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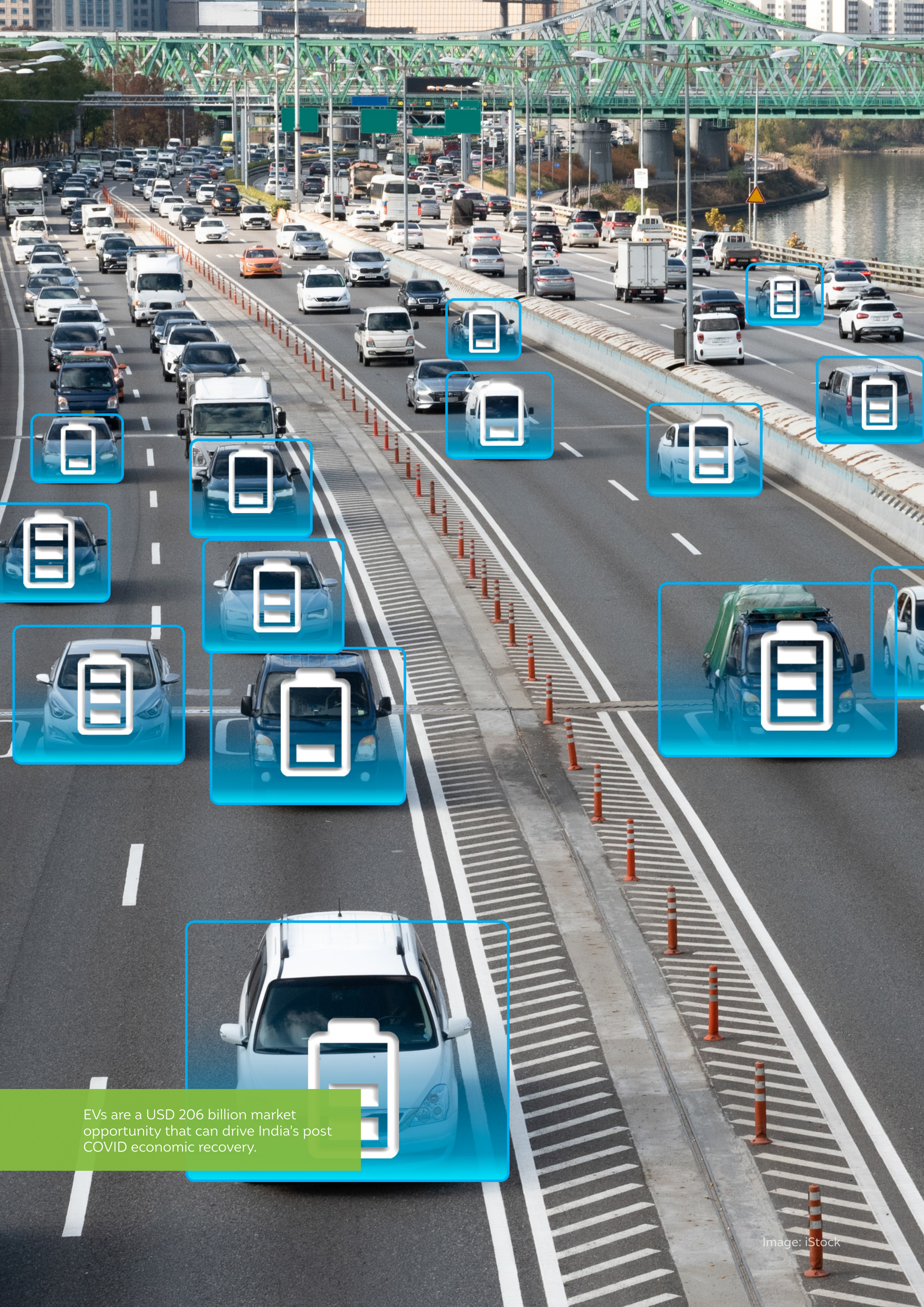
Financing India's Transition to Electric Vehicles

A USD 206 Billion Market Opportunity (FY21 - FY30)

Vaibhav Pratap Singh, Kanika Chawla, and Saloni Jain

Report | December 2020



EVs are a USD 206 billion market opportunity that can drive India's post COVID economic recovery.

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The **CEEW Centre for Energy Finance** (CEEW-CEF) is an initiative of the Council on Energy, Environment and Water (CEEW), one of Asia's leading think tanks. CEF acts as a non-partisan market observer and driver that monitors, develops, tests, and deploys financial solutions to advance the energy transition. It aims to help deepen markets, increase transparency, and attract capital in clean energy sectors in emerging economies. It achieves this by comprehensively tracking, interpreting, and responding to developments in the energy markets while also bridging gaps between governments, industry, and financiers.

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CEEW Centre for Energy Finance

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The need for enabling an efficient and timely energy transition is growing in emerging economies. In response, CEEW-CEF focuses on developing fit-for-purpose market-responsive financial products. A robust energy transition requires deep markets, which need continuous monitoring, support, and course correction. By designing financial solutions and providing near-real-time analysis of current and emerging clean energy markets, CEEW-CEF builds confidence and coherence among key actors, reduces information asymmetry, and bridges the financial gap.

Financing the energy transition in emerging economies

The clean energy transition is gaining momentum across the world with cumulative renewable energy installation crossing 1000 GW in 2018. Several emerging markets see renewable energy markets of significant scale. However, these markets are young and prone to challenges that could inhibit or reverse recent advances. Emerging economies lack well-functioning markets. That makes investment in clean technologies risky and prevents capital from flowing from where it is in surplus to regions where it is most needed. CEEW-CEF addresses the urgent need for increasing the flow and affordability of private capital into clean energy markets in emerging economies.

CEEW-CEF's focus: analysis and solutions

CEEW-CEF has a twin focus on markets and solutions. CEEW-CEF's market analysis covers energy transition–related sectors on both the supply side (solar, wind, energy storage) and demand-side (electric vehicles, distributed renewable energy applications). It creates open-source data sets, salient and timely analysis, and market trend studies.

CEEW-CEF's solution-focused work will enable the flow of new and more affordable capital into clean energy sectors. These solutions will be designed to address specific market risks that block capital flows. These will include designing, implementation support, and evaluation of policy instruments, insurance products, and incubation funds.

CEEW-CEF was launched in July 2019 in the presence of H.E. Mr Dharmendra Pradhan and H.E. Dr Fatih Birol at Energy Horizons.

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As a Senior Analyst at the CEEW Centre for Energy Finance, Vaibhav focuses on the climate finance space and he designs and develops financial instruments to unlock investments in the Indian clean energy sector. His forte lies in developing solutions and providing a simple analysis of current issues to a broad spectrum of audiences. Previously, he performed credit analysis to recommend credit ratings to financial institutions.

"Electric mobility as a sector has the potential to help register India's automotive sector globally. The Indian automobile market offers scale, and with the right levers, both policy and finance can help turn sustainable transportation into an opportunity for the upcoming and future decades."

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Kanika is a policy specialist working at the intersection of clean energy and financial markets. She is the Director of the CEEW Centre for Energy Finance and also manages The Council's research and outreach in renewable energy policy, regulation, markets, and socioeconomic value. She engages with private and public enterprises within and outside India to design and develop financial de-risking instruments.

"India's 2030 vision for electric vehicles isn't just a pursuit in advancing sustainability but a potential driver of India's green recovery and economic growth in the decade to come. With deep interlinkages with micro, small, and medium scale enterprises and opportunities for new technology innovation and market scaling, the electric mobility transition's local value addition would be significant."

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Saloni tracks policy developments in the clean energy market at the CEEW Centre for Energy Finance. She holds a master's degree in Public Policy from the National Law School (NLSIU), Bangalore, and an undergraduate degree in Mathematics from Lady Shriram College, Delhi University.

"Mobilising finance for an electric mobility-led transportation future may not be easy and policy interventions that span across the value chain are needed for tapping into this opportunity."

This report has been prepared with support and guidance from Dr Gireesh Srimali, Adviser, CEEW Centre for Energy Finance.

To realise India's 2030 vision of electric mobility, regulatory push, market pull and infrastructure support are needed.

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Image: iStock

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Acronyms

ACMA	Automotive Component Manufacturers Association of India
BS-VI	Bharat Stage VI emission norms
CAPEX	capital expenditure
CGTMSE	Credit Guarantee Fund Trust for Micro and Small Enterprises
EESL	Energy Efficiency Services Limited
EV	electric vehicle
FAME	Faster Adoption and Manufacturing of Electric Vehicles scheme
GDP	gross domestic product
GWh	gigawatt-hour
GST	goods and services tax
ICE	internal combustion engine
ICT	information and communication technology
LCV	light commercial vehicle
NBFC	non-banking financial company
NEMMP	National Electric Mobility Mission Plan
NITI	National Institution for Transforming India
OEM	original equipment manufacturers
OPEX	operational expenditure
PCG	partial credit guarantee
PCS	public charging stations
RPO	renewable purchase obligations
SGST	state goods and services tax
SME	small and medium enterprises
SMEV	Society of Manufacturers of Electric Vehicles
TCO	total cost of ownership
VC	venture capital
2W	two-wheeler
3W	three-wheeler
4W	four-wheeler

Interventions that make USD 206 billion capital available and affordable will play a leading role in determining the pace of India's mobility transition.

Image: iStock

Executive summary

Through most of 2019, India's automobile sector, which accounts for about 7–8 per cent of the country's annual GDP, faced a severe downturn. This was further exacerbated by the COVID-19 pandemic related economy-wide slowdown in 2020. Consequently, the market outlook for electric vehicles (EVs) in the country appears bleak in the short term and far short of the vision for 2030 as identified by NITI Aayog, which set an ambition of 70 per cent of all commercial cars, 30 per cent of private cars, 40 per cent of buses, and 80 per cent of two-wheeler (2W) and three-wheeler (3W) sales to be electric by 2030 (NITI Aayog and Rocky Mountain Institute 2019).

India's 2030 EV ambition translates into a total sales of 102 million vehicles, an annual battery demand of 158 GWh and a support infrastructure of 2.9 million public charge points by FY30

To address the mismatch between the market outlook and the vision and to accelerate the adoption of EVs, governmental and non-governmental actors have implemented or proposed multiple interventions. However, outcome-focused interventions must be informed by robust analyses to understand the size of the opportunity and quantum of investment (public and private) required to realise this mobility transition. In this report, we assess segment-wise EV sales, battery requirements, and the public charging infrastructure needed to support the transition along with the investment needed until FY30.

In addition to the FY30 target, this study models three transition scenarios. In the high adoption scenario, of the total new vehicle sales between FY21 and FY30, EVs are estimated to account for as much as 43 per cent. In the low adoption scenario, this drops to 23 per cent.

ES1
Translating India's 2030 EV ambitions into sales under four 'what if' transition scenarios

EV sales FY21 to FY30 (in million)	Base case	High adoption	Medium adoption	Low adoption
Two-wheelers	94	103	75	56
Three-wheelers	3	3	2	2
Cars (private)	3	3	2	2
Cars (commercial)	2	2	2	1
Total	**102**	**112**	**81**	**61**

Source: CEEW-CEF analysis

**Total includes buses sales which are of the order of 0.1 million*

For context, at the end of March 2020, the total number of registered electric vehicles in India stood at only half a million. Close to half of the total vehicles – 2,46,000, to be exact – were registered in FY20 (CEEW-CEF 2020a). Among others, several impediments such as high upfront costs, the paucity of public charging infrastructure, and range anxiety continue to inhibit the growth of EV demand. However, as consumers look for modes of transport that facilitate social distancing, India may see a surge in first-time vehicle owners. This presents an opportunity for EVs to cater to this market with competitively priced products and a suite of financing and ownership solutions. Even for the economy at large, this is an opportunity to drive significant growth in a new sector with cumulative investment needs of over INR 12,50,000 crore (USD 180 billion) till FY 30 in vehicle production and charging infrastructure in the coming decade alone to achieve the envisaged electric vehicle penetration as mentioned before.

ES2 Cumulative production costs for OEMs and estimated investments for public charging infrastructure until 2030

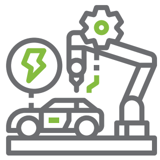
e-Vehicle categories	Total production costs (to OEMs) (in INR crore)	Initial Investment towards charging infrastructure development (in INR crore)
Cars (private)	3,37,900 (USD 48 billion)	5,450 (USD 0.78 billion)
Cars (commercial)	1,78,200 (USD 26 billion)	7,130 (USD 1.0 billion)
Buses	55,900 (USD 8 billion)	NA
Three-wheelers	34,100 (USD 5 billion)	830 (USD 0.1 billion)
Two-wheelers	6,33,700 (USD 91 billion)	7,170 (USD 1.1 billion)
Total	**12,39,800 (USD 177 billion)**	**20,580 (USD 2.9 billion)**

Source: CEEW-CEF analysis

Increased EV adoption is likely to create an unprecedented demand for batteries. The need for batteries will be driven by both new sales of electric vehicles and the demand for replacement batteries in existing electric vehicles. Realising India's EV targets would require an estimated annual battery capacity of 158 GWh by FY30. To meet this potential demand, battery manufacturers need to expand production; this will require huge investments, which will vary based on the level of battery cell manufacturing indigenisation which gains importance given the current geopolitical landscape. In a scenario where 50 per cent of the battery manufacturing capacity is indigenous, investments could amount to as much as INR 42,900 crore (USD 6.1 billion) by FY30. The cumulative investment required will exceed INR 85,900 crore (USD 12.3 billion) in case of 100 per cent indigenisation of battery manufacturing.

To assess the potential size of the EV consumer market if India meets its 2030 targets, we have combined the production costs with original equipment manufacturer (OEM) and dealer margins. This will present a sales opportunity worth INR 3,39,100 crore (USD 48 billion) in the year FY30, with both private and commercial cars, along with two-wheelers (two-wheelers), contributing nearly 93 per cent of the total sales by volume and 47 per cent by value. If India were to meet its target, until FY30, consumers would need to spend about INR 14,42,400 crore (USD 206 billion) cumulatively. This market also presents a huge challenge and an opportunity for the automobile loan market. If 50 per cent of the EV upfront costs – i.e., INR 7,21,000 crore (USD 103 billion) – required through FY21–FY30 is to be financed through debt, the banking sector will have to more than triple its current advances of INR 2,17,000 crore (USD 31 billion) towards vehicle loans in the next 10 years.

As the investment assessments suggest, the electric mobility transition presents an unprecedented opportunity for multiple market players, from battery manufacturers to commercial electric vehicle operators. This mammoth market opportunity could be an important driver for India's post-COVID economic recovery, generating jobs and economic value across the value chain including in existing industries and through the creation of new sectors. However, to capitalise on the opportunity presented by the transition, access to finance for OEMs, battery manufacturers, charge point operators, and end consumers is central to advancing the adoption of EVs. Interventions that make capital available and affordable will play a leading role in determining the pace, efficiency, and cost of this mobility transition. While this study focuses predominantly on the market opportunity and investment requirement to realise the 2030, we identify some market barriers and propose interventions that could facilitate greater flow of private capital into this sector. These are summarised in the table below. However, subsequent CEEW-CEF studies will focus on market design, regulatory and financial structures, and business models that could further facilitate the development of India's EV market.



India's EV sector presents an investment opportunity of USD 180 billion in vehicle production and charging infrastructure deployment in the coming decade

The barrier	Possible solutions
Barriers faced by SME OEMs in accessing capital for expansion into the EV space	Financial solution – A partial credit guarantee scheme Policy solution - Setting up industrial parks for SME OEMs in the auto sector; Scheme to set up venture capital and small enterprise assistance fund.
The weak business case for charging infrastructure business	Financial solution - A charging infrastructure investment facility capitalised partly with public money. Policy solution like capping leasing cost of land or other factors which otherwise could drive up the cost of setting up the station
The high upfront cost of EV	Financial solution – Annualisation in a phased manner. Policy solution - EV policies of states to combine incentives for EVs with disincentives for ICE vehicles; Developing policy around battery reuse, recycling and leasing

ES3
Barriers and solutions to the flow of capital for India's 2030 EV ambitions

Source: CEEW-CEF analysis

With merely 0.53 million registered EVs as of March 2020, India has a long way to go to achieve its 2030 vision

Image: iStock

1. Introduction

India's automotive industry contributes 7–8 per cent annual GDP and could potentially face a paradigm shift in case of an economy-wide move to electric vehicles (Invest India 2020). This potential transition mirrors the global shift towards electric mobility, driven by the perceived need for improved air quality, reduced dependence on oil imports, climate action, and decarbonisation of end-use sectors (World Economic Forum and Ola Mobility Institute 2019). These are all priorities for India as well, and recent policy moves indicate an increasing commitment towards an electric mobility-based transportation future.

Several government ministries and departments, both at the central and state level, are supporting this mobility transformation. Due to the complexity and criticality of such a transition, an immense number of parties are involved. In the central government alone, the Ministries of Road Transport and Highways; Finance; Power; Housing and Urban Affairs; and New and Renewable Energy are involved. In addition, institutions such as the Departments of Heavy Industry; Industrial Policy and Promotion; and Science and Technology; and the NITI Aayog have released support measures and directives to facilitate the mobility transition. Further, more than 15 states and union territories (including draft and notified) have developed EV policies and regulatory support pathways to accelerate the adoption of electric mobility in the country, and several other states are in the process of developing such policies (EESL 2020).

Figure 1 Whose jurisdiction is it anyway?

2010	Implementation of Alternate Fuels for Surface Transportation Programme Ministry of New and Renewable Energy
2013	National Electric Mobility Mission Plan (NEMMP 2020) Department of Heavy Industries
2014	National Urban Transport Policy (NUTP) Ministry of Urban Development
2014	Deendayal e-Rickshaw scheme Ministry of Road Transport and Highways
2015	National Auto Policy (draft) Department of Heavy Industries
2017	Charging Infrastructure for Electric Vehicles: Guidelines and Standards Ministry of Power
2018	Urban Green Mobility Scheme Ministry of Housing and Urban Affairs
2018	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) Department of Heavy Indistries and NITI Aayog
2018	Safety Provisions for Electric Vehicle (EVs) Charging Stations (draft) Central Electricity Authority
2018	National e-Mobility Programme Energy Efficiency Services Limited
2019	National Mission on Transformative Mobility and Battery Storage NITI Aayog
2019	Faster Adoption and Manufacturing of Electric Vehicles in India – Phase II (FAME – II) Department of Heavy Industries

Source: CEEW-CEF compilation

Thus, in the central government alone, as many as 10 different agencies have designed policies to support electric mobility adoption but with no clear central coordinating agency.

In the central government alone, 10 different agencies have designed policies to support electric mobility adoption but with no clear central coordinating agency

Despite various support mechanisms and policy signals to the market, there is no clear nation-wide electric mobility target. Its absence is peculiar, especially after the success of the clean energy deployment targets that the Government of India first announced in 2010 under the *National Solar Mission*, and significantly expanded in 2015 to 175 GW of renewable energy by 2022, and increased further in 2019 to 450 GW of installed renewable energy capacity. These large targets have helped signal the scale and continuity of the Indian government's policy support and ambition with regards to the clean energy market. However, the government is yet to adopt a similar approach to spur the EV transition. While there are several speculative reasons for this, scenario work by the Rocky Mountain Institute and NITI Aayog suggests that with supportive EV policies, India can increase electric vehicle sales to 70 per cent of all commercial cars, 30 per cent of private cars, 40 per cent of buses, and 80 per cent of two-wheelers and three-wheelers by 2030 (NITI Aayog and Rocky Mountain Institute 2019). In the absence of any clear policy target, we use this as an indicator of the aspirational mobility transition goal for India.

State of the market

At the end of March 2020, the total number of registered electric vehicles in the government VAHAN portal stood at 530,560 (does not include unregistered battery-powered electric three-wheelers or e-rickshaws) (CEEW-CEF 2020a). Close to half of the total vehicles – 246,000, to be specific – were added in the financial year 2019–20 (FY20) alone, with two-wheelers contributing to over 60 per cent of the total new electric vehicle stock (CEEW-CEF 2020a).

However, a transition to an electric mobility future is not without impediments. Among the several barriers to mass adoption of EVs, the high upfront cost is primary. At present EVs in the country are around 1.2X to 3X more expensive than internal combustion engine (ICE) vehicles purely based on purchase cost (World Economic Forum 2019). Further, the adoption of EVs at scale is constrained by consumer concerns around charging mechanisms, availability of adequate charging stations, and range anxiety.

As of March 2020, total number of registered EVs stood at 0.53 million. Close to half of EVs were added in FY20 with 2-wheelers contributing 60% to the new EV stock

In 2019, India's auto industry had its worst downturn marked by declining sales and rising inventories, which was then followed up with COVID-19 related slowdown, creating further disruption to the auto value chain including financing and a demand squeeze in the short term. For example, domestic passenger vehicle sales dipped 18 per cent in FY20 to 2.78 million compared to FY19 (ET Auto 2020a). The decline in sales is the result of several factors, including the liquidity crisis impacting non-banking financial companies (NBFCs) – which account for a third of all automobile loans – which affected their ability to lend at the same scale as in previous years (Ramesh, Phaugat and Sinha 2019). In the face of high upfront costs, and no clear market appetite among financial institutions to extend debt for EVs, the market demand outlook for EVs continues to be meagre and far short of the 2030 vision identified by NITI Aayog.

In the current period of FY21, sales have plummeted further across all vehicle categories due to COVID-19. The pandemic has led to severe supply chain disruptions, workforce layoffs, and possibly the largest economic recession since the Great Depression, not only in India but worldwide. We expect this event to significantly impact both the pace and scale of the mobility transition. Even though the market outlook for electric vehicles currently seems bleak, a few vehicle segments, like electric two-wheelers (such as scooters and bikes), may see a surge in first-time ownership, as consumers seek transport options that adhere to social distancing norms (Financial Express 2020). During the last couple of months, both two-wheelers and cars sales have shown a positive turn with a matchup to last year sales during the period, and some experts are of the view that automobile sector may post a recovery sooner than later especially in some categories. As such, the post-pandemic period may also present an opportunity to pivot to a more EV-dense mobility future if the right support mechanisms in the form of policy, regulation, business models, and financial structures are put in place.

Therefore, there is a critical need for robust analysis to understand the size of the opportunity and the quantum of investment – both public and private – required to realise this mobility transition. In this report, we assess segment-wise EV sales, battery requirements, the public charging infrastructure necessary to support the transition, and the investment needed until 2030, which we quantify using stated assumptions and techniques.[1] The report also analyses the barriers to the investment and touches upon the potential solutions to unlock this opportunity.

Primary research that we conducted with several stakeholders in the industry, including OEMs; relevant industry associations, like the Society of Manufacturers of Electric Vehicles (SMEV) and the Automotive Component Manufacturers Association of India (ACMA); existing charging infrastructure operators; fleet operators; and interested industry players like electricity utilities and Energy Efficiency Services Limited (EESL), form the basis for most of the assumptions in our study. We collected data through key informant interviews and surveys. Since the automobile industry is at a crucial juncture, we have used three scenarios to help assess the potential investment requirements and associated costs under the different growth paths. With insight from the scenario exercise, we aim to reduce uncertainty and provide policymakers, investors, and manufacturers access to information that allows them to make more informed decisions about the electric mobility future.

The post-pandemic pandemic period may present an opportunity to a more EV dense mobility future with the right support mechanism

1 For the currency conversion in the study we have used USD/INR exchange rate of 1/70.

India's 2030 vision of e-mobility translates into 102 million units of EV sales, demand of 158 GWh of battery capacity and 29,38,000 public chargers.

Image: iStock

2. Estimating EV adoption using the GDP method

As of FY20, the total registered electric vehicle stock in India stood at approximately 0.53 million units, while the number of registered ICE vehicles stood at 203 million in 2016 (MOSPI 2018). While the EV share currently stands at 0.26 per cent of total stock, the FAME II measures (see Box 1) could help scale the market share of EVs.

Box 1 Faster Adoption and Manufacturing of Electric Vehicles (FAME) in India

FAME India was launched in April 2015 by the Department of Heavy Industry (DHI) as a part of the *National Electric Mobility Mission Plan* (NEMMP) of 2020 to incentivise the production and promotion of electric and hybrid vehicles. In 2017, FAME was shifted from the DHI to NITI Aayog to facilitate increased collaboration by multiple ministries, even as the DHI remains the nodal agency for its implementation.

FAME covered almost all segments of vehicles: 2W, 3W, 4W passenger vehicles, light commercial vehicles (LCV), buses, strong hybrids, plug-in hybrids, and battery-operated electric vehicles. It acts in four main areas: technology development, demand creation, pilot projects, and charging infrastructure.

The scheme had two phases.

Phase I, which started in April 2015, was originally intended to span two years, but was extended till 31 March 2019.

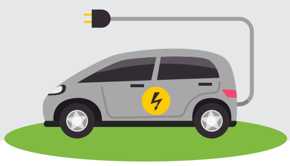
Phase 1 covered smart cities, metro agglomerations, state capitals, cities with populations exceeding 1 million, and cities in the North Eastern states. However, the 2W and 3W scheme was applicable throughout the country. It was implemented with a total outlay of INR 895 crore (USD 0.13 billion). During this phase, approximately 269,438 EVs were sold in the country. Market creation interventions to enhance demand in this phase included demand incentives in the form of an upfront reduction in the purchase price.

Table 1 Incentives under FAME scheme – Phase 1

Category	Approx. range of incentives (INR)
2W scooter	18,000–22,000 (USD 257–314)
2W motorcycle	29,000–35,000 (USD 414–500)
3W auto-rickshaw	33,000–61,000 (USD 471–871)
4W cars	13,000–1,38,000 (USD 186–1,971)
LCV	17,000–1,87,000 (USD 243–2,671)
Bus	34,00,000–61,00,000 (USD 48,571–87,143)

Source: CEEW-CEF compilation

Further, under this phase a nodal body was created – the DST Technology Platform for Electric Mobility (TPEM) – to facilitate collaboration between the Department of Science and Technology (DST) and the DHI to develop a global competitive edge in electric mobility technologies. Areas of technological development included lithium ion batteries, low-voltage charging platforms, driving cycles and traffic patterns, motors and drivers, ultra- capacitors, and light weighting.



Phase II:

Phase II of the FAME scheme came into being in April 2019 and will run till March 2022, with a total financial allocation of INR 10,000 crore (USD 1.43 billion). In this phase, an inter-ministerial committee was created for monitoring, called the Project Implementation and Sanctioning Committee (PISC). The scheme aims to disburse INR 8,596 crore as incentives and subsidies for electric 2W, 3W, buses, and commercial fleets. It reserves an amount of INR 1,000 crore specifically to support the setting up of charging stations. The scheme also incentivises manufacturers to develop electric vehicles and components, including lithium-ion batteries and electric motors (Department of Heavy Industry 2019).

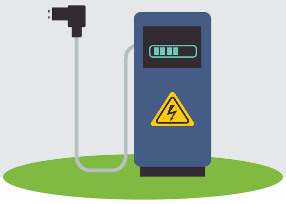
Table 2 **Allocation of funds (in INR crore) under FAME**

Category	2019–20	2020–21	2021–22	Total (INR crore)
Demand creation incentives	822	4,587	3,187	8,596
Charging infrastructure	300	400	300	1,000
Administrative expenditure – publicity and IEC (Information, Education and Communication) activities	12	13	13	38
Total for FAME II	1,134	5,000	3,500	9,634
Committed expenditure for FAME I	366	0	0	366
Total	1,500	5,000	3,500	10,000

Source: CEEW-CEF compilation

The demand incentives for FAME II cover only electric buses; 4W EVs; plug-in hybrids and strong hybrid cars; 3W EVs, including registered e-rickshaws used for public and commercial purposes only; and 2W EVs used for both private and commercial purposes. FAME II proposes that demand incentives will be provided at INR 10,000/kWh for all EVs and at INR 20,000/kWh for e-buses funded through the OPEX model. Additionally, the centre will incentivise the purchase of 7,090 electric buses with an outlay of INR 3,545 crore (USD 0.51 billion); 20,000 hybrids at INR 26 crore (USD 0.004 billion); 35,000 four-wheelers at INR 525 crore (USD 0.08 billion); and 5,00,000 three-wheelers at INR 2,500 crore (USD 0.36 billion).

The scheme also proposes to install 14,000 charging stations under the guidelines of the Ministry of Power in metropolitan cities, other million-plus cities, smart cities, and cities in hilly states across India. It will encourage the inter-linking of renewable, smart grids and the use of ICT with charging infrastructure.



Modelling methodology and assumptions

Among other indicators, new vehicle sales show a high positive correlation with India's GDP. Therefore, for the analysis, we selected GDP as the independent variable for sales projections.[2] Based on the GDP and vehicle sales data, and using a spatial forecast technique, we determined total new vehicle sales for FY22–FY30. We divided the total new vehicle sales into EV and ICE vehicles based on the targets set by the NITI Aayog and Rocky Mountain Institute study. The EV sales we obtained served as the base case on which we modelled the three scenario analyses for EV adoption in India.

2 The GDP tracks the health of a country's economy. It represents the value of all goods and services produced over a specific time period within a country's borders. To forecast new sales, we used GDP as an independent variable, owing to its high correlation with vehicle sales. The GDP data used in the study is based on OECD-GDP long term forecast (OECD 2020)

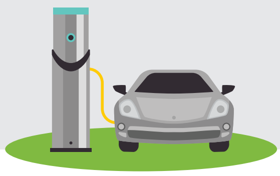
Box 2 COVID-19 related adjustments to the model

Estimate smoothening – One of the drawbacks of this linear model for the estimation of vehicle sales is that it models a linear relationship between vehicle sales and GDP. In the FY14–19 period, total vehicle sales data showed a 95 per cent correlation with GDP. This correlation indicates a strong relationship between the two variables and thus justifies the choice of GDP as an explanatory variable. However, the current COVID-19 pandemic – which has resulted in lockdowns, shrinking of consumer demand, and other behavioural changes that continue to emerge every day – has led to a deviation in the vehicle sales to GDP growth relationship. The deviation, which most estimates indicate is likely to last up to FY23,[3] has resulted in the correlation dropping from 95 per cent during the period FY14–19 to 86 per cent in FY14–20. This may be due to several other extrinsic variables that have impacted sales, prominent among which are declining liquidity, supply chain disruptions, and the increased propensity of consumers to conserve cash due to higher risk perception and lower risk appetite.

Secondary research indicates a GDP decline of 10 per cent for FY21 followed by a 9 per cent rebound in FY22 (International Monetary Fund 2020). Subsequently, GDP would remain in 7 per cent to 5 per cent band up to FY30 (OECD 2020)

Secondary research indicates that sales of passenger vehicles, commercial vehicles, and two-wheelers is likely to reach FY13 levels in FY21, with passenger and commercial vehicles witnessing a 20 per cent decline. At the same time, two-wheelers are also expected to see a 16 per cent decline (HT Auto 2020). The worst-hit among all vehicle segments will be three-wheelers, which may see a 45 per cent decline. We have adjusted the vehicle sales projections for FY21 based on this 16 per cent dip for two-wheelers, 20 per cent for passenger and commercial vehicles, and 45 per cent for three-wheelers over FY20. We used the sales figures so obtained for projections until FY30 (ETAuto 2020b). The steep drop can be primarily attributed to the low demand for first/last mile connectivity – since public transportation has been majorly shut for a large part of the year – and the associated health risk of travelling in a shared 3W.

However, based on discussions with industry experts and secondary research, we expect the automobile sector to start showing a V-shaped recovery starting FY22. The introduction of much-anticipated reforms, like the scrappage policy, may lead to a faster recovery for the automobile sector in the country.[4]



Based on the adjustments mentioned in Box 2, India is likely to achieve total net sales of 261 million units for the considered categories until FY30. The largest contributor among all vehicle segments will be two-wheelers, which will account for approximately 85 per cent of the overall sales until FY30.

India is expected to achieve total vehicle sales of 261 million by FY30 led by 2-wheelers, expected to account for 85% of the overall sales

3 These estimates confer to the automobile sector posting recovery in developed countries.

4 The scrappage policy makes it necessary to scrap old vehicles still plying on the road. This can create demand for new vehicles and help the automobile sector come out of a slump. As per estimates, if designed correctly and implemented in 2020, the policy could result in the removal of 28 million vehicles from Indian roads by 2025. Under the policy, owners who choose to scrap their vehicles get some scrap value and a certificate that provides GST savings and a discount on the purchase of new vehicles. The policy would also benefit vehicle makers who can avail recycled metals at cheaper rates and can also save on import bills and tax revenue from new vehicle sales. (Pandey 2020).

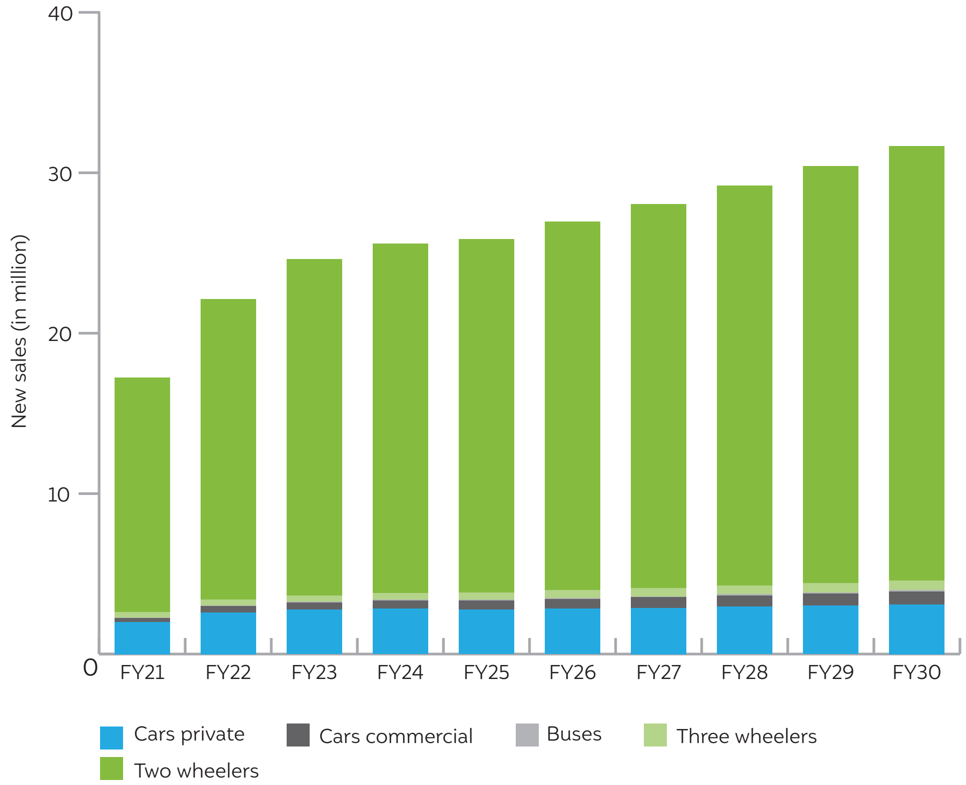


Figure 2
Total new sales projection of vehicles show an upward trend

Source: CEEW-CEF analysis

**FY20 uses actual numbers (the bifurcation in private and commercial cars of 86 per cent and 14 per cent is based on the historical split due to unavailability of data at the time of reporting).*

2.1 EV adoption trends using scenario analysis

Based on the automobile sale projections till FY30 in Figure 2, calculating the number of EVs across segments as per the NITI Aayog vision – 70 per cent of all commercial cars, 30 per cent of private cars, 40 per cent of all buses, and 80 per cent of two-wheelers and 3W – is fairly simple. We use the sales under this scenario as the base case. However, since electric vehicle adoption requires a considerable initial investment coupled with a long gestation period of two to five years and behavioural changes by the adopters, their adoption can be considered a process rather than an event. Trade-offs and technological advances around charging infrastructure, the total cost of ownership over the lifetime of the vehicle across different use cases, and rapidly declining battery costs are still evolving, which makes this a dynamic market. Policy support and regulatory interventions, like emission standards, have proven to be important levers for giving electric vehicle markets a jump start.

To reduce the unpredictability and uncertainty around the transition towards these projections, we split vehicle sales into the base case and three scenarios – the high, medium, and low adoption scenarios. The level of EV adoption in these scenarios is likely to be driven by three factors: the quantum of the **regulatory push** – both on the demand and supply side - such as restrictions on conventional vehicles; **market pull** – demand for the vehicle based on the favourable ownership costs of EV vs. ICE vehicles; and **infrastructure support** – support from the government for EV chargers. The penetration we assume in these what-if scenarios is based on our consultation with industry stakeholders.

The **high adoption scenario** considers projected sales to be 10 per cent above the base case across vehicle categories. The underlying assumption behind this scenario is significant demand-led growth, owing to a regulatory push combined with a consumer pull, and driven by the better cost economics of EVs vs. ICE in the future. It also includes the behavioural changes of consumers towards EV, along with infrastructural support in the form of higher-charging infrastructure penetration.

High adoption	Projected sales **10%** above the base case
Medium adoption	Projected sales **20%** below the base case
Low adoption	Projected sales **40%** below the base case

Figure 3
Decoding the three scenarios of EV ownership under different levels of adoption

Note: For our calculation, and due to lack of data, we assume the projected sales under all scenarios to be equivalently impacted across all vehicle categories.

Source: CEEW-CEF analysis

The high adoption scenario appears to be out of range for the moment, given the state of the automobile sector as a whole and the electric mobility sector in India. **The low adoption scenario** maps the investment required for a 40 per cent smaller EV market than the base case, considering the current economy-wide recession caused due to externalities like COVID-19, may have dampened consumer purchasing power. Also, OEMs' investments in EVs are likely to remain muted, as production is likely to remain below the optimum level for a couple of years, creating a cash constraint or at least some delay in making new investments (Ghosh 2020). In addition to COVID-19-related externalities, the ongoing geopolitical scenario exposes the EV sector's very high import dependence.

However, India is looking at several policy measures to boost EV component manufacturing locally; and although this will slow down any decrease in the costs of EVs – thus delaying their adoption – it will allow India to capture the benefits of the transition in the form of jobs and economic value, and is therefore likely to be accompanied by strong, demand-boosting measures. These constraints make both the **low and medium adoption scenarios**, which project EV sales to be 40 and 20 per cent below the stated NITI target for 2030, respectively, more likely representations of the way forward towards higher EV adoption in the country.

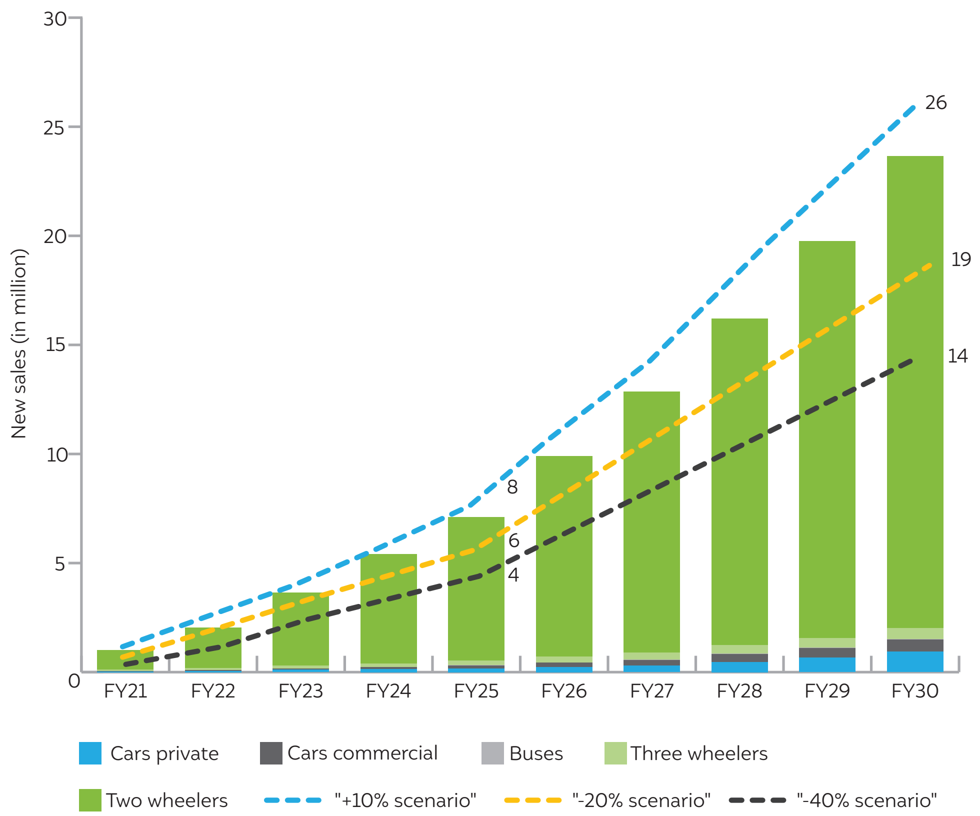


Figure 4
How will the EV sales grow under different scenarios?

Source: CEEW-CEF analysis

In the base case, the cumulative EV sales in all vehicle segments are estimated to be 102 million units by FY30; this could go up to 112 million units in the high adoption scenario, 81 million units under the medium adoption scenario, and 61 million units in the low adoption scenario. Of the total new vehicle sales, EVs account for as much as 43 per cent of the share in the high adoption scenario and as less as 23 per cent in the low adoption scenario.

Table 3
Translating India's 2030 EV ambitions in units to be sold

EV sales FY21 to FY30 (in million)	Base case	High adoption	Medium adoption	Low adoption
Two-wheelers	94	103	75	56
Three-wheelers	3	3	2	2
Cars (private)	3	3	2	2
Cars (commercial)	2	2	2	1
Total	**102**	**112**	**81**	**61**

*Source: CEEW-CEF analysis *Total includes buses*

Among the vehicle segments, we estimate EV adoption to be primarily driven by two-wheelers, followed by private cars and three-wheelers. Two-wheelers account for up to 92 per cent of the total EV sales, while electric private cars and three-wheelers account for about three per cent each of the total sales. In the base case, the cumulative sales of electric two-wheelers are likely to reach 94 million units by FY30; this can increase to 104 million units if there is high adoption and decrease to 56 million units in the low adoption scenario.

The driver for high adoption rates for electric two-wheelers and four-wheelers are likely to be driven by commercial operations, as the lifecycle savings of EVs are high, especially for fleet operations. (Since their costs are lower than those of ICE vehicles due to lower fuel costs, the result is significant savings for these categories of vehicles.)

2.2 Battery pack requirements

Battery packs – which make up 35–50 per cent of the total component costs – represent the most significant component of the total vehicle cost across all our considered categories of EVs. Other parts that contribute substantially to the cost are electric motors and power electronics (ACMA 2019). Currently, India's manufacturing capacities do not operate at the scale necessary to meet the demand for each of these vehicle components, and, as a result, we expect the mobility transition to be heavily dependent on imports. However, recent efforts towards building self-reliance (such as *Atmanirbhar Bharat Abhiyan*) must take into account accurate assessments of demand for components such as battery capacity, both for new vehicles and for the replacement of batteries in end-of-life in-stock vehicles.

Battery demand for EVs is expected to be 158 GWh by FY30 driven by two-wheelers which will account for 53% of the new battery demand

Methodology and assumptions

To estimate the demand for battery packs, we considered both new vehicle sales and the demand for replacement batteries (as the vehicle life far exceeds the life of any battery pack). Different vehicle segments use batteries of various capacities. For example, the battery capacity required for an electric two-wheeler is in the 3kW range, while that required for an electric bus is in the 200–320 kW range (Motilal Oswal 2018). We estimate the new demand for batteries in GWh using the battery capacity requirements for each vehicle segment and its respective sales. Then, we calculate the replacement demand based on battery life, the life of the average vehicle, and the average distance covered. The demand for battery replacements may initially be zero, but it will later increase depending on the vehicle's age. Thus, the total battery demand grows at a faster pace than the vehicle stock.

Based on this method, our projections, as we show in Figure 5, indicate a significant rise in annual battery demand from a mere 5 GWh in FY21 to 158 GWh by FY30.[5] By FY30, the battery replacement market is likely to contribute about 11 per cent of total EV-related battery demand.[6] In comparison, new battery demand will contribute about 89 per cent of the total battery demand.

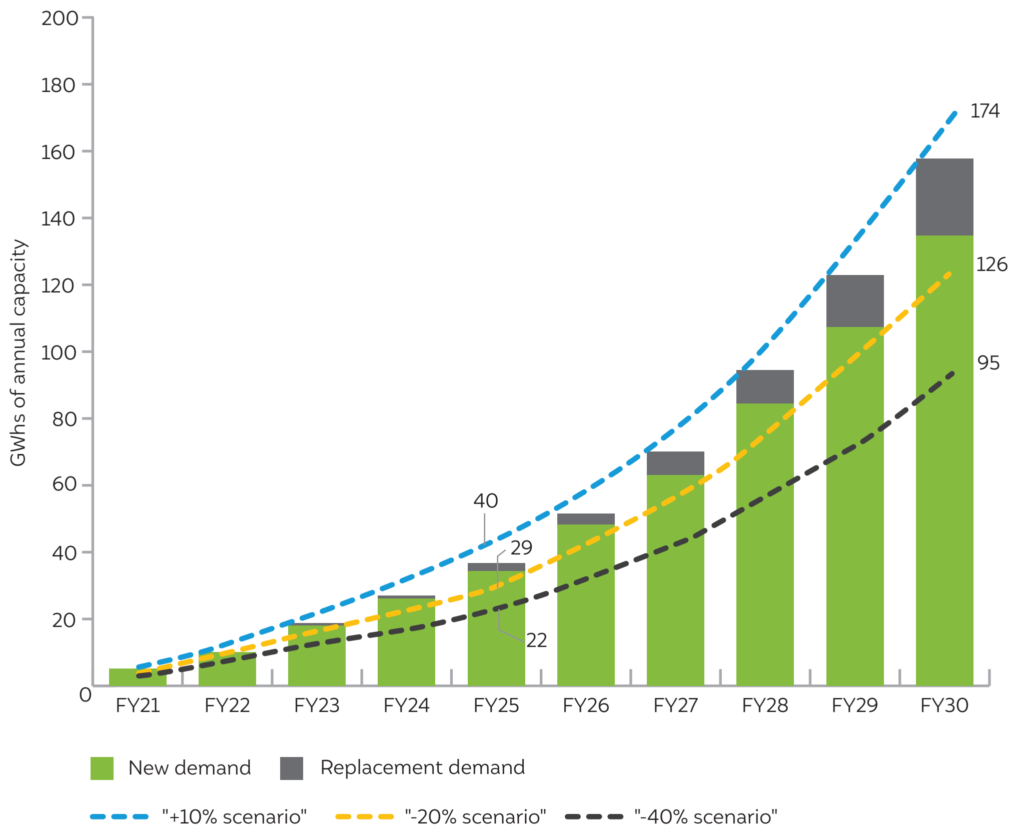


Figure 5
Battery demand for EVs will increase significantly by FY30

Source: CEEW-CEF analysis

**The numbers are based on the average battery capacity of 3KW, 5KW, 30 KW to 40 KW and 200 KW to 320 KW for two-wheelers, three-wheelers, cars and buses respectively, a battery life (assumed at 1,200 cycles), and distance driven annually as projected by Niti Ayog and under the assumption of a point charging model.*

As Figures 6 and 7 depict, across vehicle segments, we estimate the battery demand generated by new vehicle sales to be mainly driven by electric two-wheelers, which will account for 53 per cent of the new battery capacity requirement till FY30. Private and commercial electric cars follow, making up 23 per cent and 16 per cent, respectively, of the total demand. Electric three-wheelers, owing to their low battery capacity, and buses, because their sales are lower compared to the other categories, will not add much to the battery demand capacity till FY30.

5 The study projects the battery demand under the point charging mode of operations only. However, the actual battery demand depending on the share of battery swapping mode of operations may turn out higher given the mode requires a substantial capacity at the charge depots outside the vehicle.

6 The replacement demand assumes a change of entire battery package at the time of replacement which may not be true in all the cases as a battery may be refurbished by change of a few cells and other components and is placed back in the vehicle.

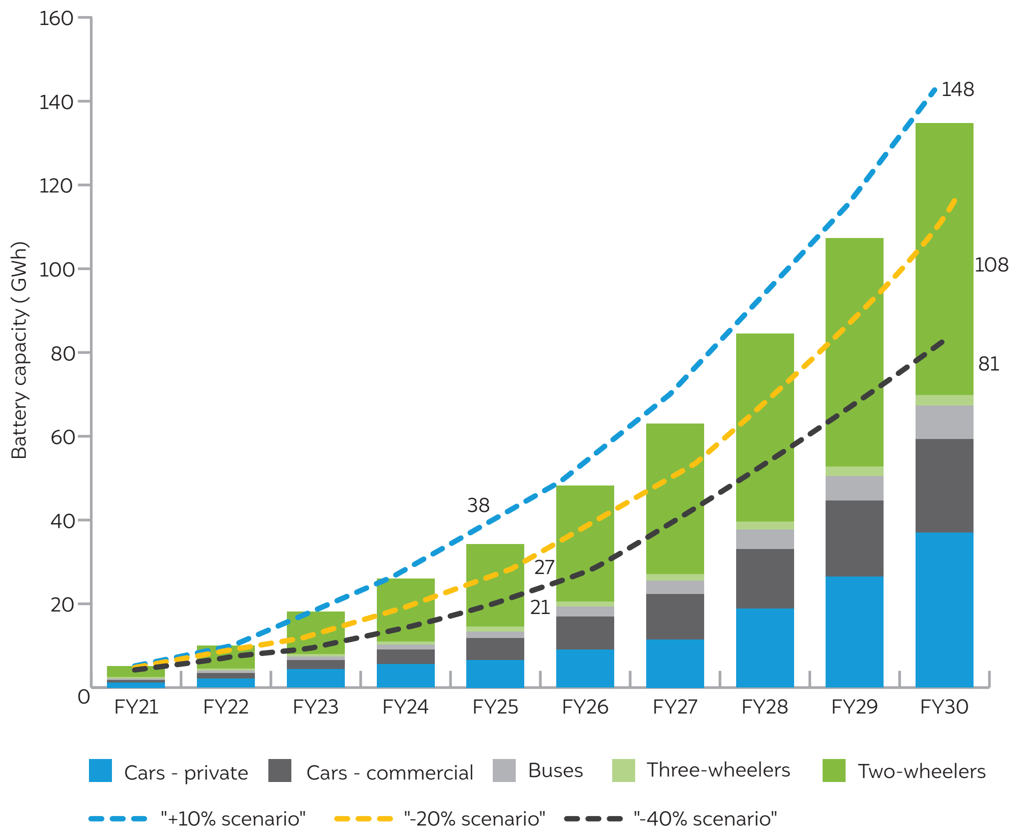


Figure 6
Demand for batteries across all vehicle segments make it critical to the EV transition

Source: CEEW- CEF analysis

** under the base case and the high, medium and low rates of adoption*

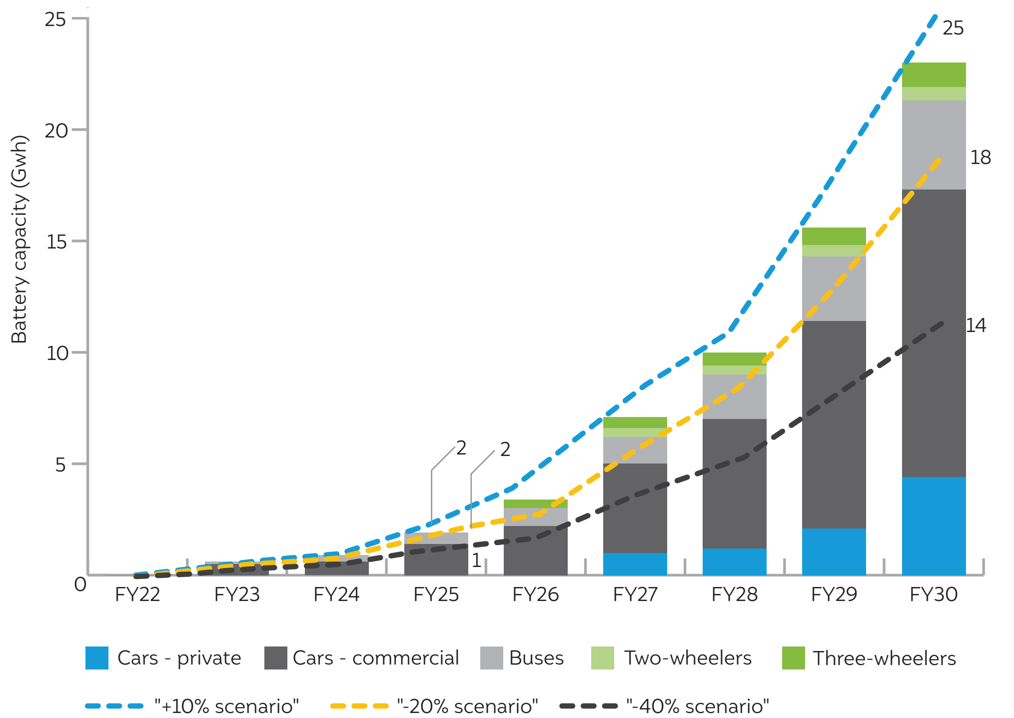


Figure 7
Commercial cars lead the battery replacement demand for EVs

Source: CEEW-CEF analysis

**under the base case and the high, medium, and low rates of adoption*

Across all vehicle segments, electric cars for commercial use are likely to be the main driver for the demand for replacement batteries, accounting for 58 per cent of the total replacement demand. Also, electric private cars and buses are likely to account for 14 per cent and 19 per cent, respectively, of the replacement demand during this period. The replacement demand for buses is higher because of the high average annual vehicle kilometres covered – which makes frequent battery replacements necessary – as opposed to other vehicle segments, which travel fewer vehicle kilometres during their lifetime.

2.3 Ecosystem – public charging stations for EV deployment

The massive charging ecosystem would be necessary to support India's EV transition. Public charging stations (PCS), like petrol stations, which form the backbone of the ICE-based vehicular system, will be an essential part of this ecosystem. PCS present a substantial investment opportunity, even for private players, if policies and business models allow for healthy returns on investment. However, according to market experts, our reliance on PCS for day-to-day personal transportation is likely to be limited. We expect the role of PCS in the Indian context to be limited to providing an initial behavioural nudge, meeting the requirements of commercial operations, providing fast-charging top-ups, and facilitating long-distance and inter-city travel.

> Demand for public charging points is not just dependent on vehicle sales but also on capacity of chargers, mode of charging, hours of operation and battery capacity of vehicles

Methodology and assumptions

The demand for public charging points will not just depend on vehicle sales, but also on other variables, such as the capacity of chargers, mode of charging and hours of operation, and the battery capacity of vehicles. Key informant interviews that we conducted with charge point operators reveal that currently, there are five kinds of chargers in the market:

i. DC charger >=50 kWh (Combined charging system (CCS) and CHAdeMO)

ii. Bharat EV charger AC-001

iii. Bharat EV charger DC-001

iv. Type 2 AC chargers

v. Type 1 AC

We assume that the average capacity utilisation factor of these chargers is about 40 per cent in the case of both, the fast and slow charging options. Our discussions also revealed that vehicles are mostly charged up to 85 per cent of their total battery capacity. Type 2 AC, CCS, and CHAdeMO are high-capacity, comparatively expensive chargers. Charging point operators deploy these chargers mostly for four-wheelers. In contrast, Bharat EV charger AC-001 and Type 1 AC (2KW) are preferred for two-wheelers and three-wheelers while AC-001 can provide a slow-charging option to four-wheelers. Based on these assumptions, Table 4 shows the number of vehicles that can be supported by each charger type.

Particulars	DC chargers >= 50 Kwh - CCS (Combined Charging System) & CHAdeMO	Type 2 AC Charger	Type 1 DC charger (Bharat DC - 001)	Bharat EV charger AC – 001)	AC-1 (small 2 KW)
Two-wheelers				25	5
Three-wheelers				15	3
Cars - private	10	4	3	2	
Cars - commercial	13	6	4	2	

Table 4
Each charger can support multiple vehicles

Source: CEEW-CEF analysis

**The EV that could be supported per charger for a capacity utilisation factor of 40 per cent.*

According to Table 2, a single Bharat EV charger AC-001 can support 25 two-wheelers while a single Bharat EV charger AC-1 small can support 5 two-wheelers. For four-wheelers, charging point operators are likely to prefer CCS and CHAdeMO and Type 2 AC over Bharat chargers because they are available in higher capacities than Bharat chargers. A single CCS and CHAdeMO charger can support 10 to 13 cars.

Since public charging stations are not the only option for charging EVs, and other possibilities like home and workplace charging are likely to become prevalent too, the network of public chargers per site can be relatively small, as long as it is widespread. In fact, in most developed economies where the uptake of EVs is high, public chargers form only a small proportion of the total number of chargers in use. For example, in Greater London, publicly accessible charging points constitute only 22 per cent of the total number of charging points (PwC 2018). Consumers use public charging only for a limited number of rides.

Further, commercial vehicles and buses are more likely to use public chargers, as they are on the road for much longer than other vehicle segments, like two-wheelers and private four-wheelers. Key informant interviews with charging point operators reveal that on an average, only 20 per cent of two-wheelers, 50 per cent of three-wheelers, 20 per cent of personal cars and 50 per cent of commercial cars require charging at a PCS. Factoring in this assumption while calculating the charge factor in Table 2 brings down the number of public chargers required per vehicle sold substantially for a few vehicle segments, as Table 3 shows. For example, 126 of all two-wheelers sold can be supported with the deployment of a single Bharat AC – 001 EV charger.

Table 5
Number of vehicles supported by each charger type under the limited use case

Source: CEEW-CEF analysis

**Numbers are based on the assumption 40 per cent utilisation factor per charger. We also consider that only 20 per cent of two-wheelers, 50 per cent of three-wheelers, 20 per cent of personal cars and 50 per cent of commercial cars require charging at PCS.*

Particulars	DC Chargers >= 50 KWh - CCS (Combined Charging System) & CHAdeMO	Type 2 AC Charger	Type 1 DC charger (Bharat DC - 001)	Bharat EV charger AC – 001)	AC-1 (small 2KW)
Two-wheelers				126	26
Three-wheelers				30	6
Cars - private	48	21	14	9	
Cars - commercial	26	11	8	5	

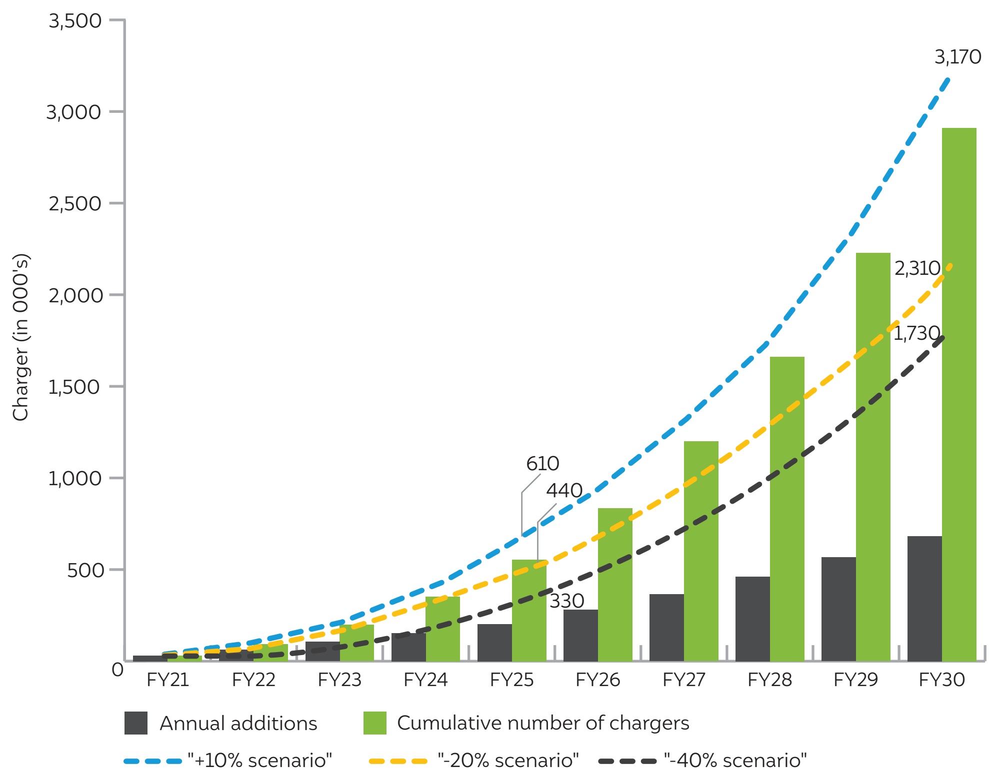


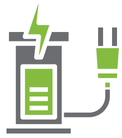
Figure 8
Public charging points needed to drive consumer adoption

Source: CEEW-CEF analysis

**Though the analysis assumes a linear relationship between time and the number of vehicles sold, the charging infrastructure may have to be set up in advance, with a demand horizon of at least two to three years, given that the unavailability of the chargers can act as a severe deterrent to the actual sales of EVs.*

Thus, on average, a public charger catering to a single vehicle segment at a time can support 76 two-wheelers, 18 three-wheelers, 23 personal cars, and 12 commercial cars (assuming an equivalent split between chargers). Based on these assumptions and inputs, India would need a network of 29,38,000 public charging stations by 2030 to support EV adoption under the base case target of NITI Aayog. Of these it is expected that about 20,71,500 (71 per cent) of chargers will be low capacity chargers used for supporting two-wheelers and three-wheelers combined. However, in the low adoption case, where a 40 per cent dip in EV sales against the base case is expected, the charger points required by 2030 could be as few as 17,63,000. These calculations do not take into account other elements like city-wise/regional vehicle density, charging patterns, swapping model adoption, the elasticity of a charge point, and other factors.

Without the deployment of adequate charging infrastructure, the adoption of EVs will remain a distant dream. India will therefore need to determine a fit-for-purpose ratio. Countries with high EV adoption also have a developed ecosystem for charging infrastructure. However, this varies significantly – for example, China has a high public charging points-to-EV ratio (1:8) compared to Norway, where the ratio is 1:20 (IEA 2019). While India need not have as numerous public charging points as in China, due to the former's high reliance on home and other private charging facilities, a geographically widespread charging network will be essential to reducing range anxiety among consumers.



India would need a network of 29,38,000 public chargers to realise its 2030 vision, with low capacity chargers accounting for 71% of the network

Indian automobile industry supports a deeply interconnected value chain, the apex of which is formed by OEMs and a network of sales outlets

Image: iStock

3. Decoding the automobile sector value chain

The Indian automobile industry relies on and supports a deeply interconnected value chain, the apex of which is formed by OEMs and a network of sales outlets. These OEMs usually assemble the vehicle by manufacturing a few critical components or software while sourcing the rest as per their specifications from a system of Tier-1 suppliers.

Based on the position of the suppliers in relation to the OEMs in the supply chain, they are classified into different tiers. Tier 0.5/1 is the direct supplier to the OEMs; they supply critical components, like the door module of a car or the braking system. The smaller components, like brake pads, are sourced from Tier-2 suppliers. These suppliers may also source raw materials from level 3 suppliers. Every single vehicle coming out of the production line has parts sourced from several manufacturers and suppliers – sometimes more than 100 vendors (Ghosh 2018).

After assembly at the OEMs, the vehicles are transported to dealer shops, which work as the consumer interface before the eventual sale. Additionally, the auto industry also has ancillary services, like insurance and financing, where insurance companies, banks, and NBFCs provide products like auto loans to finance the vehicle purchase or instruments like vehicle insurance.

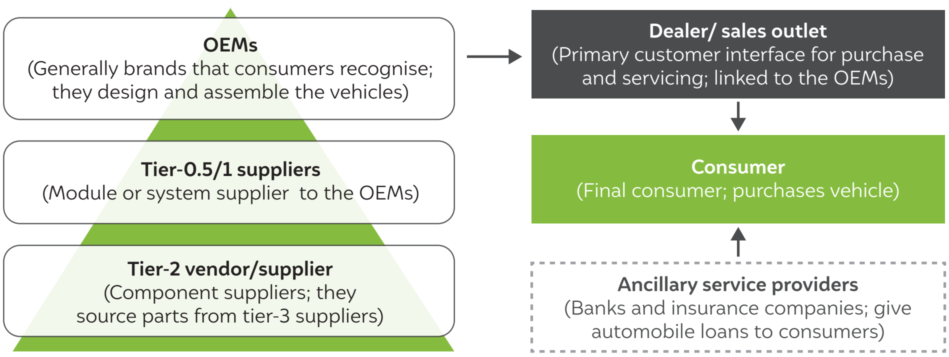


Figure 9
Automobile supply chain and ecosystem

Source: CEEW-CEF compilation

Sourcing components from a large number of suppliers and vendors to match the specifications of the vehicle production plan makes the development of the supply chain a complex, capital-intensive process. The adoption and manufacturing of EVs – other than three-wheelers battery rickshaws – in India are still in the nascent phase. So it is essential to lay a strong foundation for the ecosystem. For boosting indigenisation of vehicle components, it is crucial to understand the value that the components add,[7] which of them can be sourced from existing, conventional vehicle supply chains, and which require new investments.

The Indian ICE-based vehicle market is quite advanced, with local manufacturing of components exceeding 90 per cent (based on the type of vehicle) of the total components value (Dhawan, et al. 2018). These automobile component manufacturers achieved total sales of INR 3,99,000 crore (USD 57 billion) in FY19, catering not only to the domestic market but also exporting components worth almost INR 1,05,000 crore (USD 15 billion) and contributing 2.3 per cent to India's GDP (ACMA 2019). However, with the mainstreaming of EVs, several components that form nearly 40–50 per cent of the vehicle value in an ICE vehicle may become redundant. At present, given the small volume of sales and lack of domestic manufacturing, most EV-exclusive components are entirely or partially imported. However, clearer target-setting and policy support that create market certainty and signal a continued demand for inputs into EVs could spur domestic manufacturing.

Most EV-exclusive components are entirely or partially imported. The four major EV-exclusive component modules are: battery pack, electric drive, power electronics and VICM

These major, EV-exclusive component modules include:

1) Battery pack – includes battery cells, modules, thermal management casing, battery management systems, and other mechanical and electronic parts
2) Electric drive – includes e-motors, housing, harnesses, and connectors
3) Power electronics – includes power distribution modules, DC converters, thermal management, charger systems, and others
4) Vehicle interface control module – includes electronic modules, connectors and harnesses, and software

These four modules contribute approximately 60 per cent (+/- 10 per cent) of the total component costs across the considered EV categories (ACMA 2018). The cost curves of these components – especially the battery pack – will be the primary drivers for the reduction in the cost of EVs.

3.1 Battery pack

The battery pack is the power-storing unit of the vehicle, contributing 35–50 per cent of the overall EV cost. The production structure of the lithium-ion battery pack is very similar to that of a pyramid. At the base of the pyramid lie mining/urban mining and chemical production, which together comprise 55 per cent of the cost of production (Azevedo, et al. 2018).

The battery pack contributes 35-50% to the overall EV cost

Mining and chemical production are essential for sourcing key components like lithium, manganese, nickel, cobalt, iron, sodium, vanadium, copper, and aluminium, which are used to make up the five main features of the lithium-ion battery, namely the cathode, anode, electrolyte, separator, and safety structures.

7 A CEEW report on India's EV transition estimates that the domestic value added (at 2018 prices) by the indigenisation of electric car components excluding battery packs in 2030 – assuming 30 per cent car penetration – could vary between INR 3,22,000 crore (USD 46 billion) in case of 90 per cent indigenisation and INR 2,83,500 core (USD 40.5 billion) in case of 50 per cent indigenisation (Soman, Ganesan, and Kaur 2019).

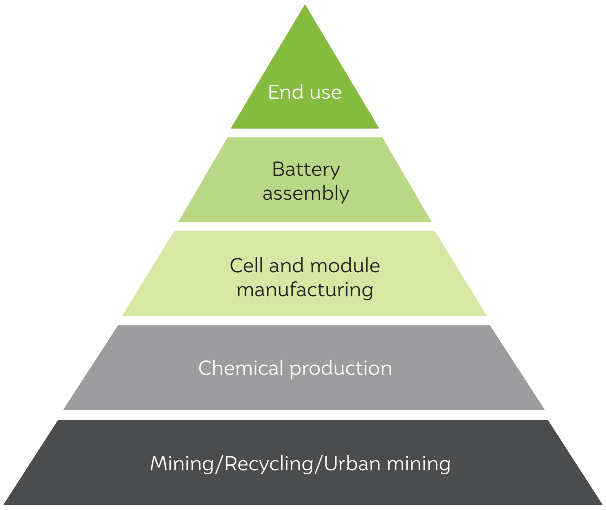


Figure 10
Battery pack value chain

Source: CEEW-CEF compilation

The second and third tiers of the pyramid are cell and module manufacturing along with battery assembly. Putting the battery pack together involves manufacturing the lithium-ion cell and assembling the battery management, thermal management, and battery housing systems. The battery management system is an essential component for the safe operation of the battery. The thermal management system for the battery pack includes pumps, pipes, valves, and a heat exchanger, which absorbs the heat generated in the battery during charging and vehicle operation. The battery housing system is made of plastics and composite materials to provide shock proofing and insulation from the external environment. At the top of the pyramid is the end use of the battery in electric vehicles.

Lithium-ion cells form the largest cost component of the battery pack, accounting for approximately 60% of its total cost

Lithium-ion cells form the largest cost component of the battery pack, accounting for approximately 60 per cent of its total cost (ACMA 2018). The manufacturing of lithium-ion cells is dependent on the sourcing and mining of lithium and other minerals like cobalt, aluminium, and copper. Currently, India does not have reserves of lithium and cobalt. It is dependent on countries like Argentina, Australia, Bolivia, Chile, and China to meet its demand for lithium, and on other countries for other crucial raw materials like cobalt, nickel, manganese, and graphite (Siddiqui 2020). However, through the use of appropriate policy measures – like making long-term preferential purchase agreements, enhancing its capacity to recycle lithium metals, and devising trade rules to ensure the stable supply of raw materials – India could bring the cost of lithium-ion cells down by 25–30 per cent, leading to an overall decline in the prices of local battery packs (ACMA 2018).

3.2 Electric drive

The electric drive consists of the electrical components of the drive train, such as the e-motor, gearbox, housing, and connectors and harnesses. At present, this module contributes 10–15 per cent of the total component costs (ACMA 2018). The primary cost driver of this module is the e-motor, which makes up approximately 60 per cent of the module cost; the gearboxes contribute about 20 per cent; and housing, harnesses, and connectors add to the remaining value of the module (ACMA 2018). We expect that in the coming years, the cost contribution of the electric drive module will increase as the battery pack costs decline. At present, India does not have adequate manufacturing capacity for induction motors that can meet the high efficiency and density requirements of EVs. The gearboxes, on the other hand, are optional for low-end, low-speed EVs, but would be required for premium cars and heavy vehicles like buses. Given that India already has adequate know-how for manufacturing the more complex ICE-based gearboxes, we expect local manufacturing of gearboxes to be easier.

Other EV exclusive component like electric drive, power electronics and VICM contribute 20 per cent to the overall EV cost

3.3 Power electronics

This module contributes 7–10 per cent of vehicle component costs. The critical power electronic components in an EV are DC-DC converters, charger systems, power distribution modules, thermal management systems, connectors, and harnesses (ACMA 2018). Currently, India imports most of the components in this module from China, as it does not have much local manufacturing capability (Lijee 2019). Imports in this segment account for nearly 65–70 per cent of the OEM demand (ElectronicsB2B 2019). However, we anticipate that architectural changes in the electric circuitry and standardisation of the charging can help boost manufacturing in the electronics industry.

3.4 Vehicle interface control module (VICM)

The VICM module acts like a data storage and distribution centre within an EV. It controls and monitors operations between interoperating electronic modules. The critical component of this module is a Printed Circuit Board (PCB) with an integrated microprocessor, which makes up 80 per cent of the VICM module cost. Other parts, like housing, connectors, and harnesses, form the remaining 20 per cent of its cost. While software advancements are expected for this module in the future, given its small contribution of three to five per cent of the overall vehicle component cost, it is not likely to significantly change the overall cost of the vehicle (ACMA 2018).

Component costs for EV production	
Module costs + assembly costs	Battery pack – 40% Electric drive – 10% Power electronics – 7–10% VICM – 3% Other non-EV-specific components + assembly costs – 30–40%

Table 6
Component costs for EV production

Source: CEEW-CEF compilation

Just as the local supply chain for conventional, ICE-based vehicles was developed through adequate policy support over time, CEEW-CEF believes that Indian suppliers, if incentivised and supported by global OEMs, and other institutes, can either develop or acquire manufacturing capabilities, especially for the battery pack and electric drive modules. This will also contribute significantly towards the indigenisation efforts of EV production, as these modules form about 50 per cent of vehicle component costs. Also, a solution to the indigenisation of power electronics and VICM will have to be worked in cooperation with other industries like electronics and others and the policymakers to achieve the advantage of scale for PCB fabrication. A collaborative approach cutting across sectors could provide the scale benefits which the EV industry will not be able to provide at least in the upcoming few years.

CEEW-CEF believes that Indian suppliers if incentivised and supported can either develop or acquire EV manufacturing capabilities. Indigenisation of EV will reap huge dividends in the future

However, following the advent of the COVID-19 pandemic, all players in the automobile industry, including its suppliers, are suffering from liquidity constraints due to low demand. However, to create a positive narrative out of the transition, the conventional players along with the OEMs will have to continue to make investments so that they are ready for manufacturing critical components locally under the government's phased manufacturing programme (PMP) notified in 2018 for localisation of components in next five years.

4. Sizing EV investment opportunities for manufacturing and deployment

Image: iStock

The entire automotive value chain to drive up the adoption and manufacturing of EVs will need to continue making substantial investments in R&D, setting up production capacities and development of an ecosystem that solves for the issue related to range anxiety and charging infrastructure. Similar to the transition during the advent of ICE in the country in 1990's the vehicles OEMs, auto-component manufacturers, and other players invested in building charging infrastructure will need extensive policy support, R&D and financing support.

Vehicle manufacturers will have to eventually develop EV specific platforms for the production of multiple vehicles to achieve the benefits of scale. The platform and eventual vehicle development exercise are fixed-cost heavy. It has a typical gestation period of two to five years, depending on the type of vehicle and the manufacturer's ability and plans. Thus to unlock the enormous opportunity that EVs present to a manufacturer, they will have to make substantial investments under a long gestation period.

Policy support and innovative business models would be necessary, especially for the players working with the long gestation period like the charging station providers, for higher EV adoption. These players will have to wait even longer to start making returns. They will have to wait until after the gestation period of infrastructure development and the lag period until EV penetration increases, resulting in fair usage of the charging network.

Policy support and innovative business models are necessary for higher EV adoption

e-Vehicle categories	Vehicle sales (in million)	Total production costs (for OEMs) (in INR crore)	Cost for consumers* (in INR crore)	Investment towards charging infrastructure development (in INR crore)
Cars (private)	3.1	3,37,900 (USD 48 billion)	3,85,600 (USD 55 billion)	5,450 (USD 0.8 billion)
Cars (commercial)	2.2	1,78,200 (USD 26 billion)	2,03,300 (USD 29 billion)	7,130 (USD 1.0 billion)
Buses	0.1	55,900 (USD 8 billion)	61,300 (USD 9 billion)	NA
Three-wheelers	2.6	34,100 (USD 5 billion)	38,700 (USD 6 billion)	830 (USD 0.1 billion)
Two-wheelers	93.7	6,33,700 (USD 91 billion)	7,53,900 (USD 108 billion)	7,170 (USD 1.1 billion)
Total	**101.6**	**12,39,800 (USD 177 billion)**	**14,42,400 (USD 206 billion)**	**20,600 (USD 2.9 billion)**

Table 7
Cumulative volume, investments for OEMs, charging infrastructure, and consumers until 2030

Source: CEEW-CEF analysis

**The cost for the consumer does not include the GST, road tax, and insurance costs applicable on the purchase of the vehicle.*

CEEW-CEF expects the investment outlay for the manufacturing and deployment of EVs until FY30, based on the high, medium, and low adoption scenarios, to follow the trajectory in Table 8.

Cost and investment summary	High adoption (in INR crore)	Medium adoption (in INR crore)	Low adoption (in INR crore)
Total production costs (for OEMs)	13,63,700 (USD 195 billion)	9,91,800 (USD 142 billion)	7,43,900 (USD 106 billion)
Cost for consumers	15,86,600 (USD 227 billion)	11,53,900 (USD 165 billion)	8,65,400 (USD 124 billion)
Investment towards charging infrastructure development	22,600 (USD 3.2 billion)	16,500 (USD 2.4 billion)	12,300 (USD 1.8 billion)

Table 8
Cost and investment summary under different adoption scenario

Source: CEEW-CEF analysis

For the calculations under different scenarios, the total production costs, costs for consumers, and the investments for developing charging infrastructure, we have assumed a linear relationship with the number of vehicles. This may not be true, given that the fixed costs follow a step function. By our calculations, for the base case, we expect the OEMs to incur fixed costs in the range INR 21,000 crore (USD 3 billion) in the first five years and INR 35,000 crore (USD 5 billion) in the next five years. Also, for the charging infrastructure, we have assumed that 40 per cent utilisation per charger to calculate the number of chargers and a fixed 1.2x to 1.5x investment multiple for various chargers. The cost calculations have not been adjusted for inflation.

4.1 Investment opportunity for vehicle manufacturers

To calculate the production costs of EVs we calculated direct costs like production and assembly costs as shown in the annexure. The component and assembly costs - were divided into two - the battery pack and cost of other components and their assembly. For analysis, battery-pack related costs have been assumed to follow BNEF cost trends. Based on industry feedback pointing to impacts of economies of scale and improved efficiency for other components and their assembly costs are assumed to follow a 2 per cent annual decline until FY30. An analysis of the cost and revenue streams of a few OEMs[8] manufacturing EVs or planning to do so shows that the direct costs contribute 62-74 per cent of the production costs. While the remaining is made up of the employee costs, research and development costs, finance costs and additional fixed costs to derive the final production costs, which are added to derive the production costs.

Since two-wheelers are expected to be the primary driver of EV sales in the projected scenarios and may contribute over 90 per cent of the total EV sales by volume, their production will require sector incurring about a third of the total costs of production across

8 Analysis based on the balance sheets of the following OEMs – two-wheelers: Honda, Bajaj, and Hero Motors; three-wheelers: Piaggio; four-wheelers: Maruti, Hyundai, and Mahindra and Mahindra; buses: Ashok Leyland and Tata Motors.

all vehicle segments until FY30. In the base case[9], two-wheelers OEMs are projected to incur annual production costs of approximately INR 7,700 crore (USD 1 billion) in FY 21, which is likely to increase up to INR 1,34,100 crore (USD 19 billion) by FY 30 as shown in Figure 10. The cumulative cost is expected to exceed INR 6,33,700 crore (USD 91 billion) over the period to meet the goal of 80 per cent of total new sales by 2030 (See Annexure 1.1 for full production cost assumptions of all vehicle segments).

While four-wheelers may seem a minor contributor to new sales in terms of the absolute sales numbers, because of their higher costs, the production of four-wheeler EVs will require OEMs to incur annual costs of INR 5,800 crore (USD 0.8 billion) in FY 21. This is expected to increase up to about INR 1,37,700 crore (USD 20 billion) in FY30 to meet the overall target of about 30 per cent of new sales by FY30. The four-wheeler segment will cost INR 5,16,100 crore (USD 74 billion) in production costs over the period until 2030.

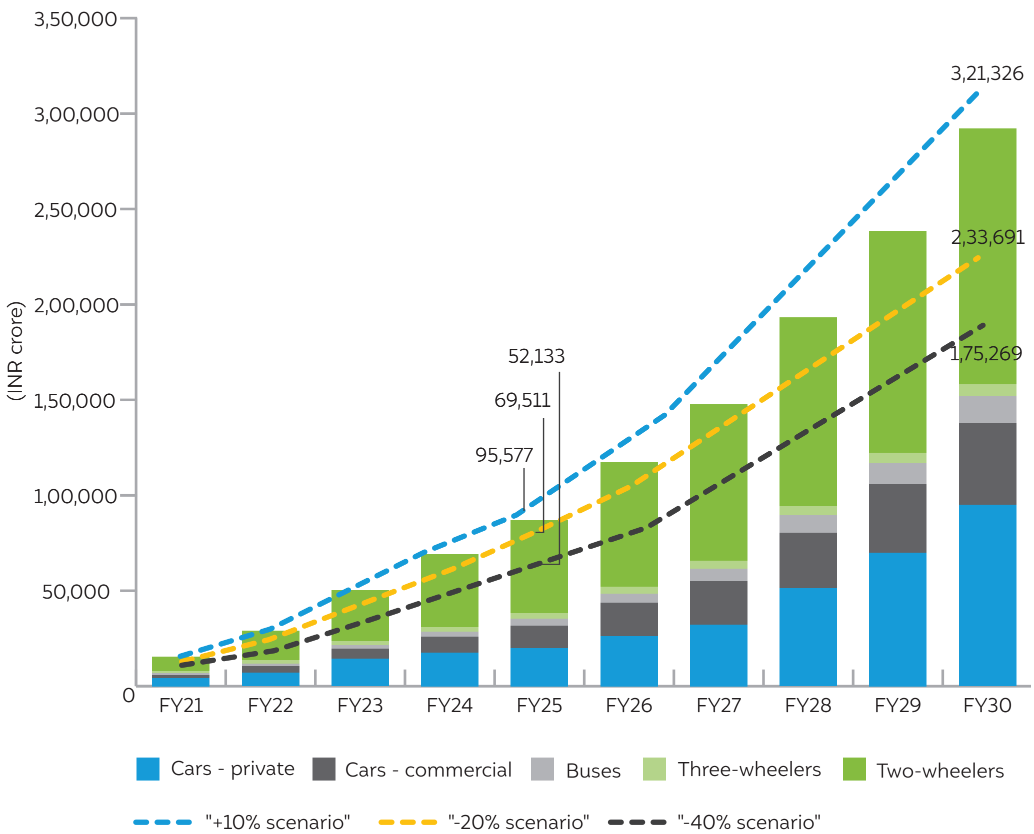
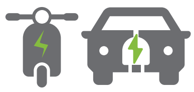


Figure 11
Industry to invest as much as INR 12,39,800 crore (USD 177 billion) in EV production by 2030

Source: CEEW-CEF analysis



Production of EVs presents an investment opportunity of USD 177 billion driven by 2-wheelers and 4-wheelers

Overall, for the electric mobility transition to reach the projected scale, cumulative investments of INR 12,39,800 crore (USD 177 billion) in the FY21 to FY30 period will be required. Of these total costs, fixed costs investments (like the cost of setting up assemble lines and other fixed assets required prior to production at scale) are expected to amount to about INR 21,000 crore (USD 3 billion) over the next five years and about INR 35,000 crore (USD 5 billion) over the five years after that to reach the desired production capacity.

For our three scenarios with different adoption rates, i.e., '+10 per cent', '-20 per cent', and '-40 per cent', we expect the transition to cost the industry INR 13,63,700 crore (USD 195 billion), INR 9,91,800 crore (USD 142 billion), and INR 7,43,900 crore (USD 106 billion), respectively.[10]

9 The base case for the production of vehicles is based on the material costs and inventory holding costs involved in the production of each vehicle segment. This cost is 76 per cent for two-wheelers, 72 per cent for three-wheelers, 76 per cent for four-wheelers, and 73 per cent for buses.

10 This is assuming that all the scenarios will follow a similar vehicle mix as within the base case.

USD 206 BILLION
THE SALES OPPORTUNITY IN INDIA'S TRANSITION TO ELECTRIC VEHICLES

Annual EV* Sales by Unit
(Million)

BASE CASE
Base case figures are based on the Rocky Mountain Institute (RMI) and NITI Aayog estimates that place India's EV sales at 70% of all commercial cars, 30% of private cars, 40% of buses, and 80% of 2-wheelers and 3-wheelers by 2030.

+10% SCENARIO
Above base case - HIGHER ADOPTION

-20% SCENARIO
Below base case - MEDIUM ADOPTION

- 40% SCENARIO
Below base case - LOW ADOPTION

	Base case	+10% scenario	-20% scenario	-40% scenario
FY21	1	1.1	0.8	0.6
FY22	2.1	2.3	1.7	1.2
FY23	3.7	4	2.9	2.2
FY24	5.4	5.9	4.3	3.2
FY25	7.1	7.8	5.7	4.3
FY26	9.9	10.9	7.9	5.9
FY27	12.9	14.2	10.3	7.7
FY28	16.2	17.8	13	9.7
FY29	19.8	21.7	15.8	11.9
FY30	23.6	26	18.9	14.2

*EV comprises electric 2-wheelers, 3-wheelers, cars (private and commercial) and buses.

Annual Revenues from EV Sales
(INR billion**)

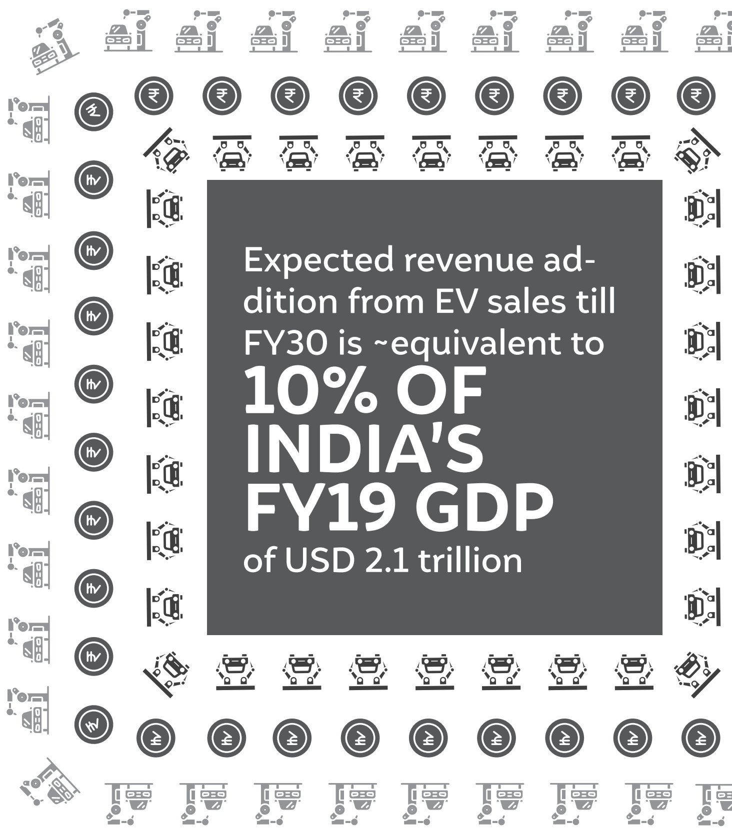
BASE CASE

+10% SCENARIO
Above base case - HIGHER ADOPTION

-20% SCENARIO
Below base case - MEDIUM ADOPTION

-40% SCENARIO
Below base case - LOW ADOPTION

	Base case	+10% scenario	-20% scenario	-40% scenario
FY21	180	198	144	108
FY22	339	373	271	204
FY23	585	644	468	351
FY24	808	888	646	485
FY25	1,013	1,114	810	608
FY26	1,368	1,505	1,094	821
FY27	1,720	1,892	1,376	1,032
FY28	2,248	2,473	1,799	1,349
FY29	2,771	3,048	2,217	1,663
FY30	3,391	3,730	2,713	2,034



**INR 1 billion = INR 100 crore

Source: CEEW-CEF analysis

4.2 Investment opportunity for battery manufacturing

The progress of EV adoption is likely to create an unprecedented demand for batteries. The need for batteries will be driven by both new sales of EVs and the demand for replacement batteries in existing EVs. In Section 1 of this report, we estimated the annual battery requirements to meet the EV transition goals to be 158 GWh in the base case in the year FY30.

Under 50% indigenisation of battery manufacturing, USD 6.1 billion investment opportunity is created which can reach USD 12.3 billion under 100% indigenisation by FY30

Methodology for calculating investment opportunity for battery manufacturing

As stated in Section 1, the demand for new and replacement batteries has been estimated based on vehicle sales, battery capacity, and the battery life of each vehicle segment. The CAPEX cost for setting up a 10 GWh production capacity has been assumed as USD 0.73 billion based on secondary research of a recent battery manufacturing collaboration between General Motors and LG Chem.[11] Based on the projected demand, the annual investment required for a battery manufacturing facility is calculated for the 100 per cent and 50 per cent indigenisation scenarios.

To meet this potential demand, battery manufacturers will need to expand their production capacity substantially. This vast expansion will require huge investments, which will vary according to the level of battery manufacturing indigenisation. Under a 50 per cent indigenisation of battery capacity scenario, investments incurred by FY30 will stand at about INR 42,900 crore (USD 6.1 billion). The cumulative investment required would top INR 85,900 crore (USD 12.3 billion) in case of 100 per cent indigenisation of battery manufacturing.

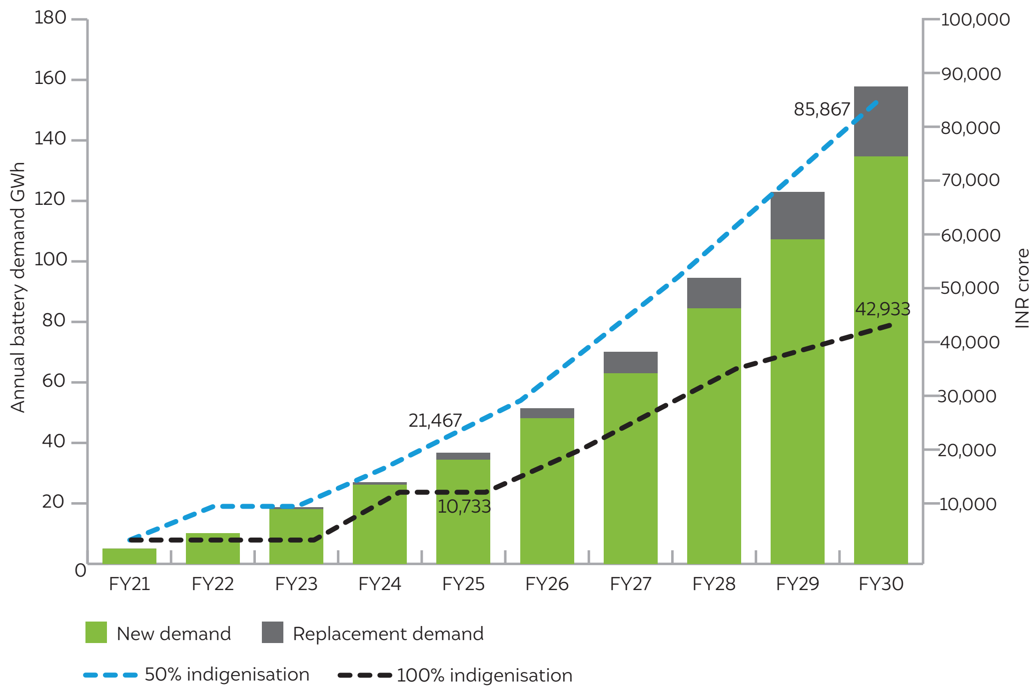


Figure 12
Battery manufacturing in India could become INR 85,900 crore (USD 12 billion) business in India by 2030

Source: CEEW-CEF analysis

**The investment figures have been arrived at by assuming CAPEX costs of INR 5,110 crore (USD 0.73 billion) for establishing a 10 GWh annual production capacity. The real investment numbers may be higher in case the cost of building Giga-factory increases substantially or if manufacturing of batteries is done at smaller facilities.*

The investment requirement for battery manufacturing is directly proportional to the level of EV adoption. In the high adoption scenario (+10 per cent scenario), the battery manufacturing investment requirement can rise to INR 92,000 crore (USD 1.31 billion). In the low adoption trajectory (-40 per cent scenario), it could dip down to INR 51,100 crore (USD 0.73 billion).

11 We do not foresee an increase or decrease in the real cost of setting up the battery facility over the period.

USD 12.3 BILLION INVESTMENT REQUIRED FOR INDIA TO MEET ITS EV BATTERY DEMAND

Battery Demand
(GWh)

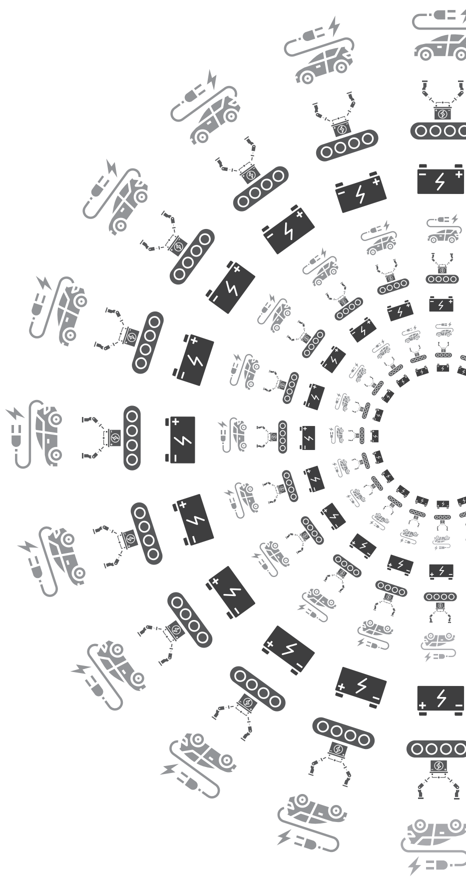
TOTAL DEMAND AS PER BASE CASE ESTIMATES
Base case figures are based on the Rocky Mountain Institute (RMI) and NITI Aayog estimates that place India's EV sales at **70% of all commercial cars, 30% of private cars, 40% of buses, and 80% of 2-wheelers and 3-wheelers by 2030.**

To meet total battery demand of **158 GWh** for EVs under the base case India will need to invest **USD 12.3 billion** by FY30 to build battery production capacity

Investments Required to Meet Battery Demand Under Base Case
(INR billion**)

Year	Battery Demand (GWh)	Cumulative investments required under 50% indigenisation	Cumulative investments required under 100% indigenisation
FY21	5	54	54
FY22	10		107
FY23	19		
FY24	27	107	161
FY25	37		215
FY26	52	161	322
FY27	70	215	429
FY28	95	268	537
FY29	123	376	698
FY30	158	429	859

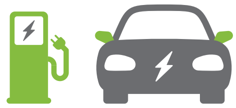
In the chart, the green bar for 54 covers FY21 to FY23, and the green bar for 107 covers FY24 and FY25. The blue bar for 107 covers FY22 and FY23.



*EV comprises electric 2-wheelers, 3-wheelers, cars (private and commercial) and buses.
**INR 1 billion = INR 100 crore

Source: CEEW-CEF analysis

4.3 Investment required for the deployment of charging infrastructure



Adoption of EVs create an investment opportunity of USD 2.9 billion for public charging infrastructure deployment

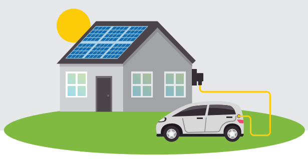
Establishing adequate charging infrastructure is key to successfully making the shift to EVs. To increase the adoption of EVs, charging stations will have to be set up across all urban areas and highways across the country. However, public charging requirements will vary not just based on EV sales but also the public charging needs of different vehicle segments. [12]

Based on interactions with industry players and the experiences of highly developed EV markets in Europe, the study assumes that only 20 per cent of two-wheelers, 50 per cent of three-wheelers, 20 per cent of personal cars and 50 per cent of commercial cars rides require charging at public charging stations. Further, different segments of vehicles (two-wheelers, three-wheelers, and four-wheelers) may require different types of chargers and follow varying charging standards.

The charging infrastructure deployment will require cumulative investments of INR 20,600 crore (USD 2.9 billion) until 2030. Under the optimistic adoption scenario, the charging infrastructure requirements are expected to be INR 22,600 crore (USD 3.2 billion). This can reduce to as low as INR 12,300 crore (USD 1.7 billion) for a '-40 per cent' lower adoption to the base case.

Box 3 Methodology for calculating investment required for setting up public charging stations

Using the number of chargers needed to support the transition as calculated in Section 1, we have calculated the initial investment required to set up the charging infrastructure. The assessment is based on inputs by India Energy Storage Alliance and Alliance for an Energy Efficient Economy on charger costs – INR 12 lakh (USD 17,140) for CCS and CHAdeMo chargers, INR 1.2 lakh (USD 1,714) for type 2 AC chargers, INR 2.2 lakh (USD 3,143) for type 1 DC, INR 42,000 (USD 600) for Bharat AC -001 chargers and INR 15,000 (USD 214) for low capacity 2KW AC-II chargers. We assume that the initial installation and setup costs such as connection charges, land lease, and installation costs will add 20 per cent to 50 per cent of the cost of charger for putting up the PCS. For the study, the costs associated with the charging infrastructure has been assumed to remain constant over the period until FY30; this has been done due to a lack of information on the trends in costs associated with establishing charging stations in the Indian context.



12 Chargers are a prerequisite to a high adoption of the EVs and at the same time their business case is correlated with the utilisation levels which is likely to stay low for initial years. The initial investments into the business calls for a patient capital coupled with low returns which points to a strong case for the concessional long term finance. The flow of private money into the business at scale would require the support of public capital or some innovation like a facility as discussed in the solutions section. Additionally, the domestic OEMs in India can also collaborate to form joint ventures like IONITY, in Europe, which provides charging network across the continent and thus helps in the build up of charging infrastructure.

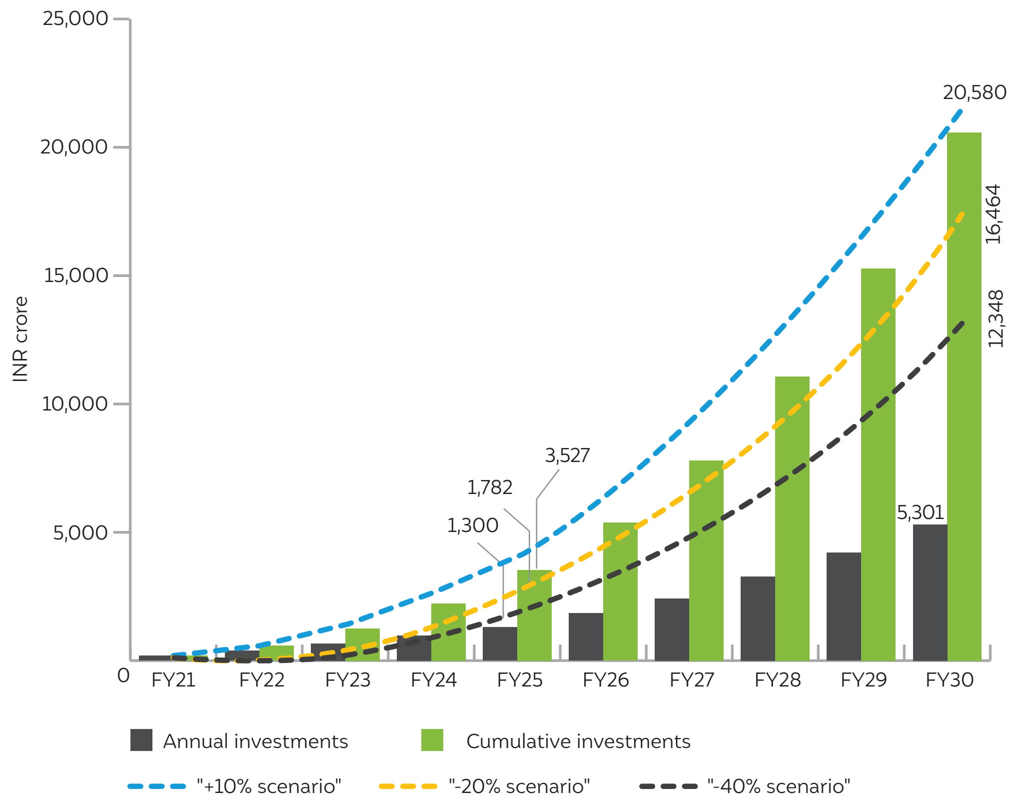


Figure 13
Sizeable investment required for public charging infrastructure

Source: CEEW-CEF analysis

** The investment required to set up the charging infrastructure assumes a 40 per cent utilisation of the asset. The analysis assumes a charger output efficiency of 80 per cent of the average rated output capacity. Although the analysis assumes a linear relationship with the number of vehicles sold, the charging infrastructure may have to be set up while considering in advance at least two to three years of future charging demand. The advancement of charging infrastructure investment is essential given that insufficient availability of chargers can act as a severe deterrent to the sale of EVs.*

4.4 End-consumer financing – sizing the challenge

Current and potential consumers of EVs see its higher upfront cost at present as a major impediment to its adoption. The overall investment opportunity that EVs present is akin to the amount of capital the end consumers will spend on the transition.

Methodology for calculating the size of investment required for end-consumers

To derive the size of investment required, we added the dealer margin on top of the OEM's margin to the production costs derived earlier. Dealer margins vary across segments, from as low as 4 per cent for four-wheelers to as high as 16 per cent for some two-wheelers. However, the end consumer may end up paying far more due to insurance, registration charges, GST (not considered here), and the cost of different optional features in the vehicle that have not been included in this study.

As shown in Figure 10, in the base case, EVs will present an investment opportunity of INR 3,39,100 crore (USD 48 billion) in the year FY30 with private and commercial cars along with two-wheelers contributing nearly 93 per cent of the total. In the period until FY30, consumers will need to spend about INR 14,42,400 crore (USD 206 billion) cumulatively.

USD 206 billion investment is required from end-consumers to achieve India's 2030 electric mobility vision

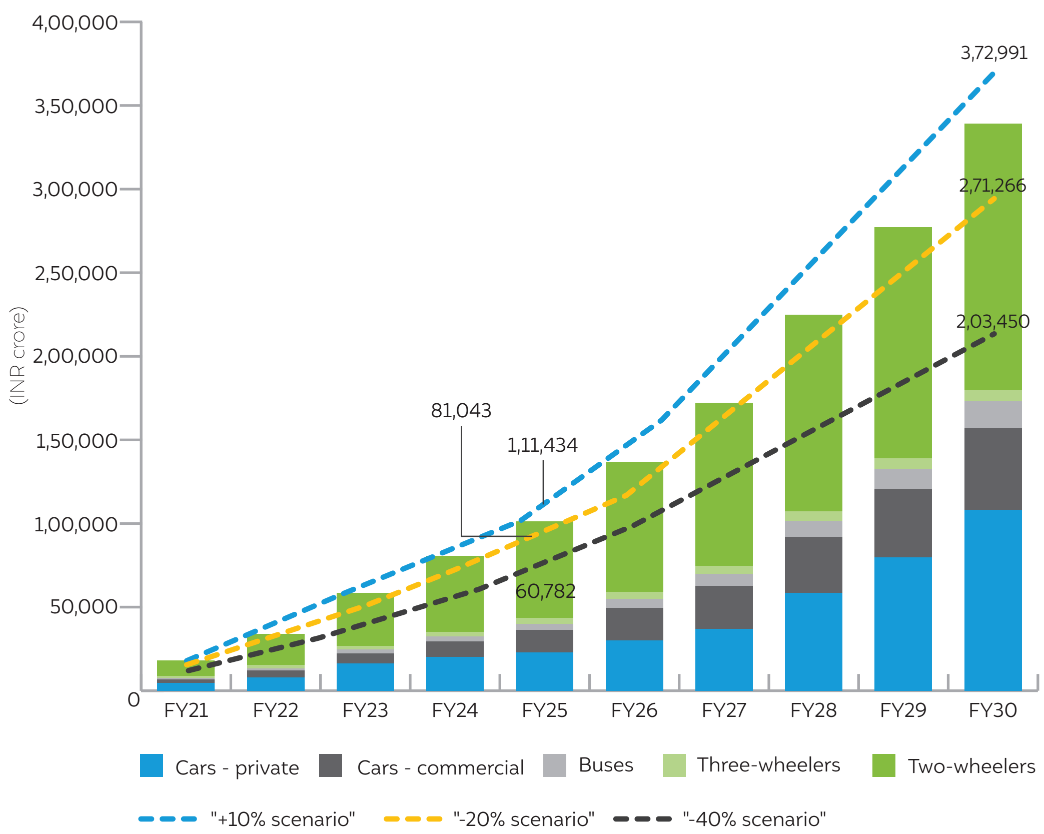


Figure 14
EVs can turn into an INR 3,39,100 (USD 48 billion) annual sales opportunity by FY30

Source: CEEW-CEF analysis

The quantum of capital required to meet the base case transition is massive. Consider this – if only 50 per cent of the EV upfront costs, i.e., INR 7,21,000 crore (USD 103 billion) required throughout FY21–FY30 is financed through debt, the banking sector will have to more than triple its current advances of INR 2,17,000 crore (USD 31 billion) towards vehicle loans in the next ten years (RBI 2020).[13]

Thus, access to consumer finance is a critical factor for the adoption of EVs not just due to the large capital requirement but also due to the high upfront costs of EVs at present as compared to conventional vehicles for building up EV infrastructure.[14] For some categories like car fleets, initial purchase cost hurdle seems to have been mitigated with improved availability of finance, where barriers like the availability of public charging stations do not majorly impact their adoption as they have private charging and optimised routes. High daily usage, as in the case of fleet operations, make EVs competitive or even cheaper than traditional vehicles owing to their low operating costs, including limited maintenance requirements (IEA 2019).

Access to finance is a critical factor for the adoption of EVs due to large capital requirement for building up EV infrastructure and high upfront cost of EVs

As had been done with conventional vehicles, one of the easiest ways to bridge this gap is to improve the availability of finance for EVs, especially for fleets like 2-whellers and 3-whellers where adoption of EVs is financially more lucrative due to the accelerated recovery of costs and clearly discernible lifetime savings. However, access to finance is likely to continue to be underwhelming due to various factors. Few significant barriers to end-consumer finance are the lack of a performance track record for EVs – how will the technology perform from a financier's perspective, i.e., both the battery and the EV, as well as its operations and maintenance especially for use cases, likes fleets of buses operated by the state transport

13 The USD 31 billion outstanding loan confers to about two third of the advances made by the financial institutions combined i.e. all the lending by scheduled commercial banks excluding the NBFCs and other lending companies as automobile loans to consumers.

14 EVs are expected to reach price parity with the ICE vehicles 2025 onwards.

units. Other factors, like the continuous decline in the cost of EVs along with no real secondary market, is another barrier to the financing of the end consumer.

The lack of a performance track record is a significant barrier. Financing for commercial vehicles like fleets takes place based on loan coverage ratios, which are dependent on the actual cash flows from operations. Thus, if the performance of the vehicle is lower than anticipated during the loan tenure, the loan extended by the financier may turn bad. This risk poses a severe constraint to the flow of finance to the segment.

The continuous and rapid decline in the cost (majorly driven by the decline in cost of battery) of EVs functions as a barrier to financing EVs as the value of loan outstanding at any time may outstrip the value of the vehicle being financed; this is likely to limit the loan to purchase value ratio, making it lower than ICE vehicles. The barrier, when combined with the comparatively high purchase cost of EVs at present, can present a big challenge for financiers and thus may severely limit the penetration of EVs in the short term. These barriers, along with the low density of EVs in the market during the initial years, will make it difficult to assess the resale value of EVs. However, as seen with other products with a declining price curve, the secondary market is small and unlucrative, making debt financing risky.

> SME OEMs and auto-component suppliers find it difficult to access capital due to the size of their balance sheets, low certainty of cash flows, and the long gestation period of investments in this sector

4.5 Barriers to the flow of capital

Taking stock of the investment required for India's mobility transition, it is clear that moving to an e-mobility future will be a massive exercise that will cost hundreds of billions of dollars. Mobilising this amount of capital to finance OEMs, battery manufacturers, charging stations, and end consumers will require systemic policy support and shifts in market design, business models, and financial structuring. Together, these will have to address the barriers that hinder the growth of the sector and in turn nudge the flow of capital into the sector. We outline some of the barriers along the value chain identified by market players in the sector below.

Barriers to the flow of capital for OEMs and auto-component manufacturers

Larger OEMs like Maruti Suzuki, Bajaj Auto, Hero MotoCorp, Tata Motors, etc., who are market leaders in their respective vehicle segments, having 51 per cent, 57 per cent, 36 per cent, and 44 per cent market shares in passenger vehicles, three-wheelers, two-wheelers, and commercial vehicle segments are not likely to face challenges with regard to financing (IBEF 2020). These traditional OEMs, and Tier 1 auto-component manufacturers who supply components directly to these OEMs, have well-financed balance sheets dependent on internal accruals, banks/NBFCs, and capital markets. However, smaller OEMs and Tier 2 and 3 auto-component suppliers may face significant barriers in accessing capital due to the size of their balance sheets, low certainty of cash flows, and the long gestation period for investments in this sector. Owing to these factors, such players find it challenging to raise money from capital markets to meet the growing requirements for the current niche EV demand. There is insufficient evidence of operations and capital raised for battery manufacturing for the EV sector so that no specific commentary can be made for this sub-sector.

> The business case for public charging stations is the weakest due to the low and unknown future demand and lower cash flows vs. high investment requirement for setting up the business

Barriers to the flow of capital for charging stations

The charging stations business, which is an essential part of the mobility transition, has the weakest business case for three main reasons—first, the low and unknown future demand for EVs. Second, the associated lower cash inflows versus the high investment requirements for setting up the business. Third, the business model for charging stations. The viability of the mobility transition hinges on charging being highly affordable, accessible, and rapid. The trade-offs between these three factors have posed a challenging balancing act around the world. The lack of cash-flow certainty results in a weaker business case for charging businesses and makes them unviable for private investors in most cases (Pillai, Suri and Kundu, et al. 2018). The weak business case becomes evident when a preliminary analysis of public charging stations reveals that for utilisation levels below 25 to 30 per cent, which is a highly likely scenario in a nascent market, charging stations will not be a viable business proposition for any investor (BEE 2019). This business, when compared with its ICE counterpart, i.e., petrol stations, which have an average payback period of three to four years, seems weak and may require some financial interventions (CRISIL 2019).

Lack of performance track record for EVs, continuous decline in the cost of EVs and absence of secondary market are main barriers in the financing of EVs for consumers

Barriers to the flow of capital for end-consumers

The Government of India has made some moves to reduce the cost of EVs for end consumers and, in turn, increase the adoption of EVs; measures include GST rate cuts and low vehicle registration costs.[15] Even after such reductions, EVs CAPEX cost is typically 1.2X–3X more than similar ICE vehicles. Thus, to increase the adoption rate, access to finance is essential. In the personal vehicle segment, the high initial cost is likely to limit the availability of finance only to high creditworthy customers (Lijee 2020).

Similarly, for commercial like fleet operators, where EVs are beneficial in terms of the total lifecycle costs, the larger operators with a longer track record of operations will enjoy easier access to bank finance. In contrast, smaller players will face numerous challenges in accessing finance (Lijee 2020). Small-scale operators or individual owners like three-wheelers drivers and individual commercial car drivers/owners, owing to their lack of credit history, may find it difficult to raise loans to adopt EVs. While there are policy solutions in the form of upfront consumer subsidies in a few states like Madhya Pradesh and Uttar Pradesh and an income tax rebate under Article 80C, interventions that directly lower upfront EV costs are still needed for end consumers (Krishna 2019).

15 Even though the central government has issued several measures to reduce the ownership costs of the EVs vehicles being a concurrent subject are subject to a diverse treatment across states. For e.g. other than a few states most of the states (even those with a EV policy) do not provide the incentives like the low registration charges to consumer on the purchase of EVs.

5. Attracting capital at scale

Image: iStock

India has set ambitious targets for its mobility transition, but attracting capital at scale will require well-thought-out interventions in the long and short term. Investments in the EV ecosystem by corporate, venture capital, and private equity firms saw exponential growth, reaching up to INR 26,600 crore (USD 3.8 billion) in 2019 as compared to INR 10,500 crore (USD 1.5 billion) in 2018 (Dewan 2020). Clearly, India is emerging as a potential investment destination for EVs, but barriers like small market size (owing to their high upfront cost), poor cost economics of the charging infrastructure business, fragmented and small markets, the reduced lending capability of financial institutions in the post-COVID-19 era, and the lack of clear policy mandates can reduce the flow of capital in the sector (Deloitte 2020). Addressing these barriers to the flow of capital will require many long- and short-term interventions that can plug in the gaps in the existing policies at the central and state level.

India is emerging as a potential investment destination for EVs but fragmented markets, poor business viability of the charging infrastructure, and the lack of clear policy mandates may affect EV investments

5.1 Existing policy and fiscal incentives

Policies have a significant role to play in India's nascent EV industry, as they can lay down the mandates for future procurement of EVs, financial incentives to end consumers and OEMs, and funding for manufacturing and charging infrastructure development. The EV ecosystem in India has been shaped by policies at both the central and state level. At the central level, under the *National Electric Mobility Mission Plan* (*NEMMP*), *FAME* (*Faster Adoption and Manufacture of Hybrid and Electric Vehicles*) was launched in 2015 (PIB 2019). In the first phase of the *FAME* scheme, demand incentives in the form of a reduced upfront purchase price for all EV segments were disbursed to create a market for them. This phase continued till 31 March 2019, supporting the sales of approximately 2.78 lakh EVs, with a total incentive disbursement of INR 343 crore (USD 50 million) (PIB 2019).

Building on the success of the first phase of *FAME*, the second phase was launched for four years, April 2019–March 2022, with a budget outlay of INR 10,000 crore (USD 1.43 billion). The incentives under the scheme are designed to focus on the following areas: demand creation, development of charging infrastructure, research and development of EV technologies, and push towards greater indigenisation. For the creation of market demand, the scheme provides incentives on the purchase of two-wheelers, three-wheelers, four-wheelers, and buses to be used for commercial purposes. The incentives are provided based on the size of the battery in the vehicle (INR 10,000 [USD 143] per kW of battery for two-wheelers, three-wheelers, and four-wheelers and INR 20,000 [USD 286] per kW of battery for buses). Under *FAME-2*, a budget of INR 1,000 crore (USD 0.14 billion) was reserved for the development of charging infrastructure. So far, the Department of Heavy Industries has already sanctioned 2,636 charging stations in 62 cities across 24 states/UTs under the scheme (Department of Heavy Industry 2020). Apart from the incentives in the *FAME* scheme, a deduction in income tax (up to INR 1.5 lakh [USD 2143]) and a GST rate reduction (from 12 per cent to 5 per cent) are also provided directly to end consumers on the purchase of EVs (Priya 2020). Further, the domestic EV ecosystem may also benefit from the increase in basic customs duty to 40 per cent from April 2021 on completely built units of EVs, which was announced during the Union Budget 2020 (Dewan 2020).

There are currently more than 15 Indian states with that have policies/ regulations/ tariffs pertaining to electric vehicles

At the state level, the focus of EV policies is similar to that of the *FAME* scheme. Currently, in India, there are more than 15 with policies/regulations/tariffs pertaining to electric vehicles (13 states have notified policy documents - 5 are draft policies while remaining are final policies). (EESL 2020). These policies offer a broad range of incentives, starting from capital and purchase subsidies and tax and fees exemptions to mandatory procurements of EVs by state agencies and reserved parking spaces. A rundown of state EV policies based on their target groups is given below:[16]

Incentives for OEMs – The EV policies of all states except for Tamil Nadu have established clear targets for the procurement of EVs. For example, Andhra Pradesh is targeting 100 per cent conversion of all government vehicles to EVs by 2024, and Telangana is aiming for 100 per cent e-mobility by 2030. Similarly, Delhi, Madhya Pradesh, and Punjab are focusing on making 25 per cent of all new vehicle registrations EVs. The primary focus in most of these states is public transport, followed by government vehicles and private transport. This target-setting creates demand certainty and can boost the manufacturing of EVs.

Also, OEMs are provided with SGST (state GST) reimbursements in six states and capital interest subsidies ranging from 15 per cent in Tamil Nadu to 50 per cent in Punjab for setting up EV manufacturing units in the state. Provisions for the development of EV-specific industrial parks and clusters in a few states like Andhra Pradesh and Uttar Pradesh may not seem like a financial incentive, but they can prove to provide significant support to OEMs in the EV space.

Along with utilisation rates and land-lease costs, the tariff of the electricity supplied to charging stations is also an important factor determining investor returns

Incentives for charging infrastructure – The state EV policies also provide incentives for the development of charging infrastructure. Even though most states have not established targets for the development of charging stations, apart from Bihar, Uttar Pradesh, and Andhra Pradesh (Bihar and Uttar Pradesh – setting up fast-charging stations every 50 km on highways; Andhra Pradesh – setting up 100,000 fast and slow charging station), other financial incentives in the form of capital subsidies and special tariffs for electricity at subsidised rates, and infrastructural incentives like exemption from land tax and land costs, easy clearances for setting up charging infrastructure within the city, and changes in building by-laws to accommodate more charging stations are featured in many state policies.

16 CEEW-CEF analysis based on state EV policies.

Capital subsidies have been allocated for equipment/machinery purchased for setting up the first few charging stations in the state. It is capped at a maximum of 25 per cent of the cost of INR 10 lakh (USD 0.05 billion) in the state policies. A key input for charging stations is electricity. The tariffs at which electricity is provided to charging stations can go a long way in determining their returns. A review of the tariff policies of various states reveals that EV tariffs (energy charges) range from INR 4/kWh (USD cent 5.5/kWh) to INR 6/kWh (USD cent 8/kWh), with the exception of Uttar Pradesh, where the tariff is more than INR 7/kWh (USD cent 9.3/kWh) (Das and Tyagi 2020). The tariffs slabs for EV charging stations are currently lower than that of commercial consumers, and EV charging tariffs have also been given a flat energy rate (instead of consumption-based slabs). Further in states like Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Punjab, Telangana, and Uttar Pradesh demand charges are not levied for EV charging business. (Das and Tyagi 2020). Apart from rebates in the electricity tariffs, other incentives such as exemption from electricity duties are also provided in the state EV policies.

> Consumer subsidies, interest free loans, road tax exemptions,etc. are a few prevalent incentives for end-consumers in the EV policies of many states

Incentives for end consumers – To incentivise the adoption of EVs and counter the high purchase cost, a few state EV policies provide upfront consumer subsidies. For example, under the Bihar EV policy, the state provides a 15 per cent subsidy on the purchase of the first 100,000 EVs at a specific price. Similarly, under the Maharashtra EV policy, a 10 per cent subsidy on the base price of passenger e-buses registered within the state and a 15 per cent subsidy (maximum limit of INR 5,000 [USD 71] for two-wheelers, INR 12,000 (USD 171) for three-wheelers, and INR 1,00,000 (USD 14,286) for four-wheelers) on the purchase of the first 100,000 EVs are to be given out. The subsidy in UP for families with a single girl child is 30 per cent.

In addition to this, financial assistance in the form of interest-free loans (as in the case of UP and Telangana), road tax exemptions, etc. are also being provided to end consumers. Further, it is also notable that other incentives, such as 10–20 per cent cheaper cab rides in EVs (already present in the EV policy of Delhi), free parking for EVs (EV policy of Punjab), and access to special lanes can serve as non-financial policy nudges that influence the market for EVs. A synopsis and analysis of the various state EV policies based on the critical focus areas and the benefits to various stakeholders like OEMs, buyers, and charger point operators is available in Annexure 1.2.

It is notable to point out that five of the state EV policies mentioned above, i.e. Bihar, Punjab, Gujarat, Uttar Pradesh and Kerala are still in draft stage and hence the incentives or targets mentioned in these policies have not been implemented on the ground. Further, our key informant interviews with industry players revealed their sentiments with regard to the implementation of EV policies in the state. Many mentioned that the capital subsidies mentioned in the state policies are not provided on the ground by state entities stating lack of funds as the reason. Many informants perceived that that EV policy in many states lack incentives and do not do justice to boost auto-component manufacturing which has clear investment cases and viability. EV policy for the vehicle and auto-component manufacturing are just providing incentives in terms of land cost, utility cost benefits, SGST reimbursement which may not be sufficient for investors who are looking at other production linked incentives scheme. Thus redesign of few incentives in the state policies and its proper implementation is key to building an EV ecosystem required for India’s 2030 EV ambitions.

5.2 Gaps and recommendations

Moving to an electric mobility future has several benefits for India not just for creating an environmentally sustainable future but also for economic development as an e-mobility transition can create jobs, reduce import bills on oil, boost renewables, and can lead to a reduction in point source vehicular emissions. For India, the transition to e-mobility is a complex problem characterised by stakeholder pluralism and interconnectedness with other social and policy problems of the day. The complexity of the problem and the several barriers like the high upfront cost of EVs, inadequate charging infrastructure, fragmented markets, and limited access to capital can slow India's move towards sustainable mobility. Existing business and financial models do not have the scale or features required to attract the mammoth quantum of private capital required for the mobility transition.

Many informants perceived that the EV policy in many states lack incentives to boost auto-component manufacturing, which has a clear investment case and viability

At present, the policies that are in place at the national and state level to encourage EV adoption may not be sufficient to address the gap between the massive EV targets and actual EV sales. It is also notable to point out that cocepts like '*green windows*' can bring the necessary focus to the nascent clean energy markets like hybrid, storage, e-mobility and distributed renewable energy and provide them with greater access to finance by mitigating and diversifying risks (Kwatra 2020). Such catalytic finance measures are definitely required to bring the required focus to these markets, but there is also a need for a comprehensive set of solutions for all the stakeholders in the e-mobility ecosystem. These solutions will need to span policy, regulation, and financial design. Arriving at the full set of solutions needs additional analysis and enquiries to be made; however, we propose a suite of solutions that could be implemented in a modular fashion to advance the pace of India's mobility transition.

What are we solving?	Who are we solving for?	What is the solution?	
		Policy	Financial
Barriers faced by OEMs in accessing capital for expansion into the EV space	Small OEMs and vendors	Industrial parks for SME OEMs in the auto sector Scheme to set up venture capital and small enterprise assistance fund	Financing windows for small OEMs and small-scale component suppliers or vendors to the OEMs, e.g., a partial credit guarantee scheme or carving out limits within existing programmes in this segment to allow for increased finance flows
The weak business case for charging infrastructure business	Charging infrastructure business holders	Capping rental cost for public charging stations	A charging infrastructure investment facility capitalised partly with public money
The high upfront cost of EV	End consumers	State EV policies that combine incentives for EVs with disincentives for ICE vehicles Policy development around battery reuse, recycling, and leasing	Annualisation in a phased manner

Table 9
Key recommendations to address barriers in accessing capital

Source: CEEW-CEF analysis

Potential solutions to improve access to capital for OEMs and auto-component manufacturers

Accelerating the pace and scale of investments required by the OEMs and vendors is challenging in the wake of a pandemic. The current situation, as shown in Section 1, is likely to result in unfavourable growth across all vehicle categories, resulting in lower utilisation of existing capacities and losses for some OEMs in the country. The downturn may also result in changes in plans to make investments in EV capacity development for both large and small OEMs. While large OEMs may recover from this shock and pick up the pace quickly once the demand normalises, small and medium OEMs are likely to struggle for a longer time. It is therefore important to take measures to remove barriers in financing for small OEMs. Further, it can also bolster innovations in supply chain management and industrialisation in backward areas. A few potential solutions to expand the horizons of accessing capital for SME OEMs are as follows:

Optimally designed industrial parks, VC funding schemes and liquidity support measures like PCG can improve SME OEMs' access to capital

- **A liquidity support measure like a partial credit guarantee (PCG) scheme for small and medium OEMs/suppliers in the automobile sector.** A targeted PCG scheme could effectively enable banks to extend credit to SME OEMs and small vendors and suppliers, who may otherwise find it challenging to raise capital. PCG facilities usually take the form of a percentage loss covered by the guaranteeing entity at a low cost to financial institutions. In the recent past, as part of the *Atmanirbhar Bharat Abhiyan* economic stimulus package, such a scheme has already been announced for NBFCs through the Credit Guarantee Trust for Micro Small Enterprises (CGTMSE) (Gopakumar 2020). This can be used as a template for a similar scheme for existing or emerging SME OEMs in the automobile sector under which public sector banks can provide a credit guarantee for the purchase of bonds/commercial papers issued by NBFCs/MFIs with ratings of AA or below.
- **Optimally designed industrial parks can provide a supportive environment and a range of incentives for the growth of SME OEMs looking to invest in EVs.** First, it can ensure the availability of robust infrastructure in the form of easy access to freight corridors, airports, ports, warehousing, and storage facilities at one place which would reduce transaction costs and provide shorter start-up times for businesses (Raheja 2018). Secondly, it can also promote technological exchange and expertise among entrepreneurs (Raheja 2018). A sum of these incentives can improve the success rates of SME OEMs in the EV space. Currently, the development of industrial park specifically for electric vehicle production ecosystem is underway in Tamil Nadu, and similar provisions for industrial parks in other states EV policies can spur the growth and development of SME OEMs (Narasimhan 2020). The Department for Promotion of Industry and Internal Trade can collaborate with state government agencies to set up industrial parks specifically for EV production ecosystem (Nagarajan 2019).
- **Schemes are needed to set up venture capital and small enterprise investment funds.** VC funding has several advantages over other forms of finance. Apart from providing long term equity finance that can boost SME OEMs' capital base, it can also involve providing mentoring support and other value additions to OEMs, which will enable them to achieve a competitive edge in both the international and domestic market (CII-PwC 2013). Currently, VC funding to SMEs is provided by institutional investors, banks, and private capital firms, but the creation of niche VC funding, especially for SMEs in the EV space, can boost their growth further. Larger OEMs in the EV space can play a big role in contributing to the initial corpus of the VC fund as it stands to benefit them in the long run by ensuring a more robust supply chain of SME OEMs in the auto-component manufacturing. Further, this will also boost larger OEMs to conduct mentor programmes for tier two or three OEMs to improve their technological capabilities which may further enhance their business viability.

Potential solutions for improving the business case of charging stations

Boosting investment in charging infrastructure businesses is important, as, without adequate infrastructure, large-scale adoption of EVs will remain a distant dream. One of the main contributors to the weak business case of charging infrastructure deployment is the low and unknown future demand for EVs. The availability and cost of capital are also influenced by the lenders' assessment of business risks. In this scenario, policy and financial solutions centred around creating demand certainty and providing direct access to finance can address the challenges faced by charging point businesses. A few of these solutions are:

> Mandatory state government procurement of EVs, rent capping for setting up PCS and charging infrastructure investment facility can boost investments in charging infrastructure

- **Mandatory state government procurement of EVs for public transport:** The EV policies of a few states have already made provisions for this. For example, Andhra Pradesh aims to convert all its APSRTC buses into electric buses by 2029 while Madhya Pradesh is aiming to convert 25 per cent of all registered public transport to EVs by 2026 (Pillai et al. 2019). However, the policies do not mandate compliance. Having mandated targets similar to the RPO targets for renewable energy, which obligates certain entities to purchase energy from renewable sources, can go a long way in creating demand certainty for charging operators (Joshi and Agarwal 2018). This move will only be beneficial if public transport vehicles use public chargers rather than private depot charging for at least some percentage of their charging needs.
- **Leasing cost for setting up charging stations in the urban agglomeration in India is costly, and it adversely impacts the business viability of charge point operators.** Our discussion with the charge point operator revealed that land cost comprises about 15 per cent of the CAPEX cost for DC charging and 25 per cent of the CAPEX cost for AC charging. Incentives in the state policies that cap the rent for setting up public charging stations in cities can improve the business case for public charging stations especially in states with a large number of five million-plus cities as these cities are also marked by both high leasing cost and purchase value of the land. (Pillai, Suri and Kundu, et al. 2018).
- **Creation of a charging infrastructure investment facility:** The aim of the facility should be to create a warehouse line of credit. Apart from providing an outlook to investors, the facility can also disburse financial assistance via viability gap funding, which will be crucial for reducing the overall cost of operations and risks due to uncertain demand. It can act as a subsidy that has the potential to lower the initial CAPEX for setting up the business. This facility can be set up in collaboration with the state nodal agencies responsible for implementing EV policies in the state and the department of finance in the state. Municipal funds of the cities can be unlocked to disburse financial assistance via the investment facilities in each state.

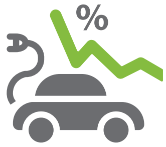
Potential solutions to end-consumer financing

The mobility transition will only be possible if there is some demand certainty for EVs. The high upfront costs of EVs make the purchase decision difficult for consumers. Suitable measures need to be taken to address this barrier. A few solutions to this effect are:

- **Financial innovation using annualisation** – An analysis of the total cost of ownership (TCO) for EVs show that while their upfront cost is high, the lifetime costs are competitive with ICEVs and grow directly with the total kilometres travelled. One way to address this problem is to distribute the upfront costs of EVs into equal annulation costs – a method called annualisation that is already common for ICE vehicles. In the case of EVs, annualisation would virtually distribute all the upfront costs as well as operating costs (including fuel, maintenance, and insurance) into equal annual costs, making

EVs competitive with ICEVs in the long run (CEEW-CEF 2020b). Not all vehicle segments need to be targeted equally for annualisation. A low-cost policy pathway based on the diffusion of vehicles with lifetime cost parity, i.e., two-wheelers, three-wheelers, and shared four-wheelers (e.g., taxis and buses) can go a long way in enabling the adoption of EV by end consumers. This can be provided by the OEMs and can be disbursed by the car dealerships in various cities. Such a measure can also go a long way in bringing down the finance cost and financier's risk perceptions.

- **The EV policies of states can combine incentives for EVs with disincentives for ICE vehicles.** Consumer subsidies and tax exemptions on the purchase of EVs are already in vogue in the EV policies of several states in India. These incentives reduce the upfront cost of EVs, but on a relative scale, it remains costlier than its ICE counterparts. Disincentives, in the form of duties or environmental cess levied on the purchase of ICE vehicles, which would increase their cost compared to EVs, can make the purchase of EVs the more lucrative option for consumers.
- **Policies promoting the development of innovative business models for battery reuse, recycling and battery leasing** – Batteries account for 40 per cent to the cost of electric vehicles (ACMA 2018). Innovative business models that enables battery leasing and its recycling and reuse can reduce the total cost of ownership of an electric vehicle and also its upfront cost if consumers purchase EVs without batteries and later rely on battery leasing for the entire life of the vehicle which has become a possibility now after Government of India allows sale of EVs without batteries (Chaliawala 2020). Further, if the consumers buy the vehicle with batteries then the development of market incentives for battery reuse for other storage applications like grid storage, reuse in cars with smaller range requirements, and in stationary applications like in buildings & hospitals and non-car powertrains (like airport vehicles, forklift trucks, golf carts, etc.) can reduce the overall cost of a battery to the consumer and go a long way in driving the adoption of electric vehicles.



Innovative financial measures like annualisation can reduce the upfront cost of EVs for end-consumers

India's EV sector has a deeply inter-connected value chain and investments in the sector will lead to local value addition, technological innovations and job creation.

Image: iStock

6. Conclusion

The global EV market has expanded significantly over the last decade. In 2010, there were only about 17,000 electric cars in circulation worldwide, which has risen to 7.2 million by 2019 (IEA 2020). An estimated stock of 350 million electric two-wheelers and three-wheelers has also been in use since 2019 (IEA 2020). The world over, this growth has been supplemented by policy and regulatory support and different business models and financial innovations. As India plans its transition to a more electric transport future, it needs to develop evidence-based, market-shaping interventions. This study aims to provide some evidence of the size of the electric mobility market. For interventions to spur capital flows, understanding the size of the investment opportunity is critical. This study aims to provide some sense of the investment opportunity available in what could become one of the world's largest EV markets.

India's EV transition has the potential to create a value add of INR 14,42,400 crore (USD 206 billion) by FY30

Based on the assessments of this study, the transition will create a market opportunity for EV sales worth INR 18,000 crore (USD 2.6 billion) in FY21, which will increase up to an INR 3,39,000 crore (USD 48 billion) by 2030.[17] In total, the transition has the potential to create a value add of INR 14,42,400 crore (USD 206 billion). At present, for EV manufacturing, a large number of components like the battery packs, motors, and power electronics are imported; this presents an opportunity for local value to be captured through increased manufacturing of these parts. New sales and replacement demand could create a need for battery sales of about 158 GWh by 2030. Under a 100 per cent indigenisation scenario, this battery demand would create an investment opportunity worth over INR 8,58,600 crore (USD 12 billion) for establishing the battery manufacturing facilities in the country.

An essential part of the transition is the creation and upgrade of the facilitative ecosystem, especially in the form of public charging infrastructure. This segment presents an investment opportunity of INR 20,600 crore (USD 2.9 billion) for the country to meet the public charging requirements of about 102 million vehicles sold during the 2020–30 period.

Although the EV transition presents itself as a massive investment opportunity both for the country and the automotive sector, there exist several barriers to domestic EV adoption. If addressed systemically and in a swift and timely manner, India could witness a pivot in investments for the electric mobility sector. It is important for the industry and government to explore opportunities for collaboration with several line ministries regulating transport, electronics manufacturing, etc. The scale of the transition as outlined is significant enough for the electric mobility sector to become an important agent of India's recovery from COVID-19 linked financial stress, offering an opportunity for innovation, entrepreneurship,

17 In the absence of any clear nationwide policy target, the base case assumes a penetration of 70 per cent of all commercial cars, 30 per cent for private cars, 40 per cent for buses, and 80 per cent of two-wheelers and three-wheelers sales to be electric by 2030, as suggested under the RMI NITI report 2019. To account for the pandemic-related downturn, sales across segments have been assumed to see a decline of about 16–45 per cent across vehicle categories. In line with expert views, the analysis assumes a V-shape recovery from FY22 onwards with the entire sector reaching the FY19 sales levels by FY23–FY24.

technological advancement, indigenous manufacturing, new jobs, and significant domestic value addition. The role of policy support in advancing this sector and unlocking these benefits cannot be overstated. This study lays out in detail the market opportunity offered by this sector, and will be followed up with studies of market barriers as well as regulatory, financial, and business model solutions for the sector.

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Annexures

Annexure 1
Total component cost (approximate) assumed for EV segments

Total component cost of EV (Battery + non-battery)	Battery capacity required (KW)	FY21 (in INR)	FY30 (in INR)
Two-wheeler	3	66,500	47,200
Three-wheeler	5	1,19,400	85,800
Cars (fleet)	30	7,98,00	5,83,00
Buses			
LCV	200	37,96,000	26,16,000
M&HCVs	320	60,74,000	41,85,000
Note - To calculate the non-battery component cost, a learning rate of 2 per cent has been used. For the battery costs, Bloomberg New Energy Finance (BNEF) battery pack cost trends have been used.			

Source: CEEW-CEF analysis

Annexure 2
A synopsis of state EV policies

Name of states	Policy focus	Incentives for OEMs	Incentives for end consumers	Incentives for charging infrastructure
Andhra Pradesh	Policy targets for 10 lakh EVs on the road by 2024 and 1 lakh slow and fast charging stations in the same period. It plans to generate INR 30,000 crore (USD 4.29 billion) and set up 10 GWh of battery manufacturing capacity over the policy period	25 per cent capital subsidy for MSMEs involved in EV and component manufacturing and 100 per cent SGST reimbursement	Exemption of registration charges and road tax on sale/lease of EVs until 2024	25 per cent of capital subsidy up to INR 10 lakh (USD 14,286) for the first 100 charging stations and 100 per cent SGST reimbursement on the purchase of fast chargers
Bihar (Draft)	Policy targets of 100 per cent e-mobility in the electric rickshaw segment by 2022; fast charging stations at every 50 km on state/ national highways and attract an investment of INR 2,500 crore (USD 0.36 billion)	Provision for a EV manufacturing cluster that includes research and development facilities and a vehicle testing track	15 per cent subsidy on the base price for the first 1 lakh EVs manufactured/registered in the state subject to cap of INR 20 lakh per bus (USD 28,571), INR 1 lakh (USD 1429) for four-wheelers (including hybrid ones), INR 12,000 (USD 171) for three-wheelers and INR 5,000 (USD 71) for two-wheelers	25 per cent capital subsidy on equipment and machinery (up to INR 10 lakh/ station [USD 14,286/ station] for the first 250 public EV charging stations)

Name of states	Policy focus	Incentives for OEMs	Incentives for end consumers	Incentives for charging infrastructure
Delhi	The policy targets electrification of 25 per cent of the total new vehicle registrations in the city by 2024		The policy provides a purchase incentive of INR 10,000 (USD 143) per kWh of battery capacity provided for electric four-wheelers (cars) for the first 1,000 cars; an incentive of INR 5,000 (USD 71) per kWh of battery capacity provided for two-wheelers and INR 30,000 (USD 429) for electric three-wheelers; and an incentive for scrapping and de-registering two-wheelers	100 per cent SGST reimbursement for battery swapping operator
Gujarat (Draft)	The policy targets having 1 lakh EVs on the road by 2022 (80,000 electric two-wheelers, 14,000 three-wheelers, 4,500 cars, and 1,500 buses)		100 per cent exemption on registration fees and 50 per cent on the motor vehicle tax	100 per cent exemption on electric duty for EV charging stations
Karnataka	The policy targets 100 per cent e-mobility in the following segments by 2030: auto-rickshaws, cab aggregators, corporate fleets, and school buses/vans	Interest-free loan for a maximum period of 13 years on the net SGST for setting up EV and component manufacturing and battery manufacturing enterprises	Tax payment exemption on all electric non-transport and transport vehicles	25 per cent capital subsidy up to INR 10 lakh (USD 14,286) for the first 100 charging stations
Kerala (Draft)	The policy aims to put one million EVs on the road by 2022 and integrate 6,000 e-buses into public transport by 2025		Consumer subsidy of 25 per cent or INR 30,000 (USD 429) on the purchase of electric three-wheelers. The policy also provides for road-tax exemptions, toll-charge exemption, free permits for fleet drivers, and free parking.	Subsidised electricity tariff between INR 5-5.5 per unit for EV charging stations
Madhya Pradesh	The policy targets switching 25 per cent of all registered public transport to electric by 2026	Some cities to stop registering new ICE autos	Exemption from motor vehicle tax, permit fee, registration fee, and tolls on select highways.	25 per cent capital subsidy up to INR 10 lakh (USD 14,286) for large charging stations
Maharashtra	The policy targets increasing the number of registered EVs to 500,000 over the policy period and generating an investment of INR 25,000 crore (USD 3.6 billion) in EV and component manufacturing		Consumer subsidy of about 10 per cent for buses and 15 per cent to other vehicles and exemption from road tax and registration fees	25 per cent capital subsidy up to INR 10 lakh (USD 14,286) for the first 250 charging stations

Name of states	Policy focus	Incentives for OEMs	Incentives for end consumers	Incentives for charging infrastructure
Punjab (Draft)	The policy targets increasing the share of electric two-wheelers and e-taxis to 25 per cent of new sales and replacing the existing bus fleet with 25 per cent e-buses	100 per cent net SGST reimbursement for the first 15 years and 50 per cent capital subsidy and employment generation subsidy for the products manufactured in Punjab		25 per cent of capital subsidy up to INR 10 lakh (USD 14,286) for the first 1,000 charging stations
Tamil Nadu	The policy targets electrification of 5 per cent of buses every year until 2030, and conversion of shared mobility fleets, institutional vehicles, and e-commerce delivery and logistics vehicles to EVs by 2030	Capital subsidy of 15–20 per cent for MSMEs involved in the supply chain along with an employment generation subsidy. The policy also targets establishing a venture capital and business incubation service to encourage EV start-ups	100 per cent exemption on road tax and registration fees	100 per cent exemption from electric tax on EV charging stations
Telangana	The policy targets achieving 100 per cent electrification of vehicles by 2030 and attracting an investment of INR 2100 crore (USD 3 billion) by 2030	Applicable for all benefits under the Telangana Industrial Policy	Exemption of registration charges on EVs purchased till 2025 and road tax exemption	Capital subsidy of 25 per cent and 75 per cent SGST reimbursement
Uttarakhand	The policy targets 100 per cent electrification of public transport by 2030	Employee provident fund reimbursement for manufacturing units	Exemption from motor vehicle tax and incentives for scrapping old vehicles that are not BS-IV certified for two years	
Uttar Pradesh (Draft)	The policy targets rolling out 1 million EVs by 2024 and 100 per cent e-mobility in school buses and vans by 2030. It aims to establish charging stations at every 50 kms on state and national highways and create manufacturing and assembling capacity of 2000 MWh for EV batteries	Capital interest subsidy of 5 per cent for a period of 5 years and SGST reimbursement. Further, the policy also makes a provision for setting up EV parks in the state to boost the manufacturing ecosystem for EVs	Consumer subsidy of 30 per cent on the on-road price of EVs for families with a single girl child and interest-free loans for state government employees on the purchase of EVs.	Capital interest subsidy of 5 per cent per annum for five years and 100 per cent exemption on electricity duty

Source: CEEW-CEF compilation
**based on state EV policies*


emissions

The EV transition presents itself as a massive investment opportunity. Addressing barriers to EV adoption can pivot investments in the sector, making it an important agent of growth and development in the coming decade.

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