost, minimum cost or cost per passenger cost.

In GCC, authority carries the revenue risk, plans overall services, manages the contract for level of service and quality, and is responsible for customer service, whereas, the operator only carries the operational risk. The operator, however, holds the responsibility for service frequency (no missed trips) and compliance with quality and safety standards (bus quality, cleanliness, driver behaviour, safety etc.).

Figure 176 Snapshot of Gross Cost Contract (GCC) PPP model



Source: 122 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

This contract is suitable if the authority wishes to take a dominant role, undertake service planning and assume the revenue risk. A city which has low ridership / routes and where the operator may perceive higher revenue risk would be suitable for adoption of such a model.

In GCC, authority holds greater control as it sets overall Minimum Service Levels (MSL)/Key Performance Indicators (KPIs) for the operator and also conducts close monitoring of these parameters.

The GCC model has several advantages and disadvantages for the authority and bus operators, as mentioned in Figure 177.

[81] Kilometerage: Distance travelled between two points

Figure 177 Advantages and disadvantages of GCC for authority and bus operators

	Authority	Bus operator
Advantages	• Full control on route and bus frequency • Controls the levers of supply, price, and service quality and system performance. • Retention of surplus revenue	• No revenue risk; receives agreed payment even when demand reduces • Easy access to finance due to no revenue risk
Disadvantages	• Exposure to revenue risk • Requires close monitoring; higher administration and monitoring cost	• Exposure to O&M cost risk • No incentive on providing quality service

Source: 123 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

Though widely adopted in Indian cities, GCC holds several disadvantages for both, authority as well as bus operator. To overcome this, a hybrid model was introduced in several cities across the globe including London, Santiago (Chile) etc.

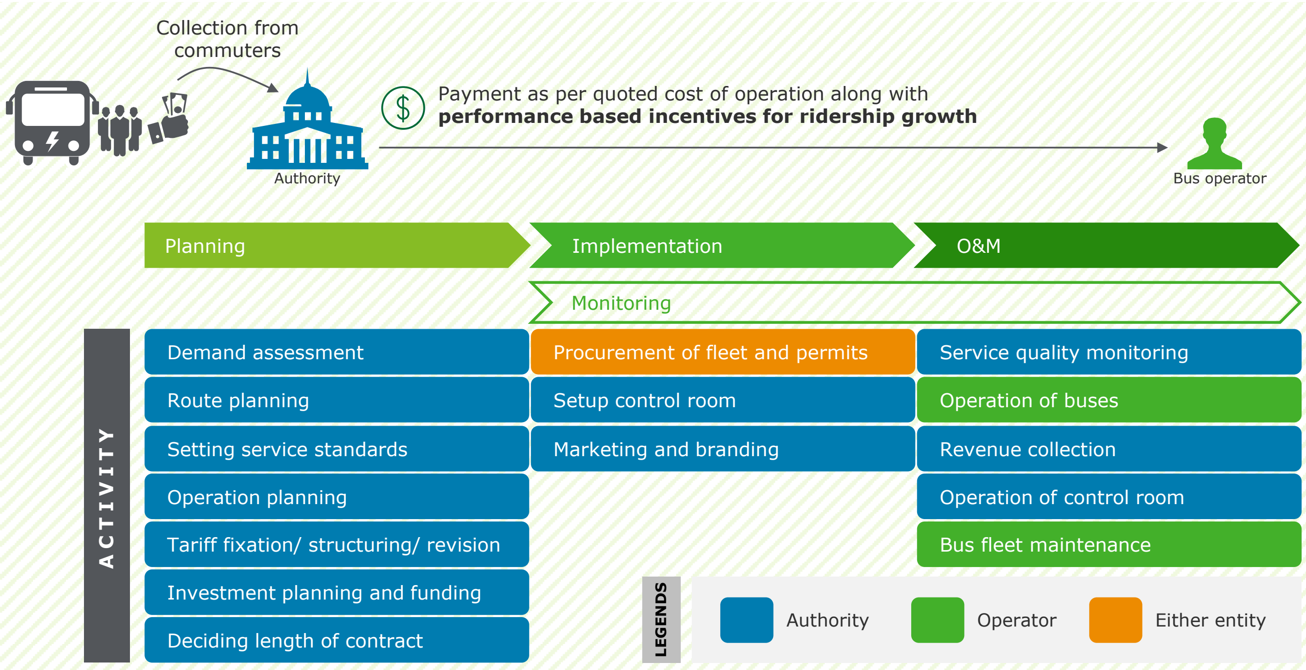
4.2.4.1.2 Hybrid GCC

In GCC, whilst the authority has full control on the services, the bus operator tends to maximise operational distance with least focus on improving the consumer services, causing revenue loss to the authority. In order to provide safeguard against such losses, Hybrid GCC model has been innovated.

Under a hybrid contract, the agency still carries the responsibility for passenger service outcomes and sets overall Minimum Service Levels (MSL)/Key Performance Indicators (KPIs) but incentivises the operator through additional payment for ridership growth. This model, thus, enables risk sharing between the agency and the operator. The model also incentivises the operator for garnering additional ridership through improvement in service levels.

The authority provides fixed payments (per km fee) along with bonuses, which are linked with growth in ridership. The operator needs to quote its cost of operation (fixed per-km fee) and the variable fee per passenger for additional ridership over base figures.

Figure 178 Snapshot of Hybrid Gross Cost Contract (GCC) PPP model



Source: 124 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

In Hybrid GCC, the bonus payment acts an additional revenue for the operator, and does not hurt its target revenue, which is assured by the authority. This increases the chances of improved customer services.

This contracting model finds its suitability for cities that require the characteristics of GCC (Authority/STU in a dominant role) as well as where the city authority would want to share the revenue risk with Operator (with intention to improve customer services). However, the model still holds some advantages and disadvantages for both authority and operator.

Figure 179 Advantages and disadvantages of Hybrid GCC for authority and bus operators

	Authority	Bus operator
Advantages	• Lower revenue risk than GCC • Full control on route and bus frequency • Controls the levers of supply, price, and service quality and system performance.	• Avenue to increase revenue
Disadvantages	• Requires close monitoring; higher administration and monitoring cost	• Share in revenue risk • Exposure to O&M cost risk

Source: 125 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

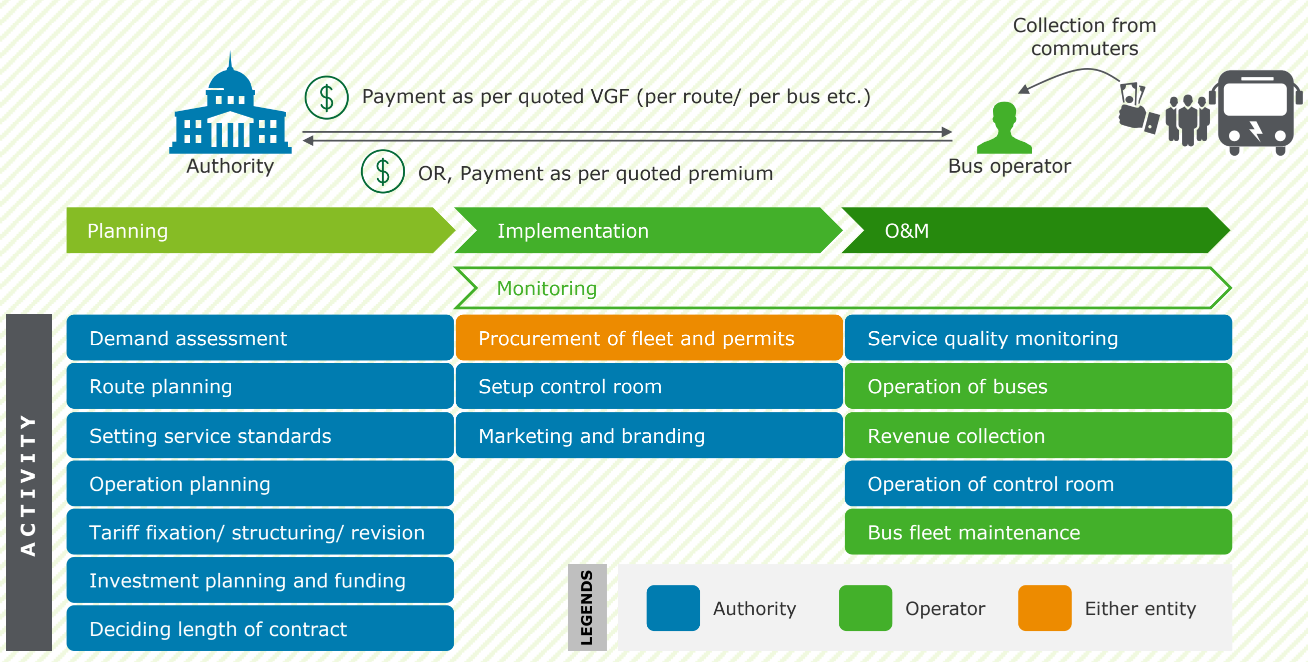
A Hybrid GCC suits situations where the operators are more skilled and experienced in the bus service business.

4.2.4.1.3 Net Cost Contract (NCC)

Under NCC, the authority permits the private operator to carry out business through designated routes or service areas in return for a monthly fee or payment of grant (VGF). In this case, the authority performs a more regulatory role, and the operator carries the entire revenue risk.

In NCC, service planning is mostly done by the operator, although an MSL and Quality KPIs are set as conditions for awarding the NCC. The operator cross-subsidises non-profitable routes with profitable ones. However, this business model has an inherent risk of reduced control by the authority on the operator which may lead to drop in the quality of customer service provided by the bus operator.

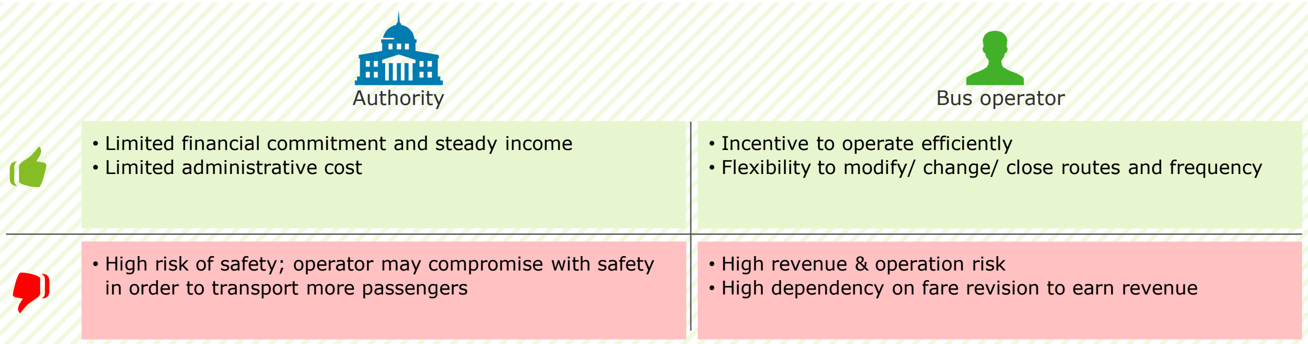
Figure 180 Snapshot of Net Cost Contract (NCC) PPP model



Source: 126 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

In India, one of the major impediment to NCC is that the operator provides services within the framework of a regulated fare scale established by the city, which is rarely revised upwards due to socio-political factors. This hampers the operator's ability to recover its operational cost. Other advantages and disadvantages of NCC model is given in Figure 181

Figure 181 Advantages and disadvantages of NCC for authority and bus operators



Source: 127 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

The NCC option is more preferable where the authority wishes to be involved minimally and relies more on the private bus operator to deliver services. In cities such as Surat and Delhi that had earlier adopted NCC model, the quality of services provided by the bus operator significantly deteriorated[82]. This decline in service quality included lack of adherence to schedule, minimal or no attention on maintenance of buses, etc.

In India, it is difficult to project revenues under NCC as the public buses, sometimes, tend to operate at socially relevant but uneconomical routes, causing revenue and opportunity loss for the bus operators. It is in this context that private bus operators have shown less interest in responding to NCC contracts.

[82] Gross cost contract v/s net cost contract: What should Indian cities opt for? (access here)

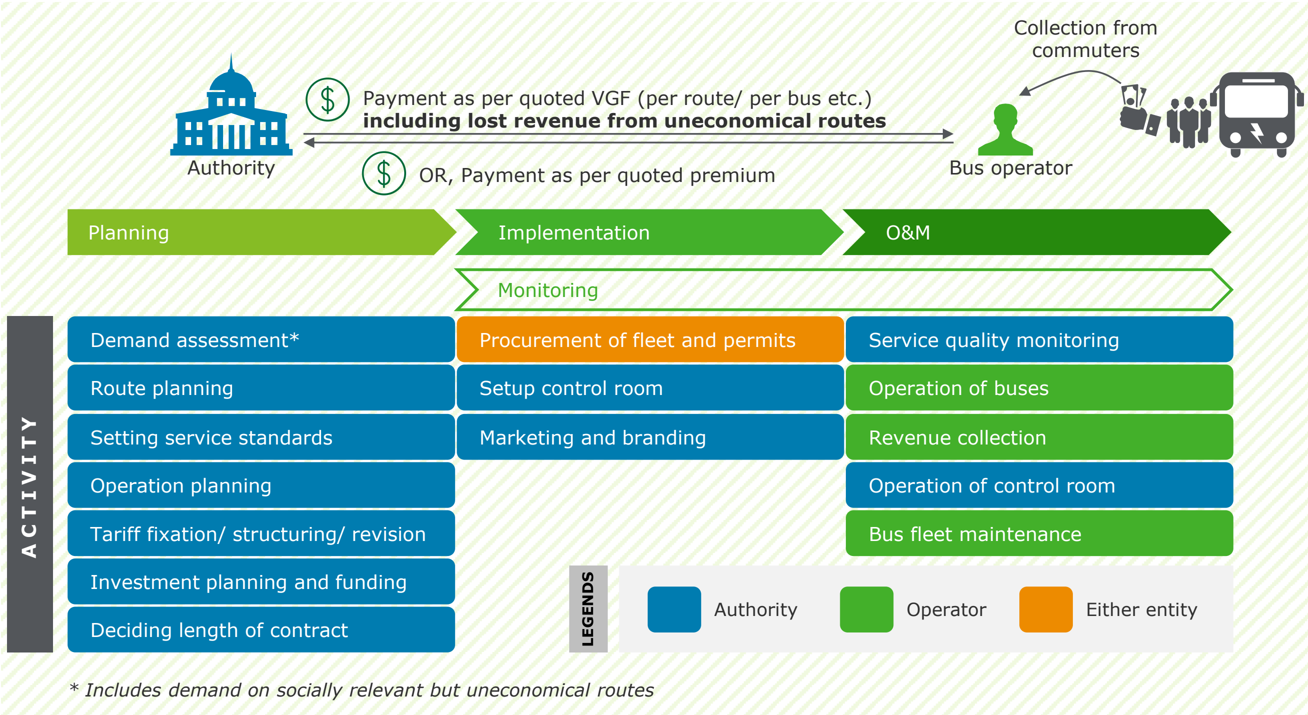
4.2.4.1.4 Hybrid NCC

As observed in NCC, bus operators may need to provide service in uneconomical but socially relevant routes resulting in loss of revenue and opportunity cost. To support bus operators in such situations, Hybrid NCC model has been developed.

In Hybrid Net Cost Contract, the authority supports non-commercial and unprofitable routes where service on the routes needs to be provided as a public service obligation (PSO). The Hybrid NCC requires a higher level of involvement by the authority (as against NCC model) in service planning as the model involves financial support on selected non-commercial routes.

The authority sets the overall Minimum Service Levels (MSL)/Key Performance Indicators (KPIs) along-with being involved in the continuous monitoring of these parameters. The level of control by the Authority, in this model, is still less than GCC contracts.

Figure 182 Snapshot of Hybrid Net Cost Contract PPP model



Source: 128 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

Figure 183 Advantages and disadvantages of Hybrid NCC for authority and bus operators

	Authority	Bus operator
Advantages	• Limited financial commitment and steady income	• Reduced revenue risk as compared to NCC • Incentive to operate efficiently • Additional compensation for operation in unprofitable routes
Disadvantages	• High risk of safety; operator may compromise with safety in order to transport more passengers • High monitoring cost	• Exposure to operation risk • High dependency on fare revision to earn revenue • Less access to finance

Source: 129 Gross Cost Contract v/s Net Cost Contract: What should Indian cities opt for? (access here); PPP arrangements in urban transport (access here); Guidelines for participation by private operators in the provision of city bus transport services (access here); Deloitte - Public Private Partnership Models for Development of Sustainable Urban Transport Systems (access here); Deloitte analysis

Hybrid NCC ensures payment for unprofitable routes to the operator and therefore elicits better participation than the pure NCC model.

4.2.4.1.5 Selection of right PPP model

Above sections discussed about PPP models for e-buses city operation. Summary of key parameters for each model is provided in Table 47:

Table 47 Features of PPP city bus operation models

Parameter	GCC	Hybrid GCC	NCC	Hybrid NCC
Suitability	Authority wants to retain control and is financially strong to assume revenue risk, has strong monitoring capacity	Authority wants to retain operational control and intends that operator shares some revenue risk	Competent operators willing to assume revenue risk exist and demand is relatively certain	Authority is willing to reduce control over operations, while financially compensating for unviable routes
Revenue risk	Authority	Shared: *Base cost by authority; Ridership increase by operators*	Operator	Operator: *Subsidy by authority on unviable routes*
Degree of operator's incentive to increase ridership	**Low** *Fixed payment irrespective of ridership*	**High** *Bonus on increase in ridership*	**High** *Revenue directly linked to ridership*	**High** Revenue directly linked to ridership
Monitoring and penalty regime	Requires **strong and consistent monitoring** with penalty for service below benchmark performance	**Higher level of monitoring** than GCC because of greater economic incentive for performance	**Less monitoring** Only service quality parameters monitored	**Level of monitoring is higher than NCC** In addition to service level parameters, monitoring of movement of bus on un-viable routes
Access to finance (Bankability of project)	**High** *Guaranteed income reduces credit risk*	**High** *Part of income assured; decreases risk*	**Low** *Revenue risk borne by operator.* *Increases credit risk especially if no track record or demand is uncertain.*	**Medium** *Since credit worthiness is increased as non-commercial routes are supported.*
Operational efficiency	**Medium** *Since operators are assured of revenue and can focus only on operational efficiency*	**High** *Since operators revenue is guaranteed, while incentives exist for increased ridership*	**Low** *Since operators bear the revenue risk and may skip trips/reduce frequency in case of low ridership*	**High** *Since operators' gets revenue from un-viable routes also*
	High on viability from the bus	High on viability from the bus	High on viability from the authority's perspective	High on viability from the authority's perspective

Parameter	GCC	Hybrid GCC	NCC	Hybrid NCC
Project viability	operator's perspective	operator's perspective		

As also stated in above sections, the hybrid models resolves some of the issues of the base PPP models and are expected to bring more participation, if adopted. However, selection of best model for adoption of e-buses will vary from city to city. Figure 184 mentions key parameters that will help in selection of best PPP model for city bus operation.

Figure 184 Contract selection framework parameters

1	Load factor on routes
2	Overlap of routes
3	Authority's control over service and network plan
4	Integration of different modes
5	Competing Modes
6	Fund Allocation for the entire term of contract
7	Provision of dedicated funding
8	Credit Rating
9	Creation of SPV
10	Adequacy of Staff for Bus Transport

Source: 130 Guidelines for participation by private operators in the provision of city bus transport services (access here)

Note: Details about each parameter is provided in Annexure 6.4

4.2.4.2 Financing mechanism for e-bus

It has been established that adoption of electric buses have positive impacts on health and environment and therefore, efforts have been made globally to induct e-buses in shared mobility fleet by respective city administration. However, e-buses offers a significantly higher cost of adoption when compared with its ICE counterpart. Acquiring e-buses as a standalone physical asset is not possible as it requires a complementary infrastructure supportive of its usage. Such an infrastructure comprises of batteries, land for charging stations, adequate power supply, possible upgrades to transformers or distribution lines, retrofitments to existing bus depots, etc.

Nonetheless, there are emerging financing mechanisms to enable the adoption of e-buses.

Figure 185: Financing options for e-buses

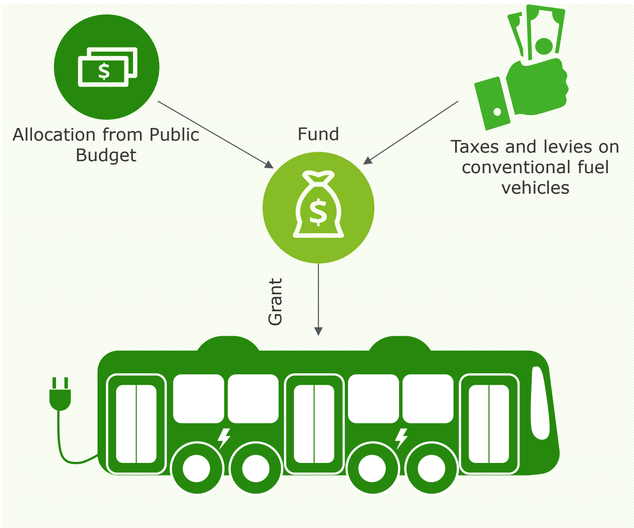
Three options of financing E-buses

- **01** Grant received from State/Central Government
- **02** Debt financing
- **03** By way of entering into legal arrangement that share finances as well as commercial risk

However, in practice, these individual approaches suit a particular business model. For instance, operators may purchase buses from grants and enter into legal arrangement to lease batteries. Although most public electric buses are still paid for by government grants, there is a growing need for affordable finance to help tackle the up-front investment gap and achieve scale.

4.2.4.2.1 Grant received from State/Central Government

This has been the traditional and predominant approach for financing of e-buses or any capital intensive asset that is intended to be used by the public. The grant may be offered as capital expenditure grant or operational expenditure grant or combination of both. Globally, there are multiple ways to arrange fund for the grant. This includes provisioning for dedicated funds in annual public budget or creating a pool that collects taxes and penalties being levied on using conventional fuel vehicle, termed as fee-bate concept and funding the grant mechanism from such pool.



The mechanism of provision of grants as per the FAME scheme is a similar example. Similarly, State EV Fund provisioned under Delhi EV policy is an example of a pool created on a fee-bate concept that would be funded through levy of additional taxes, cess, fee etc. on inefficient or polluting vehicles.

Box 20: Case Study – LoNo Program in USA

The U.S. Federal Transit Administration (FTA) established the Low or No Emission Vehicle (LoNo) Program. The Program provides funding for transit agencies for capital acquisitions and leases of zero emission and low-emission transit buses, including acquisition, construction, and leasing of required supporting facilities such as recharging, refuelling, and maintenance facilities In Philadelphia, United States, the transit agency received $2.6 million through this program for electric buses in 2016 to purchase 25 Proterra buses. Under the FAST Act, for LoNO program $55 million per year is available until fiscal year 2020.

Source: 131 United States Department of Transportation

Further, there are multiple ways in which the grants could be utilized. For example Shenzhen Bus Company in China has converted its entire fleet into e-bus from the grant and subsidy support of National and local government. Below provided box *(Case Study – Shenzhen Bus Company, World's first fully electric bus fleet company)* presents the case study of Shenzhen Bus Company highlighting extent of grant and subsidy support provided by Chinese Government. The subsidy provided by Chinese Central Government is provided in the table provided below. The precise amount of subsidy offered by Local Government is though not available, but literature review suggests that the Local Governments match the subsidy amount received from Central Government[83].

Table 48 Subsidy provided by China for e-buses

Year	Subsidy Amount
2009-2012	Pure battery electric bus and fuel cell bus with a length of more than 10 meters - 64,000 euros and 77,000 euros respectively per vehicle. Hybrid bus - 54,000 euros to 64,100 euros per vehicle determined by fuel saving ratio, battery type and maximum electric power rate.
2013-2015	Pure battery electric bus - 38,000 euros to 64,000 euros depending on the size of the bus. Plug-in hybrid busses with a length of more than 10 meters - 32,000 euros Fuel cell bus - 64,000 euros
2016-2020	Standard electric buses with a length of 10 to 12 meters - 120,000 rmb (15156 euros[84]) to 500,000 rmb (63153 euros) depending on the electric driving range and energy consumption rate. Fuel cell bus - 64,000 euros

[83] Trends and challenges in electric-bus development in China (access here)
[84] Converted at the rate of 1 RMB = 0.13 Euro, as on 9th October 2020

Another approach of utilizing government grant and subsidy support is by way of permitting Private Operators to purchase buses and operate service on behalf of the STU. GCC model under FAME scheme utilize the same principle in India.

Box 21: Case Study – Shenzhen Bus Company, World's first fully electric bus fleet company

The Shenzhen Bus Company, in China, is a state owned bus operator. The company receive financial support from the public budget for converting its fleet to e-buses. The company has transformed its entire fleet of 16,000 buses in Shenzhen as e-buses. More than half of the cost of the bus is subsidised by government as capital subsidy. In terms of operation there is another subsidy: if the company runs buses for a distance of more than 60,000 km they receive approximately 500,000 yuan [£58,000] from local government. This subsidy is put towards reducing the cost of the bus fares. To keep Shenzhen's electric vehicle fleet running, the city has built around 40,000 charging piles. Shenzhen Bus Company has 180 depots with their own charging facilities installed. Most of the buses we charge overnight for two hours and then they can run their entire service, as the range of the bus is 200km per charge.

Source: 132 Shenzhen's silent revolution: world's first fully electric bus fleet quietens Chinese megacity (access here); Financing electric and hybrid-electric buses: 10 questions city decision-makers should ask, WRI

Under the JnNURM scheme (2009) of Government of India, Ministry of Urban Department (MoUD), Government of India, announced detailed guidelines for funding purchase of buses for urban transport systems. The guidelines for funding for purchase of buses, under the scheme, was linked with reform conditions to be fulfilled by States. MoUD recommended the creation of a dedicated Urban Transport Fund (UTF) at both the state and the city level for utilizing the same for funding urban transport initiatives. Similar such innovative initiatives could also be explored to make the purchase of e-buses viable for the state authorities. A case study on Rajasthan Transport Infrastructure Development Fund (RTIDF) is provided below to highlighting its feature and area of support in developing urban transport in Rajasthan.

Box 22: Case Study - Rajasthan Transport Infrastructure Development Fund (RTIDF)

Government of Rajasthan created RTIDF in 2012, with the objective of providing organized, safe public transport. Its main aim was to fund viability gap in operations and to provide loan to assist local bodies for creation of better transport system in the urban cities, among multiple other objectives. The main sources funding for RTIDF include a cess on motorized vehicles, green tax and cess on stamp duty, funds received from industries to carry out social Responsibilities, apart from funds from the Central and State Government. RTIDF is managed by a fund management committee under the chairmanship of Chief Secretary of the State.

The funds have been utilized in following initiatives to improve urban transportation:

- Jaipur City Transport Services Limited (JCTSL) and Ajmer City Transport Services Limited (ACTSL) are provided with capital subsidy support towards purchase cost of buses (30% to JCTSL and 10% to ACTSL)
- The funds for construction of 100 Bus-Que-Shelters in Jaipur city worth Rs. 9 Crore have been provided to JCTSL.
- The funds of Rs. 12 Crore have been provided for creation of two Depots for maintenance and parking of buses of JCTSL
- Fund of Rs. 20cr. provided from RTIDF for purchase of 79 Buses to improve public transport system in Kota and Jodhpur
- Funding for setting up new traffic signals and Area Traffic Control System (ATCS)

Source: 133 Final Operations Document for Urban Transport Fund in Jaipur (access here); Rajasthan Transport Infrastructure Development Fund (RTIDF) (access here); Scheme for Utilization of Urban Transport Fund (access here)

The State and Central Government may extend the utilization of such funds created under JnNURM to provide support through either grant or concessional loan for procurement of e-buses by the State or City transport Authorities.

4.2.4.2.2 Debt Financing

Debt financing can be utilized by State Transport Utility or bus operators to pay for the high up-front costs of e-buses. However, purchase entirely on debt financing basis is still not widely used for electric buses. However, other mechanism such as concessional loans, municipal bonds and green bonds do exist for such purposes. With the growing maturity of EV technology in the future, debt-financing may, however, become common.

4.2.4.2.2.1 Soft loan or Concessional loans

Soft loan or Concessional loans are provided by a financial institution at favourable lending conditions, including lower interest rates and/ or longer repayment schedules. International development funds or multilateral development banks under their development mission can potentially offer such financial instruments to lower down the financing cost of e-buses. Two case studies have been presented below showcasing the role of such banks in extending support through concessional loan towards acquiring clean mobility solutions.

Box 23: Case Study – Technological transformation program for Bogota's Integrated Public Transport System (SITP)

In 2010 Colombia presented its investment plan to the Clean Technology Fund (CTF) to obtain support for transformational projects that will lower carbon emissions. In this plan, US$40 million were assigned to the Integrated Public Transportation System (SITP) of Bogotá, to be implemented by the IADB

The main objective of SITP was to improve public transportation in Bogotá. To fund purchase of clean technology buses (hybrid and e-bus) under SITP, the Inter-American Development Bank (IADB) had offered $40 million concessional loan to Banco de Comercio Exterior de Colombia S.A. (Bancóldex – The Colombia's National Development Bank) at interest rate of 0.25% with grace period of 10 years and amortization period of 30 years. The Republic of Columbia was guarantor for the loan amount.

Under this concessional loan program, Bancóldex have extended the loan provided by IADB to the local financial institutions (IFL), which in turn had directly finance SITP concessionaires firms through credit lines. Under this program, Bancóldex and the IFLs had co-finance each one of the vehicles in equal parts. This means that the US$40 million of this program had leverage an equal amount, for a total of US$80 million. Loan were offered with attractive financial conditions and contributed to compensate the price difference regarding the starting cost of clean technologies.

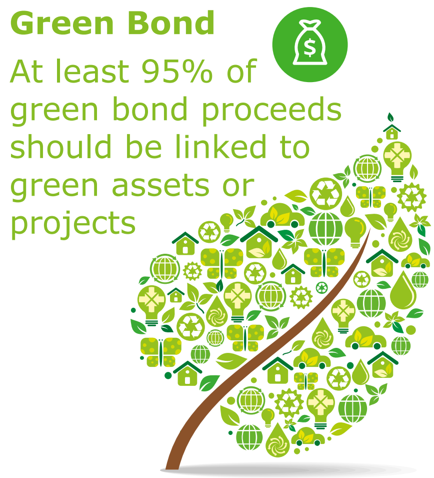
Source: 134 CTF Proposal (access here), Deloitte Analysis

In September 2020, KfW granted loan of Rs. 1,580 Crore to Government of Tamil Nadu State to acquire 2,213 new BS- VI buses and 500 electric buses. The State Government has plan to take total loan of Rs. 5, 890 Crore from KfW to purchase 12,000 new BS-VI buses and another 2,000 electric bus[85]

[85] Tamil Nadu – KfW: State to get 500 more electric buses (access here)

4.2.4.2.2.2 Green bonds

Green bonds are often identical in structure, risk, and return to traditional bonds, except that the capital raised from a green bond funds clean energy, energy efficiency, low carbon transport, smart grid, agriculture & forestry, natural resource mitigation or similar projects/ initiatives/ programs. Green bonds are marketed as "green" at the time of issuance. Green bonds share all the same financial features as other bonds, however as an internationally accepted practice, at least 95% of green bond proceeds are linked to green assets or projects86. (Climate Bonds Initiative 2018).



Nobina, the Nordic region's largest operator of public bus transport services have issued green bond of SEK 500 million (~ $ 57 million) in February 2019 to arrange funds for procurement of electric buses, bio-fuel buses and development of charging infrastructure. Below provided box (*Case Study – Nobina Green Bond (SEK 500 Million, Feb 2019)*) presents case study of Nobina's Green Bonds. Similarly, the city of Umea, in northern Sweden, has invested in a development of a sustainable system for local transport, based on ultra rapidly-charged electric buses (10 min. charging – 30 min. driving). The city has issued SEK 77 million (~ $ 8.8 million) green bonds in January 2012 to purchase electrical buses. In April 2016, the city had 9 electric buses and two fast charging stations built from the proceeds of green bond[87].

Box 24: Case Study – Nobina Green Bond (SEK 500 Million, Feb 2019)

Nobina is the largest and most experienced public transport company in Nordic region. Every day, Nobina ensures that almost one million people get to work, school or other activities by delivering contracted public transport in Sweden, Norway, Finland and Denmark. Yearly revenue of Nobina is about SEK 9 billion, and it currently employ around 11,000 people.

Nobina AB (publ) issued a green bond of SEK 500 million on February 13, 2019, with a tenor of 5 years and a floating rate coupon of STIBOR 3 months plus 155 basis points, which corresponded to an initial coupon of 1.47 percent. The bond was listed on the Nasdaq Stockholm Sustainable Bonds List on March 12, 2019. Nobina's issuance of a green bond framework is a natural part of the Company's sustainability profile and the green bond framework strengthens Nobina's focus on achieving positive environmental impacts.

Proceeds from Nobina's Green Bonds are intended to be used to finance or re-finance the Eligible Green Assets (in part or in full), providing distinct environmental benefits in accordance with the below defined main categories for Clean Transportation:

- Fossil free vehicles such as electric or vehicles powered by biofuels
- Charging infrastructure for buses

As of 2020-02-29, SEK 456 million has been invested in 140 new fossil-free buses and another four fossil-free buses are on order. Also, 45% of the Green Bonds proceeds are invested in Bio-Fuel vehicle and 55% are invest in Electric Buses.

Source: 135 Nobina AB Green Bond 2019 - Impact report (access here); Nobina Green Bond Framework January 2019 (access here)

4.2.4.2.2.3 Municipal bonds

Similar to green bonds, globally Municipal bonds are also being used by municipalities and transit agencies to fund large capital cost involved in purchase of electric buses. Dallas Area Rapid Transit (DART) in Texas had issued a bond for the purchase of electric buses in 2016. The bond was issued at interest rate of 5.0%

[86] China green bond market 2018 (access here)
[87] Supporting local government climate action through Green Loans & Green Bonds (access here)

and maturity period of 20 years. As on July 2018, the bond had raised the required capital, enabling the agency to unveil seven new electric buses. The purchase of the buses was also supplemented by a grant from the Federal Transportation Administration. The funds raised covered the cost of the buses as well as two overhead charging stations for on-route charging[88].

4.2.4.2.3 Legal arrangements as financing option

Legal arrangements, although not a pure financing mechanism for e-bus procurement, offer legal solution, through contracting, to reduce the upfront cost of the electric bus and associated infrastructure. It apportions the financial obligation on multiple interested parties thereby reducing the risk associated with the adoption of new technology. Leasing is the most prominent legal arrangement to arrange financing for the electric buses, batteries and charging infrastructure.

Leasing arrangements have multiple variants such as component leasing (e.g., batteries), operation leasing etc. Under leasing arrangement, typically a third party (who is not the operator) owns some or all of the legal rights over the assets and assumes some of the risks associated with the investment. The third party could be a bus manufacturer, a service provider or a specialized financial services company. Globally, leasing has emerged as an important model for managing the investment costs and risks involved with electric and hybrid-electric bus investments for both public and private operators. This is because leasing reduces the financial burden for the operator and transfers technology and/or credit risk onto the third party.

4.2.4.2.3.1 Component leases (battery leases)

Under component leasing, the e-buses are sold without batteries in order to reduce the upfront cost of the bus. The batteries are owned by the manufacturer (or third party) during the lease term and replaces them as and when required in accordance with the contractual obligation. Proterra, a bus company, entered into the battery leasing contract with Park City Transit Company in USA. The contract, typically called an electric bus battery service agreement, is based on the fact that the transit agency/transport utility can use the operational savings that accrue over the life of the electric bus (compared to a diesel bus) to cover the battery lease. Box provided below presents a case study of Park City Transit and Proterra company battery leasing arrangement.

Box 25: Case Study – Battery Leasing (Park City Transit and Proterra)

In 2017, Park City Transit obtained FTA Low-No grants worth $4.4 million (across two years) to deploy

Proterra buses. In order to maximize the value of these funds, Park City Transit agreed to enter a battery lease agreement with Proterra, where Park City Transit would own the electric buses, charging infrastructure, depot, and storage sites. On the other hand, Proterra will own and service the batteries on the bus. The Proterra electric bus price with battery typically cost around $750,000. However, the bus prices determined under battery leasing arrangement were established at maximum price of $614,679 per bus ($460,350 for the bus, $147,054 for configuration options, and $7,275 for spare parts).

The battery were leased for twelve (12) years, with the option to sign a 12-year agreement or an initial duration of four years plus two renewal periods of four years each. The renewal of the contract is legally expected as long as Park City Transit is able to reasonably source funds to continue the lease arrangement. Proterra guaranteed that its batteries would operate at above 70% of their original nameplate capacities. Proterra is responsible for maintenance of the batteries to ensure this level of performance and is allowed to replace or service its batteries at any point after coordination with the customer. However, the Proterra provided the guarantee of the battery performance on subjective usage condition of battery i.e., the bus batteries needs to be maintained between 20% and 90% state of charge at all times, with ten exceptions provided for falling to the 10-20% range across any five-year period.

Source: 136 Park City Transit Department (2017); Federal Transit Administration (2018) - Fiscal Year 2017 Low or No-Emission (Low-No) Bus Program Projects (access here); The U.S. Electric Bus Transition: An Analysis of Funding and Financing Mechanisms, Dexter Liu

[88] Paying for electric Bus, 2018 U.S. PIRG Education Fund

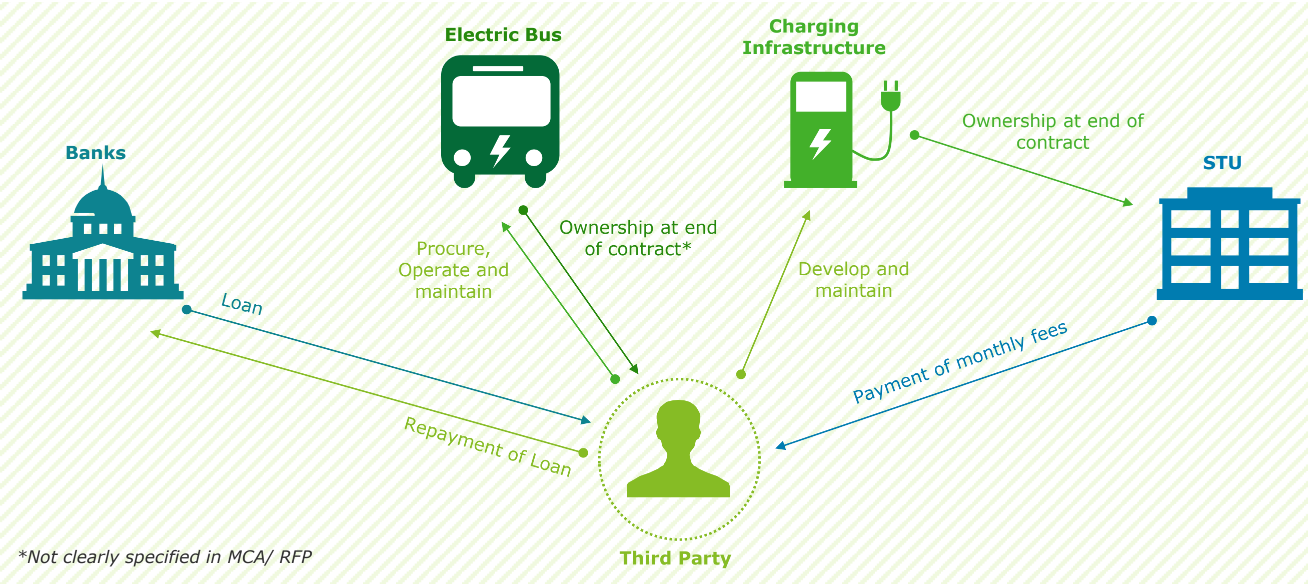
4.2.4.2.3.2 Operating leases - Third Party Owns (Manufactures or Purchases) Buses and Leases Them to Operators (Public or Private)

Under operating lease, the contract allows manufacturers and other asset owners to provide options to Transport Utility (Public or Private) to lease buses rather than buying them. The contract does not allow transfer of ownership of the vehicle. The leasing of assets is based on the third party's ability and willingness to take on some of the risks related to new technologies. Manufacturers or specialized companies offer the option to retain legal ownership of the asset, while conferring the rights to the Transport Utility for the use of the bus against payment on monthly or quarterly basis or as per the agreed terms and condition of the contract. Under such arrangement responsibility of paying for taxes and insurance is either taken by the Manufacturer or the Transport Utility as per the agreed deal or negotiation.

Operation and Maintenance is often covered separately in a different service contract with the manufacturer or another provider. Operating leases are sometimes offered as lease-to-buy schemes in which the operator has the option to purchase the assets at the end of the lease period to benefit from their residual value.

The GCC model adopted in India for procurement of e-bus is a close example of an operating lease. Multiple variants are possible with regards to transfer of asset after end of contract period, operation of bus, development of charging infrastructure, maintenance of the bus/ charging facility etc. The typical model adopted in India is shown below:

Figure 186: Operating lease arrangement in GCC model in India under FAME scheme



4.2.4.3 Review and analysis of Model Concession Agreement for procurement of e-Buses

FAME – II scheme earmarked Rs. 3545 Cr. (~USD 486 Million) to provide demand incentive to a maximum of 7090 e-Buses during the scheme period i.e., up to FY 2021-22. Department of Heavy Industry had invited the Expression of Interest (EoI) from million plus cities, smart cities, State/ UT capitals and cities from special category states for submission of proposal for deployment of Electric Buses on operational cost basis. In response thereof, 86 proposals from 26 States/ UTs for the deployment of 14988 e-Buses were received. On the advice of Project Implementation and Sanctioning Committee (PISC) the Government sanctioned total 5,595 e-buses which included 5095 electric buses to 64 Cities / State Transport Corporations for intra-city operation; 400 electric buses for intercity operation and 100 electric buses for last mile connectivity to Delhi Metro Rail Corporation (DMRC)[89].

Under Fame-I, e-buses were allowed to be procured under two models – Outright Purchase (Capex model) and Gross Cost Contract (Opex model). Five cities (Bangalore, Mumbai, Hyderabad, Ahmedabad, and Jaipur)

[89] DHI - Sanction of electric buses under Phase-II of Faster Adoption and Manufacturing of Electric Vehicles in India Scheme (access here)

have adopted Gross Cost Contract (GCC) model and rest 5 cities (Indore, Lucknow, Kolkata, Jammu and Guwahati) have adopted Outright Purchase model for procurement of e-buses. However, under FAME – II, the government mandated the purchase of e-buses on GCC model to avail subsidy.

Subsequently, NITI Aayog issued a Model Concession Agreement (MCA)[90] in January 2019 to support electric bus procurement under FAME II. The MCA outlines the OPEX model (or GCC) of procurement of e-buses. The focus of the document is to assist cities with the contract award under Gross Cost Contract (GCC) mode of procurement. The snapshot of key features of MCA are outlined below:

Contract Period:
– 16 Years

Asset transfer: Operator to transfer the Maintenance Depots to the Authority upon Termination of the Agreement

Key scope covered:
- Supply of buses conforming to the Specifications and Standards
- Operation and Maintenance of Buses
- Setting up and Operation and Maintenance of Maintenance Depots

Bus charging methodology:
Operator is free to choose any charging methodology

Route and Schedule:
Authority have the exclusive right to determine routes, frequency and schedule of the Buses as part of Deployment Plan through the Contract Period

Key obligations of Authority (STU):
- provide the routes to be undertaken by the Operator
- provide land, free from Encumbrances, on license for setting up and operating Maintenance Depots
- provide road connectivity at any location on the boundary of the Maintenance Depots
- provide reasonable support to the Operator in procuring electric transmission lines and sub-station, at any location situated within 500 m of the boundary of the Maintenance Depots
- upon written request from the Operator, assist the Operator in obtaining access to all necessary infrastructure facilities and utilities, permits etc. for construction and operation of Maintenance Depot
- upon written request from the Operator, provide the Operator with competent and trained employees to assist the Operator in carrying out its duties under the Agreement

Key obligations of Operator:
- Procure, operate and maintain buses for contract period
- Design, engineering, procurement, construction and operation of the Maintenance Depots for the maintenance of Buses
- Procure/ arrange all permits, rights, license, permission, agreements etc. for discharging duties under the contract
- Develop Charging Infrastructure at the Maintenance Depots including adequate infrastructure for metering of consumption of electricity at each of the individual charging stations.

Performance security:
Operator to provide an irrevocable and unconditional guarantee from a Bank within 30 days from date of Agreement. Amount of performance security is kept as 3% of total project cost.

Development of road connection with Maintenance Depot by Authority: within 1 year from Appointment Date

Completion of construction of Maintenance Depot by Operator: within 180 days from Appointment Date

Procurement of Buses:
Procure 1st prototype Bus within 180 days from Appointment Date. Upon approval of prototype bus, Operator to procure bus as per Procurement Schedule provided by Authority in RFP.

Invoicing of fees:
The Operator shall be paid for Bus Kilometre plied by the total number of Buses operational for that particular day, at Per KM Fee quoted by the Operator in its Bid.

Annual Assured Kilometer:

Bus Kilometer Comprises of:
- Total distance travel on operational route

[90] Model Concession Agreement for Operation and Maintenance of Electric Buses in Cities (OPEX Model) (access here)

Authority shall Commit to provide Annual Assured Kilometer for payment of fees	• Total distance travel from Maintenance Depot to First point of loading and from last point of loading to Maintenance Depot • Any other distance travelled which have prior approval from Authority

Revision of fees:
Operator is entitled for fees revision on every six months if price of electricity increased by 10% and CPIIW and WPI varies by more than 4% within six months

For 1st revision:
Indexed Fee = Fee * [1 + (0.2 * CPI IW) + (0.6 * 0.4 * WPI) + (0.2 * (price per kWh of electricity on the date of submission of the statement - price per kWh of electricity on the Base Index Date)/ price per kWh of electricity on the Base Index Date) / 100)]

For subsequent revision:
Indexed Fee = Fee * [1 + (0.2 * CPI IW) + (0.6 * 0.4 * WPI) + (0.2 * (price per kWh of electricity on the date of submission of the statement - price per kWh of electricity on the preceding Fee Revision Date)/ price per kWh of electricity on the preceding Fee Revision Date) / 100)]

Payment of fees:
The Authority shall within a period of 15 days from receipt of the invoice, subject to verification of the invoice against the records that it has in relation to the Bus Service, make the payments.

Delay in payment of fees:
The Authority shall pay Damages at the rate of 3% (above the Bank Rate) per annum calculated for each day’s delay in making the payment subject to maximum of one month of period from the date they become payable to the Operator.

Key performance indicators:
- **Reliability**– Reliability to be calculated on quarterly basis for entire fleet as quotient of the cumulative distance travelled by all Buses divided by the aggregate number of Breakdown of all such Buses multiplied by 10,000. Reliability should be more than 1
- **Operation of bus** – lighting arrangement inside bus, temperature, cleanliness, operability of seats, windows, doors and all fixtures in the Buses (no objective KPI has been defined except lighting system that needs to be available for minimum 98% in a month
- **Punctuality** – Start Punctuality (90%) and Arrival Punctuality (80%). Punctuality measured on a quarterly basis in terms of the percentage of on-time start of trips/on-time arrival to the total number of trips operated on a daily basis
- **Frequency:** Trip Frequency (94%) and Bus Km Frequency (94%). frequency of operation of Buses shall be measured on a quarterly basis in terms of percentage of the cumulative trips travelled by all Buses to the aggregate number of scheduled trips (“Trip Frequency”) and a percentage of the cumulative Bus Kilometres operated to the aggregate scheduled Bus Kilometres (“Bus Kms Frequency”), respectively
- **Safety of Operations:** General Safety and Severe safety (equal to or more than 1). The General Safety and Severe Safety shall be calculated in terms of cumulative Bus Kms operated divided by number of accidents multiplied by One lakh and cumulative Bus Kms operated divided by number of fatalities multiplied by Ten lakh, respectively.
- **Certification:** Operator to obtain and maintain ISO 9000:2005, ISO 14000:2004, ISO 18000:2007 and ISO 50000:2011 during entire Contract period

Penalty for failure to achieve Key Performance Indicators: 0.1% of the Performance Security for such shortfall in any such performance indicator. No maximum limit has been defined. No cumulativeness of KPIs for penalty calculation has been defined.

Incentive for over achievement of Key Performance Indicators: 0.05% of the Performance Security for exceeding any such performance indicator. No maximum limit has been defined. No cumulativeness of KPIs for incentive calculation has been defined.

Reporting of KPI: The Operator shall, no later than 7 days after the end of each month, furnish to the Authority a report stating the KPI of each Bus as measured on a daily basis.

Deposit by Authority in Escrow account:

- balance of at least an amount equivalent to two months' estimated Fee payable to the Operator
- all grants, payments and financial support received by the Authority from the State Government and/or GoI
- all payments by the Authority including insurance claims, if any, received;
- dues towards Termination Payment to the Operator; and
- any other revenues or capital receipts from or in respect of the Project

Deposit by Operator in Escrow account:

- all funds constituting the Financial Package;
- all the revenues generated and all the income accruing from the Project including but not limited to the, advertising revenue [and proceeds from the Real Estate Development], rentals, deposits, capital receipts or insurance claims; and
- all payments to the Authority towards Damages

Termination for Operator default (key events):

- Operator fails to replenish or provide fresh Performance Security (in case it has been encashed by Authority), within a Cure Period of 30 days
- the Operator fails to supply the Prototypes buses within the period
- Operator is in material breach of the Maintenance Requirements or the Safety Requirement
- a material breach of any of the Project Agreements
- Change in Ownership has occurred
- occurrence of any Insolvency/Bankruptcy Event
- False representation of any information

Termination for Authority default (key events):

- the Authority commits a material default in complying with any of the provisions of this Agreement and such default has a Material Adverse Effect on the Operator;
- the Authority has failed to make any payment to the Operator within the period specified in this Agreement; or
- the Authority repudiates this Agreement or otherwise takes any action that amounts to or manifests an irrevocable intention not to be bound by this Agreement

Payment upon termination (Operator default):

- 90% of the Debt Due less Insurance Cover; and
- 70% of the amount representing the Additional Termination Payment
  Provided that if any insurance claims forming part of the Insurance Cover are not admitted and paid, then 80% (eighty per cent) of such unpaid claims shall be included in the computation of Debt Due.

  Authority shall deduct any subsidy received by the Operator pursuant to Applicable Laws for implementation of the Project, for computation of Termination Payment

Payment upon termination (Authority default):

- Debt Due;
- 150% of the Adjusted Equity; and
- 115% of the amount representing the Additional Termination Payment.
  Authority shall deduct any subsidy received by the Operator pursuant to Applicable Laws for implementation of the Project, for computation of Termination Payment

4.2.4.3.1 Gaps in Model Concession Agreement (MCA)

Below are the gaps identified in the Model Concession Agreement:

Gap 1	**Contract tenure is more than asset useful life**	The Model Concession Agreement recommends a contract duration of 16 years which is longer than the life of a typical e-bus. This poses risk to both Operator and Authority (STUs) alike. (i) Risk to Operator – Since the contract period is more than useful life of the asset, the Operator may either needs to replace the asset or have to invest huge amount in maintenance, after using the e-

		bus for its maximum useful life, in order to oblige the SLAs specified in MCA This would also lead to higher quotation in response to the bid. (ii) Risk to STUs –The e-bus technology is at evolving stage and such a long commitment to the current technology may restrict STUs from taking advantage of upcoming/better technologies.
Gap 2	**Transfer of asset(e-buses) is not specified**	MCA clearly specifies that the maintenance Depot along with its entire infrastructure needs to be transferred to STUs by Operator upon termination of the Contract. However, it doesn't provide clarity on transfer of e-buses to STU upon termination of the Contract.
Gap 3	**Technical Specifications suitable for ICE buses are specified**	As per MCA, the e-buses would need to conform to the Urban Bus Specification (UBS)-II issued by the Ministry of Housing and Urban Affairs (MoHUA) in April 2013. While UBS II covers many relevant aspects, it was developed for Internal Combustion Engine (ICE) based buses and does not capture many of the e-bus related specifications like batteries and charging infrastructure. MCA could have specified the common bus specification for procurement. This would be helpful for OEMs to standardize their assembly lines. City wise variants would cause issues in standardization of assembly line, obtaining approvals etc. leading to lost opportunity of cost saving in manufacturing.
Gap 4	**Charging technology**	Operator can choose any charging technology as per the requirement. However, MCA does not put any obligation on STU to facilitate the Operator in case he wish to put Pantograph Charging or wireless charging methods. MCA confined the premises of assistance up to Depot charging. This has limited the convenience of Operator to trade-off with respect to battery size, capacity and cost that becomes available with different charging methodologies for e-bus.
Gap 5	**Development of Charging Infrastructure at each Maintenance Depot**	Development of Charging Infrastructure is a capital intensive exercise. MCA makes its mandatory for Operator to develop Charging Infrastructure at each Maintenance Depot, irrespective of number of buses plying from the Depot (i.e., even for Depot that would have low capacity utilization of charging infrastructure, Operator are still mandated to develop charging station). Instead MCA could have provided the flexibility to Operator to develop optimal Charging Infrastructure at suitable Depots to optimize the overall CAPEX requirement.
Gap 6	**Inappropriate division of responsibility among Operator and STU**	MCA requires the Operator to complete construction of Maintenance Depot within 180 days from Appointment Date. However, it provisioned 1 year for Authority from Appointment Date for completion of road up to the Maintenance Depot. Availability of road up to Depot is an enabler for timely completion of the construction work at Depot. Therefore, instead of Appointment Date, MCA should have to link the due date of completion of construction work at Maintenance Depot with date of availability of road connectivity up to Depot.

Gap 7	**Inefficient way of provisioning for Performance Security**	MCA requires Operator to provide Performance Security (based on value of Contract) for the entire duration of the Contract. However, to reduce the cost of financing of Operator, provision for yearly reducing Performance Security could be made, whereby the amount of Performance Security decreases (in same ratio of amount for which services were successfully rendered) with each completed year of satisfactory performance of Contract Obligation by the Operator.
Gap 8	**Damage liability for delay in meeting Conditions Precedent to Agreement, among Operator and STU is unjustified**	Upon not meeting the Conditions Precedent to Agreement, the STU is liable to pay an amount calculated at the rate of 0.1% of the Performance Security for each day's delay, whereas it is calculated at the rate of 0.25% of the Performance Security for each day's delay for Operator
Gap 9	**Escrow Mechanism could be a financial burden for some STUs**	MCA provides for maintaining ESCROW account wherein the Authority shall always, throughout the Contract Period, maintain a balance of at least an amount equivalent to 2 months' estimated fee payable to the Operator. Given the financial condition of STU, this provision could offer significant financial burden on STUs that have poor financial health. Instead of it, two-month revolving letter of credit from state Government could be provisioned.
Gap 10	**No provision to have system generated SLAs**	Manual calculation of SLAs are susceptible to human error and misrepresentation at times. Therefore, an IT enabled system could be warranted in the MCA to create system generated SLAs. Further, MCA has not specified any process for verification of SLAs calculated and provided by the Operator.
Gap 11	**Ambiguity in penalty and incentive provisions w.r.t. SLAs**	MCA specified Six SLAs, however, it is not clear in the document whether incentive/penalty is to be provided separately for each SLA or on achievement/non-achievement of any of single SLA. Further, maximum ceiling of incentive and penalty is not provided in MCA
Gap 12	**Bankability of Project is not considered**	The operation of fleet depends on the availability of adequate charging infrastructure. However, the risk of arranging for upstream power network up to Maintenance Depot is provided with Operator and role of STU is kept limited to providing assistance to Operator in arranging for such connectivity. Inappropriate risk sharing that has an impact on entire business model and revenue stream of the Operator may lead to reduced bankability of the Project. Further, to fund the project, operator would borrow form commercial banks that may offer loan at high interest rate owing to factors discussed above. Such high cost of financing will be passed on to city authorities. Alternative approach of profitable transport utilities (e.g. PMPML[91]) raising money, possibly at lower interest rate, has not been explored.
Gap 13	**Termination payment is not covering the entire debt due, which is**	MCA provides termination of Contract under Force Majeure which encompasses non-Political events, Indirect Political events and Political event.

[91] PMPML – P&L Statement (access here)

	further reducing the bankability of the Project	In case of non-Political event, the payment upon termination covers only 90% of the Debt-due less insurance cover.
Gap 14	**Restricting innovation in e-bus procurement**	FAME –II guidelines provides for transfer of demand incentive to OEM/ Operator. Further, MCA specifies the modus operandi for e-bus procurement using Opex based GCC model. Defining of boundary conditions have put restrictions on cities to innovate any new procurement/operation methodology that could be better than GCC model or any other model prevalent today.
Gap 15	**Other issues**	i. MCA provide that an open bidding process with RfQ followed by RfP. However, it doesn't provide any guidance on • Minimum technical and financial qualification criteria for bidders • Clarity on allowing International Competitive Bidding ii. Doesn't provide guidance on minimum technical specification requirement for e-buses iii. Guidance on timeline for completion of bidding process iv. MCA does not provide the guidance on the clauses that cannot be changed by States. This leads to inconsistent modification of MCA across States (Review of RFP covering wide variation of MCA clauses is provide v. STU to pay Termination payment to operator even if termination is on account of Operator's default

4.2.4.3.2 Review of state RFPs for e-buses procurement

Under FAME-II many STUs have floated RFPs for procurement of e-buses. The Model Concession Agreements (MCA) for these RFPs are broadly based on the standards issued by NITI Aayog with certain modifications according to the city's local needs. The variability in RFPs and MCAs combined with changes in of some key clauses like escrow mechanism and compensation in lieu of delay in payment of fees has increased the risk perception of the projects thereby reducing their bankability and increasing in cost of financing. The review of three major RFPs (under FAME – II) with procurement size of more than 300 e-buses is provided below:

Table 49 Review of Uttar Pradesh, Gujarat & Maharashtra e-bus procurement RfP

Particular	Uttar Pradesh (600 e-Buses)	Gujarat (300 e-Buses)	Maharashtra (340 e-Buses)
Contract Duration	10 years	10 years, subjected to condition assessment of buses after Eight years (8 years) from COD	10 years
Performance Security	3% of estimated project cost (i.e. ~ 27 Crores)	3% of estimated project cost (i.e. ~ 3.75 Crores)	Rs. 50,000 per e-bus
Charging Technology	Operator is free to choose any charging methodology	Operator is free to choose any charging methodology	Operator is free to choose any charging methodology
Minimum Daily Run	180 - 200 km on actual conditions with AC (with passengers and considering the traffic).	190 – 220 km	No such provision in RFP
Assured Annual Kilometre	63,000 km	70,000 km	Monthly assured Kilometre of 4750 kms for SD AC and

Particular	Uttar Pradesh (600 e-Buses)	Gujarat (300 e-Buses)	Maharashtra (340 e-Buses)
			4200 kms for Midi AC Electric buses
Payment basis	Per kilometre basis (termed as Per Kilometre O&M Fee, PKOMF)	Per kilometre basis (termed as Per Kilometre Fee, PK Fee)	Per kilometre basis
Payment of unutilised kilometre (i.e., short of Assured Annual Kilometre)	Annual Assured Payment Amount = **25% x (Tm – Ta) x PKOMF**	Annual Assured Payment Amount = **50% x (Tm – Ta) x PK Fee**	Annual Assured Payment Amount = **50% x (Tm – Ta) x Per KM fee**
Payment of excess Bus kilometre	Annual Assured Payment Amount for Excess Kms = **75% x (Ta – Tm) x PKOMF**	Annual Assured Payment Amount for Excess Kms = **50% x (Ta – Tm) x PK Fee**	Annual Assured Payment Amount for Excess Kms = **70% x (Ta – Tm) x Per KM fee**
Payment condition	Authority shall pay within 15 days of receipt of invoice.	Authority shall pay within 15 days of receipt of invoice.	70% of payment within 7th of the month in which invoice is raised. 30% of payment within 7th of the next month in which invoice is raised.
Delay in payment of fees	The Authority shall pay Damages at the rate of 2% (above the Bank Rate) per annum calculated for each day's delay in making the payment subject to maximum of one month of period from the date they become payable to the Operator.	No such provision in RFP	No such provision in RFP
Revision of fees	Yes	Yes	Yes
Formula for fees revision	Same as provided in Niti Aayog's MCA	Indexed Fee = PK Fee * {1 + [(10% * (Ref.ET –Base ET/ Base ET)) + (10% * (Ref.CPI-IW –Base CPI-IW / Base CPI-IW)) + (30% *(40% *(Ref.WPI –Base WPI / Base WPI)))]}	**For SD AC Bus:** Revised Rate/km.(R) = Quoted Rate + Change in electricity rate per unit/0.90* + *Quoted base rate (R) x {(CPI $_{Month}$ – CPI $_{Base}$)/ CPI $_{Base}$} x 0.05 + Quoted base rate x {(MW $_{month}$ – MW $_{base}$)/ MW $_{base}$} x 0.15* ***1.06 for Midi AC Bus**
Minimum duration for revision	Same as provided in Niti Aayog's MCA	12 months	2 months

Particular	Uttar Pradesh (600 e-Buses)	Gujarat (300 e-Buses)	Maharashtra (340 e-Buses)
Escrow mechanism	Yes Authority to keep a balance of at least an amount equivalent to 3 (three) month's estimated Fee payable to the Operator as a revolving fund	No such provision in RFP	Yes. Same as provided in Niti Aayog's MCA
SLA	Same as provided in Niti Aayog's MCA	Same as provided in Niti Aayog's MCA	*Breakdowns* - Below 0.5 per 10,000 km *Accidents* - Below 0.01 per 10,000 km *Availability of buses* – 100% *Passenger complaints/ Report by BEST officials against drivers* - Below 0.02 per bus per month *Serious nature of breakdowns* – Nil *No. of late turn out of buses* - 5 instances of more than 15 minutes per 100 buses per month *No. of not out of buses* – 1 per 100 buses per month
Incentive/Penalties w.r.t. SLA	0.1% of the Performance Security for such shortfall/over achievement in any such performance indicator	Same as provided in Niti Aayog's MCA	No incentive/penalties mentioned. Where the Successful Bidder has failed to cure the breach within the Cure Period of 30 days, STU shall, without prejudice to any of its other rights and/or remedies under this Agreement, be entitled to issue the Termination Notice for The Successful Bidder's Event of Default.
Damages for delay or non-fulfilment of Conditions Precedent	0.05% of the Performance Security for each day's delay subject to a maximum of 3% of the Performance Security	Same as provided in Niti Aayog's MCA	**Non-fulfilment by Operator** – STU is entitled to encash Security Deposit cum Performance Guarantee **Non-fulfilment by STU** – No penalty provision in RFP
Responsibility of setting-up upstream charging infrastructure	STU	Not clearly specified in the bid document	Discom/ STU

Particular	Uttar Pradesh (600 e-Buses)	Gujarat (300 e-Buses)	Maharashtra (340 e-Buses)
Selection criteria	L1 or Lowest Bidder	L1 or Lowest Bidder	L1 or Lowest Bidder

*Tm **=** Annual Assured Bus Kilometres x Available Fleet*
Ta = Actual Bus Kilometres Operated by all Contracted Buses
PK Fee: Per km rate provided in the Letter of Award;
Base ET: Base Electricity Rate is the Electricity Tariff applicable for Charging of Electric Buses of 7 days prior to last date of Bid submission;
Ref. ET: Reference Electricity Rate is the Electricity Tariff applicable for Charging of Electric Buses as on the date of submission of the statement
Base CPI-IW: Base Consumer Price Index for Industrial Worker which is last monthly index available 15 days prior to the Bid Due Date;
Ref. CPI-IW: Reference Consumer Price Index for Industrial Worker which is last monthly index available 15 days prior to revision date as per the provisions of the Agreement;
Base WPI: Base Wholesale Price Index for All Commodities which is last monthly index available 15 days prior to the Bid Due Date;
Ref. WPI: Reference Wholesale Price Index for All Commodities which is last monthly index available 15 days prior to revision date as per the provisions of the Agreement.
CPI_{Base} = Index value issued by Government of India's Labour Bureau's Consumer Price Index for Industrial Workers (CPI- IW) in Mumbai of bid end date
CPI_{Month} = Index value issued by Government of India's Labour Bureau's Consumer Price Index for Industrial Workers (CPI- IW) in Mumbai for particular month when the price variation is applicable.
MW_{Base}= Minimum wages applicable at the time of bid end date for skilled category (applicable for drivers)
MW_{month} = Minimum wages for skilled category (applicable for drivers) for particular month, notified by the Labour department, Maharashtra state.

Source: 137 Deloitte analysis

4.2.4.3.2.1 Gaps in States' e-bus procurement RfPs

The table above illustrates the wide variations in the RFP clauses across States. While it is desirable to amend the NITI Aayog's MCA to suit the local requirement, however it should not be done at the cost of overall bankability of the contract. The key gaps in the RFPs are provided below.

Gap 1	**L1 or lowest bidder basis for selection**	While NITI Aayog's MCA does not specify the basis for selection of successful bidder, the states have invariably resorted to selection based on L1 method. Since progress and success of these projects would lay down the foundation for future uptake of e-buses demand in India, therefore selection of bidders should be carried out based on Quality-cum-Cost Basis Selection (QCBS). EV technology is emerging, and bidder who has demonstrated its capacity to successfully deliver these projects could have been given more weightage in the selection. While L1 basis is the economical way of executing such projects but the same may not be suitable for undertaking projects involving emerging technologies such as EV and associated e-bus charging methodologies.
Gap 2	**No safeguard for Operator against delay in payment**	Assurance of time-bound payment against the services rendered is one of the vital factors considered for bankability of a contract. The RFPs issued under FAME-II have not provisioned for damages caused to Operator in case of delayed payment. This has increased the risk perception from the operator point of view.
Gap 3	**No Escrow Mechanism or alternative mechanism to ensure timely payment**	Escrow mechanism was provisioned in NITI Aayog's MCA, with an objective to ensure timely payment to Operator. Cities like Ahmedabad have not only removed such provision but also haven't provided any alternative mechanism such as Letter of Credit etc. to ensure timely payment to Operator and to increase bankability of the Contract.
Gap 4	**Unequal sharing of risk**	In RFPs issues by cities such as Mumbai, the risk sharing between STU and Operator is as the same. For example, in case of default in meeting conditions precedent to Contract within prescribed timeline,

		Operator is liable to pay damages/penalty however STU has not provisioned to compensate Operator in case of default from their end. Such terms and condition increases the project risk and resultant cost of financing.
Gap 5	**Wide variation in payment against assured kilometre**	While in all RFPs, STUs are willing to assure minimum kilometres, they have however shown wide variations in payment conditions. Whereas UP is paying only 25% of bid rate for any kilometre short of assured kilometres specified in RFP, Ahmedabad and Mumbai have provisioned to pay 50% of bid rate. The same variation is observed in payment against each kilometre above the assured kilometre level. Such variation have sensitivities on determination of fare bid prices because of variability in perceived risk by bidders and financiers.
Gap 6	**Charging Methodology**	These RFPs have also not envisaged for opportunity charging, pantograph charging, wireless charging etc. The RFPs have no clause that favours Operator to explore and provide other charging methods apart from overnight depot charging.
Gap 7	**High performance security amount**	The high amount of performance security as a percentage of Contract value has been retained by these RFPs. None of the RFP has adopted favourable mechanism for Operator for providing performance security that could reduce their financial cost. Provision for yearly reducing Performance Security could be made, whereby the amount of Performance Security decreases with each completed year of satisfactory performance of Contract Obligation by the Operator.

4.3 Review of charging infrastructure landscape in India

Availability of adequate charging infrastructure is a key to faster adoption of electric vehicle. To accelerate the adoption of electric vehicles in India, the Ministry of Power has taken various measure. There was lot of apprehension about licence requirement for setting-up of charging station. EV charging industry considered the same as a major roadblock in development of charging infrastructure. Therefore, MOP vide letter no. 23/08/2018-R&R[92] dated 13th April 2018 provided clarification on charging infrastructure or electric vehicles with reference to the provisions of the Electricity Act, 2003.

Further, MoP vide letter no. 12/2/2018-EV dated 1st October 2019 has established standards for charging infrastructure development with the objective of enabling faster adoption of electric vehicles. This is to ensure a safe, reliable, accessible and

It is clarified that during the activity of charging of battery for use in electric vehicle, the charging station does not perform any of the activities namely, transmission, distribution or trading of electricity, which require license under the provision of the Act, **hence the charging of batteries of electric vehicles through charging station does not require any license** under the provision of the Electricity Act, 2003.

– Ministry of Power (letter no. 23/08/2018-R&R dated 13th April 2018 amended vide letter no. 12/2/2018-EV dated 1st October 2019 and 12/2/2018-EV dated 8th June 2020

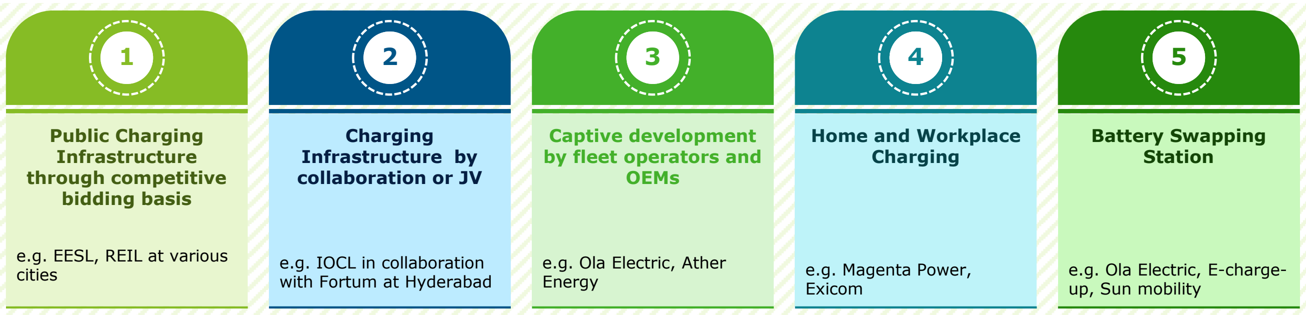
[92] Clarification on charging infrastructure for electric vehicles with reference to provision of the Electricity Act 2003 (access here)

affordable charging network, promoting affordable tariff for EV owners and charging station owners and operators. The guidelines envisaged development of public charging infrastructure in two phases. In phase 1 (1-3 years), public charging stations will be set up in all mega cities with population of 4 million plus as per census 2011, including all expressways connected to mega cities and important highways connected to these mega cities. In phase 2, (3-5 years), public charging infrastructure in state capitals, UT headquarters and highways connected with these cities will be set up. Vide letter no. 12/2/2018-EV[93] dated 8th June 2020, MoP has further introduced amendments to specify maximum capping on tariff for supply of electricity to EV Public Charging Station. By this amendment, MoP also included the definitions of Battery Swapping Station, Captive Charging Station, Battery Charging Station, Public Charging Station and Electric Vehicle Supply Equipment.

The Government of India has also earmarked Rs. 1,000 crore (~ USD 137 Million) for subsidizing development of public charging infrastructure. Further, with view to ease out implementation, the government also provisioned to have State Nodal Agency in each State, nominated by State Government to facilitate rolling out of charging infrastructure in respective State, with the help of Implementing Agency. The Implementing Agency selected by Nodal Agencies are entrusted with responsibility of installation, operation and maintenance of public charging infrastructure. As on 15th August 2020, total 26 States and UTs have appointed SNAs[94]. Few of the SNAs have appointed REIL, EESL, Exicom, Delta Electronics etc. as the Implementing Agencies, however, limited traction has been witnessed in the development of public charging infrastructure. The Central government has approved setting up 2,636 electric vehicle (EV) charging stations across 62 cities in 24 states and Union Territories of India under Phase-II of FAME India scheme, the roll-out of the same is under process.

In India, the existing charging infrastructure is being developed under following routes:

Figure 187 Routes for development of EV charging infrastructure



Source: 138 Deloitte analysis

4.3.1 Development of public charging infrastructure through competitive bidding basis

The entities such as EESL, REIL, and NTPC etc. are developing public charging infrastructure through competitive bidding basis. These entities are collaborating with the urban local bodies to have access to land[95] at suitable location within the cities and floating tender to select agencies such as Fortum, Exicom etc. to deploy charging infrastructure. The ownership and responsibility of operation of charging stations rests with the employer (e.g. EESL, REIL etc.). There are a few variations in the tender conditions though. For instance, REIL has mandated that bidders should open an authorized service centre equipped with

Competitive bidding basis is opted by entities for development of charging stations on turnkey basis with scope covering location survey, planning, engineering, manufacturing, supply, erection and commissioning.

Ownership and the liability of operation of the charging station lies with the employer floating the tender.

[93] Amendment in the revised Guidelines and Standards for Charging Infrastructure for Electric Vehicles (access here)
[94] State Nodal Agencies under the provisions of "Charging Infrastructure for Electric Vehicles – Guidelines and Standards" (access here)
[95] Economic Times (access here)

required spares and technicians before the installation of charging stations. NTPC require the selected bidder to provide ten years of maintenance service of the charging infrastructure[96].

This mode of development of public charging infrastructure has emerged as a suitable mechanism for mass deployment of charging infrastructure. Allotment of land and availability of electrical infrastructure are prime considerations in setting-up of charging infrastructure. Entities like EESL, REIL and NTPC etc. being owned by government, find it relatively easier in getting access to land and requisite power infrastructure as compared to any private entity. This model acts on the strength of each party suitably in development of charging infrastructure wherein the tendering entities bring in infrastructure support and the contractor brings-in technical expertise and know-how of development.

Figure 188 EESL Exicom's AC-DC charging stations for EVs

Source: 139 TERI (access here)

4.3.2 Development of charging infrastructure through collaboration or MoUs

Recently lot of traction has been witnessed in development of charging infrastructure through collaboration and MoU. Several players having unique strengths are joining hands to collaborate with each other to leverage their core competencies or access to infrastructure to develop charging infrastructure. Key examples includes:

Primarily Oil Marketing Companies (OMCs) are taking this route to leverage availability of land at suitable location and manpower to operate the charging station. This model has enabled OMCs to add additional revenue stream in their business portfolio by capitalizing existing assets.

Metro Rail Corporations are among other major players that are leveraging their parking space for developing charging infrastructure.

i. Tata Power has signed MoUs for setting up commercial EV charging stations at fuel outlets owned by Hindustan Petroleum Corporation Limited, Indian Oil Corporation Limited, and Indraprastha Gas Limited[97]. Tata power has also signed MoU with MG Motors to set up fast-charging stations at its select dealerships across India.

ii. NTPC is associated with IOCL, HPCL, DMRC and vehicle aggregators - Ola, Lithium, Shuttl, Bikxie, Bounce, Electrie and Zoom Car for development and utilization of public charging infrastructure. IOCL and NTPC are developing charging station in Greater Noida21[98].

iii. EESL has tied-up with private and public companies such as Apollo Hospitals, BSNL, Jaipur Metro, Chennai Metro, Maharashtra Rail Corporation Limited, BHEL and HPCL, among others, to set up public charging infrastructure[99].

iv. Indian Oil Corporation and Fortum partnered to launch Electric Vehicle public charging stations. The duo have opened their first charging station in Hyderabad. They have plan to open 50 such stations at IOCL retail outlets in upcoming years[100].

v. Exicom and BHEL sign MoU on EV charging infrastructure. Under the partnership, projects will be sought on nomination as well as through competitive bidding. Exicom shall also help state-owned

[96] Auto Economics Times (access here)
[97] Tata Power (access here), Tata Power (access here), Hindustan times (access here)
[98] NTPC (access here) and Mercom Communications India (Access here)
[99] EESL (access here)
[100] Fortum (access here)

Bharat Heavy Electricals Limited (BHEL) to set up electric vehicle (EV) charger manufacturing facility for electric mobility business[101].

vi. Tata Power partners with Tata Motors to develop charging stations in Maharashtra[102].

vii. Tata power is also partnering with Hotels, Malls, Shopping outlets of Tata Group to set-up charging stations that would provide convenience to their customer of charging vehicles.

viii. IOCL has joined hands with Sun Mobility to set up battery swapping facility at Chandigarh[103].

ix. BSES and Ola Electric signed MoU to install battery charging stations in Delhi. As part of the agreement, Ola Electric will manage and operate these stations through a cloud-based software system. BSES will facilitate in identification of strategic locations for battery swapping (and charging) stations[104].

Easy availability of land at strategic and convenient locations is driving the MoU route of developing charging infrastructure.

Although MoUs are not legal commitment but fructification of them in future needs to be closely observed. Since these MoUs are not available in public domain, the ownership structure and operational mechanism (BOO, BOOT etc.) is not known. The charging station set-up by IOCL and Fortum is on BOOT basis, details of the tie-up is provided in the box below:

Box 26: Case Study – Indian Oil's first electric vehicle charging station for general public, in collaboration with Fortum India Pvt ltd

Indian Oil Corporation Limited envisions exploring newer avenues that are presented by alternative and renewable energy sectors and be part of the evolving energy landscape. Taking this forward, Retail Team-TAPSO successfully negotiated with Fortum India for setting up of first public charging stations at retail outlets in the city of Hyderabad on exclusive basis. Fortum has developed a Charging Station at Goldstrike Fuel and Services fuel station of IOCL, Rajbhavan Road, Hyderabad.

Details on the Tie-Up between Indian Oil and Fortum India:

- Initially, the charging stations are being set up at 2 Retail Outlets on pilot basis and thereafter it would be expanded to 50 Retail Outlets in subsequent years.
- Established on BOOT basis for 7 years, the charging stations will have two DC charge points each of 10 KW or 15 KW charging capacity.
- The smart charger can be accessed by EV user using either Fortum Charge & Drive Mobile App or RFID. Payment shall be processed electronically through Credit card or debit card initially.
- Based on the efficacy of the proposed model, it will be taken up by other Service Outlets.

Source: 140 Fortum (access here)

4.3.3 Captive development by fleet operator and OEMs

Captive development of charging station to provide exclusive access to vehicles of own fleet is also emerged as another approach in developing charging infrastructure. OLA is said to be the pioneer of this concept in India. OLA partnered with carmaker Mahindra & Mahindra to launch an "electric mass transport project" in Nagpur to build charging infrastructure and bring 200 electric vehicles—including cars and auto-rickshaws—on to its app. OLA under its co-creating infrastructure strategy, broke the chicken and egg problem associated with development of charging infrastructure and adoption of EV. It has inducted EVs in its fleet and also created the charging infrastructure to provide exclusive access for charging to its fleet. On a pilot basis, it has developed charging station and battery swapping stations in Nagpur and Gurugram and has

[101] Exicom and BHEL sign MoU on EV charging infrastructure (access here)
[102] Tata Power – Media releases (access here)
[103] IOC launches battery swapping facility for quick recharge of electric vehicles (access here)
[104] BSES, Ola Electric to jointly install battery charging stations in Delhi (access here)

plan to expand in other cities as well. It has taken multiple strategy to develop charging infrastructure in Nagpur (the pilot city) which includes:

i. Partnered with ACME Group to develop charging station and battery swapping station across Nagpur city
ii. Developed and owned charging stations at Airport, dedicated zone for OLA
iii. Developed charging station in partnership with IOCL

In Gurugram, OLA owns and operate battery swapping unit for e-rickshaws. The station has around 14 battery-swapping units with 20 battery packs per unit powering 100+ e-rickshaws[105].

Source: 141 IndianWeb2 (access here)

Similarly, B2B mobility service provider company, Lithium Urban has developed its own charging infrastructure. Lithium has developed charging station under following three ways:

i. Developed charging stations on client premises;
ii. Partnered with commercial real estate developers such as Brookfield Properties and RMZ to set up charging stations on their properties;
iii. Developing "Charging hub" completely powered by solar energy that is run by Lithium and Fourth Partner Energy, a 100% rooftop solar company based in Hyderabad, as a joint venture.

Lithium has developed the first charging hub in Gurugram. The Fourth Partner Energy are responsible for delivering clean and cheap power to Lithium Urban and Lithium ensures that fleet will be charged at the hub. The company has 25-30 charging stations at the hub where 30 cars can be charged simultaneously. The company has also plan to open a charging hub in Pune in short-term with medium to long term aim to have 20-25 such hubs across the country[106].

OEMs are also actively playing role in development of charging station to promote their vehicle sales and increase brand presence.

MG Motors[107]	• MG Motors in partnership with Fortum developing 4 fast-charging stations in Delhi-NCR. First 50 kW DC charging station is unveiled at MG's showroom at Gurugram on November 2019. • AC fast charger are provided and installed by MG India at home or office, free of cost on purchase of EV • MG owner can access DC super-fast chargers available at MG Dealerships • MG owner can AC fast chargers available at MG Dealerships, along key routes in satellite cities • MG Motors provide road side assistance for mobile charging support, available 24x7 in case of an emergency
ATHER	• To promote adoption of EVs, Ather is developing its own charging station across selected cities (Chennai, Bangalore and Delhi). The company call the charging stations as Ather Grid that offers fast charging capabilities. Any non-Ather vehicle can also be charged at Ather Grid using compatible connectors. • In addition to the access to the Ather Grid, the Ather's vehicle also gets AtherDot home charger that can be installed at apartments, bungalows and shared parking spaces. A portable charger that uses a standard 5V plug point is also provided with the vehicle. 

[105] Battery Swapping: The Way Forward for Early Adoption of Electric Vehicles (EVs) in India (access here)
[106] India's Lithium Urban shows the way in running a profitable all-electric taxi fleet (access here)
[107] MG Motors (access here), MG Motor India and Fortum announce installation of the first public 50 kW DC fast charging station in Gurugram (access here)

Ather Energy[108]	• During the launch offer, charging facility through Arther Grid was offered free of charge. They have partnered with restaurants, cafes, shopping malls, tech parks, gyms etc. to install the charging points and according to the company, the charging points will be made available no more than the 4km driving distance from each other.

4.3.4 Home and workplace charging – collaboration with real estate developers

Although limited traction has been seen in this front, there are players who are providing solutions towards developing charging stations at residential complexes, commercial spaces, malls and hotel, etc.

Real estate developers are tying up with charging infrastructure developers to make their property EV ready. Magenta Charge Grid – Lodha Group collaboration and PlugNgo – DLF case studies provided in the box below.

Box 27: Case Study I – Magenta Power developing Lodha Group properties as EV ready

Magenta Power under their brand name 'ChargeGrid' offers solutions home charging and commercial charging. ChargeGrid provides services under four category, Destination Charging – Housing societies, offices; Opportunity Charging – Parking lots, Malls; Enroute Charging – Solution to develop station at highways; Commercial charging – Fleet charging, bus charging.

Lodha Group, a prime property developer has tied-up with ChargeGrid to install end to end electric mobility charging solutions in their upcoming realty projects at Dombivli and Thane. Under the partnership, ChargeGrid will install its EV charging solution - ChargeGrid Pro Chargers. The company will provide installation to charging support, round the clock service, maintenance support and remote vehicle charging monitoring & e-payments through the ChargeGrid Mobile application based on iOS & Android platforms.

Case Study II – PlugNgo joins hand with DLF, Delta electronic and ABB to develop charging stations in DLF cyber city

PlugNgo (an EV Motors Company), is developing DLF cyber city complexes and commercial spaces as EV ready. It is under their long term plan to 6500 EV charging station across India in next five years. In DLF area, The chargers will be assembled at malls and commercial complexes which will be networked and connected to PlugNgo cloud based integrated software program.

DLF Cyber City buildings are LEED Platinum certified, and therefore company has tied up with PlugNgo to make their buildings EV ready as well. The PlugNgo platform will also deliver customized installation support, round clock service, maintenance support and remote vehicle charging monitoring and e-payments through PlugNgo mobile application which is available on the iOS and Android platforms.

Source: 142 ChargeGrid (access here), Economics Times (access here); Economic Times (access here), Car and Bike (access here)

[108] Ather Energy (access here), Indian Auto Blogs (access here), Fonearena (access here)

4.3.5 Battery Swapping Stations

With the increased value proposition of electric vehicles in commercial segment, the country has recognized the need for battery swapping stations in order to minimize the downtime of commercial vehicles.

Sun mobility has installed an automated battery swap station equipped with a robotic arm to swap the 600 Kg battery within 3 minutes to cater 18 Ashok Leyland electric buses in Ahmedabad.

Battery swapping stations are useful for 2W, 3W, 4W – fleets and e-buses. In addition to providing services to the electric vehicle, battery swapping stations also provides an opportunity for enabling batteries to participate in demand response services[109] in the wholesale power market.

Many established players as well as start-up firms are venturing into the arena. Sun Mobility has partnered with Uber and Pune-based Piaggio Vehicles to provide swapping solutions for their EVs fleet. Sun-mobility has also assisted IOCL in setting-up of battery swapping station for 3W in Chandigarh.

The company is also pioneering in using information technology to provide user an ease to access the battery swapping station. It has developed an **IOT enabled keychain to access the dock to place the drained battery, pay for energy consumed and pick up a charged battery**. Further, to overcome the problem of battery standardization, the company is manufacturing its own modular Smart Batteries™ that are adaptable to different vehicle platforms.

E-Chargeup, a Noida based start-up, is also providing IoT enabled solutions for battery swapping to e-rickshaw. The company is providing battery swapping facility for only Li-ion batteries manufactured by Gurugram based Greenfuel Energy Solutions. Amara Raja has established battery swapping stations for fleet of e- Autos in Tirupati city[110].

Panasonic is conducting pilot programmes on battery swapping in Delhi NCR. Similarly, Ola Electric is planning to develop battery swapping station in Delhi NCR in collaboration with BYPL and BRPL[111].

Given the huge requirement of up-front capital in setting-up of battery swapping station this business model are observed to be concentrated in limited geographies (areas with high EV penetration) and players are not scaling up to other places, at least until capacity utilization is increased with increased EV adoption.

Together with the growth in EV charging, there have been several challenges as well in the industry. List of key challenges around development of EV charging infrastructure is provided in Annexure 6.4.

[109] A new method to plan the capacity and location of battery swapping station for electric vehicles considering demand side management (access here)
[110] E-Chargeup (access here), Amara Raja (access here)
[111] Ola Electric (access here), Panasonic (access here)

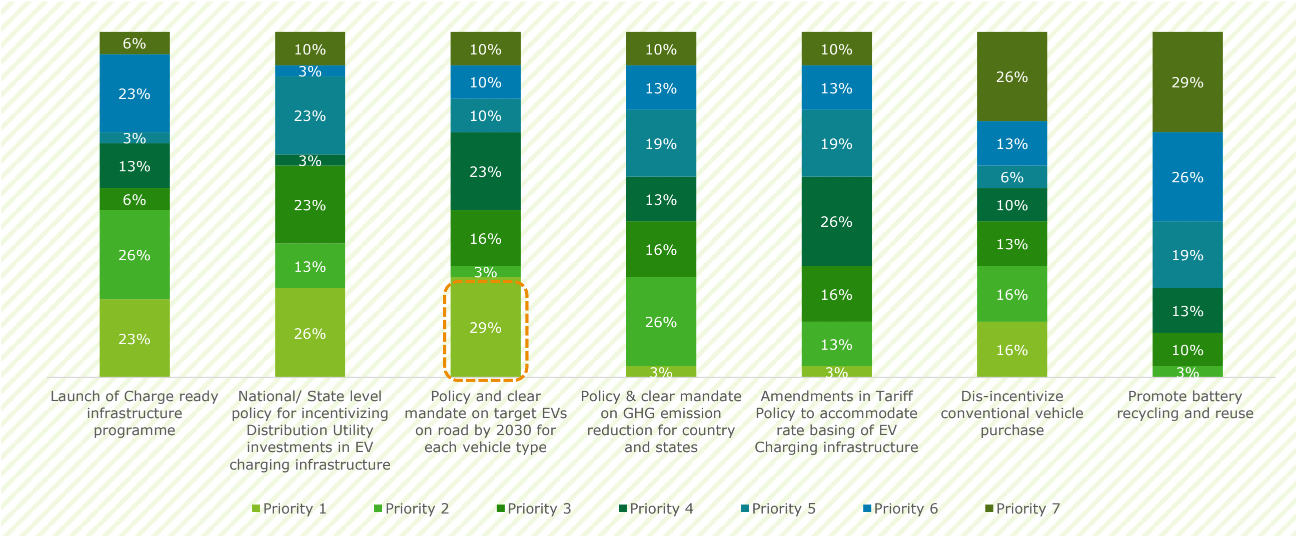
5. EV ecosystem enablers and barriers

5.1. Electric mobility stakeholder consultation

To understand the enablers and challenges in uptake of electric mobility in the country, Deloitte conducted stakeholder survey as a part of this study, where 42 individual experts across electric mobility industry, responded with their inputs. Summary of the survey output is provided below:

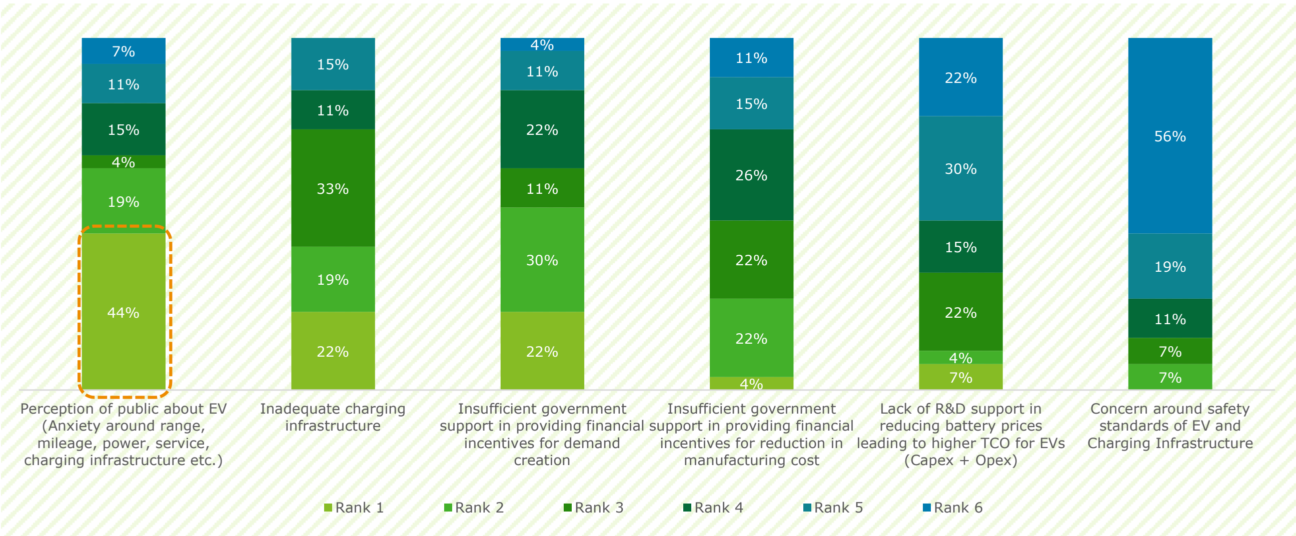
EV mandate could provide confidence in manufacturer/charging infra developer/ investors in long-term prospects of EV and payback certainty

Figure 189 Priority for policy measures to fast track EV adoption in India



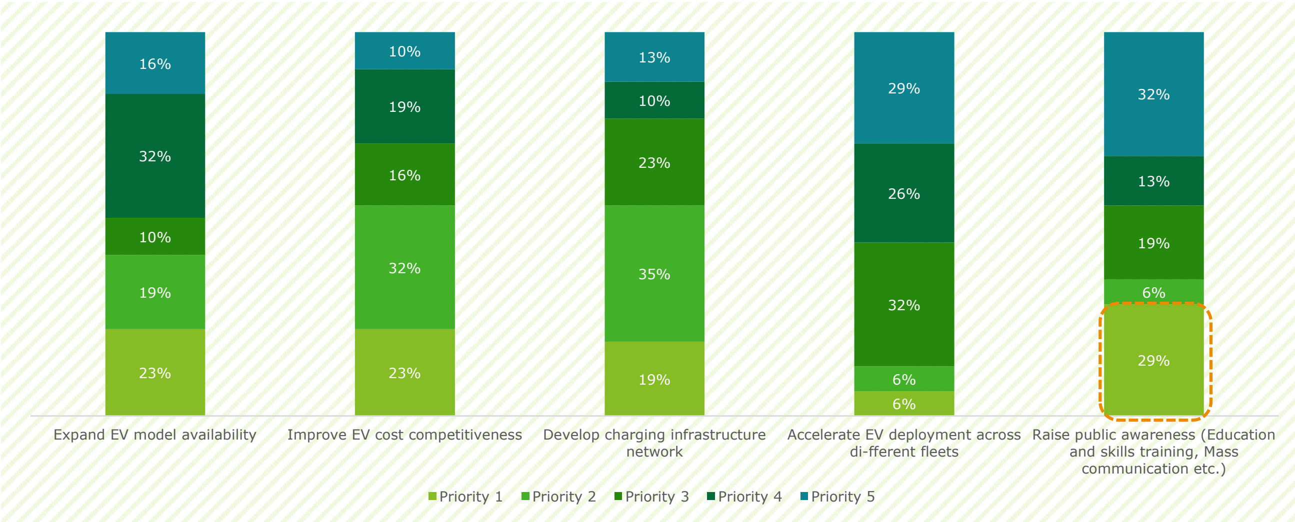
Public awareness is key in providing thrust to EV uptake

Figure 190 Ranking major challenges for EV adoption in India



Raising public awareness is essential to educate people to make them to adopt EV. Their impactful role in making the environment clean, needs to be communicated to have wider participation

Figure 191 Priority areas for policy makers to catalyze EV adoption



62% respondents believes that creating facilities such as zero emission zones will help in uptake of electric mobility.

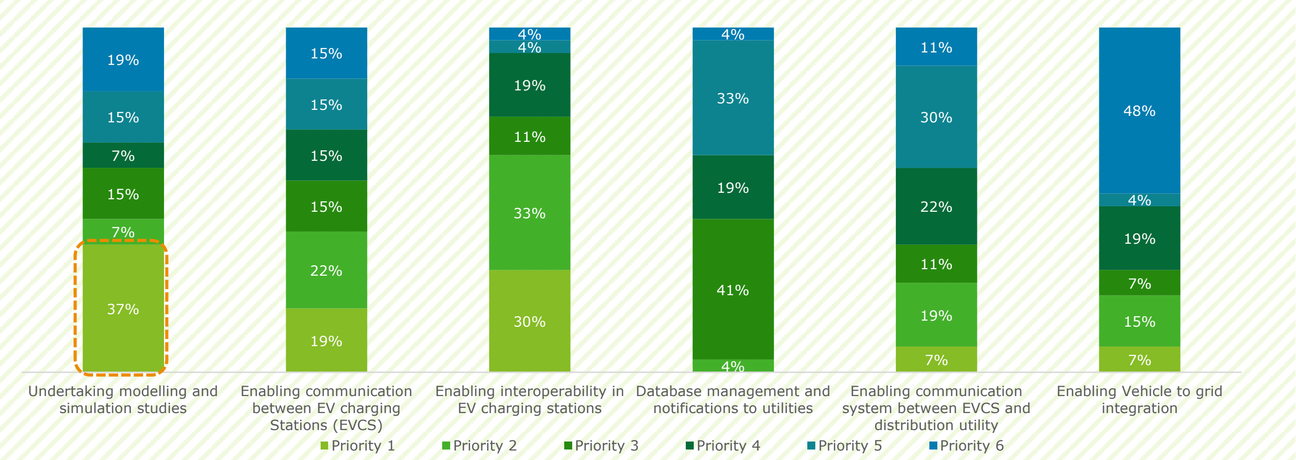
Feebate concept is largely missing in the existing policies/ schemes. Such innovative promotional mechanism needs to be adopted in India to have increased EV uptake.

97% respondents suggested that government should sponsor more system modelling/ EV charging-grid integration related pilot demonstration project.

High uptake of EVs would certainly have huge impact on electricity grid. It is prudent to be prepare for extremities by developing sufficient knowledge of grid behaviour in all possible scenarios of EV integration to enable smoother transition towards EV.

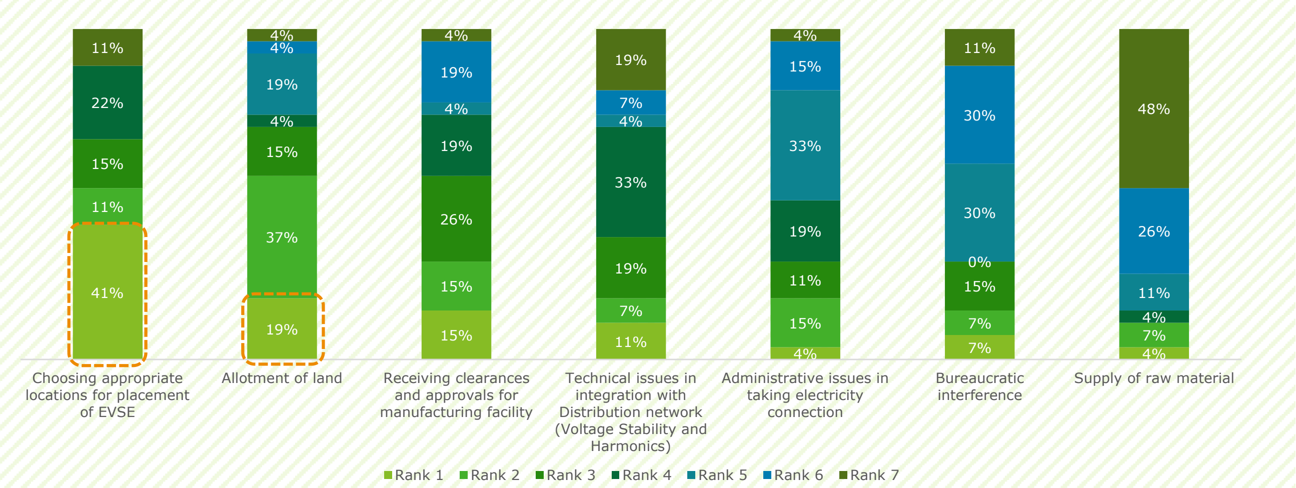
Understanding of grid behaviour should be a prime concern while making effort for high EV adoption. Grid resilience would be crucial for EV transition

Figure 192 Priority technical interventions to promote uptake of electric mobility



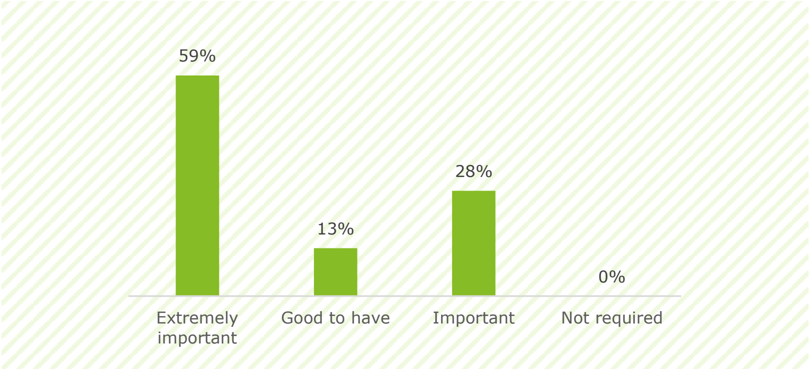
Identification of suitable location and allotment of land are two major issues causing delay in development of charging infrastructure. Administrative mechanism or institutional solution needs to be developed to avoid such delays

Figure 193 Ranking challenges faced in setting up EV charging station



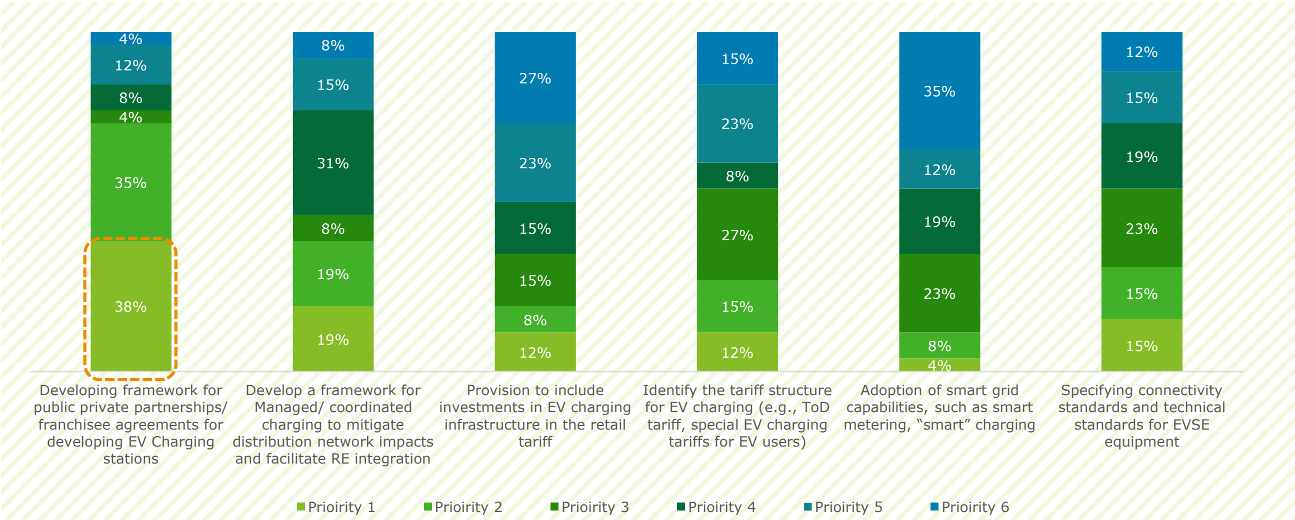
Minimizing administrative hurdles by providing single window clearance facility could act favourably for EV adoption

Figure 194 Pan India single window clearance facility



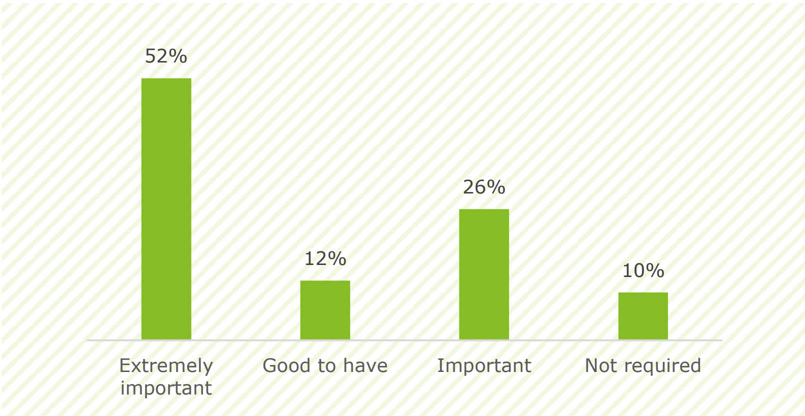
Discoms to play a major role in development of charging infrastructure. PPP is the best mechanism to leverage technical capabilities of Discom and financial capabilities of private developer. Suitable Modus-operandi for PPP needs to be developed on priority to have high penetration of charging infrastructure in India

Figure 195 Policymaker's priority for developing charging infrastructure



Enabling Discoms through regulatory measures to develop charging infrastructure is need of the hour

Figure 196 Regulatory measures for promoting charging infrastructure development in the country



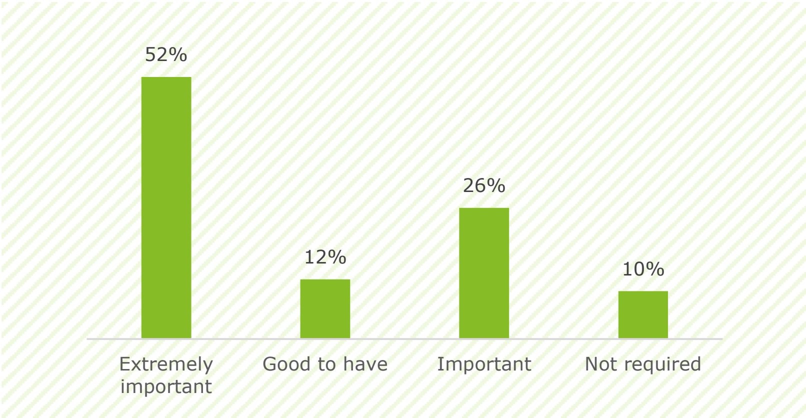
75% of respondents suggested that complimentary grant for open access or rebate in cross-subsidy surcharges/ wheeling charge should be provided to the charging station which is availing power from RE sources.

Availability of adequate greener power would be the key to attain the envisaged benefit of EV in pollution control. Suitable regulatory measures to be studied and adopted to embed RE with EV charging.

There is need to have state coordination forum to have orchestrated development in EV front across Country

State Coordination Forum can act as a common platform for state representatives to frame unified policies, regulatory measures, specification, standardization, data sharing protocols, incentives, mechanism for single-window etc.

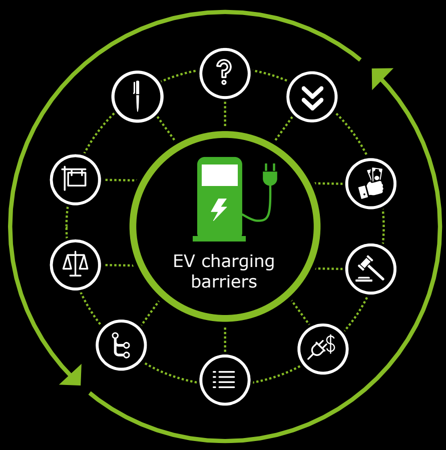
Figure 197 Need for a state coordinated forum as a common platform for state representatives to promote electric mobility



90% of respondents consider formulation of a National IT Committee important for creating an ecosystem for electric mobility.

The National IT committee will create national data standards, formulate rules for data sharing, monitoring etc.

5.2. Key barriers in EV charging infrastructure



- Uncertainty around EV penetration in India
- No mechanism for socializing the cost of power infrastructure development
- Lower capacity utilization
- Lack of Managed Charging Framework and functions
- High cost of finance
- No regulatory framework for charging service provider to participate in power market for demand response
- No mandate for Discom to develop charging infrastructure
- Land identification and allocation
- Fixed demand charges in EV tariff
- Issues related to administrative clearances

01 Uncertainty around EV penetration in India

Central and State Governments are equally promoting EVs. However, none of the governments have provided mandate for EV adoption. The capacity utilization and hence revenue assessment is largely dependent on number of EVs being served by the charging infrastructure. In case of uncertainty around rate of EV penetration in India, the business risk overshoots manifolds, causing developer to shy away from putting resources in development of charging infrastructure.

To bolster the confidence of charging infra developer to be able recover cost of finance, government must portray certainty around EV adoption

02 Lower capacity utilization

For early payback of capital invested in the business, it is required to have high utilization of assets. However, in India, since EV on road are not significant, the asset utilization remains critically low leading to multiple issues such as delay in payback, non-recovery of operating expenses, default in bank loan etc. Thus, under-utilization of the charging assets does not substantiate the business case for development of charging infrastructure and acting as a major barrier

Only higher rate of EV adoption can offer a plausible business case for charging infra development. It will remain as a chicken-egg problem, unless government mandate Discoms to take responsibility of development of charging infrastructure

03

High cost of finance

This issue is interrelated with issues presented in above points. The cost of finance has direct relationship with the perceived business risk by the financial institution. EV is an evolving technology and charging business model is not matured enough in India therefore, financial institutions are shying away from providing loans to the developer or even if it has been provided the cost of finance is high considering the risk factors involved. This is leading to insufficient scaling-up of EV charging business in India.

Policy measures to make available concessional loan or government guarantee backed loan should be taken to ensure viability of business and sufficient scaling-up of charging infrastructure in India

04

No mandate for Discom to develop charging infrastructure

Globally Discoms are playing key role in development of charging infrastructure. In China, State Owned Grid Utilities are investing hugely in development of charging infrastructure. Similarly, in USA electric utilities have to mandatorily file transportation electrification proposal. However, in India, Discoms are not obligated with the responsibility of development of charging infrastructure.

EV adoption and development of sufficient charging infrastructure is a classic example of chicken-egg problem. However, the existing policies have not adequately addressed this issue. In absence of any established business model, lower charging infrastructure utilization, and uncertainty around EV adoption (due to no EV adoption mandate), the private players perceiving huge risk in entering into charging business. Therefore, particularly in Indian context, it becomes important to delegate responsibility of developing charging infrastructure to Discoms.

Discoms to be mandated to develop charging infrastructure, at least in initial years, to provide sufficient confidence in EV adopters related to refuelling

05

Fixed demand charges in EV tariff

15 states and UTs (out of 22) such as Gujarat, Haryana, Karnataka, Maharashtra etc. have announced demand charges for EV charging stations. Electricity demand charges are fixed charges levied on charging station operator based on connected load irrespective of usage of the charging station facility.

In case of low asset utilization, levy of the electricity demand charges makes it difficult for charging station operator to achieve break-even.

There is need to design a suitable tariff that increases feasibility of operation of charging infrastructure facilities at even low asset utilization level

06

No mechanism for socializing the cost of power infrastructure development

Regulators in US allow utilities to undertake investment in "make-ready" infrastructure for EVSE integration as well as EVSE infrastructure and recover the cost through rate-basing. Rate basing is a mechanism to allow recovery of expenses incurred by utilities in developing of grid network suitable to provide make-ready

Regulators should encourage utilities to carry out such investments and provide pathway to cost recovery through rate basing. Forum for Regulators infrastructure for EV charging stations, through regulatory means of tariff determination. This allows utilities to undertake costly investment and socialize the cost of setting up "make-ready" infrastructure for EVs. Such a proactive approach creates an eco-system for setting up EV charging infrastructure.

may draft a mechanism for rate basing in India

While several states in India have introduced EV policies, state utilities and regulators are yet to facilitate large-scale investments in "make-ready" infrastructure for EVs. In the absence of regulatory clarity on allowing expenses incurred in development of upstream network in tariff, utilities are demanding cost of development of requisite grid infrastructure from the charging infrastructure developer. Such a huge investment impacting the overall business proposition.

07 Lack of Managed Charging Framework and functions

Utilities in western countries with significant levels of EVSE penetration have focused on developing a managed charging framework so as to efficiently manage the additional stress on distribution system network on account of EV charging. This entails setting up various communication and hardware protocols to implement a managed charging framework as well as creating various incentives for consumers to participate in managed charging initiatives.

While EV growth is still at a nascent stage in India, utilities and regulators will need to plan for implementing a managed charging framework with a long-term perspective.

In the Indian context, absence of standardized protocols for EV managed charging limits the discoms ability to control the charging of EVs. Therefore, in such a scenario, utilities have to upgrade and design the network for peak system demand, which is a capital-intensive affair and is posing as a major barrier in rapid scaling up of EV charging infrastructure

08 No regulatory framework for charging service provider to participate in power market for demand response

Regulator should establish a mechanism for demand response products in the ancillary market wherein charging service provider could participate

To take advantage of flexibility from managed operation of EV charging, ancillary markets in developed countries have provisions for demand response providers to participate in the ancillary market. This provides additional revenue stream to demand response sources and allows utilities to better manage its demand-supply position.

This is particularly important in the scenario where capacity utilization of existing charging infrastructure is critically low, additional revenue stream by participating in power market would increase feasibility of the business.

However, in India there is no mechanism exist that allow charging service provider to participate in power market for demand response

09

Land identification and allocation

Identification and allocation of the suitable land is critical in the entire value proposition of EV charging business. Some State EV policy have although recognized this as an issue and offered assistance in identification and allocation of land, however, our interaction from industry participants suggest that there are administrative challenges involved in land acquisition and in case of lease, uncertainty involves around the lease rental on long-term basis.

In a survey conducted by Deloitte as a part of this study reveals that identification of suitable location for setting-up of charging station and allotment of land are among key barriers in the development of charging infrastructure.

Government should develop an online portal to provide transparent information on availability of suitable land for development of charging infrastructure

Further, government should mandate Oil Marketing Company to offer land available at their retail outlets for development of charging infrastructure as most of the retail outlets are suitably placed within the city provided approval is granted by Petroleum and Explosives Safety Organization (PESO) for change in layout plan for setting up PCI

10

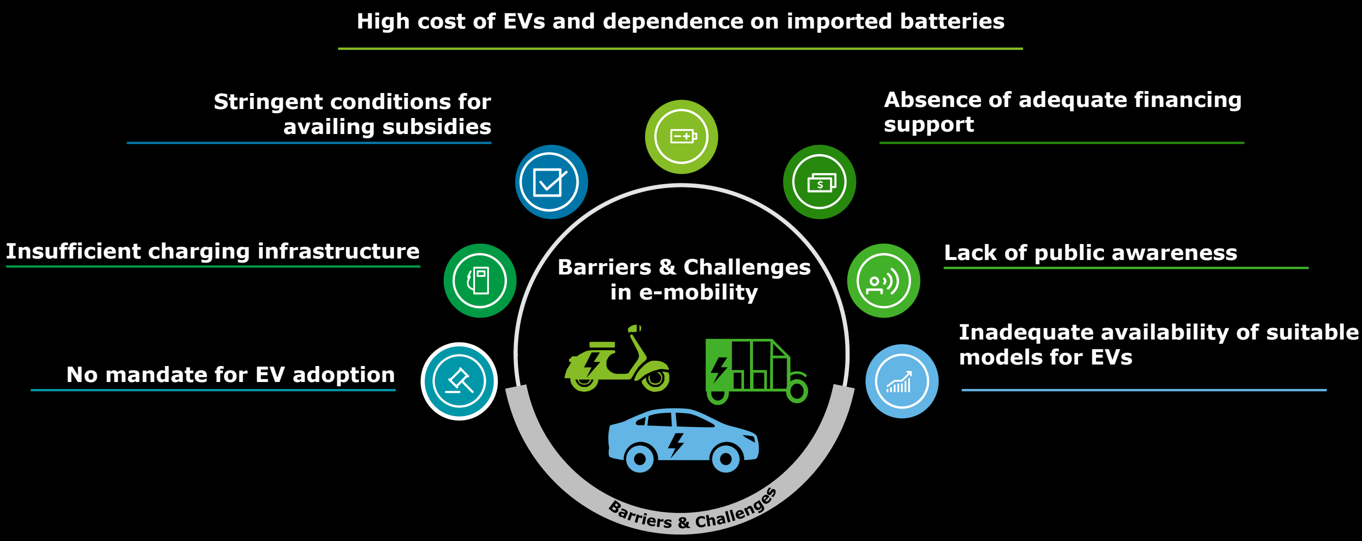
Issues related to administrative clearances

In a survey conducted by Deloitte as a part of this study reveals that there is requirement for establishment of Single Window Clearance System for providing time-bound technical and administrative approval, for matters related to land allocation, electricity connection and other issues.

Availing administrative clearances are posing significant delays in development of charging infrastructure.

Government should develop a District Level Implementation Committee chaired by District Collector to review the status of time-bound clearance provided to charging infrastructure developer under single window system

5.3. Key challenges and barriers in adoption of EV



01 No mandate for EV adoption

ICE vehicle have served all the stakeholders for many decades therefore there is inherent inertia for any change. Without mandate it would be very difficult to provide thrust for EV adoption as nearly all stakeholders are comfortable with the current state of using ICE vehicles and do not see a need for change to meet their travel needs. As for end user's perspective, any change means a learning curve and changing current ways of transportation, refuelling, servicing and maintenance. Manufacturers are heavily invested in current set of manufacturing facilities for ICE vehicles and any change in technology will need significant additional investments. Oil companies are also invested up to neck in upstream and downstream oil infrastructure. Retail outlet/fuelling stations will also have to lose their investments or will have to invest in charging/swapping facilities as a new line of business. There is a large auto repair industry that stands to lose business as electric vehicles have fewer parts. As a result, there is resistance to change and unwillingness to get out of the current comfort zone. Therefore, unless there shall be mandate for EV adoption or huge taxes on conventional vehicle, the inertia of owning and using ICE vehicles would be difficult to stop.

Globally, EV mandate and heavy taxes on ICE vehicles have played an important role in rapid EV adoption

02 Insufficient charging infrastructure

EV adoption and development of sufficient charging infrastructure is a classic example of chicken-egg problem. However, the existing policies have not adequately addressed this issue.

Wider availability of adequate charging infrastructure is vital for EV uptake in India

The range anxiety and limited availability of on-route charging infrastructure are the main concern of people shying away from purchasing EVs. Further, policies have not provided sufficient focus on promotion of development of home charging/ workplace charging infrastructure that could potentially offer a convenient alternative to on-route charging infrastructure for vehicle owner. Further, concept such as e-roaming are still not evolved in India that could provide flexibility and interoperability in charging across multiple location.

03 Stringent conditions for availing subsidies

The subsidies on EV purchase were announced to bridge the gap between the prices of EV and ICE vehicles. However, various riders placed around eligibility conditions for availing subsidies have largely defeated the purpose of extending subsidy support. For end-users riders were put on minimum range per charge and minimum top speed. Similarly, OEM are mandated to undergo re-certification process for conformity check to obtain certificate of 'FAME II India Phase II eligibility fulfilment' from approved testing agencies in India.

Such riders are posing significant barriers in utilization of subsidy utilization and EV adoption.

Purpose of the subsidies should be to have more and more EVs on road. Riders and other conditions may be postponed till EV ecosystem become sustainable in medium to long term horizon

04 High cost of EVs and dependence on imported batteries

One of the major barriers for switching to EVs is its cost. Although, there have been significant reduction in battery prices over last few years; still EVs are not able to achieve cost parity with their ICE vehicle equivalent.

Further, due to unavailability of raw material in India for battery manufacturing, there is continuous overarching risk of price change and availability of batteries owing to geo-political conditions. This is also imposing sense of uncertainty in assessing long-term operating cost of EVs that is the main proponent for its adoption.

Boosting of local manufacturing capabilities for battery and EV auto-component would help EVs in achieving cost parity with their ICE equivalents

05 Absence of adequate financing support

Particularly for e-bus there is no suitable financing support exist, except FAME –II subsidy that too available for limited no. of e-buses. Facility such as concessional loan, government guarantee backed loan, funding through green bonds, municipality bonds etc. are not available for procurement of e-buses leading to inadequate uptake of the same in shared-mobility space.

Innovative financing mechanism should be explored to arrange finance for e-bus procurement

06 Lack of public awareness

Electric vehicles technology is still evolving and details about its performance, ease of use and maintenance are relatively unknown

Many State EV policies have provisioned to have campaign and drive to raise awareness on EV to the public at large. People do not know what its benefits and challenges are. They are not aware of why it is important to make the transition. There are myths and concern about availability of spare parts and ease of availability of mechanics for repair works. Further, the vehicle owner does not know the concept of Total Cost of Ownership (TCO), therefore, purchase decisions are largely governed by upfront purchase cost only. Further, availability of subsidy scheme on purchase of EV is known to limited segment of society.

among public. EV adoption largely depends on meticulous implementation of such policy measures

07 Inadequate availability of suitable models for EVs

OEMs of ICE vehicles have invested hugely over the years in R&D and developed variety of models with varying performance parameters to cater almost all consumer segment in a society. However, this is not true with EVs. There are limited models available for consumer to choose from, that restrict their ability to select suitable model of their choice. This issue is particularly more prominent among 2W and 4W consumer segment.

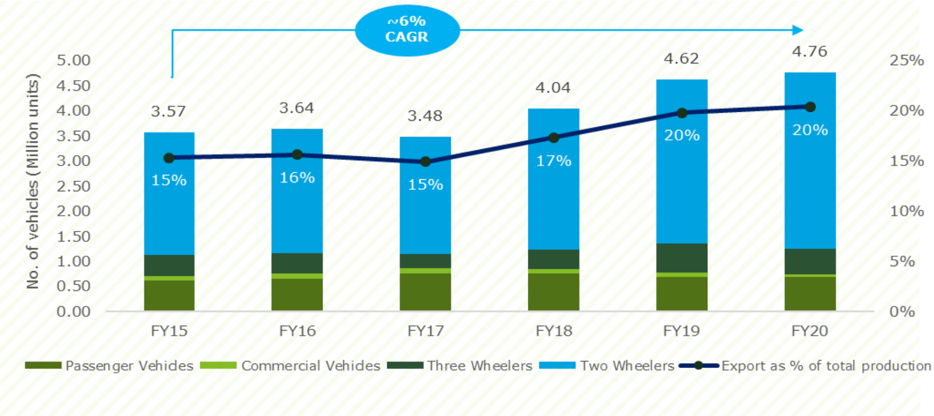
Unless there exist mandate for EV adoption, OEMs would not significantly invest in EVs development. With limited choices, EVs are less likely to be adopted.

6. Annexure

6.1 Chapter 1 As-is state of passenger road transport system in India

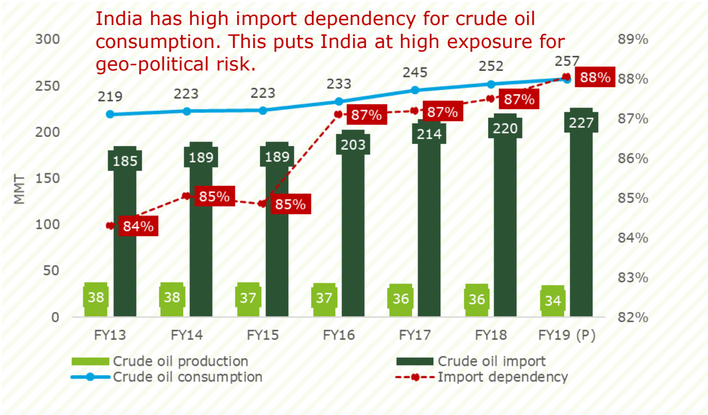
1. Automobile export

Figure 198 Category-wise vehicle export trend in India from FY15 to FY20



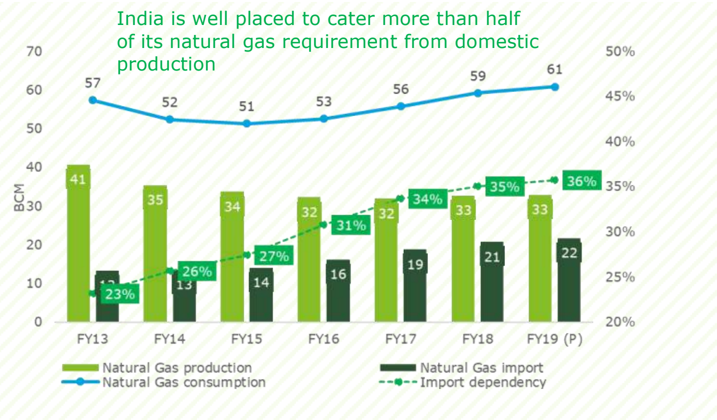
2. Import dependency of India

Figure 199 India's crude oil production, import, consumption and import dependency (FY13-FY19(P))



Source: 143 Indian Petroleum and Natural Gas Statistics 2018-19

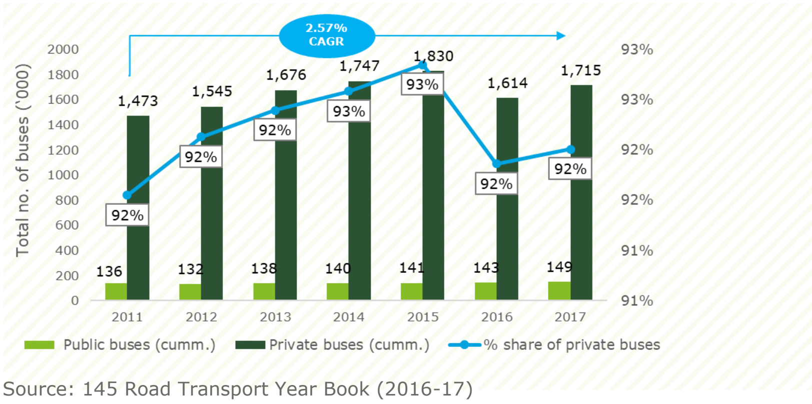
Figure 200 India's natural gas production, import, consumption and import dependency (FY13-FY19(P))



Source: 144 Indian Petroleum and Natural Gas Statistics 2018-19

3. Public v/s Private buses

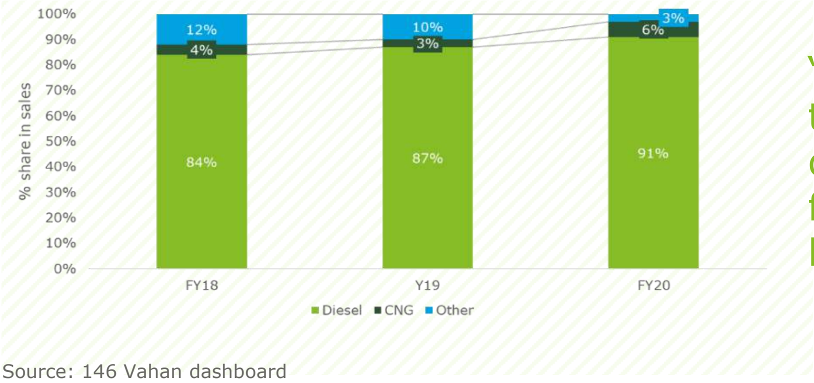
Figure 201 Total no. of buses - public and private (FY11-FY17)



Source: 145 Road Transport Year Book (2016-17)

"Private buses have significantly dominated Indian bus market. They account for more than 90% share in the overall market, and have grown at a CAGR of 2.57% from FY11 to FY17"

Figure 202 Fuel-wise share in sales of buses in India



Source: 146 Vahan dashboard

"Sales trend for last three year suggests that diesel is most preferred fuel technology for buses in India"

4. State-wise deployment of EVs as on July 2020

Table 50 State-wise total number of EVs (as on Jul'20)

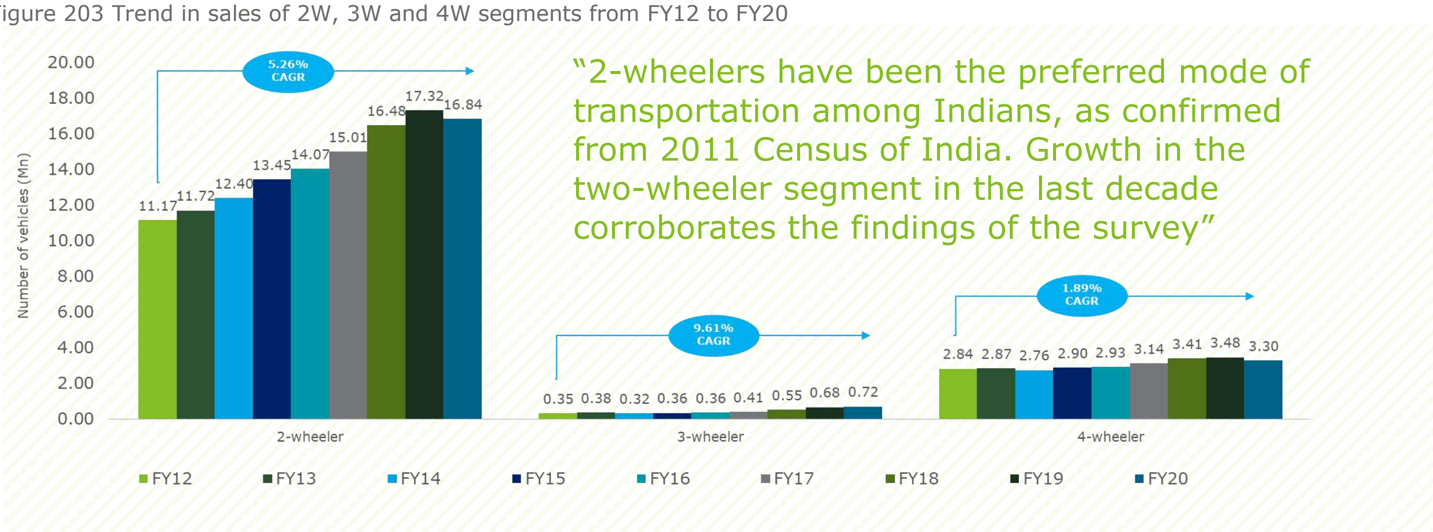
#	State/UT	2W	3W	4W	Other	Total
1.	Andaman and Nicobar Islands	0	0	0	0	0
2.	Andhra Pradesh	0	0	0	0	0
3.	Arunachal Pradesh	9	1	6	0	16
4.	Assam	176	24,605	8	27	24,816
5.	Bihar	1,447	24,988	19	15	26,469
6.	Chandigarh	74	646	33	0	753
7.	Chhattisgarh	2,624	3,136	117	92	5,969
8.	Dadra and Nagar Haveli & Daman and Diu	32	36	13	1	82
9.	Delhi	4,792	89,493	2,082	42	96,409
10.	Goa	320	39	88	3	450
11.	Gujarat	3,224	1,056	555	260	5,095
12.	Haryana	3,197	10,282	217	116	13,812
13.	Himachal Pradesh	22	120	78	59	279
14.	Jammu and Kashmir	152	34	16	44	246
15.	Jharkhand	868	6,225	137	73	7,303
16.	Karnataka	14,021	754	1,348	101	16,224
17.	Kerala	369	441	60	-21	849
18.	Lakshadweep	0	0	0	0	0
19.	Madhya Pradesh	0	0	0	0	0
20.	Maharashtra	19,905	3,706	1,674	231	25,516
21.	Manipur	61	331	3	0	395
22.	Meghalaya	15	3	6	4	28
23.	Mizoram	9	1	7	0	17
24.	Nagaland	39	0	2	0	41
25.	Odisha	3,681	893	63	194	4,831
26.	Puducherry	885	23	87	10	1,005
27.	Punjab	1,708	957	112	43	2,820
28.	Rajasthan	5,374	18,906	141	10	24,431
29.	Sikkim	1	0	20	0	21

#	State/UT	2W	3W	4W	Other	Total
30.	Tamil Nadu	13,223	351	4,049	1,600	19,223
31.	Telangana	0	0	0	0	0
32.	Tripura	58	3,687	10	0	3,755
33.	Uttar Pradesh	9,997	1,74,063	359	42	1,84,461
34.	Uttarakhand	1,109	16,599	14	1	17,723
35.	West Bengal	1,218	29,192	4,118	543	35,071
	India	**88,610**	**4,10,568**	**15,442**	**3,490**	**5,18,110**

Source: 147 Vahan dashboard (accessed on 25th July 2020)

5. Category-wise vehicle sales growth

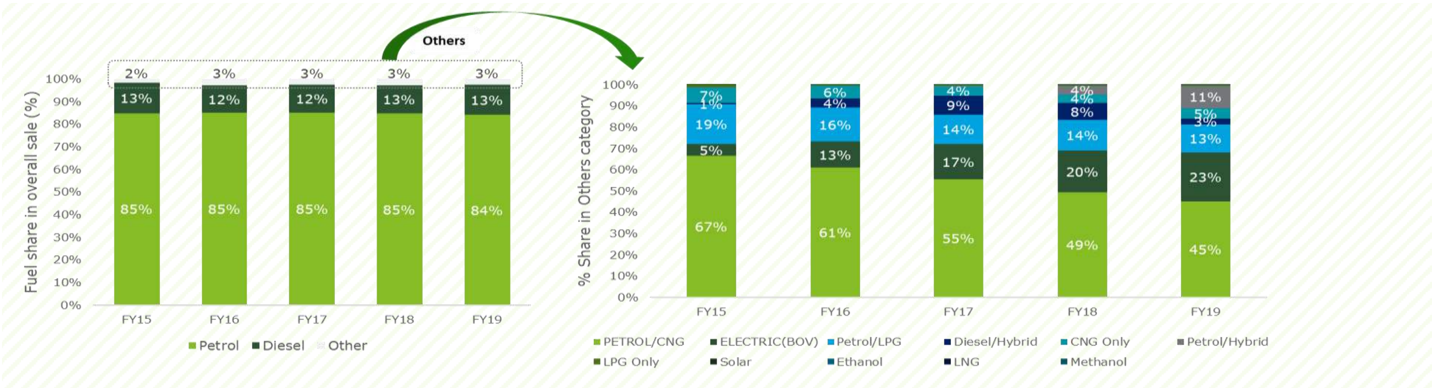
Figure 203 Trend in sales of 2W, 3W and 4W segments from FY12 to FY20



Source: 148 Vahan dashboard

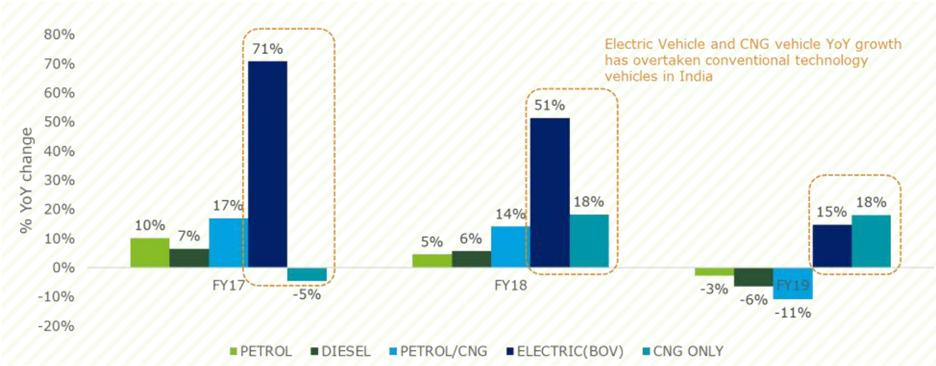
6. Fuel categorization

Figure 204 Fuel wise break of annual vehicle sales



Source: 149 Vahan dashboard

Figure 205 YoY sales trend in key vehicle fuel technologies

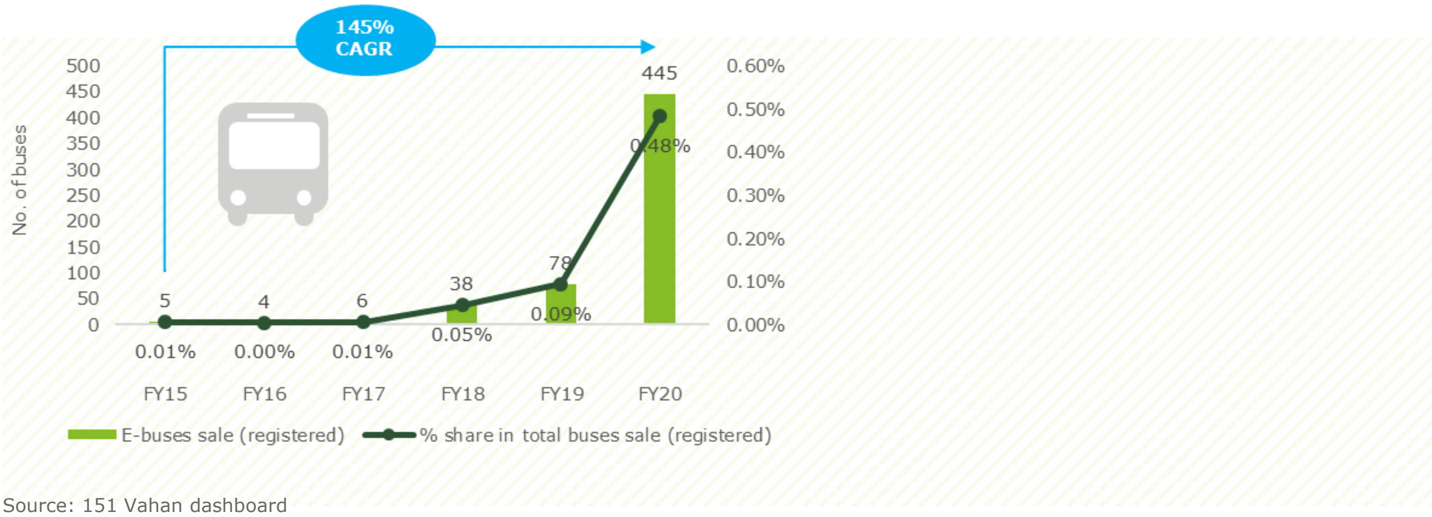


Source: 150 Vahan dashboard

"Looking at the last three years, EVs and CNG vehicles have started gaining momentum in the Indian market"

7. Adoption of e-buses

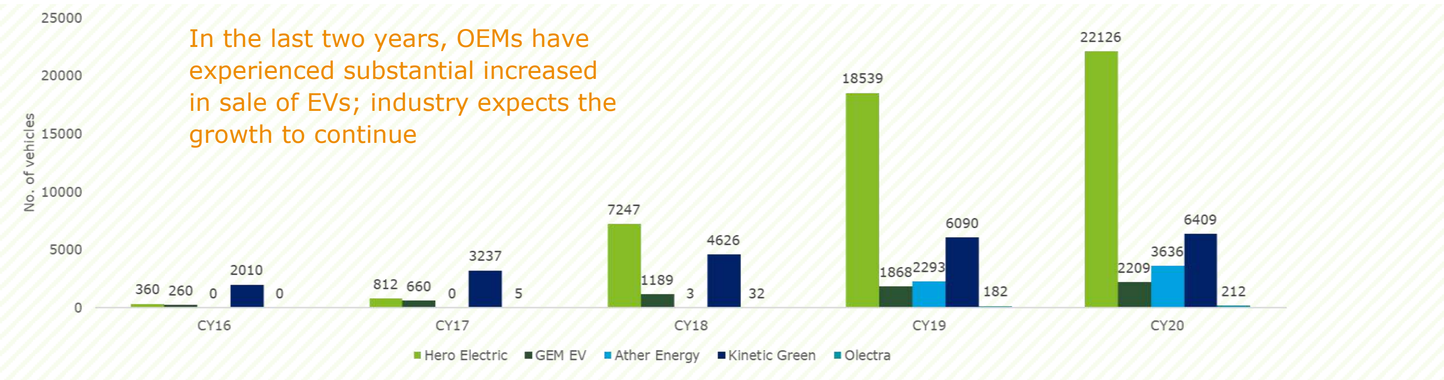
Figure 206 Trend of e-bus adoption and its share in overall bus sales



Source: 151 Vahan dashboard

8. Growth in OEM sales

Figure 207 Total vehicles sold by key electric mobility OEMs (Cumulative)



Source: 152 Vahan dashboard

9. Key initiatives by automobile players in EV space

Table 51 Key actions by auto players in India

S.No.	Operator	Vehicle category (4w,3w,2w, buses)	Key models	Key Initiatives
1	**Mahindra Electric** Mahindra electric	4w	eSupro (2) e20 Plus eVerito	• Zoomcar partners with Mahindra Electric to offer self-drive • EV cars in Mumbai, Hyderabad, Mysore. • Mahindra Electric has joined hands with Meru Cabs to deploy electric vehicles. • LG Chem is Mahindra Electric's Lithium battery technology partner. • Signs MoU with Government of Maharashtra for EV manufacture and deployment. • Partnered with Ola for Nagpur pilot. • New EV SUV models are under design stage and to be launched soon.
2	**Tata Motors** TATA MOTORS	4W	Nexon EV, Tigor EV	• Lithium Urban Technologies has given an order of 500 EVs to Tata Motors • Tata Motors announced to separate its passenger vehicles arm from the commercial vehicle wings, and merges Electric and Passenger Car Entities
3	**Maruti Suzuki** MARUTI SUZUKI	4W	WagonR EV	• In September 2017, Suzuki announced partnership with Denso and Toshiba for Lithium battery technology. • In November 2017, partnered with Toyota Motor Corp to benefit from its electric car technology for Indian market. • Plans to invest US$14.5 billion for the development of EV technology. • Maruti Suzuki deferred launch of Wagon R EV in 2020 due to lack of charging infrastructure in India
4	**Honda** HONDA	4W	Honda EV Plus	• Honda enters in a partnership with GM to build its two new electric vehicles using GM's flexible EV platform with its Ultium-branded improved battery packs
5	**Hyundai**	4W	Kona EV	• Hyundai Motor India Limited (HMIL) plans to launch its electric SUV in 2020 • Hyundai plans to launch its first India-made electric SUV by 2022
6	**MG Motors**	4W	ZS EV	• MG Motors launched their first electric car in India in January 2020
7	**Ashok Leyland**	Buses/ Trucks	-	• Ashok Leyland is looking to enter into a partnership with multinationals to start a joint venture in the electric mobility space

S.No.	Operator	Vehicle category (4w,3w,2w, buses)	Key models	Key Initiatives
				• Ashok Leyland setup its electric vehicle (EV) facility in its Ennore plant.
8	**Eicher motors**	Buses	-	• VE Commercial Vehicles (VECV), a joint venture of Volvo Group India Pvt. Ltd and Eicher Motors Ltd, is developing a new line of products, including a complete range of electric vehicles for public transportation
9	**Olectra-BYD**	Buses	K9	• Olectra – BYD launches electric buses in Hyderabad
10	**Bajaj**	2W, 3W	Chetak	• Bajaj launched its first EV, Chetak, in January 2020
11	**TVS**	2W	iQube	• TVS plans to expand its electric vehicle portfolio in the coming years in a phased manner
12	**Hero Electric**	2W	ES series, E5 series, E2 series	• Hero Electric has aggressive investment plans to ramp its electric scooter production capacity up the 5 lakh units annually in the next three years • Hero Electric targeting 1,000 dealer touchpoints across India by 2020 end
13	**Toyota**	4W	Camry (Hybrid)	• Toyota is in collaboration with Suzuki Motor Corporation (SMC) to develop electric vehicles in India

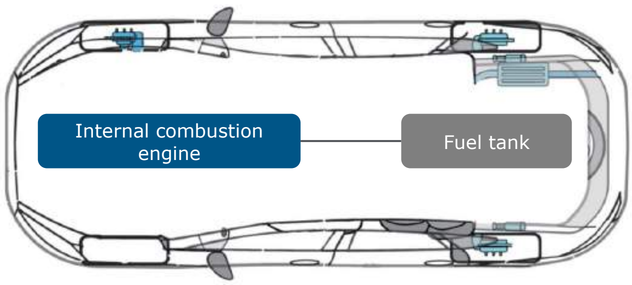
10. Vehicle technology

1. Conventional technology

As mentioned above, the Indian vehicle industry is heavily dominated by conventional fuel technologies such as petrol and diesel vehicles. These technologies have contributed to ~97% of passenger vehicle sales in last five years. In the forthcoming sections, we will discuss the conventional technologies in brief.

a. Petrol vehicles

Figure 208 Propulsion system of a petrol vehicle



Petrol based vehicles are one of the oldest fuel technologies and is also the most preferred fuel technology in the Indian market.

In its propulsion system, the petrol vehicle has a fuel tank for petrol storage and a spark-ignited internal combustion engine (IEC) that provides mechanical power to the transmission enabling the vehicle to move.

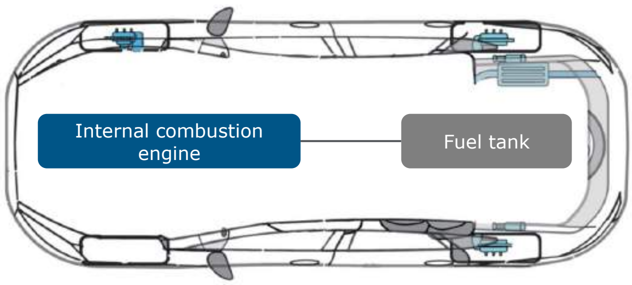
In petrol vehicles, fuel is injected into the combustion chamber and combined with air. Using the spark plug, a spark is generated by the air and fuel mixture. The gases that are generated from the combustion pushes the piston, which in turn rotates the crankshaft. This ultimately provides mechanical power to the transmission enabling the vehicle to move.

Petrol contains carbon and hydrogen atoms. During combustion, the carbon (C) from the fuel combines with oxygen (O_2) from the air to produce carbon dioxide (CO_2). The CO_2 impacts the environment which is one of the reasons why the world is now looking beyond petrol vehicles for transportation.

b. Diesel vehicles

Diesel is second most preferred fuel type in India after petrol. Similar to petrol, diesel vehicles also use an internal combustion engine (ICE). However, unlike petrol, they have compression-ignited injection based ICE rather than spark-ignited ICE. In the compression-ignited injection, diesel fuel is injected into the combustion chamber of the engine and is ignited by the high temperatures achieved when the gas is compressed by the engine piston. Once there is ignition, mechanical power is transferred to the transmission and the vehicle moves.

Figure 209 Propulsion system of a diesel vehicle



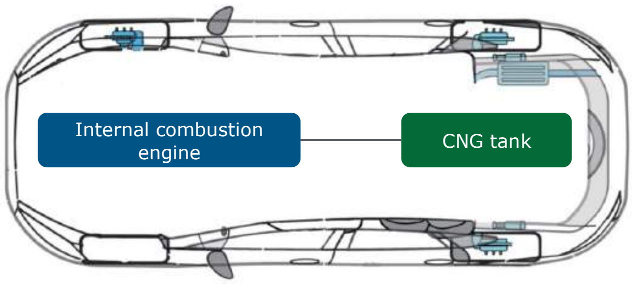
Similar to petrol vehicles, diesel vehicles also contribute to the CO_2 emission in the environment and warrant exploration of low-carbon fuels for transportation.

2. Non-conventional technology

a. CNG vehicles

Compressed Natural Gas, also known as CNG, is methane stored at a high pressure. Italy was the first country to use Natural gas as vehicle fuel in the 1920s. GAIL (India) Limited initiated the pilot program in 1992 to use CNG as vehicle fuel in India in collaboration with Indian Institute of Petroleum in 3 cities namely Delhi, Mumbai and Baroda. Since then, 1730 CNG stations[112] have been set-up with a total of 33.47 lakh CNG vehicles[113] on road (as on 31st March 2019). A simple Hydrocarbon structure (CH4) with less C atoms, makes CNG a cleaner fuel. Higher Octane allows use of higher Compression Ratio in spark ignition engines that provides better fuel efficiency. Likewise, lighter density with respect to air and high self-ignition temperature contribute to its cleanliness characteristic[114].

Figure 210 Propulsion system of a CNG vehicle



There are are three types of CNG vehicle technologies available in India:

i. **Dedicated CNG engine** - Dedicated CNG vehicles have Spark Ignition (SI) engines that are operated only on CNG.

ii. **Bi-fuel retrofitted gasoline engine** - Bi-fuel vehicle can run on either CNG or gasoline. Such vehicles have regular Internal Combustion Engine. The vehicle can be operated on any fuel type by flipping a switch on the dashboard. Any existing gasoline vehicle can be converted to a bi-fuel vehicle.

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[112] Indian PNG Statistics 2018-19 (access here)
[113] Indian PNG Statistics 2018-19 (access here)
[114] Gaseous Fuels for Transport Sector (access here)

iii. **Dual-fuel diesel engine -** Dual-fuel vehicle are based on Compressed Ignition (CI) engine technology. They run either on diesel only or utilize a mixture of natural gas and diesel, with the natural gas/air mixture ignited by a diesel pilot injection system.

i. Operating principle

The operation of Compressed Natural Gas (CNG) vehicles are similar to gasoline-powered vehicles with spark-ignited internal combustion engines. CNG is stored on-board the vehicle under pressure in the fuel storage cylinder to a maximum pressure of approximately 200 bar[115], typically at the back of the vehicle. The CNG fuel system transfers high-pressure gas from the fuel tank through the fuel lines, where a pressure regulator reduces the pressure to a level compatible with the engine fuel injection system. Finally, the fuel is introduced into the intake manifold or combustion chamber, where it is mixed with air and then compressed and ignited by a spark plug.

ii. Developments in India

Uniquely, the thrust for rollout of CNG in India wasn't initiated by a policy push. Instead, it was a judiciary initiative. Supreme Court in 1998 issued a directive calling for the conversion of all buses, taxis and three-wheelers to CNG in Delhi in the wake of rising air pollution. Subsequently, Government of India announced the National Auto Fuel Policy on 6th October 2003. The policy recommended the use of CNG/LPG in cities that are affected by higher vehicular population. Additionally, it also recommended to have a planned development of natural gas infrastructure. Government of India vide notification dated 31.3.2006 enacted the Petroleum and Natural Gas Regulatory Board Act 2006 for establishment of Petroleum and Natural Gas Regulatory Board (PNGRB). The PNGRB started functioning w.e.f. 1.10.2007 and its first regulations came in March 2008 for City Gas Distribution and CNG infrastructure. So far, CNG stations, CNG sales and CNG vehicles have grown a CAGR of 16.16%, 10.85% and 11.00% respectively during the last five years.

b. Hydrogen Fuel Cell Vehicles

i. Developments in India

Indian Oil Corporation limited (IOCL) and Society of Indian Automobile Manufacturer (SIAM) in Oct 2005 have collaborated to undertake a pilot project (funded by MNRE) to setup a Hydrogen and Compressed Natural Gas (HCNG) dispensing station.

In the following year (2006), India notified National Hydrogen Energy Road Map (NHERM) in bid to make itself a hydrogen based economy. The road map proposed 1 Mn Hydrogen based IC Engines and fuel cells vehicles by 2020.

In September 2007, MNRE supported a project for demonstrating Hydrogen up to 30% with CNG in 7 automobiles (3 buses, 2 cars and 2 three-wheelers) to Society of Indian Automobile Manufacturers SIAM). However, after that, there hasn't been any significant progress recorded in Hydrogen mobility space.

It was only in June 2017, when Tata Motors, in association with ISRO (Indian Space Research Organisation), announced the launch of India's first hydrogen-powered automobile bus. Tata later flagged off the trial run of the vehicle in partnership with IOC in 2018.

11. EV Charging technology

Technical aspects of EV charging

a. Classification of EVSE

Electric Vehicle Supply Equipment (EVSE) is an equipment or a combination of equipment which provides dedicated functions of supplying electric energy from a fixed electrical installation or supply network to an EV for the purpose of charging. There are different ways to classify an EVSE depending on power supply (AC or DC), power rating levels, speed of charging and communication and connector type.

[115] study and analysis of CNG/LPG conversion system (access here)

b. Classification by EVSE output – AC and DC

In AC charging, the vehicle has an on-board charger to convert AC from the grid into DC to charge the vehicle. A DC charger, on the other hand, can be used to charge the vehicle directly using the Battery Management System. An AC EVSE comes in different power ratings ranging from 3.3 kW to 43 kW. A DC EVSE is able to supply higher power rating ranging from 10 kW to 240+ kW.

c. Classification by power rating and charging speed

There are three levels of charging stations available with each successively providing faster charging capability and associated costs of charging. These are as follows:

Table 52 Various levels of charging and rated capacity (power)

Charging station	Voltage (V)	Power (kW)	Type of Vehicle	Type of compatible charger
Level 1 (AC)	240	<= 3.5 kW	4W, 3W, 2W	Type 1, Bharat AC-001
Level 1 (DC)	>= 48	<= 15 kW	4W, 3W, 2W	Bharat DC-001
Level 2 (AC)	380-400	<= 22 kW	4W, 3W, 2W	Type 1, Type 2, GB/T, Bharat AC-001
Level 3 (AC)	200-1000	22 to 43.5 kW	4W	Type 2
Level 3 (DC)	200-1000	Up to 400 kW	4W	Type 2, CHAdeMO, CCS1, CCS2

Further, an EV consumer will also need to decide on the type of charger available at a specific charging station along with the level of charging station. The table showcases the type of chargers which are compatible with each of the charging station type. Usually EV charging network services providers provide apps on which consumers can easily figure out the type of charging station and chargers available in a network. Level 1 charging stations are more suitable for 2W and 3W while Level 2 and Level 3 are more suitable for 4W.

EV consumers can decide their choice of charging station level based on the time required and associated cost of charging. An example of charging experience of a 2017 Chevy Bolt with an approximate range of 220 miles of range with a 60 kilowatt-hour (kWh) in US provides more insight. The table below provides the time required to charge the Chevy bolt at each level of charging station:

Table 53 Charging time for a Chevy Bolt

Charging station	Charging Time of Chevy Bolt
Level 1	40 hours
Level 2	9 hours
Level 3	1 hour, 20 mins

Source: NRDC – EV charging 101 (access here)

A level 1 charging station would take 40 hours to charge the battery, while a level 2 charging station fill up the whole battery in 9 hours (25 miles/hour charge), and a level 3 charging station can charge the same in 1 hour and 20 mins (150 miles/hour charge). Correspondingly, the cost of using a level 3 charging station is USD 30[116]. While the charging time in level 3 is low, the corresponding cost of charging is also high. In current scenario, level 2 is a suitable for charging a 4W for most of the instances given a US car owner

[116] *NRDC - Electric Vehicle Charging 101 (access here)*

drives about 31 miles a day. Level 3 charging station may be more suitable for quick top up or during long range journey. With awareness on how to optimize charging behaviour, EV consumers can benefit from cost savings and choosing right options which suit their need.

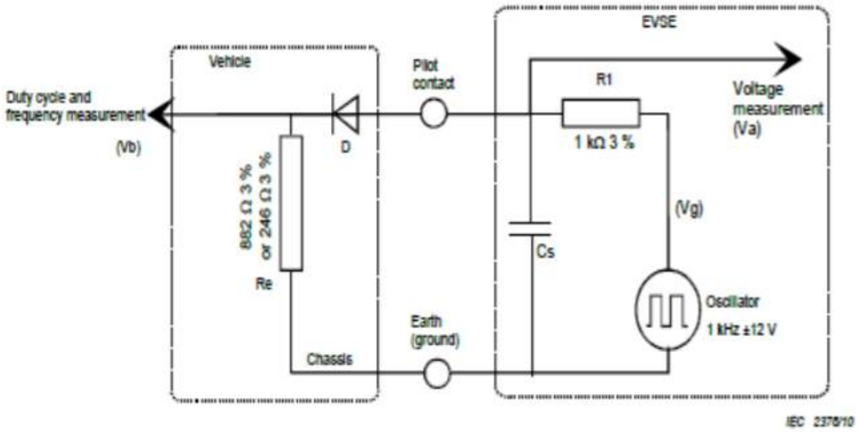
Key features and functions of a Charger:

Charging infrastructure standards provide a description of the physical conductive electrical interface requirements between the Vehicle and EVSE. The description under the ASI138 (Part 1) standard for IEC 62196 is provided below:

Table 54 Various contacts in a charging gun

Contact Number	IEC 62196	Function
1	Three Phase, 63 A	L1
2	Three Phase, 63 A	L2
3	Three Phase, 63 A	L3
4	Three Phase, 63 A	Neutral
5	Rated for Fault	Protective Earth
6	-	Control Pilot
7	-	Proximity

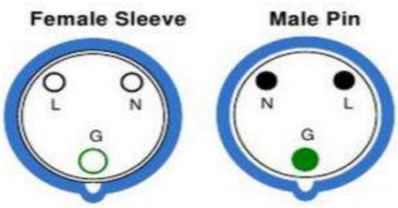
While several functions are self-explanatory, the Control Pilot is the control conductor in the cable assembly connecting the in-cable control box or the fixed part of the EVSE, and the EV earth through the control circuitry on the Vehicle. It is a key part of the charger. It can be used for managed charging of the EV. For example, Control Pilot signal can be used to command the battery management system in the EV to change the rate of charge. A simplified circuit for control pilot is provided below:



All chargers do not have such functionality. Functions for IEC 60309 charger connection points are provided below:

Table 55 IEC 60309 charging connector

Contact Number	IEC 60309	Function
1	Single Phase, 15 A	L



Contact Number	IEC 60309	Function
2	Single Phase, 15 A	Neutral
3	Rated for Fault	Protective Earth

Charging functions

The AIS standards for DC charging list the following functions to be performed by a charging system:

- Verification that the vehicle is properly connected;
- Protective conductor continuity checking;
- Energization of the system;
- De-energization of the system;
- DC supply for EV;
- Measuring current and voltage;
- Retaining / releasing coupler;
- Locking of the coupler;
- Compatibility assessment;
- Insulation test before charging;
- Protection against overvoltage at the battery;
- Verification of vehicle connector voltage;
- Control circuit supply integrity;
- Short circuit test before charging;
- User initiated shutdown;
- Overload protection for parallel conductors (conditional function);
- Protection against temporary overvoltage
- Emergency shutdown.

The charging station is a specialised equipment with wide functionalities. Combined with a charging management system, the EVSE can be operated without manual input. In addition to the above functions, the EVSE is also capable of accepting payments and accessing the payment gateway to settle the financial transactions.

d. Technical standards of EV charging equipment

Technical specifications for EV chargers vary across Level 1, Level 2, and Level 3 charging stations across different countries. Table below showcases the mapping of different charger specification in different countries.

Slow charging

In North America and Japan, most electric vehicles use the SAE J1772 connector, which contains five pins and a mechanical lock. In Europe, Level 2 charging uses the Type 2 or Mennekes connector, which has seven pins and takes advantage of the three-phase alternating current grid. China also requires a variant of the Type 2 plug, although legacy vehicles and charging stations have not yet been converted.

The exception to this regional breakdown is Tesla, which uses a proprietary connector for its vehicles sold in North America, although adapters to SAE J1772 are available. In Europe and Asia, Tesla vehicles have a Type 2 plug.

Source: International Council on Clean Transportation

Fast charging

For DC fast charging, connector types vary by automakers in addition to regional variations. For instance, Nissan and Mitsubishi created and promoted the CHAdeMO (Charge de Move) fast charging standard beginning in 2011. This type is majorly used by Nissan, Mitsubishi, Kia, Citroën, and Peugeot.

In contrast, several automakers from the United States and Europe focus on Combined Charging System (CCS), which uses the SAE J1172 or Mennekes AC plugs along with two additional DC pins for fast charging. This has now been adopted by BMW, Daimler, Ford, Fiat Chrysler, General Motors, Honda, Hyundai, and Volkswagen.

As in the case of Level 2 charging, Tesla uses its proprietary plug for its DC Supercharger stations in the United States, although the company also makes Tesla-to-CHAdeMO adapters. China has recently mandated the use of a new standard (GB/T 20234.3-2015) for all new vehicles and fast charging infrastructure; Tesla vehicles sold in China will also use this standard.

Source: International Council on Clean Transportation

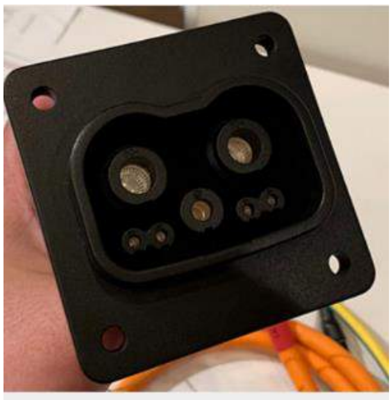
Tables suggests that technical specifications of EV chargers for Level 1 AC charging stations vary widely across countries. For Level 2 and Level 3 AC charging stations, IEC 62196-2 Type 2 chargers are most common. CCS and CHAdeMO are most common for Level 3 DC charging stations.

Table 56 Charger characteristics

	Conventional plugs	Slow chargers	Fast chargers	
Level	Level 1	Level 2	Level 3	
Current	AC	AC	AC, Three-phase	DC
Power	<= 3.7 kW	>3.7 kW and <= 22 kW	> 22 kW and <= 43.5 kW	Currently < 400 kW

	Conventional plugs	Slow chargers	Fast chargers	
Australia	Type 1	IEC 62196-2 Type 2		Accepts all IEC 62196-3 standards (CCS Combo 2, CHAdeMO). Tesla has its own connector.
China	Type 1	GB/T 20234 AC		Requires GB/T 20234 DC.
European Economic Area	Type C/F/G	IEC 62196-2 Type 2	IEC 62196-2 Type 2	Requires CCS Combo 2, (IEC 62196-3) and accepts all IEC, 62196-3 standards (including CHAdeMO). Tesla has its own connector.
India	Type C/D/M	IEC 62196-2 Type 2 and IEC 60309 (Bharat AC-001) (<10 kW) Bharat DC-001 (<15 kW)	IEC 62196-2 Type 2	Requires CCS Combo 2 and CHAdeMO (IEC 62196-3).
Japan	Type B	SAE J1772 Type 1 Tesla has its own Connector.		Accepts all IEC 62196-3 standards (CCS Combo 1, CHAdeMO). Tesla has its own connector.
Korea	Type A/C	IEC 62196-2 Type 2		CCS Combo 1 (IEC 62196-3) and accepts all IEC 62196-3 standards (including CHAdeMO). Tesla has its own connector.
New Zealand	Type 1	IEC 62196-2 Type 2	IEC 62196-2 Type 2	Requires CCS Combo 2 and CHAdeMO (IEC 62196-3).
North America	Type B; SAE J1772 Type 1	SAE J1772 Type 1, Tesla has its own connector.	SAE J3068	Accepts CCS Combo 1 (SAE J1772 and IEC 62196-3) and CHAdeMO (IEC 62196-3). Tesla has its own connector.
Singapore	Type G	IEC 62196-2 Type 2	IEC 62196-2 Type 2	Requires CCS Combo 2 (IEC 62196-3).
Thailand	Type A/B/C/F	IEC 62196-2 Type 2		Accepts all IEC 62196-3 standards (CCS Combo 1, CCS Combo 2, CHAdeMO). Tesla has its own connector.

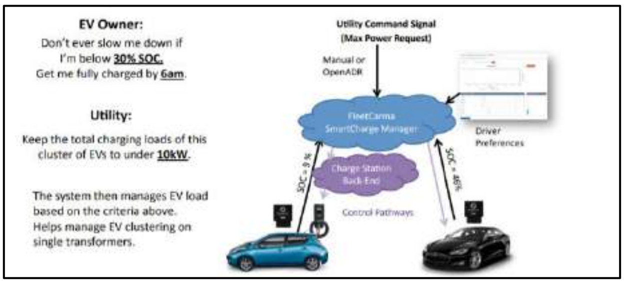
There have been notable recent developments in consolidating charging standards for ultra-fast charging standards such as between the Japanese CHAdeMO Association signing a memorandum with China Electricity Council (GB/T Standard). The new standard is called as Chaoji. The goal is to design a new common plug and vehicle inlet that can support up to 600A at up to 1,500V for a total power of 900 kW. This compares to the CHAdeMO 2.0 specification to support 400A at up to 1,000V or 400 kW. China's GB/T DC charging standard has supported 250A at up to 750V for 188 kW. Following are the key aspects of the Chaoji specifications:-



- Control pilot circuit harmonized with new GB/T and CCS (and IEC 61851-23-1)
- Backward compatible with CHAdeMO GB/T and CCS
- Covers currents up to 600 A with liquid cooling

e. Key Technical specifications for Managed charging

Utilities can decide which managed charging control strategy to implement based on factors such as customer preferences, level of EV penetration in network, and infrastructure available to implement passive and active controls. While passive charging management can induce customers to shift their EV charging loads, a sudden onset of EV charging loads during the off-peak period can lead to steep surge in load on the distribution transformer at the onset of the off-peak period. Ideally, this concern can be addressed by staggering charging times using an intelligent assessment of charge status of vehicles, obtaining desired departure time of vehicles, the charge rate, and other factors, thus distributing the charging across a wider time window. This is essentially referred to as managed charging. The following are the pre-requisites for implementation of managed charging:



Source: fleetcarma

- **Setting of User preferences:** A vital input to managed charging is driver preferences for charging
- **Signalling of utility DR events:** The signals which utility would send to EVs and vehicle chargers combines messaging, or application, protocols (e.g., OpenADR 2.0, OCPP) and transport layer protocols, also known as network communication interfaces (e.g., Wi-Fi, cellular).
- **Assessment of vehicle parameters:** Manage charging will work through an intelligent assessment of charge status of the vehicle, incorporating customers' desired "charge by" times, the charge rate, and other grid factors. The charging time could be distributed across a large time window
- **Determining the charging levels:** Different EV charging levels offer different potential for managed charging. Long- duration of charging with Level 1 or Level 2 provide more time for managed charging events and flexibility for deferring customer charging. Alternatively, the high power demand of DC Fast Charging (DCFC) may be less attractive
- **Communication Pathways:** Communication between the EV user- EV / EVSE, utility-/grid-operator, aggregator, EVSE provider, EVSE and the vehicle itself are critical factors for effective managed charging.

The various communication protocols for managed charging are highlighted below:-

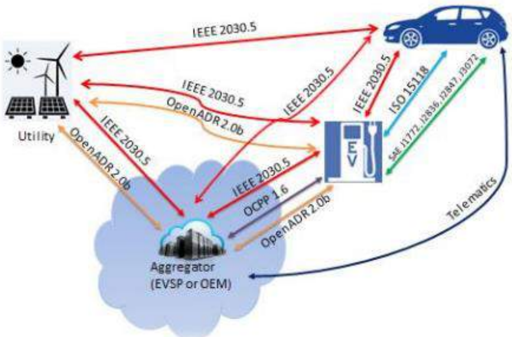
Table 57 Communication protocol for managed charging

Medium	Details
Wi-Fi	Wi-Fi signal can be sent directly to the EVSE via Control Pilot (CP) Smart Adapter or sent directly to the car by using a telematics link or on-board diagnostic interface (OBD2).

Medium	Details
AMI	Utility AMI backhaul link to a smart meter, using Power Line Carrier (PLC) protocols (e.g., Green PHY), and wireless networking protocols (e.g., Wi-Fi, ZigBee) which send signals directly through power lines.
Cellular network	Cellular broadband signal can be sent to the EVSE by using Global System for Mobile communications (GSM), which sends data via code division multiple access (CDMA) low bandwidth wireless connections (data speed requirements for EVSE can also vary, e.g., 2G, 3G, 4G, LTE) or general packet radio service (GPRS). Cellular signals can also be provided to the vehicle through onboard integrated communications
Radio network	FM radio broadcast through a Radio tower to embed digital information directly to the vehicle or the EVSE.
Ethernet	Ethernet also called as Local Area Network (LAN) connection to the EVSE

Messaging Protocol: In EV managed charging, messaging protocol signifies the rules, formats, and functions for exchanging messages between **EV, charging station, and charging station network.** Following are two **types of messaging protocols** widely used in managed charging

Table 58: Protocols and uses

Type of protocol	Details
Open source	• For managed charging, it is vital that uniform and non-proprietary communications / messaging protocols are used between the EVSE and EV, for e.g. ISO/IEC 15118 that enables the managed charging functionality in an EV and can give an improved EV consumer participation. • The Electric Power Research Institute (EPRI) is synchronizing a software application (Open Vehicle Grid Integration Protocol) that connects EVSE and EVs to various nodes to allow utilities to more dynamically manage charging activity that could help with a variety of grid applications. • The standards followed by the OVGIP are IEEE 2030.5,36 ISO/IEC 15118, and telematics with utility standard interface protocols (i.e., OpenADR 2.0b, IEEE 2030.5) and EV charger application program interfaces (i.e., ISO/IEC 15118, OCPP, and industry applied standard and proprietary APIs) through a common platform. 
Proprietary	GPS tagging • Vehicles can be managed through an on-board diagnostic interface (OBD2) which has built-in capabilities, like GPS location software, which can be managed according to the local grid circuit Programming capabilities • Currently multiple EVs already have the ability to program their charging window that would enable the user to align charging with TOU or other EV rates. A more advanced way to strength, these vehicles would for the utility or aggregator to send price, emissions, or grid stress signals directly to the vehicle, so that the EV's charging program could use the information to modify its schedule of charging the vehicle time. • Some examples that are using Proprietary protocol are eMotorWerks JuiceNet, Siemen's VersiCharge platform, and Itron/ClipperCreek's OpenWay network.

Source: Elaadnl, EV related protocol study

12. Total cost of ownership (TCO)

Table 59 Total cost of ownership calculation of fuel technologies

Particulars	Tata Tigor EV	Tata Nexon EV	Petrol Ford Ecosport	Diesel Ford Ecosport	CNG Maruti Suzuki Ertiga Vxi
BHP	40.2	127.0	120.7	99.0	91.0
Ex showroom Price (in Rs.)*	9,85,000.00	15,99,000.00	11,56,000.00	11,71,000.00	8,95,000.00
Fuel consumed in running 1 km	0.101	0.097	0.068	0.046	0.038
Fuel cost	Rs. 8.5/unit	Rs. 8.5/unit	80.43/litre	81.94/litre	46.60/Kg
Cost of fuelling for per 1 km run (Rs.)	0.86	0.82	5.47	3.78	1.78
Duration of Ownership (years)	5.00	5.00	5.00	5.00	5.00
Total running in 5 year (km) - 50 km per day	91250.00	91250.00	91250.00	91250.00	91250.00
Cost of refuelling	7902.59	7267.02	33963.80	15878.50	6194.64
Average Maintenance for 5 years (Rs.)*	7500.00	7500.00	23670.00	30525.00	26955.00
Cost of running for 5 year (Rs.)	10,00,402.59	16,13,767.02	12,13,633.80	12,17,403.50	9,28,149.64

Source: 153 Deloitte analysis

6.2 Chapter 2 Review and assessment of electric vehicle and charging infrastructure stakeholder landscape

13. Review of central level initiatives in electric mobility space

a. Central level policies

Electric mobility initiatives in India, initially, were led by the Ministry of Heavy Industries and Public Enterprises (MoHIPE) which launched National Electric Mobility Mission Plan (NEMMP) in 2013 and Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles in India (FAME India) scheme in 2015.

a.1. National Mission on electric mobility

As a first step towards electric mobility, the Government of India approved the National Mission on Electric Mobility in 2011. Primarily governed by Department of Heavy Industry (DHI), NMEM aims to resolve challenges in EV adoptions due to high EV cost, battery technology etc. The primary objective of the mission is to resolve barriers by government intervention and adopting mission mode approach for fast decision-making and ensuring collaboration among various stakeholders. This comprises of forming empowered bodies at apex level in form of National Council for Electric Mobility (NCEM) and National Board for Electric Mobility (NBEM) for formation of policies and frameworks for increased EV adoption.

The mission focused on curbing depletion of petroleum resources and minimize the impact of vehicular pollution on the environment by providing incentives and drawing a policy landscape. However, due to lack of concrete framework and limited focus on pilot programs, NMEM got dissolved in 2013 and was succeeded by the National Electric Mobility Mission Plan (NEMMP) 2020.

a.2. NEMMP

The National Electric Mobility Mission Plan (NEMMP) was unveiled in 2013 and provides for the development of mission plan and roadmap for promoting electric mobility solutions in India. NEMPP outlines incentives along four priority areas for EVs viz. demand incentives, manufacturing of EVs, charging infrastructure development and Research and Development. The Mission aims to achieve 6 to 7 million on road electric vehicles by 2020.

In terms of the assessment made by the joint Government-Industry study, the total investment needed for setting up the required infrastructure up to 2020 (both power and charging infrastructure), vehicle segment wise, is summarized in following table:

Table 60 NEMMP Targets

Area	4W	2W	3W	Buses	LCV	Total
Additional generation Capacity (MW)	150-225	600	10-15	<5	10-20	775-865
Power Infrastructure (Rs Crore)	1,200-1,300	3,300-3,400	75-85	20-30	90-100	4,685-4,915
Charging Infrastructure (Rs Crore)	950-1000	-	70-80	10-20	115-125	1,145-1,225

Source: Department of Heavy Industries. 2013. "National Electric Mobility Mission Plan 2020"

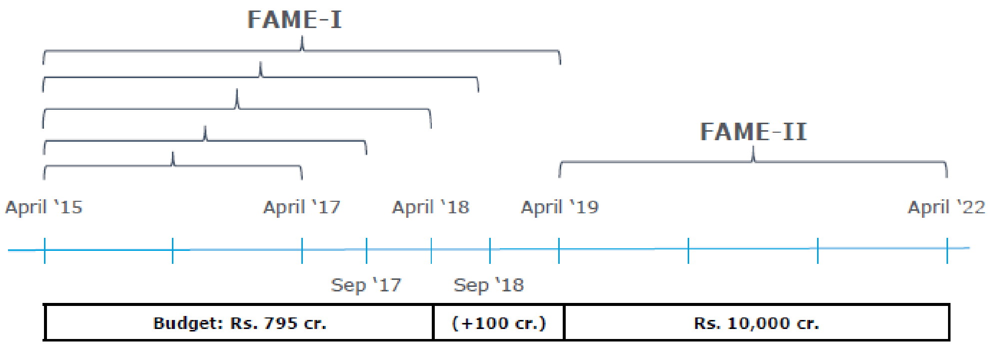
It is expected that GoI will support the development of electric vehicle charging infrastructure in the initial stages of development when the pilot projects will be rolled out for cities and during the phase when the business model will be at a nascent stage. Subsequently, private sector participation will be required to set up country wide charging infrastructure. Moreover, there will be a phased roll out of the EV charging infrastructure as follows:-

- **Phase I (first year)**: This will involve detailed and in-depth evaluation of various options, prioritization and putting in place the required frameworks and models for EVSE adoption, enabling policies, charging infrastructure standards, laws and undertaking detailed studies that will facilitate the roll out of the optimum EV infrastructure.
- **Phase II (Year 1 - 3)**: The activities in the medium time frame would build on the initial basic work done and include deeper impact assessment studies and programs, pilot projects in various cities, EV infrastructure consortium building activities, development of possible business models, etc.
- **Phase III (Year 3 to 2020)**: This will include the following activities:-
  a) Ensuring availability of reliable and regular electricity supply,
  b) Making available adequate recharging facilities with convenient access,
  c) Development of EV charging as a viable business entity,
  d) Well established and synergic linkage between EV charging infrastructure with renewable energy generation infrastructure,
  e) Development of public recharging infrastructure that includes opportunities for rapid recharging through either setting up of optimal number of fast recharging centres or by use of batteries swapping stations that allows quick replacement of discharged battery packs with charged ones.

a.3. Department of Heavy Industries – FAME

Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) programme was launched by DHI in 2015. It is the flagship scheme under the NEMMP 2020 mission plan of Central government to enhance hybrid and electric technologies in India. The overall scheme is proposed till FY 2022 to support market development for EVs. Phase 1 of the scheme has been implemented over a two-year period starting from FY 2015-16 to FY 2016-17 and was extended till FY 2018-19. Phase 2 of the scheme has been launched from FY 2019-20 till FY 2021-22. In March 2019, the ministry notified FAME –II scheme with increased layout of Rs 10,000/- crores, which includes a spill over from FAME-I of Rs 366 Cr.

Scheme phasing



Allocation of funds in Phase II

Initial Allocation of Funds under FAME-II				
Component	**2019-20 (Rs. cr)**	**2020-21 (Rs. cr)**	**2021-22 (Rs. cr)**	**Total Fund (Rs. cr)**
Demand Incentives	822	4587	3187	8596
Charging Infrastructure	300	400	300	1000
Administrative Expenditure	12	13	13	38
Total for FAME-II	1134	5000	3500	9634
Committed from Phase-I	366	0	0	366
Total	1500	5000	3500	10000

Government of India has released its policy document on "Transformative mobility for All" in 2017 with a vision for the future of India's mobility system. Spread over three phases (I 2017-19, II 2020-23, III 2024-32), the plan entails taking near-term actions to build political and market confidence followed by phase two which involves refining of regulatory incentives and policy measures along with continued expansion of charging network and scaling up of domestic manufacturing. In phase three market forces are allowed to drive full scale expansion along with the introduction of regulatory mechanisms to capture full grid value of EVs.

a.4. National Mission on Transformative Mobility and Storage

The aim of the mission is to drive strategies for transformative mobility and Phased Manufacturing Programmes for EVs, EV Components and Batteries. Following are the key roles:-

- Creating a Phased Manufacturing Program (to localize production across the entire EV value chain
- Details of localization will be finalized by the Mission with a clear Make in India strategy for the electric vehicle components as well as battery
- The Mission will coordinate with key stakeholders in Ministries/ Departments/states to integrate various initiatives to transform mobility in India

a.5. Ministry of Power's notifications on Public Charging infrastructure

The Ministry of Power, Government of India on 14 December 2018 released the guidelines on EV charging infrastructure which addresses the need for adequate availability of charging stations. These guidelines have subsequently been revised and updated on 01 October 2019. The guidelines and standards aim to enable faster adoption of EVs in India by ensuring safe, reliable, accessible, and affordable charging infrastructure and ecosystem along with promoting affordable tariffs, creating standard guidelines for EV charging business, and encouraging utilities and other parties to be prepared for adopting EV charging infrastructure. Key aspects of the notification are highlighted below:

Setting up a Charging Station

- Setting up and operation of **Public Charging Stations (PCS)** was made a deregulated activity
- PCS to be provided connections on a priority basis by distribution companies
- Charging stations/group of charging stations can procure electricity directly from generators through open access

Location of PCS

- A PCS is required in every 3 km X 3 km grid and every 25 km on roads
- A fast charging station every 100 km on both sides of highways/roads
- Additional EV charging stations to be set up only after meeting initial requirements
- Governments may give priority to existing Retail Outlet of Oil Marketing Companies

Priority Rollout of Charging Infra.

- **Phase I (2019-2021):** Targeting all cities with more than 4 million population and major roads connecting these cities
- **Phase II (2021-2024):** Big cities such as State Capitals, Union Territory headquarters and all major road/highways connecting these cities
- A Central Nodal Agency will coordinate with all governments and other such stakeholders to roll out charging infra

Other Key Features

- **e-Database:** CEA will maintain online database of all PCS through distribution companies
- **Tariff for PCS:** Appropriate commissions will determine tariffs not more than 15% of average supply cost
- **Service Charges for PCS:** Service Charges for PCS will be in accordance to Ministry of Power guidelines

Other requirements are specified below:

- An exclusive transformer and related substation equipment, 33/11 kV lines, appropriate civil works, space for charging and entry / exit of vehicles, etc.
- Charging stations are required to tie up with at least one online Network Service Provider (NSP) to enable advance remote/online booking of charging slots by EV owners.
- EVSE shall be type tested by an agency/lab accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL) periodically.
- Captive charging for 100% internal use of a company will not come under the purview of this.

The minimum technical requirements for fast and slow charging stations in the guidelines are shown below.

Table 61 Technical requirement of slow and fast chargers

Charger Type	Charger Connectors	Rated Voltage(V)	No. of charging Points/No of connector guns	Charging vehicle type (W=Wheeler)
Fast	CCS (min 50kW)	200-1000	1/1 CG	4W
	CHAdeMO (min 50kW)	200-1000	1/1 CG	4W
	Type-2 AC (min 22kW)	380-480	1/1 CG	4W, 3W, 2W
Slow/Moderate	Bharat DC-001 (15kW)	48	1/1 CG	4W, 3W, 2W

Charger Type	Charger Connectors	Rated Voltage(V)	No. of charging Points/No of connector guns	Charging vehicle type (W=Wheeler)
	Bharat DC-001 (15kW)	72 or higher	1/1 CG	4W
	Bharat AC-001(10kW)	230	3/3 CG of 3.3 kW each	4W, 3W, 2W
In addition, any other fast / moderate /slow charger as per approved BIS standards whenever notified, Note: Type-2 AC (min 22 kW) is capable of charging e-2W/3W with the provision of an adapter				

Source: Ministry of Power, 2019, "Charging Infrastructure for Electric Vehicles – Revised Guidelines and Standards"

The Ministry of Power issued a clarification on EV charging in April 2019, namely that charging of an EV battery by a charging station is a service consisting of electricity consumption and hence should earn a revenue for this specific service. The value of the electricity is realized through a charging station operator, and hence is distinct from a typical sale of electricity. As such, EV charging does not fall under the purview of the Electricity Act of 2003 and is not subject to the other conditions of electricity retail distribution; this clarification has paved the way for participation of private players.

a.6. Amendment in the revised Guidelines and Standards for Charging Infrastructure for Electric Vehicles

In June 2020, Ministry of Power notified amendment in the revised guidelines and standards for charging infrastructure for electric vehicles. Key notified amendments are provided below:

Figure 211 Key amendments in revised charging infrastructure guidelines and standards

Key amendments in the revised guidelines and standards for charging infrastructure

1. Tariff for EV charging will be determined by the state electricity regulatory commission, and the tariff **will not be higher** than the **average cost of supply plus 15%**
2. **Recognition to "Battery Swapping Stations"** as a station where any electric vehicle can get its discharged battery or partially charged battery replaced by a charged battery

Source: 154 Amendment in the revised Guidelines and Standards for Charging Infrastructure for Electric Vehicles – reg (access here)

a.7. MoHUA guidelines

Ministry of Housing and Urban Affairs has notified Amendments in Model Building Bye-Laws (MBBL) - 2016 for EV charging infrastructure in February 2019. Key provisions of the same are highlighted below:

Table 62 MoHUA guidelines for public charging stations

Particulars	Details
Parking bays for EV charging	Residential and commercial buildings to allot about 20% of their parking space for EV charging infrastructure.
Power load for EV charging	Building premises should have additional power load equivalent to the power required for all charging points to be operated simultaneously with a safety factor of 1.25.

Particulars	Details			
No of slow and fast chargers	**4W**	**3W**	**2W**	**PV (Buses)**
	One slow charger for 3 EVs One fast charger for 10 EVs	One slow charger for 2 EVs	One slow charger for 2 EVs	One fast charger for 10 EVs

Source: Ministry of Housing and Urban Development(MoHUA), February 2019, "Amendments in Building Bye-Laws (MBBL-2016) for Electric Vehicle Charging Infrastructure"

b. Rollout plan for EV charging infrastructure

It is expected that this procurement round shall ensure that most selected cities shall have an EV charging station in a grid of 3 Km x 3 Km (MOP Guidelines). Similar incentives for large scale procurement of EV charging stations shall enable the EV ecosystem and also help in building the back-bone of EV transition.

a. **Charging Station Technology:** This mandates the mix of fast and slow charging stations that will be required and highlights any optional chargers that can be deployed at PCS.

Types of Charging Stations	Minimum number of charging guns	Minimum number of EVs to be charged simultaneously	Types of charges-Mandatory	Optional Charges (Any number in combination of one or more type of chargers)
Slow Charging Stations	10	10	Bharat AC 001 10KW (3 guns of 3.3 kW each)	• Bharat DC 001(15 KW) 1 Gun • Type II AC Charger
Fast Charging Stations	6	6	CCS II and CHAdeMO 50 kW or higher capacity	• Bharat DC 001 (15 KW) 1 Gun • Type 2 AC 22 kW or higher capacity

b. **Charging Location:** Charging location has been classified into three categories based on the nature of the location where charging station will be set up. These are:

Category A	Category B	Category C
• Commercial Complexes • Example: Municipal Parking lots, Petrol stations, Malls, Market Complexes, Airports, Railway stops etc.	• Stations for Captive use • Example: Charging station in Udyog Bhawan, PSU office complex etc.	• Aggregator based charging stations • Example: EV Charging Stations for taxies, Co-operative societies.

c. **Performance Monitoring:** Selected agency for the development of charging stations has **to tie up with at least one real time EVSE Network Management Software Platform provider** to enable advance remote/ online booking of charging slots by EV owners.

c. Incentives for EV public charging infrastructure deployment

A range of pilot projects deploying EV charging infrastructure have been underway across India in the past two to three years. National, state, and city level agencies as well as private EV charging service providers have taken up initiatives to install a first set of EV charging stations on an experimental basis. A large-scale deployment across a city or nationally, which can lead to consolidation and a sustainable network of EV charging stations, is yet to take place. As national and state EV frameworks gradually take shape and as corresponding incentives energize the EV landscape in India, achieving this objective is not far from reach.

Capital subsidies for setting up of EV charging stations is a key incentive provided under state and national policy. Amongst various programs, FAME II scheme is playing a pivotal role in large scale deployment of EV charging infrastructure. Department of Heavy Industries has recently approved setting up of 2,636 electric vehicle charging stations across 62 cities in India. Public and Private entities shall avail financial incentives under the FAMEII scheme for setting up charging stations. Commercial purpose EV charging stations shall receive 50-70% of the cost of EVSE under the scheme. Distribution of the selected 2,363 approved projects out of the received EOI of 7,000 EV charging stations is as follows:

d. Initiatives taken by various PSUs and other Govt bodies

Over the past few years, public and private entities have taken up pilot projects in installing EV charging stations. While large scale EV charging infrastructure pilot projects are still under planning and implementation stage, there has been a steady increase in standalone charging station pilot. Some of these examples are shown below:

Table 63 City-wise developments

S No	City/ State	Implementing Agency	Detail
1	Nagpur (Maharashtra)	Nagpur Municipal Corporation	200 electric cars, buses, e-rickshaws, and four public charging stations launched as part of the 'Multi-Model Electric Vehicle Project' in 2017.
2	Delhi	NITI Aayog	55 locations shortlisted across Gurgaon-IGI-South Delhi-Noida Corridor for installing 135 EV charging stations (46 – DC Fast, 89 – AC Slow). Project is still under planning and implementation stage
3	Mumbai (Maharashtra)	Magenta Power	Installed DC Fast charging infrastructure in 2018 in Turbhe Mumbai and also launched an APP which provides consumers with location of chargers, status, and type.
4	Jaipur (Rajasthan)	MNIT Jaipur	Five charging stations installed at different locations in MNIT Jaipur under the FAME scheme in 2018.
5	Hyderabad (Telangana)	Telangana Municipal Corporation and Urban Development	The Municipal Corporation and Urban Development Corporation launched EV smart parking and charging station on 18, March 2019
6	Kochi (Kerala)	Bharat Petroleum	Installed 3 charging stations in Kochi. Charging station installed at least 6 meters away from fuel vending machine due to safety reasons. Both direct charging and battery swapping facilities are available.
7	Kolkata (West Bengal)	New Town Kolkata Development Authority (NKDA)	New Town Kolkata Development Authority (NKDA) has installed 10 public charging stations for e-scooters and e-cars. These have been installed near the Kolkata gate, Tata medical centre, and eco parking area gates in 2018.
8	Bengaluru (Karnataka)	BESCOM	BESCOM has installed a total of 5 no. of charging at different locations across the city.
9	Vishakhapatnam (Andhra Pradesh)	NTPC	NTPC has installed a charging station at Simhadri which is capable of charging 3 numbers of EV simultaneously.
10	Jammu and Kashmir	J&KSRTC	J&K Road Transport Corporation is planning to commission six charging stations for supporting its fleet of 30 electric buses provided by TATA Motors.
11	Guwahati (Assam)	Assam Power Distribution Company Limited (APDCL)	APDCL has set up charging infrastructure for 15 e-buses procured under the FAME scheme
12	Hyderabad	Hyderabad Metro Rail	Fortum, a Finnish Government-owned company has already installed EV charging points at 8 places at

S No	City/ State	Implementing Agency	Detail
		Limited (HRML)	Begumpet, Kukatpally, KPHB, Moosapet, Stadium, Tarnaka, Mettuguda, and Habsiguda Metro Stations. Apart from Fortum, Power Grid Corporation of India, a government of India has installed 3 charging stations at Miyapur and Balanagar Metro stations.

Source: 155 GTG India EV White Paper (access here); Proposal for a Quick Pilot on EV Charging Infrastructure (access here); NITI Aayog for deployment of charging stations (access here)

14. Home v/s Public Charging - Cost benefit analysis

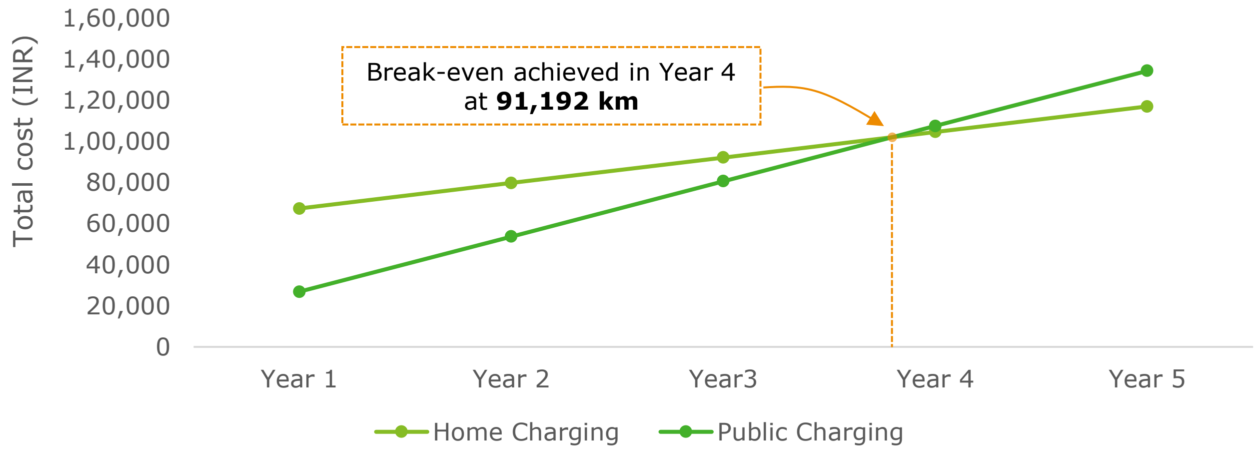
To conduct the cost benefit analysis, Hyderabad was considered as the sample city. Other inputs and assumptions for the analysis is provided in the below table:

Table 64 Inputs and assumptions for cost benefit analysis

Sr. No.	Particular	Unit	Home Charging	Public Charging	Remarks
1	Cost of charger (L2)	INR	55,000	NA	
2	Cost of charging	INR per unit	6.00	12.99	TSERC FY19 Tariff order & Fortum charging rate in Hyderabad
3	EV battery capacity	kWh	39	39	Hyundai Kona EV
4	EV battery range	Km	452	452	Hyundai Kona range
5	Average monthly run	Km	2000	2000	
6	Charging cost per month	INR	1,035	2,242	

It is further assumed that the charging rates for home and public charging will remain same in future years. Also, any cost incurred towards maintenance of home charger is not considered.

Figure 212 Assessment of overall cost of charging through home and public chargers



Initially, the cost of home charging will be higher as it includes purchase of charger. However, with the assumed charging rates and average monthly run, home charging turns out to be the profitable option for the longer run.

15. EV charging stations in India by 2030

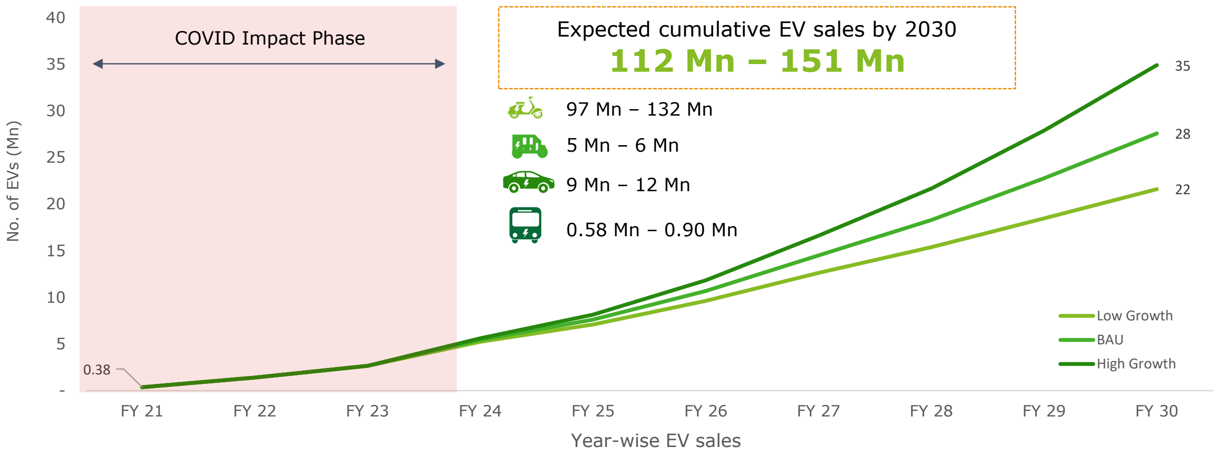
To determine the quantum of charging stations by 2030, firstly, the overall growth of automobile industry is determined. It is expected that the EV sales will depend on the overall performance of automobile industry. Therefore, to project the EV sales, we have assumed the following three scenarios of automobile industry growth:

a) **As-is growth (BAU- Business As Usual):** It is assumed that the sales of vehicles will follow the CAGR of the past five years.
b) **High growth:** In this scenario it is assumed that sales of vehicles will increase fuelled by availability of cheaper (and economical EVs) and conducive environment by the policy makers.
c) **Low growth:** In this scenario it is assumed that the sale of vehicle would see a flattening effect mostly due to non-availability of suitable infrastructure and change in consumer behaviour.

Impact of COVID 19: Due to the ongoing lockdown and economic slowdown, the auto industry will take 2-3 years to recover. During this period, the growth will be subdued and minimal. It is assumed that till FY23, the growth would remain subdued and from FY24 onwards only, the sector would witness normal growth patterns. We have considered the above three scenarios post FY23.

Once the growth of the automobile industry is determined, sales of EVs were projected. For that, penetration levels by 2030 were taken from NITI Aayog-RMI report[117]: 4 Wheelers – 50%, Buses – 40%, 3 Wheelers – 80%, 2 Wheelers – 80%. Based on the penetration levels, expected sale of EVs by 2030 is calculated and provided in below figure:

Figure 213 Expected EV sales by 2030



To determine the quantum of charging stations, Vehicle-to-Charging Station ratio is assumed for 4-Wheelers and E-buses. For 4-Wheelers, by FY 30, it is assumed that for every 10 4-wheeler EVs, there will be one standalone public charging station. Whereas, for e-buses, by 2030, there would be one public charger for 50 e-buses.

For 2-Wheelers, only a portion of the owners is expected use a public charging station and charge their vehicles at their respective residences as charging unit at home is cheaper. For 3-Wheelers, it is assumed that the owners will use their own charging stations or shared charging stations at their depots. By 2030, it is expected that there will be one charging station/ charger for every two 2 & 3-Wheelers, however, only

[117] India's Electric Mobility Transformation (access here)

marginal of that will be public charging. To calculate public charging for 2 & 3-Wheelers, it is assumed that 0.5% of total chargers/ charging station will be public charging.

Based on the above assumptions, below are the expected number of public charging stations by 2030:

Table 65 Expected public charging stations in India by 2030

2 & 3-Wheelers	4-Wheelers	E-buses	**TOTAL**
0.22 Mn – 0.30 Mn	0.68 Mn - 0.90 Mn	~15,000 – ~24,000	**0.92 Mn to 1.23 Mn**

16. Setting up EV charging infrastructure in India

State Nodal Agencies for setting up EV charging infrastructure

BEE has appointed about 25 State Nodal agencies as per the directions of the MoP.

Table 66 BEE appointed State Nodal Agencies (SNA) for EV charging infrastructure

State	State Nodal Agency	Category of Organization
Andhra Pradesh	New and Renewable Energy Development Corporation of Andhra Pradesh (NREDACAP)	SNA for EE and RE
Gujarat	Gujarat Energy Development Corporation (GEDA)	SNA for RE and EE
Himachal Pradesh	Himachal Pradesh State Electricity Board Limited	Discom
Karnataka	Bengaluru Electricity Supply Company (BESCOM)	Discom
Meghalaya	Meghalaya Power Distribution Corporation Limited	Discom
Mizoram	Power and Energy Department	Discom
Punjab	Punjab State Power Corporation Limited	Discom + Genco
Rajasthan	Jaipur Vidyut Vitaran Nigam Limited	Discom
Uttarakhand	Uttarakhand Power Corporation Limited	Discom
Telangana	Telangana State Renewable Energy Development Corporation Limited	SNA for EE and RE
West Bengal	West Bengal State Electricity Distribution Company Limited	WBSEDCL
Delhi	Delhi Transco Limited	Transmission Company
Lakshadweep	Lakshadweep Energy Development Agency	SNA for RE and EE

State	State Nodal Agency	Category of Organization
Jammu	EM and RE Wing	Department (Discom)
Kashmir	EM and RE Wing	Department (Discom)
Ladakh	EM and RE Wing	Department
Kerala	Kerala State Electricity Board	Integrated Discom
Madhya Pradesh	Madhya Pradesh Power Management Company Limited	Power trader/Holding company
Haryana	Uttar Haryana Bijli Vitaran Nigam Limited	Discom
Andaman and Nicobar	Directorate of Transport	Transport Department
Sikkim	Power Department Sikkim	Integrated Discom
Arunachal Pradesh	Central Electrical Zone, Department of Power	Department in Discom
Bihar	Transport Department	Transport Department
Tamil Nadu	Tamil Nadu Generation and Distribution Company	Discom + Genco
Puducherry	Electricity Department	Discom

Source: BEE Website

In addition, the state nodal agencies listed by BEE, the Urban Local Bodies (ULB) and Municipalities are also major stakeholders in installation of PCI.

17. Delay in installation of Charging infrastructure

A. Additional time required to provide electricity connection:

(i) Supply where distribution mains require extension:

Sl.	Particular	Line length	Days
(i)	LT Line		15days
(ii)	11 KV Line	Up to first 5 Km	30days
		Next 5 Km each	15days

(ii) Supply where augmentation of transformer sub-station capacity is required:

Sl.	Particular	Days
(i)	11/0.4 kV S/S	15 days
(ii)	33/11 kV S/S	60 days
(iii)	132/33/11 kV S/S	6 months

18. Key observations in the EV charging landscape

a. Standardization

EV standards and technical specifications have increasingly moved towards standardization and encouraging interoperability in developed countries. Standardization of equipment, design and technical standards promotes investor confidence and encourages investments in the sector. While, there have been certain progress in issuing various guidelines on technical specifications, institutions such as CEA/ BIS/ARAI, etc. shall further have to play a coordinated role in standardization of the EVSE equipment specifications. As the technology is still evolving, it is necessary that the standards prescribed are flexible to accommodate innovations and improvements in technical standards and specifications.

b. Cost recovery through rate-basing "make-ready" infrastructure

Utilities in US are encouraged to invest in EV infrastructure through a range of legislative mandates such as for clean air and reducing overall emissions from transportation sector. Regulators allow utilities to undertake investment in "make-ready" infrastructure for EVSE integration as well as EVSE infrastructure itself and recover the cost through rate-basing. This allows utilities to undertake costly investment and socialize the cost of setting up "make-ready" infrastructure for EVs. Such a proactive approach creates an eco-system for setting up EV charging infrastructure. While several states in India have introduced EV policies, state utilities and regulators are yet to facilitate large-scale investments in "make-ready" infrastructure for EVs. A first step would be for regulators to encourage utilities to carry out such investments and provide pathway to cost recovery through rate basing.

c. Managed Charging Framework and functions

Utilities in advanced power markets with significant levels of EVSE penetration have focused on developing a managed charging framework. This has allowed them to efficiently manage the additional stress on distribution system network on account of EV charging. It entails setting up various communication and hardware protocols to implement a managed charging framework as well as creating various incentives for consumers to participate in managed charging initiatives. While EV growth is still at a nascent stage in India, utilities and regulators will need to plan for implementing a managed charging framework with a long-term perspective.

Absence of standardized protocols for EV managed charging is a major barrier in the Indian context. Managed charging will involve adequate coordination between various stakeholders viz. utility, grid operator, aggregator, EV user, network operator, etc. and therefore there is need to formulate adequate systems and infrastructure which would allow proper coordination. The concept of aggregators is still being explored in India. Moreover, robust electricity grid and network infrastructure are vital for effective functioning of managed charging in India.

d. Pilots on managed charging of EVs

From the international case studies, it can be observed that many of the new technology related to managed charging of EV has been introduced first using a pilot platform. The results for these pilots are then used to carry out large scale deployment of technology. While standards and guidelines introduced in India do provide provisions for communication protocol between EVSE and other stakeholders, there has been no pilot initiative on large-scale managed charging pilots. Utilities and regulators across India need to take initiative on introducing pilot projects which can demonstrate the benefits of managed charging of EVs.

e. EV tariffs and incentives

It has been observed that having dedicated tariffs and incentives for EV encourages adoption. While few states in India have taken EV policy initiatives, a large number of states are yet to introduce EV specific tariffs for public and home charging as well as incentives under state policies for purchasing EVs and setting up home and public charging stations.

f. Scientific modelling studies of the network and investments by all distribution utilities

It is imperative for all the electricity distribution utilities to undertake scientific modelling studies to understand potential growth of Electric vehicles in the long run and understand how it would lead to changes in loading patterns of distribution network infrastructure (Distribution transformer and distribution lines), voltage and frequency fluctuations, etc. Significant business focus and priority should be given to EVs as an additional load in the system along with consumer load growth and scenario planning-/-prioritization strategy needs to be developed for the following:

- Peak load management
- Reducing technical losses in the distribution system by controlled EV charging
- Reducing system costs by enabling RE based generation sources to be utilized for EV charging instead of resorting to costlier conventional sources

Distribution utilities should develop multiple system cost scenarios with/-without storage systems and managed charging etc., to effectively design the network and address future load conditions. In certain cases, it is possible that some areas of the distribution network can get overloaded during peak times, however for rest of the time it could be lightly loaded. Hence, utilities need to analyse and model their respective load profiles and simulate scenarios to determine the most cost-effective solutions (given below) for managing EV load:

- Active managed charging
- Passive managed charging like TOU tariff structures-/-Demand Side Management incentives
- Charging through distributed RE sources
- De-congesting the network and-/-or charging through local Battery Energy Storage System (BESS) installations in the grid, etc.
- Undertaking optimal investments to augment network infrastructure

Managed charging can present significant opportunity for load shifting of EVs and avoid / defer network investments to cater to increased loading due to EVs. To enable a framework for managed charging, utilities should initiate a dialogue and represent to concerned regulators for justification and subsequent introduction of managed charging practices, TOU tariff pricing, etc.

- Managed charging can provide significant means to mitigate overloading of the distribution system at times of peak demand by modulating the charging rate of EVs and delaying the charge over a larger timeframe
- There could be certain pockets where managed charging may not be attractive due to variations in EV charging profile by the users or absence of time periods for charging to be delayed and staggered. Passive mechanisms like TOU tariffs can act as suitable incentive for users to shift their EV charging to off-peak periods.

g. Demand Response Market

To take advantage of flexibility from managed operation of EV charging, ancillary markets in developed countries have provisions for demand response providers to participate in the ancillary market. This provides additional revenue stream to demand response sources and allows utilities to better manage its demand-supply position.

CERC has introduced a discussion paper on market-based procurement of tertiary services in India. Currently there is no established mechanism for demand response products in the ancillary market wherein aggregators can participate.

19. Development by power utilities in EV space

Table 67 Power utilities in the field of EV charging

Sr. No.	Operator	Notes
1	TATA Power	• Tata Power and Tata Motors have partnered to install 300 fast charging stations by the end of the FY20, across key five cities namely Mumbai, Delhi, Pune, Bangalore, and Hyderabad. • Has already installed 100 fast charging stations in various cities, including Delhi, Mumbai, Bengaluru, Pune and Hyderabad, which it plans to take to 300 by March 2020. • Tata Power has also signed MoUs for setting up commercial EV charging stations at HPCL, IOCL, and IGL retail outlets; plans for setting up of home charging as well as public charging at metro stations, shopping malls, theatres, and highway, among others • May also look at installing charging stations that will adhere to 30-50 kW standards as demand grows • Tata Power will provide charging solutions to Jaguar Land Rover in India
2	Bangalore Electricity Supply Company Ltd. (BESCOM)	• Readied 80 EV charging stations which have 126 charging units • Has drawn a plan for setting up 678 electric vehicles (EV) charging stations across the state of Karnataka. The proposed plan has 100 charging stations proposed for Bangalore. • Charging stations at corporate office to be integrated with solar rooftop
3	BSES	• MoU with Indian Railways • This will be a pilot project. Indian Railways will pay 8 cents/kWh as charging tariff once approved by the regulator. • MoU with EV Motors India Pvt ltd to set up EV charging stations in Delhi • Plans to set up 150 charging stations, 50 by end of 2020
4	NTPC	• NTPC – IOCL commissioned first EV charging station at IOC petrol pump in Greater Noida, Uttar Pradesh. • NTPC has entered into agreements with fuel retailers, Delhi Metro Rail Corp and state government entities for providing electric mobility solutions.

20. EV charging station inspection checklist

Table 68 Inspection checklist of an EV charging station

Criteria	Reference Standard	Verification Remarks
Overall Condition of Service	Delhi Electricity Supply Code and Performance Standards Regulation, 2007	Connecting voltage: 415V, TP, LT or 11kV, TP, HT Frequency : 50Hz
Protection	CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2013, as amended from time to time.	Detection of various faults/ abnormal conditions and provision of appropriate means to isolate the faulty equipment or system automatically. Ensure that fault of charging equipment or charging system does not affect grid adversely.
Harmonic Current	IEEE 519 – 2014 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2013, as amended from time to time.	Harmonic Current Injections from the generating system do not exceed the limit specified in IEEE 519.
DC Injection	IEEE 519 – 2014 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2013, as amended from time to time.	Prosumer shall not inject direct current greater than 0.5% of rated output at the interconnection point.
Voltage Sag, Voltage Swell, Flicker, Disruptions, etc.	Relevant BIS standards or as per IEC / IEEE standards if BIS not available.	Power Quality parameters
Overload	CEA (Measures relating to Safety and Electric Supply) Regulations, 2010, as amended from time to time.	All EV charging stations shall be provided with protection against the overload of input supply and output supply fittings.
Installation Height	CEA (Measures relating to Safety and Electric Supply) Regulations, 2010, as amended from time to time.	All EV charging stations shall be installed so that any socket-outlet of supply is at least 800 mm above the finished ground level.

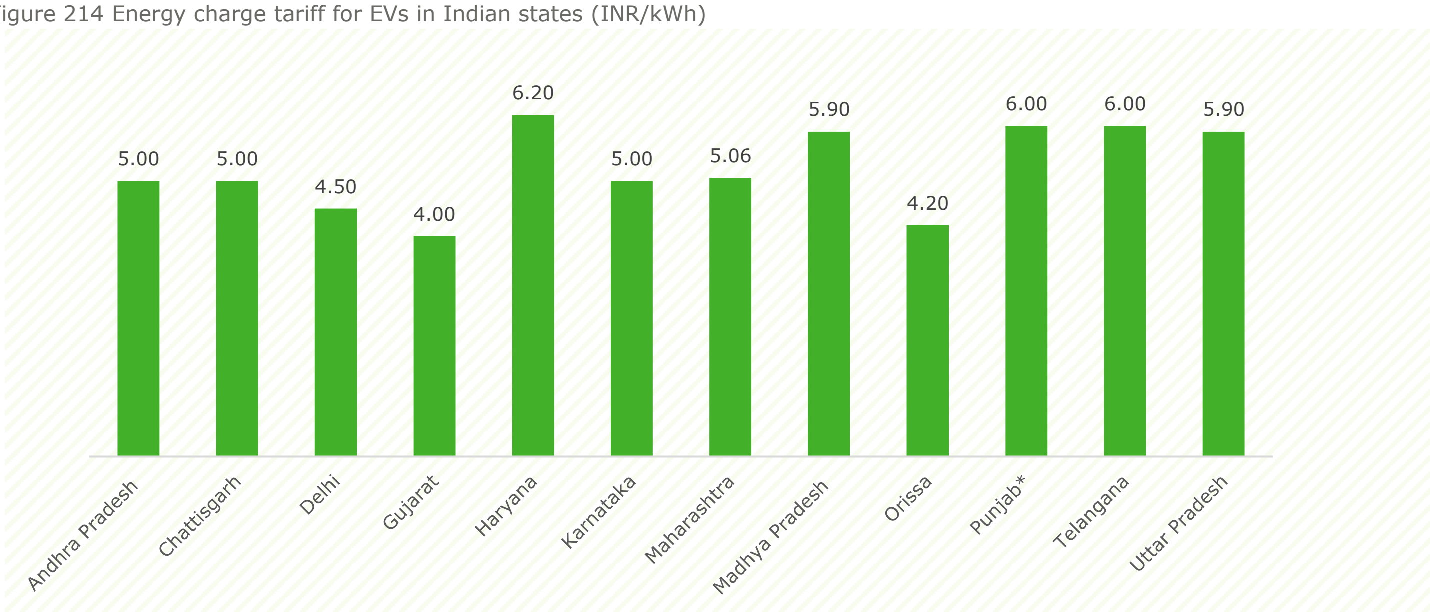
Criteria	Reference Standard	Verification Remarks
Cord extension set or second cable assembly	CEA (Measures relating to Safety and Electric Supply) Regulations, 2010, as amended from time to time.	A cord extension set, or second cable assembly shall not be used in addition to the cable assembly for the connection of the EV to the Electric Vehicle Charging Point. A cable assembly shall be so constructed so that it cannot be used as a cord extension set.
Adaptors	CEA (Measures relating to Safety and Electric Supply) Regulations, 2010, as amended from time to time.	Adaptors shall not be used to connect a vehicle connector to a vehicle inlet.
Maximum Cable Length / Parking Space	CEA (Measures relating to Safety and Electric Supply) Regulations, 2010, as amended from time to time.	Maximum length of the supply lead is 5m / Parking Place shall be within five meter from the electric vehicle charging point.
Portable socket-outlets	CEA (Measures relating to Safety and Electric Supply) Regulations	Portable socket-outlets are not permitted to be used for EV charging.
Lightning Protection	CEA (Measures relating to Safety and Electric Supply) Regulations. IS/IEC 62305	Suitable lightning protection system shall be provided for the EVs charging stations as per IS/IEC 62305.
Protective device	CEA (Measures relating to Safety and Electric Supply) Regulations.	The EVs charging stations shall be equipped with a protective device against the uncontrolled reverse power flow from vehicle.
Disconnection of EV from the supply	CEA (Measures relating to Safety and Electric Supply) Regulations. IEC 60950	One second after having disconnected the EV from the supply (mains), the voltage between accessible conductive parts or any accessible conductive part and earth shall be less than or equal to 42.4 V peak (30 V rms) , or 60 V D.C., and the stored energy available shall be less than 20 J (as per IEC 60950). A warning label shall be attached in an appropriate position on the charging stations in case voltage is greater than 42.4 V peak (30 V rms), or 60 V D.C., or the stored energy is 20 J or more.
Locking of the coupler	CEA (Measures relating to Safety and Electric Supply) Regulations.	A vehicle connector used for D.C. charging shall be locked on a vehicle inlet if the voltage is higher than 60 V D.C. The vehicle connector shall not be unlocked (if the locking mechanism is engaged) when hazardous voltage is detected through charging process including after the end of charging. In case of charging system malfunction, a means for safe disconnection may be provided.
Protection against overvoltage at the battery	CEA (Measures relating to Safety and Electric Supply) Regulations.	The D.C. EV charging point shall disconnect supply of electricity to prevent overvoltage at the battery, if output voltage exceeds maximum voltage limit sent by the vehicle.
Verification of Vehicle Connector Voltage	CEA (Measures relating to Safety and Electric Supply) Regulations.	The EV Charging station shall not energize the charging cable when the vehicle connector is unlocked. The voltage at which the vehicle connector unlocks shall be lower than 60 V.
Residual Current Devices (RCDs)	CEA (Measures relating to Safety and Electric Supply) Regulations.	All Residual Current Device (RCDs) for the protection of supplies for EVs shall a) have a residual operating current of not greater than 30 mA, b) shall operate to interrupt all live conductors, including the neutral and c) have a performance at least equal to Type A and be in conformity with IS 732-2018 These shall be permanently marked to identify their function and the location of the charging station or socket outlet they protect. Where required for service reasons, discrimination (selectivity) shall be maintained between the residual current device protecting a connecting point and a residual current device installed upstream. The owner of the charging station shall ensure that the tests as specified in the manufacturer's

Criteria	Reference Standard	Verification Remarks
		instructions for the residual current device and the charging station have been carried out
Overcurrent Protection device	CEA (Measures relating to Safety and Electric Supply) Regulations.	Each EV charging station shall be supplied individually by a dedicated final sub-circuit protected by an overcurrent protective device complying with IEC 60947-2, IEC 60947-6-2 or the IEC 60269 series. The overcurrent protective device shall be part of a switchboard. Co-ordination of various protective device shall be required.
Voltage independent RCD	CEA (Measures relating to Safety and Electric Supply) Regulations.	All EV charging stations shall be supplied from a sub-circuit protected by a voltage independent RCD and also providing personal protection that is compatible with a charging supply for an electric vehicle.
Earth Continuity Monitoring system	CEA (Measures relating to Safety and Electric Supply) Regulations.	All EV charging stations shall be provided with an earth continuity monitoring system that disconnects the supply in the event that the earthing connection to the vehicle becomes ineffective.
Earthing	IS – 732	Earthing of all EV charging stations shall be TN system as per IS 732.
Cable	CEA (Measures relating to Safety and Electric Supply) Regulations.	The cable may be fitted with an earth-connected metal shielding. The cable insulation shall be wear resistant and maintain flexibility over the full temperature range. Power supply cables used in charging station or charging points shall conform to IEC 62893-1 and its relevant parts
Detection of the electrical continuity by the protective conductor	CEA (Measures relating to Safety and Electric Supply) Regulations.	A protective earth conductor shall be provided to establish an equipotential connection between the earth terminal of the supply and the conductive parts of the vehicle. The protective conductor shall be of sufficient rating to satisfy the requirements of IEC 60364-5-54.
Firefighting System	CEA (Measures relating to Safety and Electric Supply) Regulations.	Firefighting system for EVs Charging Stations shall be as per relevant provisions of CEA (Measures Relating to safety and Electric Supply) Regulations 2010.
Enclosure	CEA (Measures relating to Safety and Electric Supply) Regulations.	Enclosure of charging stations shall be made of fire retardant material with self-extinguishing property and free from Halogen.
Alarm and Control System	CEA (Measures relating to Safety and Electric Supply) Regulations.	Fire detection, alarm and control system shall be provided as per relevant IS.
Insulation Resistance	IEC: 61851 – 1	All apparatus of EV Charging Station shall have the insulation resistance value as stipulated in the relevant IEC 61851-1.
Energisation of Charging stations	CEA (Measures relating to Safety and Electric Supply) Regulations.	Every charging station shall be tested and inspected by the owner or the Electrical Inspector or Chartered Electrical Safety Engineer before energisation of charging stations.
Periodical Maintenance	CEA (Measures relating to Safety and Electric Supply) Regulations.	An electric vehicle charging station operator shall arrange periodic test/ inspection of an EV charging station or EVSE should be carried out by electrical inspector/CESE in every year in the initial period of first three years after the energisation of charging station and in every four years thereafter. The owner/operator shall establish and implement a safety assessment programme for regularly assessing the electrical safety of EVSE, conductors and fittings.
Ingress Protection	IEC 60529	Where the connection point is installed outdoors, or in a damp location, the equipment shall have a degree of protection of at least IPX4 in accordance with IEC 60529.

Criteria	Reference Standard	Verification Remarks
Maintenance of Records	CEA (Measures relating to Safety and Electric Supply) Regulations	(1) The owner of the charging station shall keep records in regard to design, construction and labelling to be compatible with a supply of standard voltage at a nominal frequency of 50 Hertz of the charging station. (2) The owner of the charging station shall keep records of the relevant test certificate as indicated in these regulations and as per IEC 61851. (3) The owner of the charging station shall keep records of the results of every inspection, testing and periodic assessment and details of any issues observed during the assessment and any actions required to be taken in relation to those issues. (4) The owner of the charging station shall retain a copy of all records, as specified in sub regulation (1), (2) and (3) of above, either in hard form or in electronic form, for at least seven years and shall provide a copy of the records to the officials during the inspection.
International Standards for Charging stations	CEA (Measures relating to Safety and Electric Supply) Regulations	(1) The safety provisions of all Alternating Current charging stations shall be in accordance with IEC 61851-1, IEC 61851-21 and IEC 61851-22. (2) The safety provisions of all Direct Current charging stations shall be in accordance with IEC 61851-1, IEC 61851-21, IEC 61851-23 and IEC 61851-24.

21. State-wise EV tariff

Figure 214 Energy charge tariff for EVs in Indian states (INR/kWh)



Source: 156 State tariff orders; * - kVAh

22. Development by key fleet operators in India

Table 69 Key fleet operators in India

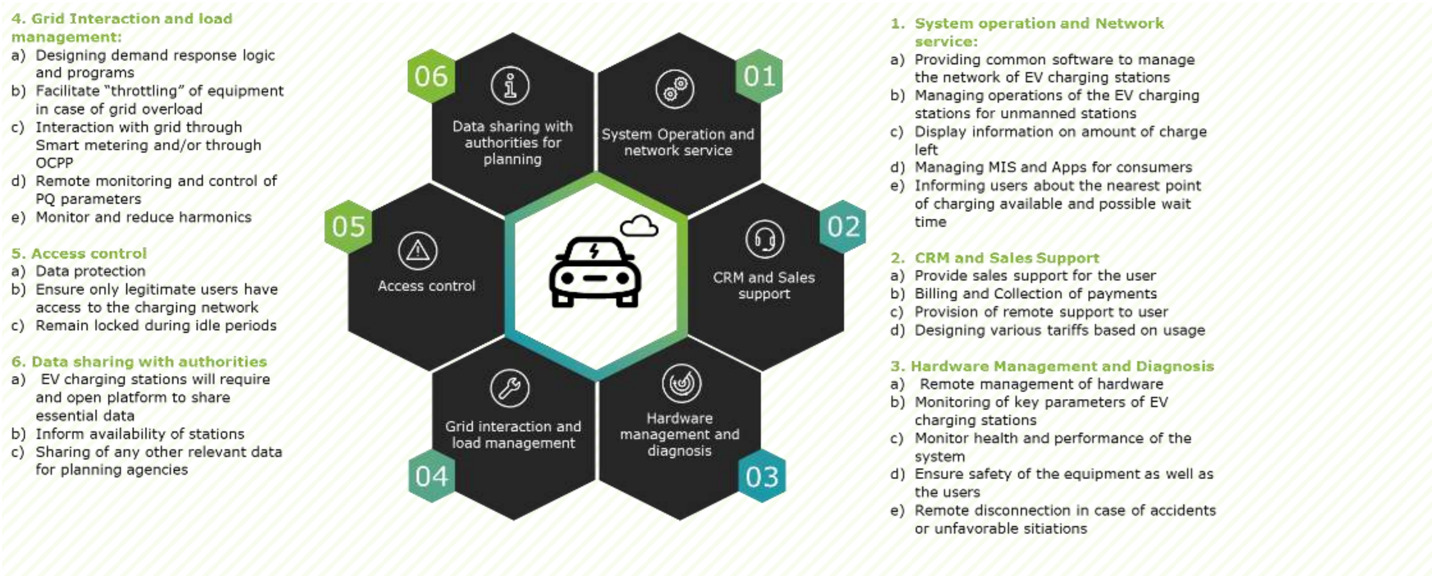
Sr. No.	Operator	Notes
1	OLA	• Partnered with Mahindra Electric to pilot EV in Nagpur • India's first charging station was established by Ola in Nagpur. • Plans to add 10,000 EV in one year, majority being e-2w and 3w. • Has inked a partnership with India's leading power distribution companies, BSES Yamuna Power Limited (BYPL) and BSES Rajdhani Power Limited (BRPL) to build a network of charging and swapping stations in Delhi NCR (mainly for 2w, 3w)

Sr. No.	Operator	Notes
2	TATA Power	• Tata Power and Tata Motors have partnered to install 300 fast charging stations by the end of the FY20, across key five cities namely Mumbai, Delhi, Pune, Bangalore and Hyderabad. • Has already installed 100 fast charging stations in various cities, including Delhi, Mumbai, Bengaluru, Pune and Hyderabad, which it plans to take to 300 by March 2020. • Tata Power has also signed MoUs for setting up commercial EV charging stations at HPCL, IOCL, and IGL retail outlets; plans for setting up of home charging as well as public charging at metro stations, shopping malls, theatres and highway, among others • May also look at installing charging stations that will adhere to 30-50 kW standards as demand grows • Tata Power will provide charging solutions to Jaguar Land Rover in India
3	Ather	• Signed an agreement with Sanmina Corporation, a leading integrated manufacturing solutions company headquartered in San Jose, California. • Sanmina will exclusively manufacture Ather's charging system, battery management systems and dashboards at its state-of-the-art manufacturing facility in Chennai, India. • 6500 charging points across the country by 2022
4	Lithium Urban cabs	• Lithium Urban has incorporated a joint venture to set up EV charging hubs from early 2020 • 10 charging hubs with the facility to charge e-buses and electric cars to be setup. • Plans to expand to cities like Pune, Hyderabad, Chennai and Mumbai and put close to 500 additional fast electric chargers in these cities.
5	SmartE cabs	• Partnership with Delhi Metro to rollout e-rickshaws. • Signed partnership with more than 15 organizations. • Served more than 20 million passengers in the first two years of operation
6	Hyderabad Metro Rail Limited (HRML)	• Partnered with L&T and PGCIL to establish fast charging stations
7	Fortum (Finnish Clean Energy Company)	• Fortum signed MoU with NBCC (India) for developing changing infrastructure across India in an upcoming project. • Plans to setup 150 charging stations in the next 12-18 months.
8	Sun Mobility	• Indian Oil Corporation Limited (IOCL) and SUN Mobility announced the launch of a battery swapping facility for electric vehicles (EVs) at IOCL petrol pumps, offering to replace discharged batteries with fully charged ones in a procedure that would take only a few minutes.

23. Network Service Providers and charging infrastructure OEMs

The network service providers perform a gamut of functions. Some of them are shown in the diagram below:

Figure 215 Functions of a network service provider



Source: 157 Deloitte analysis

There are various other organizations in the country who have developed prototype products complying with existing standards. Organization who are in the business of power electronics, solar plant components and battery services have easy access to the technology of developing the hardware for EV charging stations. Selected network service providers and OEMs operating in India in the business of EV charging stations are listed below:

- **Magenta Power (Charge Grid):** They have developed solutions to remotely manage network of charging stations. In addition, Charge grid has also developed few models of AC charging stations. Some of their charging stations are installed in Mumbai and in Mumbai Pune Expressway.
- **Fortum – Charge and Drive:** Fortum has installed around 70 charging stations in India (Both Public and Private). Most of the charging stations are located in Hyderabad (42 Nos)[118] the company has also developed a web platform (SaaS) to commercially manage network of Charging station. Globally the company has installed more than 3000 stations worldwide[119].
- **TecSo ChargeZone (P) Ltd – Charge+Zone:** The company is into manufacturing of charging stations along with network solutions for fleet operators. They have developed an open network for linking OCPP compliant charging station to their network.[120]
- **Tvesas Electric Solutions (P) Ltd – Volttic:** The company is into manufacturing of various types of charging stations including CCS, CHAdeMo, Bharat chargers (Bharat AC 001 and Bharat DC 001). They have also developed cloud based CMS and Mobile app for Electric Vehicle Charging stations.[121]
- **Ather Energy – Ather Grid:** They have installed about 40 charging stations in Bangalore and Chennai. The company started with manufacture of Electric 2 Wheelers and have now forayed into network of EV chargers. They have also developed an app for managing the network of EV chargers.

Some global organizations have developed dedicated software for managing EV networks. Some of them are listed below:

- **Greenlots:** They have developed SKY™ EV Charging network Software with various features like Grid Balancing, Smart Charging and Optimization and Fleet Charging solutions
- **Driivz:** This software is also used for managing EV Charging network with features like energy optimization and chare management

[118] Fortum Website (access here)
[119] Top EV charging networks in India (access here)
[120] Charge+Zone website (access here)
[121] Volttic (access here)

- **Kitu Systems:** This software has site management, access control and is delivered as s SaaS model.
- **Etrel:** The website of this software shows that more than 25,000 active users are subscribed to this

6.3 Chapter 3 Review of policy, regulation and technical standards for electric mobility and LCPRT

24. National Green Tribunal (NGT)

The National Green Tribunal (NGT) was established as a specialized body to address challenges related to environmental protection, and conservation of forests and natural resources from a multidisciplinary approach. It has the power to intervene on substantial questions related to environment and is also responsible for the enforcement of legal rights. It comprises experts from legal, scientific and technical backgrounds, and considers principles of sustainable development, precautionary principle and polluter pays principle in decision-making. The tribunal has the powers of a civil court in executing a decision. It deals with issues related to environment, and disputes arising from questions related to environmental and pollution laws. The NGT interventions with respect to vehicle air pollution cases, including restriction of old vehicles and restriction on the number of vehicles. In the eco-sensitive area of Rohtang Pass, Himachal Pradesh, in an attempt to reduce the impact of air pollution, the NGT has ordered the banning of diesel vehicles and has also restricted the number of vehicles to 1,000 per day for a period of 3 months. It has also ordered an environment tax of INR 1,000 for petrol vehicles and INR 2,500 for diesel vehicles entering the tourist area. As a pollution mitigation measure, the Tribunal suggested the state government to explore CNG vehicles. In NCR, Delhi, the NGT ordered heavy diesel vehicles more than 10 years old off the road. In an attempt to mitigate air pollution, the Tribunal also ordered the regional transport authorities to not register diesel vehicles that were older than 10 years old and petrol vehicles older than 15 years old.

25. National Urban Transport Policy (NUTP)

The National Urban Transport Policy (NUTP) and the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), which can be considered as precursors to the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Faster Adoption and Manufacturing of Electric Vehicles (FAME) schemes, set the trend for sustainable urban transport planning in India. The NUTP encouraged greater use of public transport and non-motorized transport. It also called for the establishment of quality-focused integrated multimodal public transport systems in urban areas. The fiscal incentives from the central government through the JNNURM focused on the provision of inventory in terms of buses to urban areas to meet the public transport demand. Although the JNNURM provided funding for fleet augmentation, it did not provide for operating costs, something that FAME/AMRUT might want to incorporate. Similarly, any initiative regarding urban transport must address issues of sustainability (e.g., the ASI framework). This would require a sustained policy intervention toward promoting public transport projects – and, specifically, non-polluting technologies such as pure EV technology.

26. Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Yet another policy that can be a finance vehicle in the transition toward public transport through adoption of EVs is the AMRUT scheme. Under this scheme, the central government proposed to spend INR 1 lakh crores during its tenure (2014–2019). Projects selected under the scheme would have special focus on urban infrastructure development. AMRUT adopts a project approach to ensure basic infrastructure services related to water supply, sewerage, transport and development parks, to name a few sectors under the initiative. The mission will be implemented in 500 cities and towns each with a population of 1 lakh and above. Under this mission, states get the flexibility of designing schemes based on the needs of identified cities, and in their execution and monitoring. States will only submit the State Annual Action Plans to the center for a broad concurrence, based on which funds will be released. Special-Purpose Vehicles (SPVs) will be created for each selected city and the respective states will be responsible to ensure that adequate resources are made available to the SPVs. The center will extend funding to the extent of 50% for cities with a population of up to 10 lakhs and a third of the project cost for cities with a population of above 10 lakhs. Given the fact that each city and town is unique, and has its own priorities for development, the center proposes an "area-based" approach to development that will cover retrofitting or redeveloping as per the local plan. Therefore, all state planning committees could plan projects on a need basis across the transportation, sanitation, housing and other sectors. Like its predecessor – the National Urban Renewal Mission – which financed the purchase of buses by city transport corporations, which led to a rejuvenation of public transport in Indian cities – AMRUT presents itself as an ideal platform for city bus transport corporations to leapfrog technologies and contribute positively toward air quality, energy security and job creation through the adoption of EV technology.

27. National Heritage City Development and Augmentation Yojana (HRIDAY)

Yet another scheme that has been launched in tandem with the initiatives mentioned above is HRIDAY. The duration of the HRIDAY scheme was 4 years starting December 2014. The objective of this scheme was to preserve the rich and diverse natural heritage areas. This scheme has been implemented by the center with 100% funding by the central government. Cities were required to prepare a Heritage Management Plan for identified projects for availing assistance under this scheme. These schemes present a different approach to bringing about holistic development of states and have a component of timely project reviews by the center, which will ensure that projects are implemented efficiently.

28. Smart City Mission (SCM)

The intention of building smart cities in India has been pursued by previous governments at the center and the states, although through seemingly disjointed initiatives such as smart townships along the Delhi–Mumbai Industrial Corridor and the GIFT city in Gujarat. In early 2014, a budgetary allocation of INR 7,060 crores for the development of "100 Smart Cities" in India was introduced. Over the past years, various city governments signed a Memorandum of Understanding with various external and foreign agencies to secure both technical and financial assistance in making their cities smart. The Smart Cities Mission Statement and Guidelines released by the Ministry of Urban Development (MoUD) identifies 10 core infrastructure elements, where "sustainable development" and "public transport" are also listed. Thus, adoption and deployment of EVs can become a significant strategy in potential smart cities. The guidelines also seek to ensure convergence between SCM, AMRUT and HRIDAY. Adhering to a common reference framework becomes particularly significant in drawing this convergence, which has remained one of the major challenges in attaining India's urban goals. For example, the goals of AMRUT and SCM cannot be treated as mutually exclusive and the habitations under AMRUT shall need as much "smart solutions" as cities under the SCM.

29. Clean fuel initiatives

The concern for environment in India has gained momentum with 42nd amendment of the Indian constitution in 1976. Among many additions and alterations made to the Indian constitution through this amendment, inclusion of Article 48A and Sub-clause (g) of Article 51A is regarded as one of the landmark initiatives of Government of India towards protection of environment, forest, and wildlife.

Box 28: Provision made to protect environment, forest, and wildlife through 42ndnstitutional Amendment

In the Chapter of Directive Principles of State Policy, a new Article 48A was inserted which state as follows:

"***Article 48-A: Protection and Improvement of Environment and safeguarding of Forests and Wildlife. - The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country***."

As Article 51A "Fundamental Duties" inserted in Indian Constitution, Sub-clause (g) of Article 51A is provides:

"Article 51A (g): It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures."

In India, CPCB is the apex body in country for pollution control and act as a technical wing of Ministry of Environment, Forest, and Climate Change (MoEF&CC). As its primary function, CPCB advise the Central

Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air.

30. Air Quality monitoring

- ✓ **List of all AQI stations along with current AQI level can be accessed from here**
- ✓ **List of operating stations under National Air Quality Monitoring Programme (NAMP) can be accessed from here**

31. National Ambient Air Quality Standards (NAAQS)

Table 70 Comparison of norms specified under NAAQS and WHO guidelines

Sl.	Pollutant	Time Weighted average	NAAQS as per CPCB notification of 2009[122]		WHO guidelines, 2005[123]
			Industrial, Residential, Rural and Other Area	Ecologically sensitive area	
1	Sulphur Dioxide (SO_2), µg/m3	Annual*	50	20	-
		24 hours**	80	80	20
2	Nitrogen Dioxide (NO_2), µg/m3	Annual*	40	30	40
		24 hours**	80	80	-
3	Particulate Matter size less than 10 µm) or PM10µg/m3	Annual*	60	60	20
		24 hours**	100	100	50
4	Particulate Matter size less than 2.5 microns) or PM2.5 µg/m3	Annual*	40	40	10
		24 hours**	60	60	25
5	Ozone (O_3) µg/m3	8 hours **	100	100	100
		1 hour **	180	180	-
6	Lead (Pb) µg/m3	Annual*	0.5	0.5	-
		24 hours**	1	1	-
7	Carbon Monoxide (CO) mg/m3	8 hours**	2	2	-
		1 hour**	4	4	-
8	Ammonia (NH_3) µg/m3	Annual*	100	100	-
		24 hours**	400	400	-
9	Benzene (C_6H_6) µg/m3	Annual*	5	5	-
10	Benzo (a) Pyrene (BaP) – particulate phase only ng/m3	Annual*	1	1	-
11	Arsenic (As) ng/m3	Annual*	6	6	-
12	Nickel (Ni) ng/m3	Annual*	20	20	-

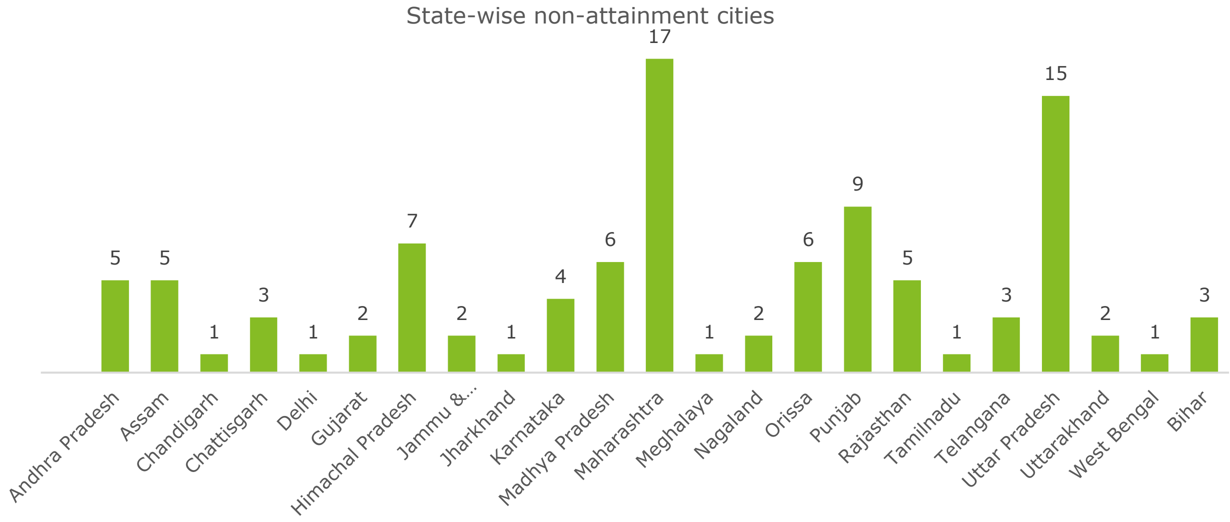
Red: Norms lesser stringent norms than WHO guidelines; Green: Norms at par with or more stringent than WHO guidelines

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

32. City-wise break-up of attainment cities across States

[122] National Ambient Air Quality Standards (access here)
[123] WHO - Ambient (outdoor) air pollution (access here)



33. AQI

Box 29: Brief overview of methodology for calculation of AQI

Primarily two steps are involved in formulating an AQI:

1. formation of sub-indices (for each pollutant); and
2. aggregation of sub-indices to get an overall AQI

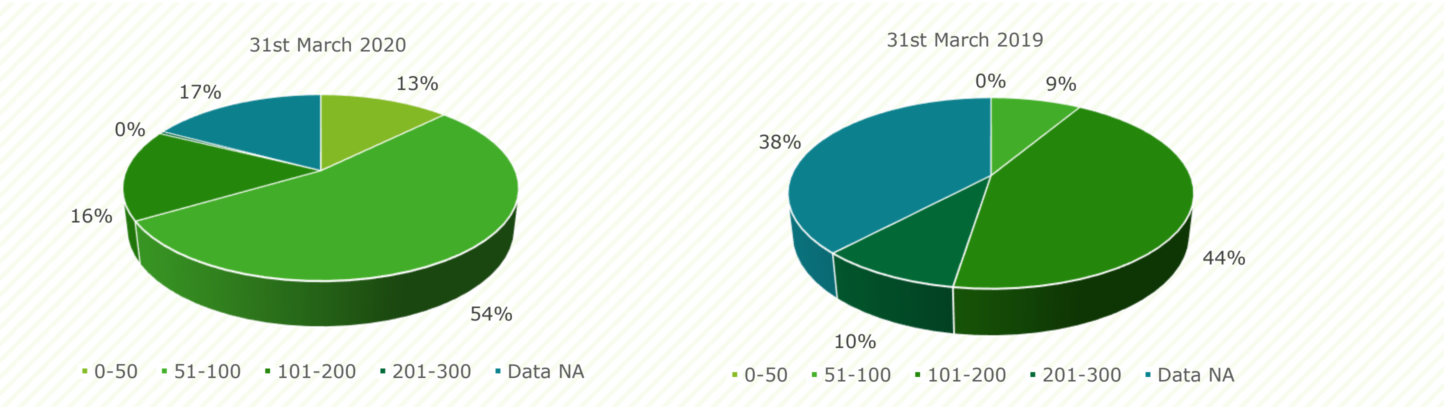
The AQ sub-index and health breakpoints are evolved for eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Lead (Pb)) for which short-term (up to 24-hours) National Ambient Air Quality Standards are prescribed.

Based on the measured ambient concentrations of a pollutant, a sub-index is calculated, which is a linear function of concentration (e.g., the sub-index for PM2.5 will be 51 at concentration 31 µg/m3, 100 at concentration 60 µg/m3, and 75 at concentration of 45 µg/m3)

Unlike other international AQI calculation methodology, which aggregates the sub-indices to get an overall AQI, (e.g. weighted additive method or Root-Sum-Power Form or Root-Mean-Square Form), India adopted the worst sub-index to determine the overall AQI. This means that the highest sub-index among each sub-indices for individual pollutant forms the overall AQI.

Below figure provided AQI data for 31st March 2020 is compared with data of 2019 for same day of month.

Figure 216 AQI data for 31st March 2020 and 2019



Source: 158 Note 1: Out of 221 Stations, data for 38 Stations in March 2020 and 84 stations in March 2019 was not available/recorded

It can be inferred from above graphs that availability of data at monitoring stations have been improved over the year. Whereas in March 2019 data was not available for 38% of the stations, it was only 17% in March 2020.

Since data of significant number of stations are not available in March 2019, the comparison of trend of AQI would not be prudent. With the strengthening of air quality monitoring system as envisaged under National lean Air Programme, it is expected that availability of data would be improved that could enable drawing of logical conclusions from AQI trends and able to help policymakers to take informed decisions.

34. State-wise details of action plan

State	No. of Cities	Action plan identified								Total
		Trans port	Indu stry	Po wer	Clean Construction and Road dust Management	Agric ulture	Waste Manageme nt	Indoor	Other measu res	
Andhra Pradesh	5	290	40	45	105	45	15	15	35	590
Assam	5	36	10	0	55	0	10	15	35	161
Chandigarh	1	12	3	0	9	4	0	0	3	31
Chhattisgarh	3	26	11	0	30	0	6	3	16	92
Delhi	1	50	6	12	5	3	8	3	6	93
Gujarat	2	24	6	0	19	1	6	1	10	67
Himachal Pradesh	7	98	56	0	63	0	49	0	28	294
Jammu and Kashmir	2	30	10	0	22	0	4	4	22	92
Jharkhand	1	9	5	0	13	0	1	0	9	37
Karnataka	4	48	7	0	43	0	9	0	18	125
Madhya Pradesh	6	67	30	0	54	0	18	6	36	211
Maharashtra	17	268	108	20	142	1	88	28	33	688
Meghalaya	1	11	4	0	10	0	5	0	6	36
Nagaland	2	22	10	0	18	0	8	0	12	70
Orissa	6	360	51	47	101	0	60	18	72	709
Punjab	9	116	42	0	92	0	29	0	50	329
Rajasthan	5	85	20	0	65	0	36	0	35	241
Tamil Nadu	1	18	5	5	18	0	5	0	6	57
Telangana	3	46	13	0	27	0	12	0	23	121
Uttar Pradesh	15	261	115	0	232	0	105	0	151	864
Uttarakhand	2	16	6	0	16	2	8	0	18	66
West Bengal	1	23	3	3	5	0	5	3	6	48
Bihar	3	46	14	4	26	0	15	13	33	151
Total	**102**	**1962**	**575**	**13 6**	**1170**	**56**	**502**	**109**	**663**	**5173**

35. Action-points for each sector under NCAP

Action Points identified under NCAP for key components segregated across – Mitigation Actions, Knowledge and Database Augmentation, and Institutional Strengthening

I. Mitigation Actions

A. STRINGENT ENFORCEMENT THROUGH THREE TIER MECHANISM FOR REVIEW OF MONITORING, ASSESSMENT AND INSPECTION

1. Web-based system on the above-mentioned lines to be evolved in association with the NIC and other relevant national and international agencies.
2. Adequate manpower will be made available for strengthening, monitoring, and inspection.
3. Intensive training of all the stakeholders involved in implementation of this web based system.
4. Mandating use of this three tier mechanism in 102 cities.

B. EXTENSIVE PLANTATION DRIVE

1. Plantation initiatives under NCAP at pollution hot spots in the cities/towns to be undertaken under GIMs with Compensatory Afforestation Fund (CAF) being managed by National Compensatory Afforestation Management and Planning Authority (CAMPA).
2. Development of plantation plans for the non-attainment cities/towns.
3. Execution of city-specific plantation plans.
4. Institutes as Indian Institute of Forest Management (IIFM), Universities as Delhi University and other Research Organizations and institutions with expertise in plantation to be involved for evolving these plans and for implementation of these plans in these 102 cities.
5. Planation target to be indicated in city-specific plantation plans.
6. 6. Scheme on agroforestry to be prioritized and strengthened.

C. TECHNOLOGY SUPPORT

1. Clean Technologies with potential for air pollution prevention and mitigation will be supported for R&D, pilot scale demonstration and field scale implementation.
2. The mechanism for such support will be formulated as an action plan.

D. REGIONAL AND TRANSBOUNDARY PLAN

Regional

1. Various measures specially implementation of pollution abatement policies as Transport- Auto fuel policy for stringent norms for fuel and vehicles, road to rail/waterways, fleet modernization, electric vehicle policies, clean fuels, bye-passes, taxation policies, etc.; Industries—stringent industrial standards, clean fuels, clean technology, enforcement (continuous monitoring); and biomass– enhanced LPG penetration, agricultural burning control and management need to emphasized through regional level inter-state coordination specifically for the Indo-Gangetic plain. A comprehensive regional Plan to be formulated incorporating the inputs from the regional source apportionment studies.

Transboundary

1. Linking NDC's target of additional forest and tree cover of 2.5 to 3 billion tonnes of CO_2 equivalent by 2030 to NCAP. There needs to be more focus on the western regions of India (Rajasthan and Gujarat) for enhanced tree cover, which will reduce wind-blown dust within the country and will also act as barriers for trans-boundary dust.
2. The initiatives under United Nations Convention to Combat Desertification (UNCCD) to be integrated for addressing the issue of transboundary dust.
3. Air quality management at South-Asia regional level by activating the initiatives under 'Male Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia' and South Asia Cooperative Environment Programme (SACEP) to be explored.
4. 4. A comprehensive Transboundary Plan to be formulated.

E. SECTORAL INTERVENTIONS

POLLUTION FROM ROAD DUST AND C&D

1. Introducing mechanical sweepers on the basis of feasibility study in cities.
2. Evolve SOP for addressing the specific issue of disposal of collected dust from mechanical sweeping, taking into consideration all the above cited factors.
3. Stringent implementation of C&D Rules, 2016, and Dust Mitigation notification, 2018, of Government of India.
4. Wall-to-wall paving of roads to be mandated.

5. Stringent control of dust from construction activities using enclosures, fogging machines, and barriers.
6. Greening and landscaping of all the major arterial roads and national highways after identification of major polluting stretches.
7. Maintenance and repair of roads on priority.
8. Sewage treatment plant-treated water sprinkling system along the roads and at intersecting road junctions and spraying of water twice a day before peak traffic hours.

POWER SECTOR EMISSIONS

1. Stringent compliance by all TPPs with respect to the emission norms according to the timelines up to December 2022 and as per the action plan prescribed in the direction dated December 2017 issued under EPA 1986.
2. CGD network distribution shall be taken up on priority within the country, emphasizing on 102 non-attainment cities.
3. There is need for optimizing the use of the existing power plants by prioritizing capacity utilization of natural gas/ clean fuel-based thermal power plants.
4. Phasing out older coal-based power plants and converting specific coal based power plants to natural gas.
5. Emphasis on improved power reliability in urban areas to eliminate the operation of DG sets.
6. Emphasizing the expansion of renewable power initiatives prioritizing the use of existing framework of NAPCC in non-attainment cities.
7. Need to explore the possibility of Fly ash utilization in extensive way in 102 non-attainment cities.

INDUSTRIAL EMISSION

1. Introduction of gaseous fuels and enforcement of new and stringent SO2/ NOx/PM2.5 standards for industries using solid fuels.
2. Stricter enforcement of standards in large industries through continuous monitoring.
3. Full enforcement of zig-zag brick technology in brick kilns.
4. Elimination of DG set usage by provision of 24x7 electricity.
5. Control by innovative end of pipe control technologies.
6. Evolve standards and norms for in-use DG sets below 800 KW category.
7. For DG Sets already operational, ensure usage of either of the two options:
    a. use of retrofitted emission control equipment having a minimum specified PM capturing efficiency of at least 70%, type approved by one of the 5 CPCB recognized labs; or (b) shifting to gas-based generators by employing new gas-based generators or retrofitting the existing DG sets for partial gas usage.
8. Utilize the Gujarat case study for a compelling case for other states to adopt third-party audits for polluting industries for enhancing Implementation (States)

TRANSPORT SECTOR EMISSION

In Use Vehicle

1. Stringent implementation of BS VI norms all over India by April 2020.

Green Mobility

1. Stringent implementation of National Biofuel Policy with respect to ethanol and biodiesel blending target of 20% and 5%, respectively by 2030.
2. City action plans to review the extension of MRT in cities/towns.
3. Improvement and strengthening of inspection and maintenance system for vehicles through extension of I&C centres.
4. Stringent implementation of PUC certificate through regular inspection and monitoring.
5. Fleet modernization and retro-fitment programmes with control devices.
6. Reducing real-world emissions by congestion management.
7. Review the Green Corridor Project and feasibility of its extension with reference to 102 cities.
8. To review the scaling up of Pilot project of MoPNG for introducing CNG in 2-wheelers and ensure timely implementation.
9. Scaling up of R&D on use of Hydrogen as transport fuel.

Electric mobility

1. Formulation of a national-, state-, and city-specific action plan for electric mobility.
2. Rapid augmentation of charging infrastructure in the country focusing on 102 cities.
3. Central government offices fleets older than 15 years to be shifted to electric vehicles.
4. Government-run buses for public transport, private buses, and 3-wheelers to be converted to EVs.
5. Gradual transition to electric mobility in the 2-wheeler sector.
6. Specific allocations for creating a venture capital fund.
7. Investment in R&D and pilots focusing on the indigenization of battery manufacturing, cheap alternate resource to lithium and cobalt, resource efficiency associated with a circular economy, re-use and recycling for lithium batteries, etc.

AGRICULTURAL EMISSION

1. Evaluate the status of implementation of the above scheme in the states and impact on reduction of air pollution in Delhi and the NCR.
2. Evaluate the socio-economic feasibility for implementation of ex-situ options like production of Prali-Char, biochar, pellets, briquettes, bioCNG, bioethanol, etc., as ex-situ solutions for management of crop residue burning especially with NPB in place.
3. Extending the initiatives for addressing the issue of crop residue burning from the NCR to other part of the country and from paddy to sugarcane and other crops.
4. Coordination with ISRO for regular availability of Remote Sensing Monitoring data for crop burning by the farmers.
5. Evolve plan for management of agricultural emissions from fertilizers and livestock waste on the basis of strong R&D. The R&D for the purpose to be supported.
6. Implement plan for management of agricultural emissions
7. The capacity-building initiatives for Krishi Vigyan Kendra (KVK) shall be strengthened

EMISSIONS FROM UNSUSTAINABLE WASTE MANAGEMENT PRACTICES

1. Use the smart cities framework to launch the NCAP in the 43 smart cities falling in the list of 102 non-attainment cities.
2. Transform our centralised waste disposal infrastructure to a sustainable decentralized system in 102 cities.
3. Source segregation into dry and wet waste to be made mandatory through involvement of municipalities and the RWA.
4. Mandatory Training and capacity building of municipalities and the RWA.
5. Transitioning towards a zero-waste pathway through an integrated solid waste management strategy, including targeting waste prevention, recycling, composting, energy recovery, treatment, and disposal.
6. Waste reduction schemes such as 'polluters pay' principle, recycling projects, composting, bio methanation, RDF plants and co-processing to be supported under an integrated solid waste management strategy.
7. Construction of decentralized compositing plant, bio methanation plant and C&D waste plants.
8. Deployment of fixed compactor and doing away with dhalaos.
9. Focus on training municipalities and SPCBs to be on national and international technologies for integrated waste management options.
10. In line with the National Biofuel Policy, promote technologies which can convert waste/plastic, MSW to energy resulting in reduction of traditional fuel use.
11. Stringent implementation and monitoring for extended producer responsibility for e-waste and plastic waste.
12. Strict implementation of existing six waste management's rules on solid, Hazardous, Electronic, Bio-medical, Plastics and C&D waste.
13. The Swachh Bharat Mission and National Mission on Sustainable Habitat to be used as a platform to push the objectives under this sector.

INDOOR AIR POLLUTION MANAGEMENT

1. Building specific guidelines and protocols on monitoring and management of indoor air pollution.
2. Extend PMUY in 102 cities/towns and the associated village areas.

3. 3. Guidelines and provisions for building designs that define proper ventilation, clean cooking, and living areas to maintain healthy air quality inside the house to be integrated with the Pradhan Mantri Awas Yojana (PMAY).

F. CITY SPECIFIC AIR QUALITY MANAGEMENT PLAN FOR 102 NON-ATTAINMENT CITIES

1. Preliminary city-specific action plans to be formulated for 102 non-attainment cities.
2. City-specific action plans to be taken up for implementation by State Government and city administration.
3. City-based clean air action plans are to be dynamic and evolve based on the available scientific evidence, including the information available through source apportionment studies.
4. A separate emergency action plan in line with GRAP for Delhi to be formulated for each city for addressing the severe and emergency AQIs.

G. STATE ACTION PLAN FOR AIR POLLUTION

1. Preliminary State Action Plan for Air Pollution to be formulated for all 23 states which harbour 102 non-attainment cities;
2. State Action Plan for Air Pollution to be taken up for implementation by State Government and city administration;
3. The State Action Plan to have detailed funding mechanism.

II. Knowledge and database augmentation

A. AIR QUALITY MONITORING NETWORK

1. Manual monitoring stations

With reference to existing 4000 cities in the country, 703 manual monitoring stations in 307 cities reflects limited number and need augmentation. It is proposed to augment it to 1500 stations from existing 703 stations.

2. CAAQMS

Recognizing the need to monitor real time and peak concentration levels of critical pollutants avoiding the time lag, more specifically with reference to the AQI, it is proposed under the NCAP to augment the existing number of Continuous Ambient Air Quality Monitoring Stations (CAAQMS). Presently, there are 134 CAAQMS stations in 71 cities and 17 States. Acknowledging the fact that air pollution in India has regional ramifications and the Indo-Gangetic plain, spanning approximately 45–50 cities spreads across the states of Assam, Bihar, Haryana, Jharkhand, Madhya Pradesh, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, and West Bengal, is the main region impacted by air pollution; the expansion of real-time monitoring stations would mainly focus on this region, and approximately 150 CAAQMS with an average of 2–3 stations in each city is to be decided on the basis of population, industrial activities, etc., will be targeted.

Further, impetus will be on low-cost indigenous real-time monitoring stations. Real-time monitoring in other cities will be taken up with identification of these low-cost sensors.

3. Satellite based monitoring

Application of Aerosol Optical Depth (AOD) from satellite-based observations is being widely accepted for the assessment of ambient particulate matter levels. This is significant considering the extensive monitoring needs and required resources. The NCAP proposes to use this technique to supplement its monitoring network. Under the programme, capacities will be strengthened to develop indigenous satellite-based products and techniques to derive useful air quality information. The required algorithm to correlate AOD values with ground-level PM concentrations over the Indian regions will be derived from an indigenous database. Other satellite-based products also need to be explored to assess gaseous pollutant concentrations.

4. Identification of alternative technology for real time monitoring

CPCB is to steer the process of identifying and for developing/validating alternative cost-effective technology for source and ambient air quality monitoring in consultation with the IIT, CSIR, and other such institutes as NEERI. Mobile air quality monitoring network are to be made part of these alternative technologies.

5. Rural Monitoring Network

Air quality in rural areas remains a neglected issue so far. The common belief is that rural areas are free from air pollution. On the contrary, air quality in the rural areas all over the world and particularly in the developing countries may be more polluted than some of the urban areas. Rural areas suffer from outdoor air pollution as well as indoor air pollution. Major sources of outdoor air pollution are indiscriminate use of insecticides/pesticides sprays and burning of wheat and paddy straw. Atmospheric concentration of ozone has been observed higher in rural areas as compared to urban areas. Since rural areas have not been covered under NAMP it is proposed to set up 75 such stations in rural areas.

6. Protocol for setting up of monitoring stations and monitoring

Guidelines for Ambient Air Quality Monitoring has been issued by the CPCB in 2003 for assisting and taking decision with respect to the setting up of monitoring stations. However, it is noted that the guideline needs revision in reference to sound decision making in selection of pollutants, selection of locations, frequency, duration of sampling, sampling techniques, infrastructural facilities, manpower, and operation and maintenance costs. The network design also depends upon the type of pollutants in the atmosphere through various common sources. Accordingly, it is planned to review the existing guideline and issue protocol for setting up of monitoring stations and monitoring.

7. Monitoring of PM2.5

Particulates are the deadliest form of air pollutants due to their ability to penetrate deep into the lungs and blood streams unfiltered, causing various health issues. The smaller PM2.5 are particularly deadly, as it can penetrate deeper into the lungs and blood stream. The monitoring data also indicates higher concentration of PM2.5 in major cities. Accordingly, in order to evolve a comprehensive mechanism for the management of PM2.5, it is proposed to augment the number of monitoring stations for PM2.5 from the existing 167 in 80 cities to all stations under NAMP.

8. Setting up of 10 city Super Network

This network may capture the overall air quality dynamics of the nation, impact of interventions, trends, investigative measurements, etc. The cities may be identified for capturing possible variations (e.g., metro city, village, mid-level town, coastal town, controlled background location, industrial town, etc.). Each city may have one well-equipped monitoring station representing the city background. In addition to the notified 12 pollutants, constituents of PM1, particle number, etc., may be monitored. It should generate highly-quality controlled data and will represent national air quality dynamics. The plan for this network to be formulated and implemented in consultation with the CPCB.

9. Super sites as representative sites in cities and rural areas

These representative monitoring sites are to be selected to assess the background level and major sources so as to draw a scientific statistically sound assessment of pollution and its impact on health.

B. EXTENDING SOURCE APPORTIONMENT STUDIES TO ALL NON-ATTAINMENT CITIES

1. Unified guideline for source apportionment study will be formulated and updated (centre).
2. Source apportionment studies to be extended to all 102 non-attainments (centre).

C. AIR POLLUTION HEALTH AND ECONOMIC IMPACT STUDIES

1. Study on the National Environmental Health Profile to be completed in time.
2. Response study and cohort study programme to be undertaken.
3. Ministry of Health to actively take up environmental health for ensuring regular health profile or database for assisting decision making.
4. Studies on health and economic impact of air pollution to be supported.
5. Framework for monthly analysis of data w.r.t health to be created. The data from mapping of industry; tabulation of daily AQI, PM2.5 and PM10 measurements (24 hours average); metrological parameters; deaths due to heart attacks, strokes, respiratory arrest, following the existing respiratory ailments, trends in lung cancer if available with respect to all cities to be fed in to a central computer and to be analysed every month by people trained in environmental health for correct interpretation.
6. Awareness and orientation workshops to be undertaken focussing on a target audience

7. Media is to be used for wide dissemination of information and the precise information to be shared has to be carefully worked out by a team of experts in air pollution and environmental health.
8. Training researchers in study design through holding workshops in epidemiology, toxicology, and biostatistics

D. INTERNATIONAL COOPERATION INCLUDING SHARING OF INTERNATIONAL BEST PRACTICES ON AIR POLLUTION

1. International scientific and technical cooperation in the area of air pollution will be established in accordance with national priorities and socio-economic development strategies and goals.
2. Modalities of such cooperation may include joint research and technology development, field studies, pilot scale plants and field demonstration projects with active involvement of academia, research institutions and industry on either side.

E. REVIEW OF AMBIENT AIR QUALITY STANDARDS AND EMISSION STANDARDS

1. The CPCB to come up with guidelines with respect to the periodicity of review of such standards.
2. The existing standards need to be strengthened periodically and new standards need to be formulated for the sources where standards are not available, based on extensive scientific evidence with reference to protection of public health and environment.

F. NATIONAL EMISSION INVENTORY

1. Comprehensive National Emission Inventory which is still lacking in the country will be formalized under the NCAP.

III. Institutional Strengthening

A. PUBLIC AWARENESS AND EDUCATION

1. City-specific awareness programme targeting key stakeholders to be formulated and taken up for implementation. This could include awareness generation in general public for prevention of adverse effects of air pollution.
2. Sensitization of the media for right interpretation of international reports and data as well as for disseminating information on measures being taken by the government for the abatement of air pollution to be undertaken.

B. TRAINING AND CAPACITY BUILDING

1. Extensive capacity-building programmes for both the CPCB and SPCBs with reference to both manpower and infrastructure augmentation.
2. Intensive training, comprising national and international best practices and technological options, of all the associated stakeholders.

C. SETTING UP AIR INFORMATION CENTRE

1. Plan accordingly for setting up of these centres will be formulated.
2. Air information centres at the central level and regional level will be set up in some of the identified institutes.

D. CERTIFICATION SYSTEM FOR MONITORING INSTRUMENTS

1. To operationalize the NPL-India Certification Scheme (NPL-ICS) at the central and regional levels to cater to the country’s needs with respect to the online monitoring of air pollution.
2. To evolve an action plan for the need of certification agencies for air pollution mitigation equipment in addition to monitoring equipment.

E. AIR QUALITY FORECASTING SYSTEM

All the ongoing and future initiatives under SAFAR will be integrated with the NCAP for taking all preventive measures to draw the benefits for addressing the air pollution issue from available information.

1. The efforts will be to extend it to 102 non-attainment cities under NCAP.
2. Hotspot-based forecasting to be taken up moving ahead from city-specific forecasting in 102 cities
3. The satellite data available through the satellite network of ISRO to be integrated for monitoring and forecasting under the NCAP.

F. NETWORK OF TECHNICAL INSTITUTIONS KNOWLEDGE PARTNERS

1. A detailed action plan for the setting up of the network integrating with the existing network under the NAPCC needs to be formulated.
2. System of a regular web-based online interaction mechanism will be evolved to ensure continuity of interactions.

G. TECHNOLOGY ASSESSMENT CELL

1. A detailed action plan for this cell is to be formulated.
2. The Technology Assessment Cell will be created involving the IITs, IIMs, the major universities, industries, and using the existing mechanisms and programme of the DST, India Innovation Hub, etc.

H. INSTITUTIONAL FRAMEWORK

Centre level

1. National Apex Committee at the MoEF&CC
2. Five sectoral working groups on a co-chairing basis
3. Technical Expert Committee at the MoEF&CC
4. National-level Project Monitoring Unit (PMU) at the MoEF&CC
5. National-level Project Implementation Unit (PIU) at the CPCB

State level

1. State-level Apex Committee under the chief secretaries in various states
2. City-level Review Committee under the municipal commissioner
3. DM-level Committee in the districts
4. State-level Project Monitoring Unit (PMU) at the SPCBs

36. Policies in India supporting Alternate Fuel

Timeline	Action	Remarks
	Ethanol Blending Program	
January 2003	The Ministry of Petroleum and Natural Gas made mandatory – 5 percent bending of ethanol with petrol across nine major sugar producing states and five Union territories in India.	Partially implemented due to unavailability of ethanol (due to low sugarcane production in 2003/04 and 2004/05).
October 2008	Third phase of implementing EBP envisaged blending ratio to be increased to 10 percent.	Since there was no official notification released, oil marketing companies have not started 10 percent ethanol blending.
August 2010	Government fixed an ad-hoc provisional procurement price in Indian Rupees (INR) of 27 per litre of ethanol by Oil Marketing Companies (OMC) for EBP program. Decision was taken to constitute expert committee under Chairmanship of Dr. Choudhary, Member of Planning	Expert Committee in March 2011 had recommended that ethanol be priced 20 percent lower than gasoline price. No consensus yet on pricing policy of ethanol. In any event when ethanol supply runs short, government proposed to reduce import duty on alcohol and molasses. OMC stipulated that alcohol or molasses could not

Timeline	Action	Remarks
	Commission, to recommend a formula for pricing ethanol.	be imported for EBP but must be exclusively sourced from domestic-produced molasses.
November 2012	In a bid to renew its focus and strongly implement the EBP, the Cabinet Committee on Economic Affairs (CCEA) on November 22, 2012, recommended five-percent mandatory blending of ethanol with gasoline (the blending target was already decided by the CCEA in the past). Henceforth, the procurement price of ethanol shall be decided by between the OMC and suppliers of ethanol (CCEA recommendation). According to one of the CCEA recommendations, in the case of any shortfall in domestic availability, the OMCs and chemical companies were free to import ethanol for EBP. Since OMCs were falling short by more than 820.3 million liters of ethanol, they floated a global tender in the third week of January to augment remaining supplies.	The Union government under the Motor Spirits Act on January 2 notified that a few states such as Uttar Pradesh, Delhi, Haryana, Punjab, Karnataka and Goa can even achieve up to 10 percent ethanol blending target, but the overall average for the country as a whole should reach five percent by end of June 30, 2013. The interim (ad-hoc) price of INR 27 per liter would no longer hold as price would now be decided by market forces. The fuel ethanol blend rate that could be achieved then was 1.6 percent.
CY 2014	GOI considered raising the EBP program target from five to 10 percent in near future. On December 10, 2014, GOI announced a price control schedule for fuel ethanol procurement for OMCs. The program fixes landed-ethanol prices at OMC depots from INR 48.50 to INR 49.50 per liter ($0.76 to $0.77/liter), a three to five percent increase over the previous price.	Total quantity accepted by OMC was thus 247 + 53 million liters = 300 million liters. Assuming that OMC shall come out with another tender soon for ethanol procurement for CY 2015, Post anticipated that OMC shall procure another 50 million liters in December 2014. The cumulative volumes likely to be accepted by OMCs for blending with gasoline will be 350 million liters, which translates to market penetration at 1.4 percent. This will likely accelerate India's EBP, infuse cash into the local sugar industry, help millers pay down debts, and curtail (by some estimates) upwards of $750 million in crude oil imports. In previous years, Post has observed that India has the capacity to fulfil its ethanol blending mandate, provided there are equal incentives for both the producers and blenders.
April 2015	GOI removed 12.36 central excise duty levied on ethanol supplied for blending with gasoline.	The excise duty exemption will be applicable for ethanol produced from molasses generated during the next sugar season (October 2015-September 2016) and supplied for blending with gasoline, Press Information Bureau (PIB) Press Release. Industry sources claim that sugar mills are

Timeline	Action	Remarks
		expected to benefit to an extent of INR five per liter on sale of ethanol for blending.
National Biodiesel Mission		
April 2003	Phase I (Demonstration) from 2003 – 2007: Ministry of Rural Development appointed as nodal ministry to cover 400,000 hectares under Jatropha cultivation. This phase also proposed nursery development, establishment of seed procurement and establishment centers, installation of trans-esterification plant, blending and marketing of biodiesel.	Public and private sector, state government, research institutions (Indian and foreign) involved in the program achieved varying degrees of success.
October 2005	The Ministry of Petroleum and Natural Gas announced the biodiesel purchase policy. OMC to purchase bio diesel from 20 procurement centers across India at INR 26.5/liter	Cost of biodiesel production higher (20 to 50 percent) than purchase price. No sale of biodiesel.
October 2008	Phase II (Self Execution) from 2008 to 2012: Targeted to produce sufficient biodiesel for 20 percent blending by end of XI (2008-12) five-year plan	Lack of largescale plantation, conventional low yielding Jatropha cultivars, seed collection and extraction infrastructure, buy-back arrangement, capacity, and confidence building measures among farmers impeded the progress of this phase.
October 2014	GOI deregulated diesel prices in line with gasoline.	The retail price will now be decided by the market forces and GOI will no longer have to compensate OMCs for selling diesel below market prices. This step will incentivize firms engaged in biodiesel production in India.
CY 2015	In January, Union Cabinet chaired by the Prime Minister, Shri Narendra Modi, gave its approval for amending the motor spirit (MS) and high-speed diesel (HSD) Control Order for Regulation of Supply, Distribution and Prevention of Malpractices dated 19.12.2005. The Cabinet has also decided to suitably amend Para 5.11 and 5.12 of the National biofuel policy for facilitating consumers of diesel in procuring directly from private biodiesel manufacturers, their authorized dealers and Joint Ventures (JV) of OMCs authorized by the MoPNG. This decision will encourage the production and use of biodiesel in the country.	The amendment will allow private biodiesel manufacturers, their authorized dealers and JVs of OMCs authorized by the Ministry of Petroleum and Natural Gas (MoPNG) as dealers and give marketing and distribution functions to them for the limited purpose of supply of biodiesel to consumers. The investment and production conditions (as applicable) specified in the marketing resolution dated March 8, 2002, of MoPNG will also be relaxed and a new clause added to give marketing rights for pure biodiesel (B100) to the private biodiesel manufacturers, their authorized dealers and JVs of OMCs authorized by the MoPNG for direct sales to consumers.

Timeline	Action	Remarks
	On August 10, GOI had issued notification to allow the sale of Biodiesel (B100) by private manufacturers to bulk (Gazette Notification No. General Statutory Rules (GSR) 621 (E)). The order is called the Motor Spirit and High-Speed Diesel (Regulation of Supply, Distribution, and Prevention of Malpractices) Amendment Order, 2015. On August 11, 2015, Minister of State (I/c), Petroleum and Natural Gas, launched sale of B-5 Diesel on World Bio Fuel Day. (Source: News Release, IOC).	Bids were invited until August 19. The policy is meant to help with local price discovery ahead of a potential 20 percent blend for biodiesel in 2017. A 20 percent blend for ethanol has also been proposed but is unlikely since the current 5 percent blend has yet to be reached. Federal government may permit the sale of biodiesel (B100) for blending with HSD to bulk consumers such as Indian Railways, State Transport Undertakings and other bulk consumers having minimum requirement of biodiesel for their own consumption by a tank truck load supply which shall not be less than twelve thousand liters. As part of the initial run, B-5 was expected to be sold to customers at some retail outlets in New Delhi, Vijayawada, Haldia, and Vishakhapatnam. The Biodiesel Purchase Policy was announced in October 2005 and became effective January 2006.
March 2017	The Cabinet Committee on Economic Affairs has approved closure/winding up of the biofuel venture between Chhattisgarh Renewable Energy Development Agency (CREDA) and Hindustan Petroleum Corporation Limited (HPCL) called CREDA HPCL Biofuels Ltd (CHBL) and the one between Indian Oil CREDA called Indian Oil CREDA Biofuels Ltd (ICBL).	The offices of CHBL/ICBL have been closed. Joint Ventures (JV) between CREDA HPCL Biofuel Ltd (CHBL) and Indian Oil-CREDA Biofuels Limited (ICBL) were formed for carrying out energy crop (Jatropha) plantation and production of biodiesel in 2008 and 2009 respectively. The CREDA, an arm of Chhattisgarh state government, had provided wasteland to CHBL and ICBL through Land Use Agreement for plantation of Jatropha. Due to various constraints such as very poor seed yield, limited availability of wasteland, high plantation maintenance cost etc. the project became unviable and Jatropha plantation activities were discontinued.
National Policy on Biofuels		
September 2008	5 percent blending mandatory across all states in the country	GOI deferred the plan again due to short supply of sugarcane and sugar molasses in 2008/09.

37. Amendment to Rule 115D of Central Motor Vehicles Rules, 1989

The Central Motor Vehicle Rules, 1989 were laid down as per the provisions of Central Motor Vehicle Act, 1988 that came into being in 1st July 1989. The Act has been divided into 15 Chapters, Central and State Governments are conferred with power under each chapter to make rules under the Act.

In exercise of the powers conferred by section 110 of the Motor Vehicles Act, 1988 (59 of 1988), the Central Government have amended rule 115D of the CMVR, 1989 to allow, “Retro-fitment of hybrid electric system or electric kit to Motor Vehicles”.

The draft notification was issued on 6th January 2016, however it took nearly three years in finalization of the amendment rule and it published on gazette notification on 1st March 2019. In the absence of vehicle scrappage incentives in most of the States, the said amendment is said to be a welcome move in context of EV adoption in country.

Through this amendment following category of vehicle are permitted for

i. Retro-fitment of Hybrid Electric System Kit
ii. Conversion of motor vehicles for pure electric operation with fitment of Pure Electric Propulsion Kit by replacing the engine of Motor Vehicles

However, such vehicle needs to conform to the compliance standard mentioned under AIS-123 (Part 1)/ (Part 2)/ (Part 3) as per applicability.

The manufacturer or supplier of hybrid electric system kit or pure electric system kit are held liable for obtaining the type approval certificate from a test agency specified in CMVR 126 for conforming to the AIS standard mentioned above.

38. Amendments to Model Building Bye-Laws, 2016

Ministry of Housing and Urban Affairs has notified Amendments in Model Building Bye-Laws (MBBL) - 2016 for EV charging infrastructure in February 2019. Key provisions of the same are highlighted below:

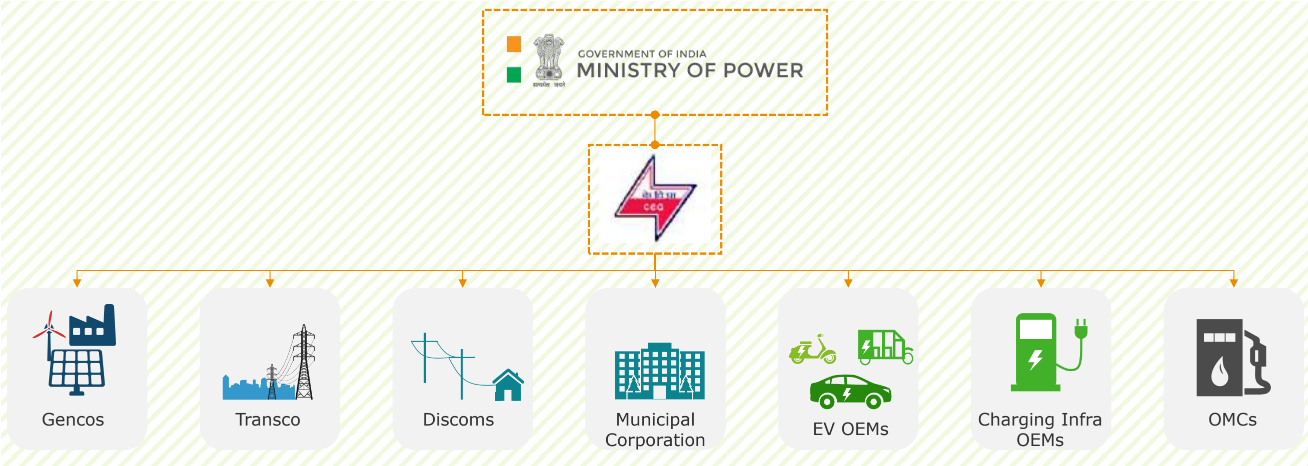
Table 71 MoHUA guidelines for public charging stations

Particulars	Details			
Parking bays for EV charging	Residential and commercial buildings to allot about 20% of their parking space for EV charging infrastructure.			
Power load for EV charging	Building premises should have additional power load equivalent to the power required for all charging points to be operated simultaneously with a safety factor of 1.25.			
No of slow and fast chargers	**4W**	**3W**	**2W**	**PV (Buses)**
	One slow charger for 3 EVs One fast charger for 10 EVs	One slow charger for 2 EVs	One slow charger for 2 EVs	One fast charger for 10 EVs

Source: Ministry of Housing and Urban Development(MoHUA), February 2019, "Amendments in Building Bye-Laws (MBBL-2016) for Electric Vehicle Charging Infrastructure"

39. CEA Stakeholders for forming EV charging regulations

Figure 217 CEA stakeholders for forming EV charging regulations



40. Vehicle categories

Table 72 Vehicle categories and description

Sr. No.	Category	Description
1.	Category A	Agricultural Tractor; Means any mechanically propelled 4-wheel vehicle designed to work with suitable implements for various field operations and / or trailers to transport agricultural material. Power tillers are included in this category.
2.	Category C	Construction Equipment Vehicle; Means rubber tyred (including pneumatic tyred), rubber padded or steel drum wheel mounted, self-propelled, excavator, loader, backhoe, compactor roller, dumper, motor grader, mobile crane, dozer, fork lift truck, self-loading concrete mixer or any other construction equipment vehicle or combination thereof designed for off-highway operations in mining, industrial undertaking, irrigation and general construction but modified and manufactured with " on or off" or " on and off" highway capabilities
3.	Category L1	Motorcycle with maximum speed not exceeding 45 km/h and engine capacity not exceeding 50cc if fitted with thermic engine or motor power not exceeding 0.5 kilo watt if fitted with electric moto
4.	Category L2	Motorcycle other than Category L1
5.	Category L3	Two-wheel motorcycle with an engine cylinder capacity in the case of a thermic engine exceeding 50 cm3 or whatever the means of propulsion a max. design speed exceeding 50 km/h. with more than 50 cc and speed of more than 50 kmph
6.	Category L5	A three wheeled motor vehicle with maximum speed exceeding 25 kmph and engine capacity exceeding 25 cc if fitted with a thermic engine, or motor power exceeding 0.25 kW if fitted with electric motor. This vehicle is normally used for: ✓ carrying persons; or, ✓ carrying goods
7.	Category L5M	Passenger carrier (Auto rickshaw) and Gross vehicle Weight is equal to 1500 kilograms. A three-wheeler on account of its technical features intended to carry passengers.
8.	Category L5N	A three-wheeler on account of its technical features intended to carry goods.
9.	Category M	A Motor vehicle with at least four wheels used for carrying passengers

Sr. No.	Category	Description
10.	Category M1	A vehicle used for carriage of passengers, comprising not more than eight seats in addition to the driver's seat
11.	Category M2	A vehicle used for carriage of passengers, comprising nine or more seats in addition to the driver's seat, and having a maximum Gross Vehicle Weight (GVW) not exceeding five ton
12.	Category M3	A vehicle used for the carriage of passengers, comprising nine or more seats in addition to the driver's seat and having a GVW exceeding 5 ton
13.	Category N	A motor vehicle with at least four wheels used for carrying goods. These vehicles can carry persons in addition to the goods.
14.	Category N1	A vehicle used for carriage of goods and having a GVW not exceeding 3.5 ton
15.	Category N2	A vehicle used for the carriage of goods and having a GVW exceeding 3.5 ton but not exceeding 12 ton
16.	Category N3	A vehicle used for the carriage of goods and having a GVW exceeding 12 ton
17.	Category T1	A Trailer having a maximum weight not exceeding 0.75 ton
18.	Category T2	A trailer having a maximum weight exceeding 0.75 ton but not exceeding 3.5 ton
19.	Category T3	A trailer having a maximum weight exceeding 3.5 ton but not exceeding 10 ton
20.	Category T4	A trailer having a maximum weight exceeding 10 ton
21.	Category T5	A semi-trailer intended to be drawn by a three-wheeled haulage tractor

Source: 159 AIS-053: 2005 (Amendment 07 (08/2018))- Automotive Vehicles -Types –Terminology (access here)

41. Fuel efficiency for Heavy Duty Vehicles (HDVs)

I. Phase I – Effective from 1st April 2018

Table 73 Category N3- Rigid vehicles at 60 km/h

N3 Rigid vehicles at 60 km/h		
Gross vehicle weight range	Axle configuration	Equation for deriving target fuel consumption (l/100km)
12.0-16.2	4x2	Y=0.788X+9.003
16.2-25.0	6x2	Y=0.755X+9.546
16.2-25.0	6x4	Y=1.151X+3.122
25.0-31.0	8x2	Y=0.650X+12.160
25.0-31.0	8x4	Y=0.968X+7.692
31.0-37.0	10x2	Y=0.650X+12.160

Table 74 Category N3- Tractor Trailer vehicles at 40 km/h

N3 Tractor Trailer at 40 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
35.2-40.2	4x2	Y=0.986X-7.727
40.2-49.0	6x2	Y=0.628X+6.648
40.2-49.0	6x4	Y=1.255X-18.523

Table 75 Category N3- Tractor Trailer vehicles at 60 km/h

N3 Tractor Trailer at 60 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
35.2-40.2	4x2	Y=0.208X+32.198
40.2-49.0	6x2	Y=0.628X+15.298
40.2-49.0	6x4	Y=1.342X-13.390

Table 76 Category M3- Vehicles at 40 km/h

M3 Vehicles at 40 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
12.0 and above	4x2 and 6x2	Y=0.509X+11.062

Table 77 Category M3- Vehicles at 60 km/h

M3 Vehicles at 60 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
12.0 and above	4x2 and 6x2	Y=0.199X+19.342

II. Phase II – Effective from 1st April 2021

Table 78 Category N3– Rigid vehicles at 40 km/h

N3 Rigid vehicles at 40 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
12.0-16.2	4x2	Y=0.329X+9.607
16.2-25.0	6x2	Y=0.523X+6.462
16.2-25.0	6x4	Y=0.673X+4.032
25.0-31.0	8x2	Y=0.430X+8.780
25.0-31.0	8x4	Y=0.732X+2.558
31.0-37.0	10x2	Y=0.963X-7.753

Table 79 Category N3– Rigid vehicles at 60 km/h

N3 Rigid vehicles at 60 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
12.0-16.2	4x2	Y=0.600X+9.890
16.2-25.0	6x2	Y=0.515X+11.271
16.2-25.0	6x4	Y=0.932X+4.515
25.0-31.0	8x2	Y=0.382X+14.598
25.0-31.0	8x4	Y=1.318X-5.148
31.0-37.0	10x2	Y=1.043X-5.913

Table 80 Category N3– Tractor Trailer vehicles at 40 km/h

N3 Tractor Trailer at 40 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
35.2-40.2	4x2	Y=0.826X-3.165
40.2-49.0	6x2	Y=0.630X+4.732
40.2-49.0	6x4	Y=1.008X-10.480

Table 81 Category N3– Tractor Trailer vehicles at 60 km/h

N3 Tractor Trailer at 60 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
35.2-40.2	4x2	Y=0.260X+27.888
40.2-49.0	6x2	Y=0.2364X+28.838
40.2-49.0	6x4	Y=0.563X+15.728

Table 82 Category M3– Vehicles at 40 km/h

M3 Vehicles at 40 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
12.0 and above	4x2 and 6x2	Y=0.659X+6.582

Table 83 Category M3– Vehicles at 60 km/h

M3 Vehicles at 60 km/h		
Gross vehicle weight range	**Axle configuration**	**Equation for deriving target fuel consumption (l/100km)**
12.0 and above	4x2 and 6x2	Y=0.340X+14.300

42. Innovations to curb air pollution

Table 84 Innovation to curb CO_2 emission

Air Ink by Graviky Labs

- Graviky Labs have developed "Air Ink" which is made entirely out of pollution. They capture air pollution with their retrofit technology from diesel generators, other fossil fuel chimney stacks, ambient air etc. It can be customized for all sizes and use-cases for outdoor pollution capture.[124]

Odd-even policy by Govt. of NCT of Delhi

- The Government of NCT of Delhi implemented odd-even scheme with the objective of reducing air pollution in Delhi. The policy was first introduced for five days in November 2015.
- Under the policy, odd numbered vehicles would move on odd numbered days, while even numbered vehicles would move on even numbered days.

[124] Graviky (access here)

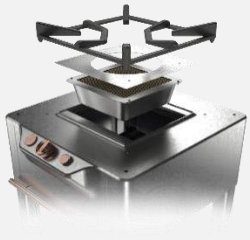
Chakr Innovation
Revolution through pollution

From pollution to product by Chakr

- Chakr Innovation have developed world's first retro-fit emission control device for diesel generators. It captures ~90% of particulate matter emissions from the exhaust air without reducing energy efficiency. The diesel soot captured from the exhaust is converted into inks and paints.[125]

Solar Ferry by NavAlt

- Founded in 2013 NavAlt Solar & Electric Boats Pvt. Ltd envision towards efficient water transport system which doesn't use fossil fuels. The company build India's first solar ferry, ADITYA for Kerala State Water Transport Department. This ferry is the first commercially viable mode of transport powered by solar energy in India and the world.[126]



Energy efficient radiant heat gas burners by Agnisumukh

- Agnisumukh has built an energy efficient burner system that reverses the conventional gas fuel mechanism. The burner not only suits the cook pot but also emits flameless horizontal radiant heat at a low gas pressure without producing any carbon soot. Their burners are flameless, smokeless, noiseless, and produce uniform radiant heat. The device has been tested and certified by LERC at a thermal efficiency, under IS 14612, between 65-68.9% as against conventional commercial gas burners with efficiency rating between 36-45%.[127]

Carbon capture to concerete by Blue Planet

- Blue Planet's technology uses CO_2 as a raw material for making carbonate rocks. The carbonate rocks produced are used in place of natural limestone rock mined from quarries, which is the principal component of concrete. CO_2 from flue gas is converted to carbonate (or $CO_3=$) by contacting CO_2 containing gas with a water-based capture solution. Using this method, they produce lightweight coarse and fine aggregate, available for residential and commercial construction, sack concrete, roofing granules, high solar-reflective cool pigments, titanium oxide and many others.[128]

43. Vehicle safety standards and regulations

Domestically manufactured vehicles in India required to comply with Indian Standards (IS) and Automotive Industry standards (AIS). The safety standards are divided into two parts: Active safety and passive safety.

Active Safety Systems provides advance warning or additional assistance to the driver in steering/ controlling the vehicle. Whereas, Passive safety system, does not actively participate in continuous assistance but comes to action only when needed.

[125] Chakr (access here)
[126] NavAlt (access here)
[127] Agnisumukh (access here)
[128] Blue Planet (access here)

Some examples of Active safety systems are ABS (Anti-lock braking system), ESC (Electronic Stability Control), ACC (Adaptive Cruise Control), LDW (Lane Departure Warning) etc. Examples of Passive safety system are Airbag, seat belt, Child Safety Systems (CSS)

Table 85 Active and passive safety standards

Active Safety		
1.	Steering Gear	CMV Rule – 98, IS:11948
2.	Horn Performance	CAA/ Rule-119, IS:1884
3.	Horn Installation	CMV Rule-119, AIS-014
4.	Drivers Field of Vision	CMV Rule-124-34, AIS:021
5.	Speedometer	CMV Rule-117, IS:11827
6.	Rear View mirror Performance	CMV Rule-125, AIS-002
7.	Tyre Performance	CMV Rule-96, AIS:044
8.	Tyre Installation	CMV Rule-95, AIS:061
9.	Condition of Tyres	CMV Rule-94
10.	Brakes Fitment	CMV Rule-96
11.	High Speed Brake Requirements	CMV Rule-96B
12.	Brakes Requirements	CMV Rule-96, IS:1852
13.	Lighting Signalling Installation	CMV Rule-124-20, AIS
14.	Lighting Signalling Performance	CMV Rule-124-20, AIS:012
15.	Hydraulic Brake Hose	CMV Rule-123-2, IS 18654
16.	Wheel Rims	CMV Rule-123-8, IS 9436
17.	Wheel nut disc & Hub caps	CMV Rule-124-14, IS-13941
18.	Hood Latch	CMV Rule-124-17, IS 14226
19.	Tell Tale Symbols and Control	CMV Rule-124-15, SS:12.1
20.	Acc. Control System	CMV Rule-124-15, 14283
21.	Windscreen Wiper	CMV Rule-101, AIS:019
22.	Wheel Guards	CMV Rule-124-13, IS:13843
23.	Bumpers	CMV Rule-124-41, AIS:006
24.	Arrangement of Foot Controls	CMV Rule-124-45, AISL035
25.	Gradeability	CMV Rule-124-23, AIS:003
26.	EMI	CMV Rule-124-21, AIS 004
Passive Safety		
1.	Safety Belt	CMV Rule-125,AIS:005
2.	Safety belt, Anchorages	CMV Rule-125, AIS:015
3.	Seats, their Anchorages and Head Restraints	CMV Rule-125, AIS:016
4.	Exterior Projections	CMV Rule-124-11, IS:13942
5.	Fuel Tank- Non Plastic	CMV Rule-124-7, IS:12056
6.	Interior Fittings	CMV Rule-138-a, IS-15223
7.	Safety Glass	CMV Rule-100, IS:2563

8.	Steering impact GVW up to 1.5t	CMV Rule-124-5, IS:11939
9.	Side door impact	CMV Rule-124-6, IS:12009
10.	Door Locks & retention components	CMV Rule-124-16, IS:14225
11.	Fuel Tank Plastic	S.O. 1431 dt. 20th Aug 2007, IS: 15547

Source: 160 SIAM

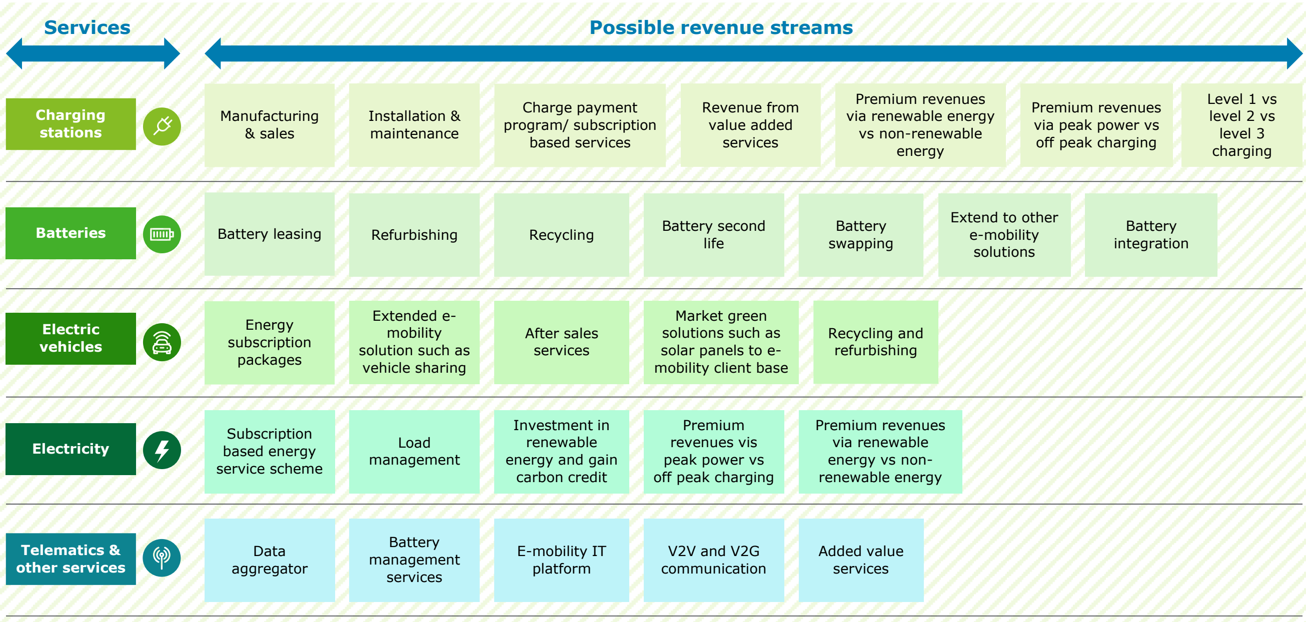
Along with these standards, India has mandated airbags, anti-lock braking system (ABS), speed limit indicators all new vehicles

6.4 Chapter 4 Review of Services and Business Models in electric mobility

44. EV charging business model

As the market of electric mobility will develop, business operating in the segment will also evolve. In the chapter, we discussed business models that are promoting uptake of EVs within the customers. However, for investors and business operating in the electric mobility segment, there are multiple potential revenue streams within the EV ecosystem which can be explored. Some of such revenue streams are provided in the figure below.

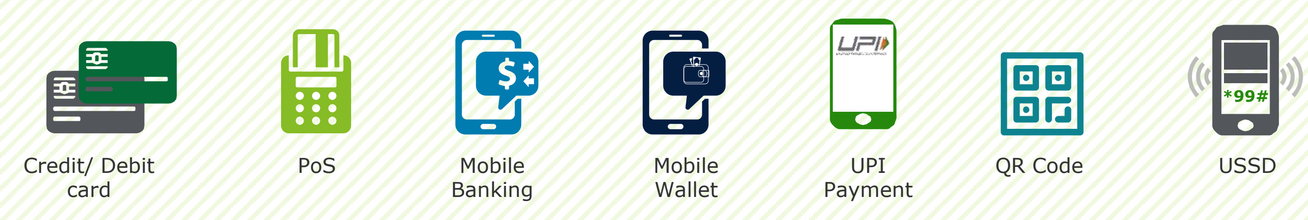
Figure 218 Potential revenue streams for business in the electric mobility ecosystem



Source: 161 F&S - 360 Degree Perspective of the Global Electric Vehicle Market Opportunities and New Business Models (access here)

45. Payments services

Figure 219 Payment methods for enabling electric mobility services



Source: 162 Cashless India, Deloitte analysis

Note: PoS: Point of Sale; UPI: Unified Payment Interface; USSD: Unstructured Supplementary Service Data

A. Card payments

Card payments are one of the widely used mode for transaction in India. Cards are categorised into two categories: Debit card & Credit card.

A debit card is a payment card in which money is deducted directly from the customer's bank account to pay for a purchase, whereas credit card enables the cardholder to borrow funds from the financial institution for the payment towards purchase of goods and services.

These cards eliminate the hassle of carrying cash and are convenient for making transaction. These can be used at PoS (Point of Sale) machines, ATMs, Micro ATMs, Shops, wallets, online transactions, and for e-commerce websites.

B. PoS (Point of Sale) payment

This type of payment is done using Point of Sale (PoS) machine, generally placed at merchant stores. In PoS payment, customer prefers to pay for the goods and service digitally using card or mobile and the merchant, using the PoS machine process the transaction.

In the PoS machine, transaction is done either by swiping the card or by using NFC (Near Field Communication).

In swipe transaction, the card is inserted into the machine and the PoS machine reads its magnetic fields and matches it with the customer's bank account information.

Whereas, In NFC (Near field communication), contactless communication takes place between the PoS machine and NFC card or smartphone. Here the customer one needs to wave the card/ smartphone over the NFC compatible PoS device to send information without needing to touch the devices together. Example of NFC based payment is Samsung NFC Payment; ICICI touch and Pay etc.

Figure 220 Swipe transaction at PoS

Figure 221 Transaction using NFC at PoS

C. Mobile Banking payment

Mobile banking is a digital payment method used by customers to pay for the purchased goods and services. In mobile banking, customers make financial transactions with the help of mobile apps developed by banks/ financial institutes. Some of the example of mobile banking apps are SBI YONO, ICICI iMobile, Standard Chartered SC Mobile etc.

D. Digital Wallet payment

A mobile wallet is a virtual wallet that stores user's money electronically and use it when needed. Mobile wallet needs a smartphone and internet connected to operate. It is one of the most convenient option to pay online for the purchase of goods/ service.

Mobile wallets are categorized into three categories: Open wallet; Closed wallet; and, Semi-closed wallet

Open wallet	Open wallet allows user to carry multiple operations such as purchase of goods and services, withdraw of cash at ATM, deposit money, fund transfer etc. *E.g. M-Pesa by ICICI Bank and VMPL (Vodafone M-Pesa Limited)*
Closed wallet	In this wallet, amount of money is locked with the merchant to place order, use in case of a cancellation or return of the order, or gift cards. *E.g. MakeMyTrip Wallet*
Semi-closed wallet	This wallet does not permit cash withdrawal but allows users to buy goods and services at the listed merchants. *E.g. Paytm, OLA Money*

E. UPI payment

Unified Payments Interface (UPI) is a system which connects multiple bank accounts into a single mobile application for immediate money transfer through mobile device round the clock 24x7 and 365 days. It uses a single mobile application for accessing different bank accounts.

Electric mobility service providers can use UPI apps for receiving payments for their services from the customer.

E.g. BHIM app

F. QR code payment

Quick Response Code (QR code) is a 2D matrix barcode that stores encoded information such as hyperlinks to website pages, app downloads, etc. Users can decode it simply by scanning the QR code image using any device with built-in camera and QR code reader application installed.

Bharat QR, developed by NPCI (National Payment Council of India), is the widely used QR solution in India. Electric mobility merchants can display these QR codes at their premises and customers can pay through linked account by scanning these QR codes via Bharat QR enabled application.

Figure 222 QR payment

Source: 163 Payment expert

G. USSD (Unstructured Supplementary Service Data) payment

Launched in 2012, USSD is a mobile banking service catering to immediate low value remittances. Unlike other mobile banking services, USSD does not require internet service and works on network provided by telecom operator. In USSD, customers access financial services by dialling *99# from their mobile number registered with the bank.

46. Summary of mobility business models

In Chapter 4, we have reviewed various business models in the mobility space. Each of the business model is unique in its own way. Some of them are tailored for short distance ride, while in others, customer may use vehicle for long journeys and can even keep the vehicle for months.

In the figure provided below, summary of mobility business models is represented:

Figure 223 Summary of mobility business models

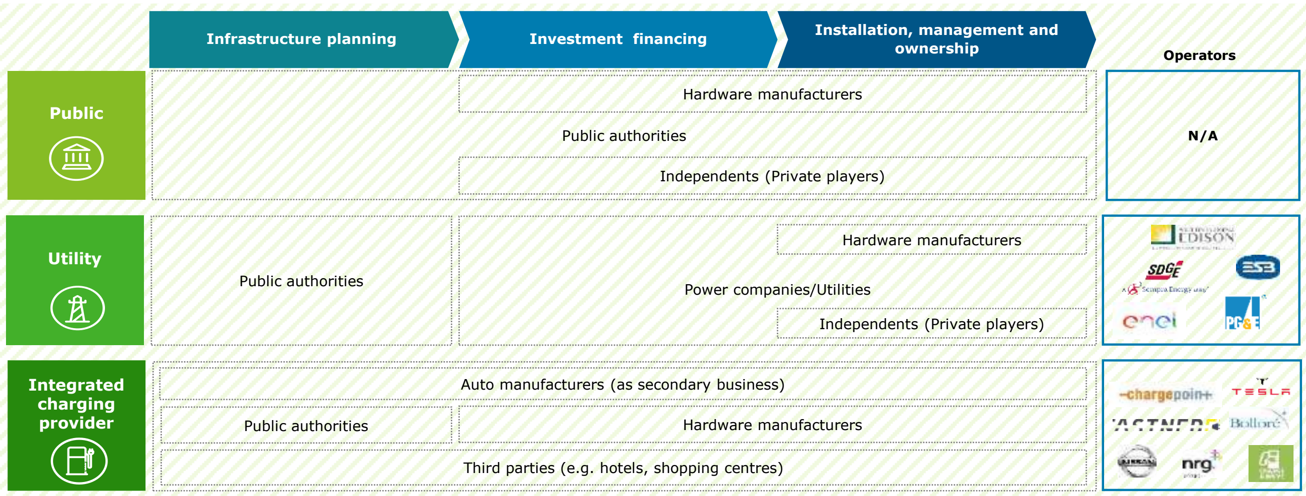
	Particular	Micro-mobility	Ride Hailing	Car Sharing	Ride Sharing/ Carpooling	Car Subscription
1	Value proposition	Affordable short distance trips	Convenient, safe, and affordable transportation	Short-term car rental	Economical travel	Personal mobility experience
2	Vehicle ownership	Company	Driver	Company; Private owners	Private owners	Company; private owner
3	Travel distance	Short	Short-Medium	Medium-Long	Short-Medium	Medium-Long
4	Cost & convenience	Low	High	Medium	High	High
5	Customers	Short distance travelers; Delivery	Daily commuters; Corporates	Point to point commuters; Corporates	Daily commuters	Travelers
6	Disadvantage	-	Costly	Less flexible; Costly	No personal mobility experience	Expensive for longer tenure
7	Value addition by EV	High	High	Medium-High	Medium	Medium-High

As noticed from above figure, electric vehicles hold strong potential to add value in the existing mobility business models.

Growth in the mentioned business models is expected to trigger higher adoption of electric vehicles.

47. EV charging infra business models

Figure 224 Snapshot – Key global EV charging business models



Source: 164 Deloitte analysis

A. Public authority

Public authority plays vital role in development of EV infrastructure, especially during the early stage of adoption. The authority uses its budget to plan for the infrastructure and deploy charging stations in public place using public procurement process. In some cases, the authority however contracts out specialist companies to manage the charging network. NDMC (Delhi) and BBMP (Bengaluru) are good example of them.

B. Power utility

Power utility is an essential player in EV charging ecosystem. It is the public utility that provides connectivity to the charging stations as it requires significant power output from the grid. Growth in adoption of EV charging business is beneficial for utilities as they may experience growth in their revenue stream.

Internationally, it is observed that other than providing connectivity to the charging stations, utilities are joining hands with EV charging ecosystem players and investing in development of EV charging stations. Utilities are adopting three key business models to participate in EV charging business: Franchisee model; Power Supplier model; Lease model

C. Vehicle manufacturers

Players in vehicle manufacturing provides customers with charging solutions. Many EV manufacturers are actively working on development of public charging solutions by partnering with CPOs, fleet owners, dealerships and/ or charging hardware manufacturers.

These players offer integrated charging services with the purchase of the EV. This includes access to public charging networks at a reduced price and includes a private charging wall box with the purchase of the vehicle.

Pricing models usually used by these players in charging infrastructure includes discounting charging as part of the vehicle or including access to a closed or public charging network with the purchase.

Some of the major EV manufacturers with focus on EV charging business are:

Tesla

Nissan

Renault

BMW

Box 30: Case Study – Tesla Supercharger Network

The Tesla Supercharger network of fast-charging stations was introduced beginning in 2012. As of March 2020, Tesla operates ~16,000 Superchargers in 1,826 stations worldwide. Tesla has installed Superchargers in urban areas where city dwellers and out of town visitors can charge their EVs. These stations are placed through partnerships at convenient locations viz. grocery stores, commercial centres, restaurant chains, shopping complexes, etc.

Independent of the Superchargers, Tesla also has Destination chargers. As of September 2019, Tesla has distributed 23,963 destination chargers to locations (such as hotels, restaurants, and shopping centers) worldwide. These chargers are slower (typically 22kW) than Superchargers and are intended to charge cars over several hours. These chargers are typically free to Tesla drivers who are customers of the business at the location.

The benefits of offering credits to superchargers results in EV buyers to buy Tesla models more rather than from a lower cost competitor who does not have a robust charging network. Increased sales cover the costs of installation and maintenance of Tesla superchargers. Consumers then prefer to buy less of non-Tesla models since Tesla models offer mileage and convenience of fast charging along various locations.

Source: 165 Image: teslarati

D. Location owners

Location owners can be divided into two types: governmental locational owners and private owners.

Local government provides its spaces for development of EV charging station and in turn encourages its public to use EV.

Private players are mostly the retail businesses aiming at the B2C market. Typically, these players enter in the electric mobility market from partnerships with charging point operators or hardware players to give access to a location where the charging point equipment can be installed. The locational players rent, sell or partners with charging service providers to provide customers with a charging service in addition to their core service offering of the co-located retail business.

E. Indian players

Fortum India

Fortum, an electricity retailer in the Nordics, ventured in India in 2012. The company brought their "Charge & Drive" offering in India, outside Europe for the first time. Fortum Charge & Drive is highly advanced solution for operating a charging network. The company operates a widespread DC fast public charging network. It also offers cloud based EV charger management system. Fortum is currently present in selected cities such as Delhi, Noida, Gurugram, Hyderabad, Ahmedabad, Mumbai, and Bengaluru. The company operates in 40 locations, with 43 chargers and 73 charging points[129].

[129] Fortum Charge & Drive (access here)

Value proposition		• Fast DC charging; IT enabled network; cloud-based charger management
Value creation	**Key partnerships:**	• Partnership with MG for installation of DC fast charging
	Key resources:	• DC fast chargers
	Key processes:	• Turnkey installation/ operation/ maintenance • Customer service • End-user operation
Value communication	**Story/ Channel for communicating value:**	• Website • Mobile App
Value capture	**Cost structure:**	• Operation and maintenance of charging station/ charger
	Revenue stream:	• Energy charge (INR/ kWh) for vehicle charging (Pay-as-you-Go basis)
Value Delivery	**Distribution channels:**	• Mobile app to navigate driver to nearest charging point
	Customer segments:	• EV owners

48. Contract decision framework parameters

Table 86 Decision framework to selected suitable PPP contract for e-bus procurement

Sr. No.	Parameter	Definition
1.	Load factor on routes	This parameter takes into account the average load factor cumulatively on all the routes.
2.	Overlap of routes	This parameter pertains to the presence of multiple bus operators in a city, often leading to deployment of multiple operators on a route or overlapping of multiple routes.
3.	Authority's control over service and network plan	The contracting authority's ability to make changes to the service and network plan varies with the type of contract
4.	Integration of different modes	There may be multiple modes of transport in a city. Integration among these modes of transport and coordination among the various agencies responsible for respective mode is important to provide seamless public transport to users.
5.	Competing Modes	Competing modes refer to the presence of multiple modes such as metros, BRTS, intermediate public transport (IPTs), etc. Higher number of competing modes lead to a higher score since competition leads to less load factor on buses. However, as IPTs are prevalent in every city in India, the minimum score will be one (1).
6.	Fund Allocation for the entire term of contract	It is important to demonstrate the allocation of funds by the contracting authority to undertake city bus private operation for the entire term of the contract, which covers initial financing as well as financing during the operational period. If the envisaged funds are to be provided by a government entity other than the contracting authority, approval from such entity shall also be obtained prior to initiating the bidding.
7.	Provision of dedicated funding	To provide an additional level of comfort to the operators and their lenders, it is preferable to provide for dedicated funding arrangements

Sr. No.	Parameter	Definition
		such as Urban Transport Fund or any other alternative mechanisms to undertake the project.
8.	Credit Rating	Credit Ratings assess the financial health including debt repayment ability, ability to recover the cost of services and track record of service delivery among other things. This should cover the contracting authority, municipal body or any other government entity responsible for financing city bus operations, either in full or part. A higher rated agency is better able to cover its liabilities.
9.	Creation of SPV	Incorporation of SPV that is fully functional to undertake public bus transport in the city.
10.	Adequacy of Staff for Bus Transport	Adequate staffing of the contracting authority to undertake the project for tasks such as contract management, monitoring the project, technical staff to verify physical conditions at depot, etc. A well-staffed contracting authority shall have employees for control room functions, monitoring functions and project administration functions.

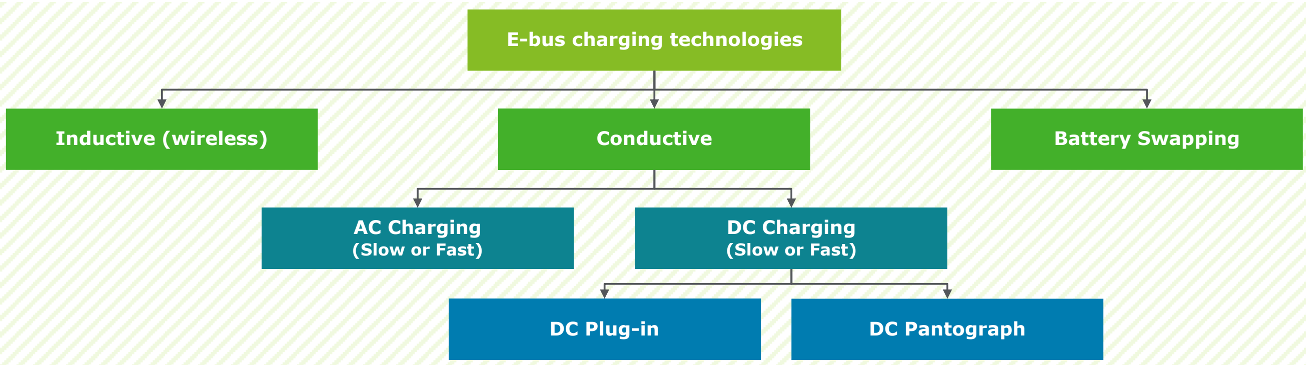
Note: Using the above listed parameters, most suitable PPP contract can be determined. Please refer to Guidelines for participation by private operators in the provision of city bus transport services (access here) to under the calculations in detail.

49. Charging of E-buses

Charging technologies for e-buses

Globally, there are multiple charging technologies deployed for charging e-buses, there could be multiple ways to segregate the charging technologies on the basis of method of electricity transfer, power output levels, control and communication capabilities, etc. However, broadly the charging methodology differs in way electricity transfer from grid to the electric bus. It can be majorly classified as plug-in charging (dominant), battery swapping, and inductive charging technologies.

Figure 225 Classification of e-bus charging methodologies based on way of electricity transfer



Source: 166 Deloitte analysis

Based on the charging speed and capacity, charging technologies could also be categorized as fast and slow charging. The definitions of fast and slow charging may differ by country, but the speed can be measured by C-rates, or the rate of charge and discharge as compared to the capacity of the battery. Based on the location of usage, charging can be classified as depot/terminal charging and on-route or opportunity charging. **Depot charging** usually occurs overnight for hours or during the day for around an hour during bus shift. **Terminal charging** usually occurs after the bus finishes one trip and normally takes only minutes to partially recharge. Plug-in charging is most commonly used for depot/terminal charging. On-route or **Opportunity charging** can be plug-in or inductive. Plug-in chargers use an automatic connection that may link buses to high-capacity overhead chargers (used in Berlin, Germany). Inductive chargers are wireless and use specially equipped pads on the road and underbelly of the bus to transfer electricity (used in Gumi, South Korea, and in Turin, Italy). Opportunity charging allows buses to remain in use without returning to an off-route service centre for battery charging throughout the day. Further, ABB have developed **flash**

charging method as well, that has been deployed in Geneva and is said to fully charge the e-bus in 15-20 seconds[130].

Deployment of charging stations in a meticulous way is critical for a bus service provider to achieve smooth operation of its e-bus fleet and make the corresponding electrification investment worthwhile. In order to make a seamless transition to electric mode, it is imperative that the establishment of required charging infrastructure is planned in advance and with enough due diligence. Among the different operating factors, the range of an e-bus and charging time could potentially impact the service of a public bus fleet.

AC conductive Charging

An EV can be charged by conductive AC charging technology provided the e-bus has an on-board charger that can convert AC supply from grid to DC power for charging the vehicle battery. AC charging is the most prevalent type of charging since the grid supplies the electricity in AC. Further, AC charging technology offers better cost advantage over DC charging, where the cost of the converter and other auxiliary equipment adds to the charger cost. However, AC charging is only possible when the vehicle has an on-board charger, and the capacity of the on-board charger limits the capacity of AC charging. AIS 138 (Part 1) prescribes the specifications for performance and safety for AC charging Stations for EV and HEV application for Indian conditions. The Ministry of Power vide its letter no. 12/2/2018/EV dated 1st October 2019, prescribed fast charging station for public charging infrastructure with at least two charger of minimum 100 kW (200-750 V or higher) each of different specification (CCS/CHAdeMO or any fast charger approved by DST/BIS for above capacity) with single connector gun[131].

DC charging

On the basis of design of the charging systems, DC chargers are classified as plug-in or pantograph. This categorisation is irrespective of the charging power level. A key advantage of DC charging over AC charging is the DC charging does not require on-board charger in the e-bus. Only in case of continuous charging via catenary, on-board chargers would be required.

[130] Flash-Charging Electric Public Transport: TOSA Buses, Centre for European Policy Studies
[131] Ministry of Power - Charging Infrastructure for Electric Vehicles (EV) - Revised Guidelines (access here)

Box 31: Case Study – Vienna on board DC charger: on-line charging via catenary

Vienna is striving to be a leader in green transport. In its e-mobility strategy of 2012, it sets the aim to reduce personal motorised transport to less than 20% in 2025. Wiener Linien is the company running most of the public transit network in the city of Vienna, Austria. In October 2012, Wiener Linien has started commercial operation of e-buses in two bus routes with 12 buses which are charged continuously via catenary. The buses recharge at their end stations by hooking up to the overhead lines of the Viennese tram using an extendable pantograph, an arm on the roof.

The overhead lines from the tram system supplies direct current, however alternating current is required to recharge the bus. As the bus needed to connect to the power lines without additional equipment, both the charger and inverter were requested to be included in the bus – a feature which had not been available on the market until then. Siemens provided the solution; the direct current is converted to alternating current by an IGBT power inverter included on the bus. Each bus with 96 kWh battery reportedly takes 6 - 8 minutes for charging per cycles, during which passengers can get off and on the bus. At night, the batteries are recharged at the depot.

With this recharging technique, it is possible to install a smaller battery system (nine lithium iron phosphate batteries with a total capacity of 96 kWh instead of the 180 kWh electric buses usually need).

Source: 167 Siemens eBus Charging Infrastructure (access here); Innovative Electric Buses in Vienna (access here)

DC plug-in charging

DC plug-in charging enable DC charging by a plug-in connection. AIS 138 (Part 2) prescribes the specifications for performance and safety for DC charging Stations for EV and HEV application for Indian conditions. Fast chargers for electric vehicles make use of DC charging; they convert the power before it enters the vehicle. After conversion, the power goes directly into the car battery, bypassing the car's converter.

A DC installation requires more power (as compared to AC installation) from the grid (around 125 A)[132]. This makes its costs (production, installation, and operation) quite high, resulting in higher tariffs for charging. A DC charging station is technologically much more complex and many times more expensive than an AC charging station (a study[133] suggest that deployment of DCFC station cost $64,158, for AC charging station it cost $12,875). In addition, a DC charging station requires to communicate with the car instead of the on-board charger in order to be able to adjust the output power parameters according to the condition and capability of the battery.

However, as it usually allows for much faster charging, it is the preferred charging method to quickly recharge during long-distance trips.

DC pantograph charging

This category includes DC charging via pantograph with on-board bottom-up or off-board top-down configuration. DC pantograph charging technology is expensive and requires auxiliary infrastructure including distribution transformer (DT), associated LT and HT switchgear, cables, protection system, SCADA system. Such type of charging is suitable for opportunity charging.

[132] AC Charging vs DC Charging (access here)
[133] Electric Vehicle Charging Infrastructure Deployment Guidelines British Columbia (access here)

Opportunity charging (low/high power) consists of charging the bus along the line, either at selected bus stops or at the head/end of the line using inductive or conductive charging. Both technologies allow quick charging through high power. The bus can either charge when needed along the line at the available charging points or is required to charge along the line at pre-identified charging points. Batteries need to fully recharge overnight as well. This charging strategy enables the operator to use small batteries, but they have to be suitable for high power.

The ABB has developed and installed flash charging system as opportunity charging for e-buses in Geneva. In the time e-bus takes for passengers to get on and off the bus, a laser-guided arm sends 600 kW straight into on-board lightweight batteries with flashing technology developed by ABB. The charge allows for the propulsion until the next bus / next charging station. Box provided below represents details of DC pantograph-based flash charging technique for en-route opportunity charging.

Box 32: Case Study – Flash-Charging Electric Public Transport: Opportunity charging

TOSA (Trolleybus Optimisation Système Alimentation) flash charging technology has been developed by ABB and it is in operation in Geneva. The city of Geneva employs DC pantograph-based technology for charging trolley e-buses.

In July 2016, ABB has been awarded orders totalling more than $16 million by Transports Publics Genevois (TPG), Geneva's public transport operator, and Swiss bus manufacturer HESS, to provide flash charging and on-board electric vehicle technology for 12 TOSA fully electric buses. ABB piloted e-buses on the route connecting the city's airport to suburban areas of Geneva.

There are two types of chargers along the route:

1. Flash-charging stations at selected stops, which provide a short high-power boost at 600 kW for 15 to 20 seconds.
2. Terminal feeding stations, which deliver prolonged charges of 4-5 minutes at 400 kW to fully top-up the on-board batteries

When Bus stops at charging stations equipped with a converter, fed by alternating current (AC) from the utility grid and delivering direct current (DC) to the e-bus, a laser-controlled arm on the roof connects in less than a second to an overhead receptacle built into the bus shelter. The connection provides a high-power charge – using a feed of up to 600 kilowatts. The boost recharges the battery enough to let the bus continue on its way. To ensure public safety, the high-voltage overhead connectors are energized only when the battery is being recharged.

Source: 168 ABB's innovative flash-charging technology ushers in a new era of sustainable public transportation (access here); Flash-Charging Electric Public Transport: TOSA Buses, Centre for European Policy Studies

Inductive Charging

Inductive charging is also used as opportunity charging method like DC pantograph charging technique. However, in inductive charging there is no physical contact established between electric bus and the power source. The inductive charging category includes all charging technologies which achieve wireless transfer of electricity, either by static or dynamic induction. As far as economics is concerned, inductive charging technology using underground power delivery systems are found to be expensive, although the required area for installation is minimal (in Sweden, ElectReon is developing 11 million[134] Euros smart road project covering 4.1 km of road, enabling trucks and buses on highway to get inductively charged). These systems

[134] Will Inductive charging be the future of EV charging (access here)

require auxiliary infrastructure including special high- frequency transformer, associated LT and HT switchgear, cables, protection system, SCADA system, vehicle alignment monitoring system, etc.

This technology is still evolving and very few examples exist worldwide of using wireless technology for electric bus charging. It has been successfully deployed in Gumi, South Korea. Few examples also exist in USA. Below box provides the case study of inductive charging technology deployed at Gumi.

Box 33: Case Study – Korean OLEV system: inductive charging

The city of Gumi, South Korea have deployed in e-buses in 2014, where the fleet is charged via induction. The Korea Advanced Institute of Science and Technology (KAIST) developed the Online Electric Vehicle (OLEV) platform used for charging e-bus batteries under a $69 million funding from the government. Every On-Line Electric Vehicle (OLEV) e-bus is equipped with a special receiver which can collect electric power wirelessly from the underground power supply while in motion or at the stationary condition. When an induction-capable bus passes over that charging plate, the two magnets become "tuned," and current flows to charge the on-board battery.

The route is although 15 miles on which this technique is operational. It is using 100 kW charging system. However, in USA Momentum Dynamics Company is working on 200 kW and 300 kW charging system as well. With a 6.7-inch gap between the road and the bus, there's 85 percent charging efficiency reported in Gumi.

Source: 169 South Korea - Wireless Charging Powers Electric Buses (access here); Wireless Charging of Electric Bus in Gumi (access here); Economic Analysis of the Dynamic Charging Electric Vehicle (access here); The first 200-kW wireless charging system for electric buses is deployed (access here)

Battery Swapping

In conventional electric vehicles, the battery is charged inside the vehicle as needed, using direct or alternating current. However, battery swapping provides alternative route for refuelling - the drained batteries are replaced with freshly charged ones. This alternative is particularly useful for commercial vehicles that would like to minimize their downtime to the extent possible for refuelling of vehicles.

Battery swapping system consists of the battery charging system and the battery swapping mechanism. Hence, the technical parameters for a battery swapping system would depend on both the charging point for batteries and the swapping infrastructure.

India's first battery swapping station for public buses (with capacity to charge 12 batteries at a time) has been set up at Ranip, a central spot on Route 1, in Ahmedabad. Bus manufacturer, Ashok Leyland has collaborated with the energy service provider, Sun Mobility to implement the battery charging infrastructure and swapping system. Swapping the 600 kg battery after each trip takes just 3-4 minutes. By reducing battery size while using swapping en-route swapping arrangement, the space inside the bus could be increased to accommodate more passengers.

Snapshot of e-bus charging technologies categorized on the basis of method of electricity transfer is provided in table below:

Table 87 E-bus charging technologies

Technology	Key features	Potential advantages	Potential Disadvantages
Electric: plug-in charging	Plug-in charging uses a physical connector that engages power source with electric bus	• Can be used in a depot or on the route (opportunity charging) • On-route charging leaves buses in operation without needing to return to off route depots for recharging. • Using fast-charge technology increases operational capacity	• Requires careful route optimization • Requires investment in embedding on-road charging technology or in overhead chargers • May affect grid reliability
Electric: inductive charging	Buried underground and connects wirelessly to special coils underneath the buses. This is at evolution stage and is not commercially available on a large scale till date	• Less obtrusive and minimally exposed to damage or vandalism than other charging technologies • Operators can have on-route battery top-up that keep buses near full charge for the entire route and extends their range	• Requires careful route optimization • Reduces flexibility of route design • Relatively expensive
Battery swapping	Battery swapping system consists of the battery charging system (normally plug-in arrangement) and the battery swapping mechanism (for e-bus, due to heavy weight of batteries, robotic arms are used as swapping mechanism)	• Provide flexibility of refuelling within few minutes • In case of availability of sufficient on-route swapping stations lower battery size could be used leading to lesser bus weight and cost • Battery health can be monitored better, and slow charging would prolong battery life as compared to fast charging	• Costly, particularly for e-buses, due to requirement of mechanized swapping system • Reduces flexibility of route design, bus may need to travel off-route for battery swapping • Range anxiety

50. Modeling of EV charging station

To understand the feasibility of an EV charging station in India, a sample financial model was prepared with assumptions relevant to Indian context.

Following were the assumption of the model:

Table 88 General assumptions

Parameters	Assumptions
General assumptions	
Charger type	Bharat DC001
Charger Output	15 kW
Charger life	10 years
Charger operation	Unmanned
Capex assumptions	
Gross equipment (EVSE) cost	INR 4,50,000
Civil cost, aux equipment, power infrastructure	INR 1,80,000
Labour	INR 45,000
Total Cost of Installation	**INR 6,75,000**
Opex assumptions	
1st Year CUF	10%
10th Year CUF	16% (YoY increase @5%)
Land leasing	INR 1500/ month

Parameters	Assumptions
Software, CCTV, network charges etc.	INR 12000/ month
O&M expense	INR 1,688/ month
O&M escalation	3% per annum
Retail tariff cost (1st Year)	INR 4.5/ kWh (No demand charge)
YoY change in Retail tariff	+2%
Revenue assumptions	
Energy sales price	INR 12.99/ kWh
Escalation	0%
Financing assumptions	
Debt : Equity	70:30
Interest on loan	10.5%
Loan tenure	10 years
Moratorium period	NO
Return on Equity	16% (post tax)
Project WACC/ Discount rate	9.58%

DHI in its subsidy for EV charging station, under Fame II scheme provides 70% subsidy to Category A[135] chargers.

Note: Although the eligibility of the subsidy requires minimum five chargers in the charging station whereas the model considers only one charger; as ideal assumption of 70% subsidy on EVSE cost is considered.

Charging station subsidy	**70% on EVSE cost**

The model was simulated for 10 years of life of the charging station and below were the outputs:

[135] Charging stations established at public places for commercial purpose to charge electric vehicles and are available to any individual without any restrictions for charging their vehicles; and are installed as per MoP notification dated 14th Dec 2018 and its amendment thereof. (e.g., EV Charging station established in at Municipal Parking Lots, Petrol Stations, Streets, Malls, and Market Complexes etc.)

I. Profit & Loss Statement

Figure 226 Profit & Loss statement

EV Charging infrastructure											
Profit & Loss Statement		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
No. of operating days in year	days	365	365	365	365	365	365	365	365	365	365
CUF		10%	11%	11%	12%	12%	13%	13%	14%	15%	16%
Operating income											
Total units sold in the year	kWh	13140	13797	14486.85	15211.19	15971.75	16770.34	17608.86	18489.3	19413.76	20384.45
Revenue per unit of energy sold	INR/kWh	12.99	12.99	12.99	12.99	12.99	12.99	12.99	12.99	12.99	12.99
Total revenue from sale of power	INR Lakh	**1.71**	**1.79**	**1.88**	**1.98**	**2.07**	**2.18**	**2.29**	**2.40**	**2.52**	**2.65**
Operating expenses											
Per unit power purchase cost	INR/kWh	4.50	4.59	4.68	4.78	4.87	4.97	5.07	5.17	5.27	5.38
Total cost of power purchase	INR Lakh	0.59	0.63	0.68	0.73	0.78	0.83	0.89	0.96	1.02	1.10
Charge for the area	INR Lakh	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Wages	INR Lakh	-	-	-	-	-	-	-	-	-	-
Software fees	INR Lakh	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
O&M excl. of wages	INR Lakh	0.11	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14
Total operating expense	INR Lakh	**3.94**	**3.98**	**4.03**	**4.08**	**4.14**	**4.20**	**4.26**	**4.33**	**4.40**	**4.48**
EBITDA	INR Lakh	**-2.23**	**-2.19**	**-2.15**	**-2.11**	**-2.06**	**-2.02**	**-1.97**	**-1.93**	**-1.88**	**-1.83**
(Less) Depreciation/Amortization	INR Lakh	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
EBIT	INR Lakh	**-2.59**	**-2.55**	**-2.51**	**-2.47**	**-2.42**	**-2.38**	**-2.33**	**-2.29**	**-2.24**	**-2.19**
(Less) Interest	INR Lakh	0.26	0.25	0.23	0.21	0.19	0.16	0.14	0.11	0.08	0.04
EBT	INR Lakh	**-2.86**	**-2.80**	**-2.74**	**-2.68**	**-2.61**	**-2.54**	**-2.47**	**-2.40**	**-2.31**	**-2.23**
(Less) Tax	INR Lakh	-	-	-	-	-	-	-	-	-	-
PAT	INR Lakh	**-2.86**	**-2.80**	**-2.74**	**-2.68**	**-2.61**	**-2.54**	**-2.47**	**-2.40**	**-2.31**	**-2.23**

End of sheet

II. Balance Sheet

Figure 227 Balance sheet

EV Charging infrastructure											
Balance Sheet		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
No. of operating days in year	days	365	365	365	365	365	365	365	365	365	365
Assets											
Fixed asset	INR Lakh	3.24	2.88	2.52	2.16	1.80	1.44	1.08	0.72	0.36	-
Cash	INR Lakh	-2.65	-5.26	-7.83	-10.36	-12.84	-15.28	-17.68	-20.02	-22.32	-24.57
Total assets	INR Lakh	**0.59**	**-2.38**	**-5.31**	**-8.20**	**-11.04**	**-13.84**	**-16.60**	**-19.30**	**-21.96**	**-24.57**
Liabilities											
Equity share capital	INR Lakh	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
Reserve and surplus	INR Lakh	-2.86	-5.66	-8.40	-11.08	-13.69	-16.24	-18.71	-21.10	-23.42	-25.65
Debt	INR Lakh	2.37	2.20	2.01	1.80	1.57	1.31	1.03	0.72	0.38	-
Total liabilities	INR Lakh	**0.59**	**-2.38**	**-5.31**	**-8.20**	**-11.04**	**-13.84**	**-16.60**	**-19.30**	**-21.96**	**-24.57**
Check		-	-	-	-	-	-	-	-	-	-
End of sheet											

III. Cash Flow Statement

Figure 228 Cash flow statement

EV Charging infrastructure											
Cash Flow Statement		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
No. of operating days in year	days	365	365	365	365	365	365	365	365	365	365
Cash from operation											
PAT	INR Lakh	-2.86	-2.80	-2.74	-2.68	-2.61	-2.54	-2.47	-2.40	-2.31	-2.23
Adjustment for non-cash and non-operating expenses											
Add: amortization expense	INR Lakh	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Add: interest paid	INR Lakh	0.26	0.25	0.23	0.21	0.19	0.16	0.14	0.11	0.08	0.04
Cash flow from operating activities	INR Lakh	-2.23	-2.19	-2.15	-2.11	-2.06	-2.02	-1.97	-1.93	-1.88	-1.83
Cash from investing											
Capex		-3.60	-	-	-	-	-	-	-	-	-
Cash flow from investing		-3.60	-	-	-	-	-	-	-	-	-
Cash from financce											
Issue of equity share capital		1.08	-	-	-	-	-	-	-	-	-
Add: Debt raised		2.52	-	-	-	-	-	-	-	-	-
Less: Debt repayed		-0.15	-0.17	-0.19	-0.21	-0.23	-0.25	-0.28	-0.31	-0.34	-0.38
Interest paid		-0.26	-0.25	-0.23	-0.21	-0.19	-0.16	-0.14	-0.11	-0.08	-0.04
Cash flow from financing activities		3.18	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42
Beginning cash balance		-	-2.65	-5.26	-7.83	-10.36	-12.84	-15.28	-17.68	-20.02	-22.32
Add: Cash Generated during the year		-2.65	-2.61	-2.57	-2.53	-2.48	-2.44	-2.39	-2.35	-2.30	-2.25
Closing cash balance		**-2.65**	**-5.26**	**-7.83**	**-10.36**	**-12.84**	**-15.28**	**-17.68**	**-20.02**	**-22.32**	**-24.57**

End of sheet

Output of the model

Figure 229 NPV - Basecase

EV Charging infrastructure											
Output		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
No. of operating days in year	days	365	365	365	365	365	365	365	365	365	365
EBIT	INR Lakh	-2.59	-2.55	-2.51	-2.47	-2.42	-2.38	-2.33	-2.29	-2.24	-2.19
Tax	INR Lakh	-	-	-	-	-	-	-	-	-	-
NOPAT	INR Lakh	-2.59	-2.55	-2.51	-2.47	-2.42	-2.38	-2.33	-2.29	-2.24	-2.19
Add: Depreciation	INR Lakh	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Less: Capex	INR Lakh	-3.60	-	-	-	-	-	-	-	-	-
FCFF	INR Lakh	**-5.83**	**-2.19**	**-2.15**	**-2.11**	**-2.06**	**-2.02**	**-1.97**	**-1.93**	**-1.88**	**-1.83**
Add: Debt raised	INR Lakh	2.52	-	-	-	-	-	-	-	-	-
Less: Debt repaid	INR Lakh	-0.15	-0.17	-0.19	-0.21	-0.23	-0.25	-0.28	-0.31	-0.34	-0.38
Less: Interest paid	INR Lakh	-0.26	-0.25	-0.23	-0.21	-0.19	-0.16	-0.14	-0.11	-0.08	-0.04
FCFE	INR Lakh	**-3.73**	**-2.61**	**-2.57**	**-2.53**	**-2.48**	**-2.44**	**-2.39**	**-2.35**	**-2.30**	**-2.25**
Cumm. FCFF		-5.83	-8.02	-10.18	-12.28	-14.35	-16.37	-18.34	-20.27	-22.15	-23.98
Payback period		0	0	0	0	0	0	0	0	0	0
Project NPV	INR Lakh	-16.24									
End of sheet											

Project feasibility

Table 89 Model output on project feasibility

Parameters	Assumptions
Project feasibility	
Project NPV	INR -19.78 Lakh
Project IRR	No positive cash flow
Payback period	NA

It can be observed that even after 70% subsidy on EVSE cost, the project is not viable. To understand the sensitivity of the project NPV & IRR, sensitivity analysis has been done based on certain input parameters.

Input parameters selected for sensitivity are:

1. Annual utilization of charging station
2. Retail tariff of electricity for the operator
3. EV charging tariff operator charges from the customers

To assess the sensitivity, above output on Project NPV and IRR was considered as basecase. Selected parameters for assessing sensitivity in the basecase scenario is mentioned below:

Figure 230 Parameters considered to assess sensitivity of the project

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Base-case												
Subsidy		70%										
Utilization (%)	%		10%	11%	11%	12%	12%	13%	13%	14%	15%	16%
YoY change		5%										
Retail Tariff	INR/kWh		4.50	4.59	4.68	4.78	4.87	4.97	5.07	5.17	5.27	5.38
YoY change		2%										
EV charging tariff	INR/kWh		12.99	12.99	12.99	12.99	12.99	12.99	12.99	12.99	12.99	12.99
YoY change		0%										
NPV	INR Lakh	-16.24										

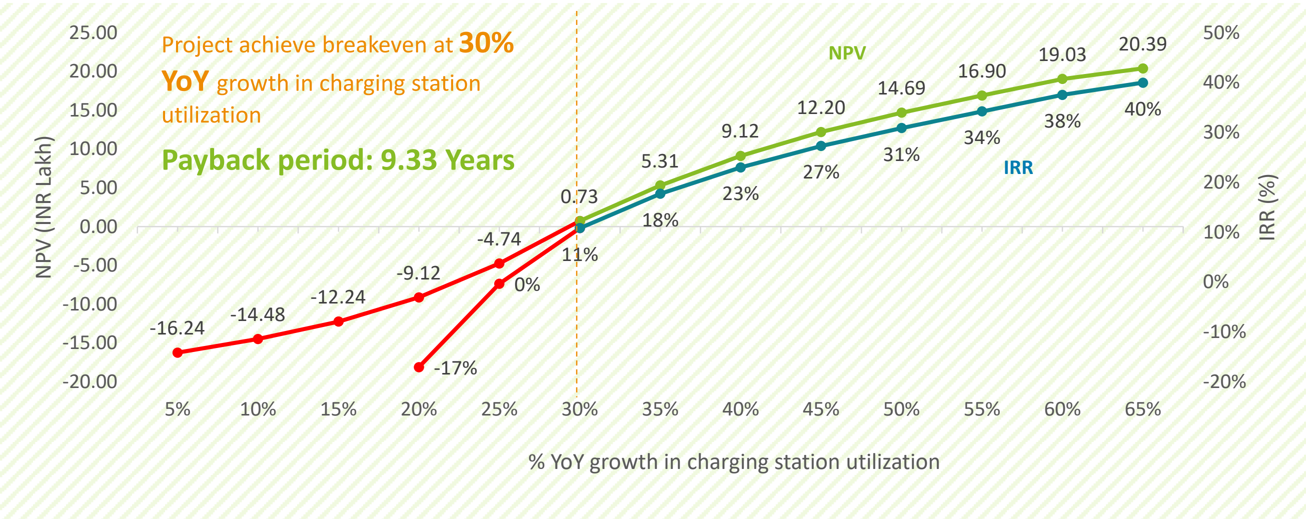
On the above-mentioned parameters, four scenarios were created where YoY growth in selected parameters were changed:

Base case	Scenario I	Scenario II	Scenario III	Scenario IV
Subsidy: 70% YoY change in: Utilization: 5% Retail tariff: 2% EV charging tariff: 0%	**Subsidy: 70%** YoY change in: Utilization: 5%-65% Retail tariff: *Basecase* EV charging tariff: *Basecase*	**Subsidy: 70%** YoY change in: Utilization: *Basecase* Retail tariff: 0%-6% EV charging tariff: *Basecase*	**Subsidy: 70%** YoY change in: Utilization: *Basecase* Retail tariff: *Basecase* EV charging tariff: *0%-6%*	**Subsidy: 0%** YoY change in: Utilization: 5%-65% Retail tariff: *Basecase* EV charging tariff: *Basecase*

Scenario I

Utilization YoY growth gradually increased from 5% to 65%. Below is the impact on Project NPV & IRR:

Figure 231 Project sensitivity w.r.t charging station utilization



Source: 170 Non-discounted payback period

CUF has significant impact on project viability. With the current assumption, CUF YoY growth of 30% will make project profitable with payback period of 9.33 years. Year-wise % utilization of the charging station at 30% YoY growth is provided below:

Figure 232 Year-wise charging station utilization at 30% YoY growth

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Scenario I											
Subsidy	**70%**										
Utilization (%)	%	10%	13%	17%	22%	29%	37%	48%	63%	82%	100%
YoY change	**30%**										

Project viability output in Scenario I is provided in the below table:

Figure 233 Model output - Scenario I

Parameters	Assumptions
Project feasibility @ 30% YoY Utilization growth	
Project NPV	INR 0.73 Lakh
Project IRR	10.80%
Payback period	9.33 Years

Scenario II

Retail tariff YoY increase gradually increased from 0% to 6%. Below is the impact on Project NPV & IRR:

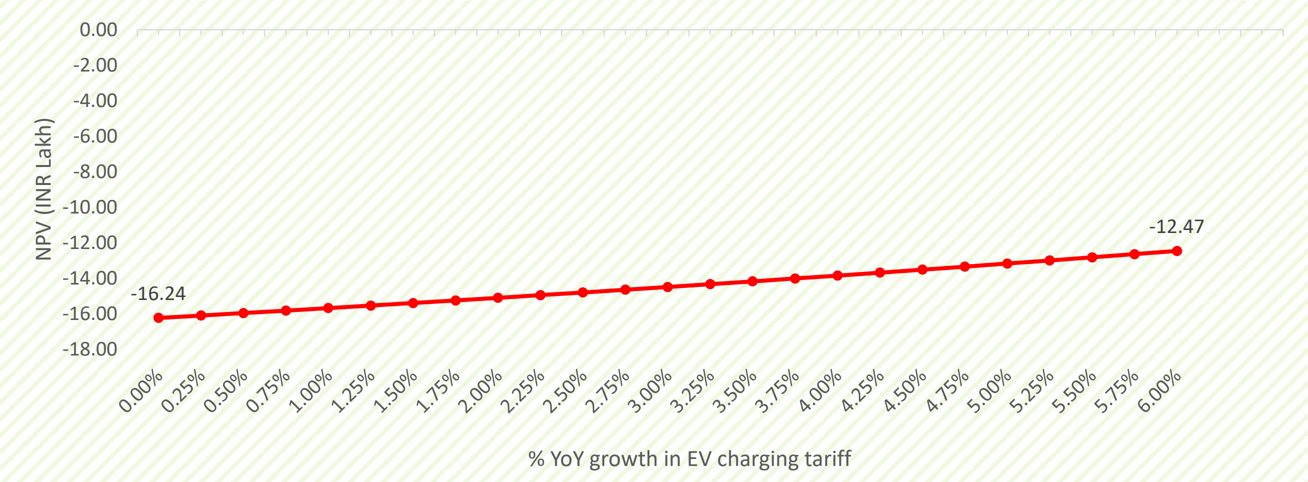
Figure 234 Project sensitivity w.r.t retail tariff

As understood from above figure, change in retail tariff will not have significant impact on project profitability.

Scenario III

EV charging tariff YoY growth gradually increased from 0% to 6%. Below is the impact on Project NPV & IRR:

Figure 235 Project sensitivity w.r.t EV charging tariff

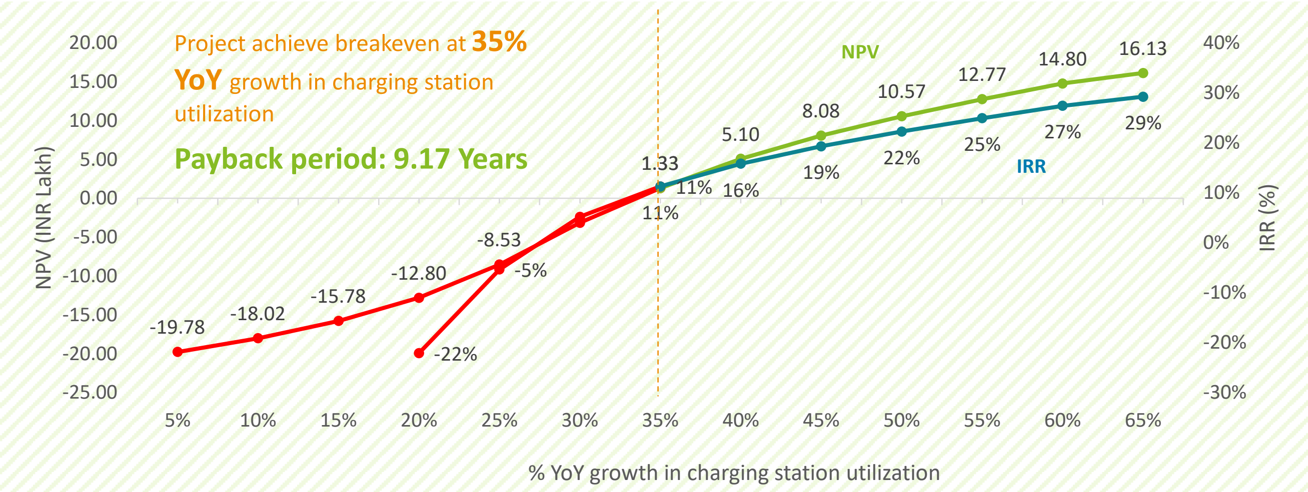


As understood from above figure, change in EV charging tariff will not impact project profitability.

Scenario IV

Project subsidy is reduced to 0, and Utilization YoY gradually increased from 5% to 65%. Below is the impact on Project NPV & IRR:

Figure 236 Project sensitivity w.r.t charging station utilization with no subsidy



As found out from the sensitivity analysis, even with no subsidy, with high utilization, the charging station business can gain profitability. With the current assumption, CUF YoY growth of 35% will make project profitable with payback period of 9.17 years. Year-wise % utilization of the charging station at 35% YoY growth is provided below:

Figure 237 Year-wise charging station utilization at 35% YoY growth

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Scenario IV											
Subsidy	0%										
Utilization (%)	%	10%	14%	18%	25%	33%	45%	61%	82%	100%	100%
YoY change	35%										

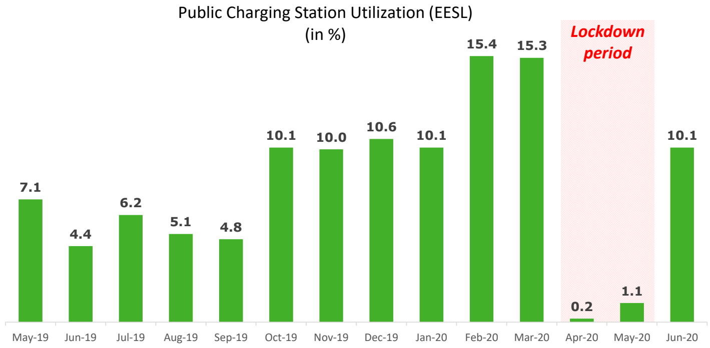
Project viability output in Scenario IV is provided in the below table:

Figure 238 Model output - Scenario IV

Parameters	Assumptions
Project feasibility @ 35% YoY Utilization growth	
Project NPV	INR 1.33 Lakh
Project IRR	11.28%
Payback period	9.17 Years

From the sensitivity analysis, it can be concluded that high utilization of charging infrastructure is key for the profitability of the business

51. Key challenges around development of EV charging infrastructure

Issue	Challenge	Description
Issue 1	**Low utilization of charging infrastructure**	Setting-up of charging station requires huge capital that is generally be borrowed from a financial institution. For early payback of capital invested in the business, it is required to have high utilization of assets i.e., charging infrastructure. However, in India, since EV on road are not significant, the asset utilization remains critically low leading to multiple issues such as delay in payback, non-recovery of operating expenses, default in bank loan etc. The charging station utilization of EESL is provided in the graph below: 
Issue 2	**Two-part electricity tariff – Demand charges on connected load**	15 states and UTs (out of 22) such as Gujarat, Haryana, Karnataka, Maharashtra etc. have announced demand charges for EV charging stations. Electricity demand charges are fixed charges levied on charging station operator based on connected load irrespective of usage of the charging station facility. In case of low asset utilization, levy of the electricity demand charges makes it difficult for charging station operator to achieve break-even.

Issue 3

No regulatory mechanism for setting EV charging tariff (tariff charged by operator to consumer)

Many State Electricity Regulatory Commissions have notified separate EV tariff that is to be charged by Discom to EV charging station operator. However, there is no guidance available on setting maximum limit on charges that a charging station operator could levy on their customer. The charges levied by Fortum for using its charging facility is provided as below:

Location	Type of charger	Capacity of charging gun	Price (per minute)
Hyderabad	Bharat DC 001	10kW/15kW	INR 10.99*
Ahmedabad	CCS/ Chademo Charger	50 kW	INR 13.99
Delhi	CCS/ Chademo Charger	50 kW	INR 14.49
Hyderabad	CCS/ Chademo Charger	50 kW	INR 15.99
Mumbai	CCS/ Chademo Charger	50 kW	INR 15.99
Noida	CCS/ Chademo Charger	50 kW	INR 17.99
Gurgaon	CCS/ Chademo Charger	50 kW	INR 18.99
Bengaluru	CCS/ Chademo Charger	50 kW	INR 18.99
Hyderabad	DC Charger	10kW/15kW	INR 12.99*
Mumbai	DC Charger	10kW/15kW	INR 12.99*
New Moti Bagh - Delhi	Type 2	11 kW	INR 12.99

* Price in per kWh

Source: Fortum - Pricing list and Terms & Conditions (access here)

Issue 4

No mechanism for socializing the cost of power infrastructure development

To develop a charging infrastructure, it is required to have availability of suitable and adequate upstream power infrastructure. There is regulatory uncertainty around whether the cost of network upgradation for providing electricity connection to charging station could be passed on to consumer through electricity tariff. Therefore, power distribution companies are charging cost of upstream network upgradation from the charging station developer that is increasing the project cost and associated risk of investment recovery leading to low bankability of the project.

Further, there is no timeline provided in any supply code in relation to network upgradation for the EV charging station. This leads to delay in project execution that has further adverse cascading impacts on the financial viability of the overall business.

Issue 5

High capital requirement – lack of financial support

Setting-up of charging infrastructure is a capital-intensive business. In the scenario where EV adoption rate in 1-2%, charging station utilization is less than 20%, and the risk of evolving technology; financial institutions are shying away from providing loans to the developer or even if it has been provided the cost of finance is high considering the risk factors involved. This is leading to insufficient scaling-up of EV charging business in India.

Further, there is facility extended by government in any policy, for providing soft/concessional loan or loan backed by government guarantee to the charging station developer.

Issue 6

No policy for EV adoption mandate

Unlike China and California, there is no EV mandate provided under the scheme/policy that puts uncertainty around long-term prospects of EV in India. In China, State Owned Grid Utilities are investing hugely in development of charging infrastructure as EV mandate in the country provide assurance to investors in terms of business continuity, higher utilization of assets and early payback.

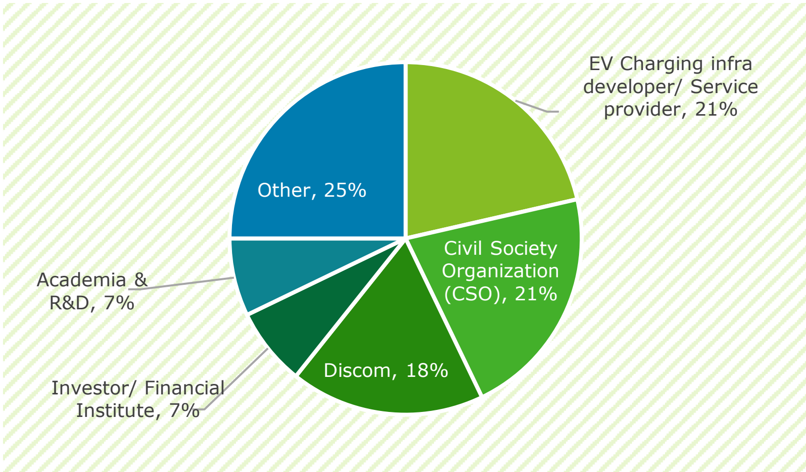
		However, in India, due to lack of demand certainty from EV, the investors are shying away from putting in resources in development of charging infrastructure.
Issue 7	**Land allocation**	Identification and allocation of the suitable land is critical in the entire value proposition of EV charging business. Some State EV policy has although recognized this as an issue and offered assistance in identification and allocation of land, however, our interaction from industry participants suggest that there are administrative challenges involved in land acquisition and in case of lease, uncertainty involves around the lease rental on long-term basis.

6.5 Chapter 5 EV ecosystem enablers and barriers

52. Stakeholder consultation

Total **42** expert individuals from the EV industry participated in the survey

Figure 239 Survey participants category break-up



Note: Other category includes: Non profit organization, research and consulting firms, think-tank etc.; The above break-up is provided for 28 participants; 14 participants submitted their response as anonymous

Online survey questionnaire

Q1	*"Central and State Governments have announced few policies to promote Electric Vehicles."* What additional policy measures the government should adopt to fast track EV adoption? Please rank the following (1 – highest priority) 1. Launch of Charge ready infrastructure programme 2. National/ State level policy for incentivizing Distribution Utility investments in EV charging infrastructure 3. Policy and clear mandate on target EVs on road by 2030 for each vehicle type 4. Policy & clear mandate on GHG emission reduction for country as a whole and then segregated for each state and how much of the emissions have to reduce from transport sector through transitioning to EVs 5. Amendments in Tariff Policy to accommodate rate basing of EV Charging infrastructure 6. Dis-incentivize conventional vehicle purchase (e.g. Introduce fossil fuel tax/carbon tax to fund EV initiatives, Levy parking surcharges etc.)

	7. Promote battery recycling and reuse (e.g. Incentivize end-of-life recycling, Commercialize battery second life etc.)
Q2	What according to you is the major challenge in adoption of EVs in India? Please rank the following (1 – most important challenge) 1. Perception of public about EV (Anxiety around range, mileage, power, service, charging infrastructure etc.) 2. Inadequate charging infrastructure 3. Insufficient government support in providing financial incentives for demand creation (Consumer to achieve price advantage over ICE vehicles) 4. Insufficient government support in providing financial incentives for reduction in manufacturing cost (Manufacturer to achieve cost advantage over ICE vehicles) 5. Lack of R&D support in reducing battery prices leading to higher TCO for EVs (Capex + Opex) 6. Concern around safety standards of EV and Charging Infrastructure
Q3	Governments around the world have taken a number of actions to address the barriers to electric vehicle market development and to accelerate the transition to electric mobility. All such measures can be bucketed into broad five clusters (mentioned below). Please rank them from high priority to least priority for the formulation of State/Central level policy. (Rank 1 - highest priority) 1. Expand EV model availability (Stimulate investment in EV production, Support R&D and demonstration activities) 2. Improve EV cost competitiveness (Financial and non-financial incentives) 3. Develop charging infrastructure network (Regulations and frameworks, incentives for charging infrastructure investment, home and workplace charging infrastructure) 4. Accelerate EV deployment across di-fferent fleets (Public fleet transition, Commercial and corporate fleet transition) 5. Raise public awareness (Education and skills training, Mass communication etc.)
Q4	*"Many European countries have demarcated Zero Emission Zone. Except for EVs, other vehicles need to pay tax to enter into such zone."* Do you think that demarcating similar zones in India would provide the necessary thrust for EV uptake? 1. Extremely important 2. Important 3. Good to have 4. Not required
Q5	Integration of EVs with Indian electricity grid is an important aspect in the development of EV ecosystem. Do you think that the Central/State government should sponsor more system modelling/ Grid integration-related pilot demonstration project? 1. Yes 2. No
Q6	Which of the technological intervention can catalyse the pace of creation of EV ecosystem in India? Please rank the following (1 – highest priority) 1. Undertaking modelling and simulation studies 2. Enabling communication between EV charging Stations (EVCS) 3. Enabling interoperability in EV charging stations 4. Database management and notifications to utilities 5. Enabling communication system between EVCS and distribution utility 6. Enabling Vehicle to grid integration

Q7	Please rate the challenges that you have faced/ are facing in setting up a Charging Infrastructure. (1 – highest challenge; 8 – lowest challenge) 1. Choosing appropriate locations for placement of EVSE 2. Allotment of land 3. Receiving clearances and approvals for manufacturing facility 4. Technical issues in integration with Distribution network (Voltage Stability and Harmonics) 5. Administrative issues in taking electricity connection 6. Bureaucratic interference 7. Supply of raw material
Q8	*"States such as Madhya Pradesh, Uttar Pradesh, Tamil Nadu, Telangana and Punjab have made provision for Single Window Clearance for EV/Battery Manufacturer, in their EV policies."* Do you consider it as a good suggestion to establish Single Window Clearance System across all States for providing time-bound technical and administrative approval, for matters related to land allocation, electricity connection, open access, type-test approval of vehicle systems, parts and equipment license, permit etc., for EV/Battery/Charging equipment Manufacturer, Charging infra developer? 1. Extremely important 2. Important 3. Good to have 4. Not required
Q9	What should be the priority of Government/Policy maker in India in order to develop charging infrastructure? Please rank the following (1 – highest priority) 1. Developing framework for public private partnerships / franchisee agreements for developing EV Charging stations 2. Develop a framework for Managed/ coordinated charging to mitigate distribution network impacts and facilitate RE integration 3. Provision to include investments in EV charging infrastructure in the retail tariff 4. Identify the tariff structure for EV charging (e.g., ToD tariff, special EV charging tariffs for EV users) 5. Adoption of smart grid capabilities, such as smart metering, “smart” charging 6. Specifying connectivity standards and technical standards for EVSE equipment
Q10	*"Regulatory measures for charging infrastructure have been a major focus area for electricity regulators the world over."* Would it be a good consideration to have the National Tariff Policy and the Forum of Regulators look specifically into regulatory measures for promoting charging infrastructure development in the country? 1. Extremely important 2. Important 3. Good to have 4. Not required
Q11	To make the future of electric mobility greener, it is essential to promote renewable energy integrated with EV charging infrastructure. Do you think that complimentary grant for Open Access or rebate in Cross-subsidy surcharges/ wheeling charge provided along with electricity connection to a Charging Station owner availing power from RE sources? 1. Yes 2. No

Q12	*"GoI have constituted National Council for Electric Mobility and National Board for Electric Mobility (NBEM) as apex bodies to steer the EV growth in Country. However, EV policies notified by several States vary significantly across many dimensions."* Do you think that for coordinated action on several fronts, across States, there is a need to have a State Coordination Forum, at National level, (similar to NCRPB, constituted for the coordinated development of Delhi-NCR region), as a common platform for State representatives to frame unified policies, regulatory measures, specification, standardization, data sharing protocols, incentives, mechanism for single-window clearance etc.? 1. Extremely important 2. Important 3. Good to have 4. Not required
Q13	*"Ministry of Power, Government of India on 14 December 2018 released the guidelines on EV charging infrastructure, mandating Charging stations to tie up with at least one online Network Service Provider (NSP) to provide IT enabled services to EV owner. With the development of EV ecosystem, there would be a requirement for huge amount of data sharing among various participant – EV owner, power utilities, Charging Station, Service providers etc. In absence of any secure protocol for data sharing, cyber security and data privacy; secure operation of Electricity Grids, privacy of EV owner data etc. would be jeopardized. "* Do you think that there is a need to formulate a National IT Committee for EV, under MeitY to establish institutional framework to create national data standards, formulate rules for data sharing, and build capacity within the government and private sector to handle data use, monitoring, and issue resolution? (This institution could also create and maintain a central database for relevant data.) 1. Extremely important 2. Important 3. Good to have 4. Not required

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