ELECTRIC MOBILITY

POLICY FRAMEWORK

Smart City
MISSION TRANSFORM-NATION

Ministry of Housing and Urban Affairs
Government of India

ROCKY MOUNTAIN INSTITUTE

Ministry of Housing and Urban Affairs
Government of India

ABOUT MINISTRY OF HOUSING AND URBAN AFFAIRS (MoHUA)

The Ministry of Housing and Urban Affairs is the apex authority of Government of India to formulate policies, coordinate the activities of various central ministries, state governments and other nodal authorities and monitor programs related to issues of housing and urban affairs in the country. The Smart Cities Mission was launched by the Ministry in 2015 to promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions.

ABOUT ROCKY MOUNTAIN INSTITUTE (RMI)

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing. RMI has been supporting India's mobility and energy transformation since 2016.

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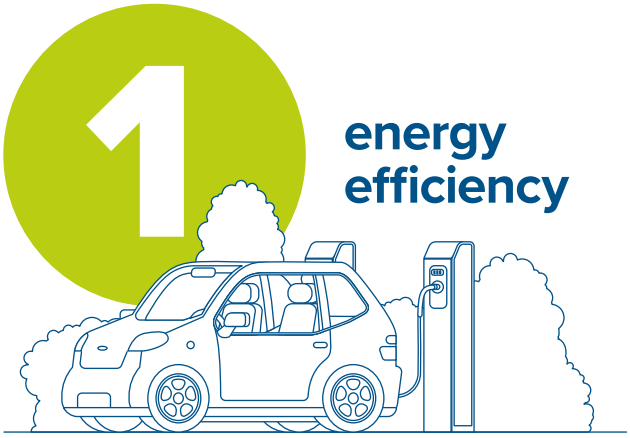
Document outline

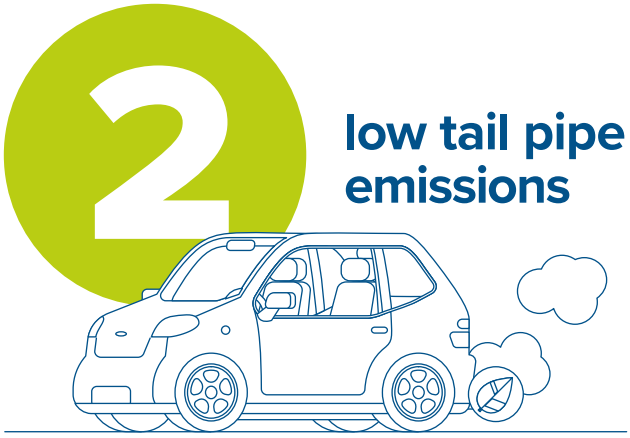
This document introduces city managers to the basics of electric mobility. It presents various components of an electric mobility ecosystem, particularly the different types of electric vehicles (EVs) and charging infrastructure. It orients city managers to the status of EV uptake around the world. The document discusses initiatives to promote electric mobility by national and city governments and other key stakeholders, globally. To enable city managers, introduce or improve uptake of electric mobility in their respective cities, the document provides information on the electric mobility landscape in India with a focus on relevant schemes and policies. For the cities, which are keen to implement and promote electric mobility, it is important for them to understand and measure their progress. This document provides a set of Key Performance Indicators (KPIs) to equip cities to measure their progress and understand the impact of their actions and take necessary corrective course, if required, to meet the transport electrification goals.

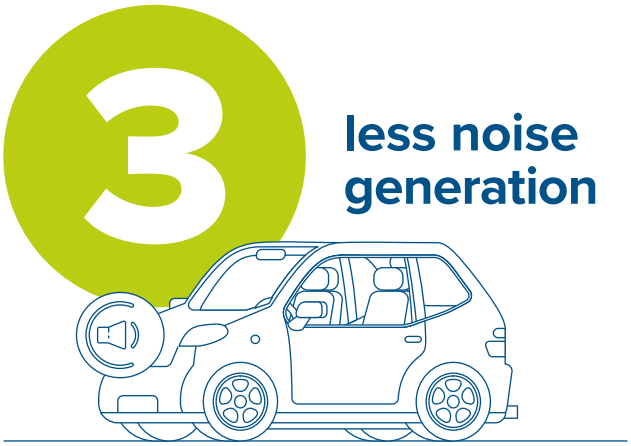
Glossary of terms

EVs	Electric Vehicles
BEVs	Battery Electric Vehicles
PHEVs	Plug-in Hybrid Electric Vehicles
FCEVs	Fuel Cell Electric Vehicles
ZEVs	Zero Emission Vehicles
NEVs	New Energy Vehicles
ICEVs	Internal Combustion Engine Vehicles
OEMs	Original Equipment Manufacturers
KPIs	Key Performance Indicators
EESL	Energy Efficiency Services Limited
MoP	Ministry of Power, Government of India
MoHUA	Ministry of Housing and Urban Affairs, Government of India
MoHIPE	Ministry of Heavy Industries and Public Enterprises, Government of India
DHI	Department of Heavy Industries, MoHIPE
MoEF	Ministry of Environment and Forest, Government of India
MoRTH	Ministry of Road Transport and Highways, Government of India
ULB	Urban Local Body

1.0 Why promote electric mobility?







The world is transitioning to cleaner mobility options with the aim at improving air quality, reducing carbon emissions and reducing dependency on fossil fuels. By their virtue of being energy efficient and clean (zero or significantly lower tailpipe emissions), in comparison to similar Internal Combustion Engine Vehicles (ICEVs), EVs have emerged a popular clean mobility choice and have the potential to reduce carbon emissions and other criteria pollutants. As the EVs are powered fully or partially by batteries, they can also help reduce dependence on imported fossil fuels and address energy security concerns for India.

2.0 What is an electric vehicle?

Electric Vehicles (EVs) use one or more electric motors or traction motors for propulsion. An electric vehicle may source its power from off-vehicle onboard battery, or other sources such as solar panels or electric generators.

Based on the degree of electrification of the propulsion system, the EVs can be classified into[1]:

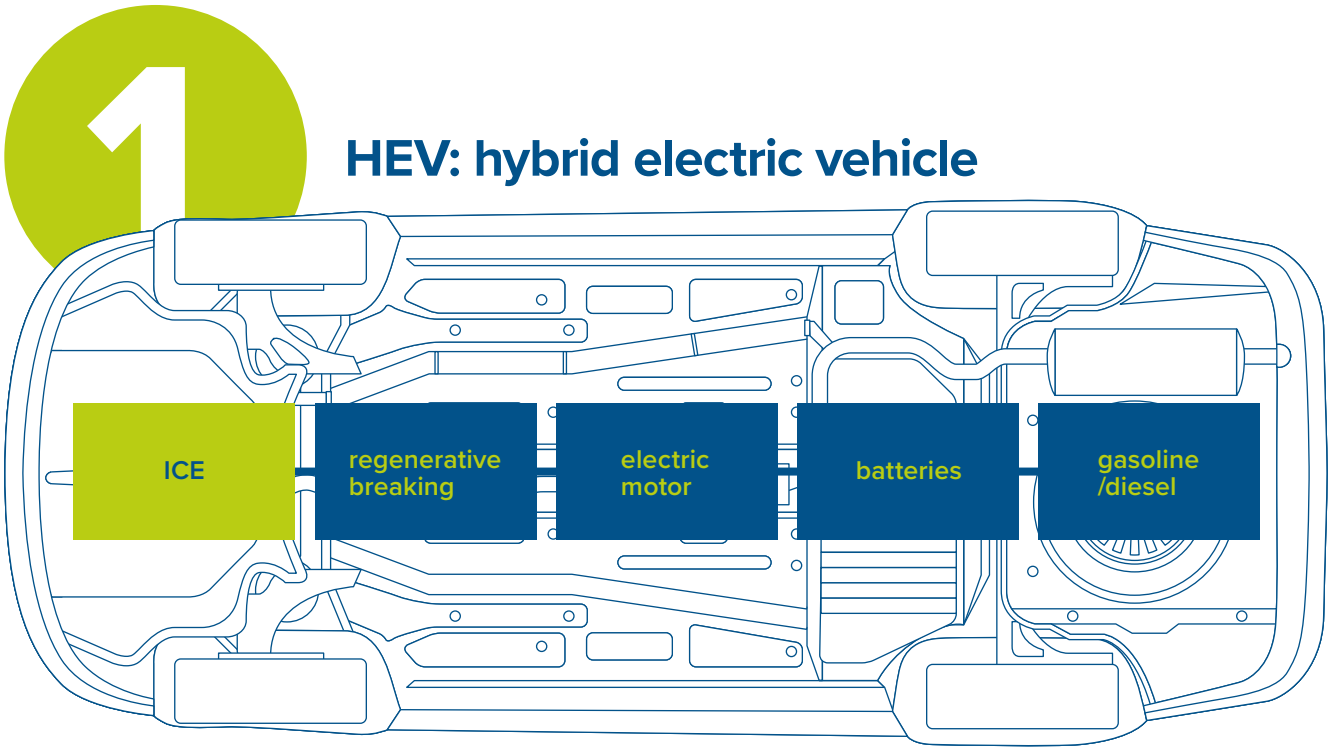


Figure 1

» **Hybrid Electric Vehicle (HEV):** Uses both an electric motor and an internal combustion engine (ICE), which work in tandem to propel the vehicle and lead to higher fuel efficiency. If the battery is used only when the vehicle is started or stopped, for regenerative breaking and limited electric motor assist, it is classified as a mild hybrid. In contrast to this, full hybrids have a full electric launch assist and motor drive.

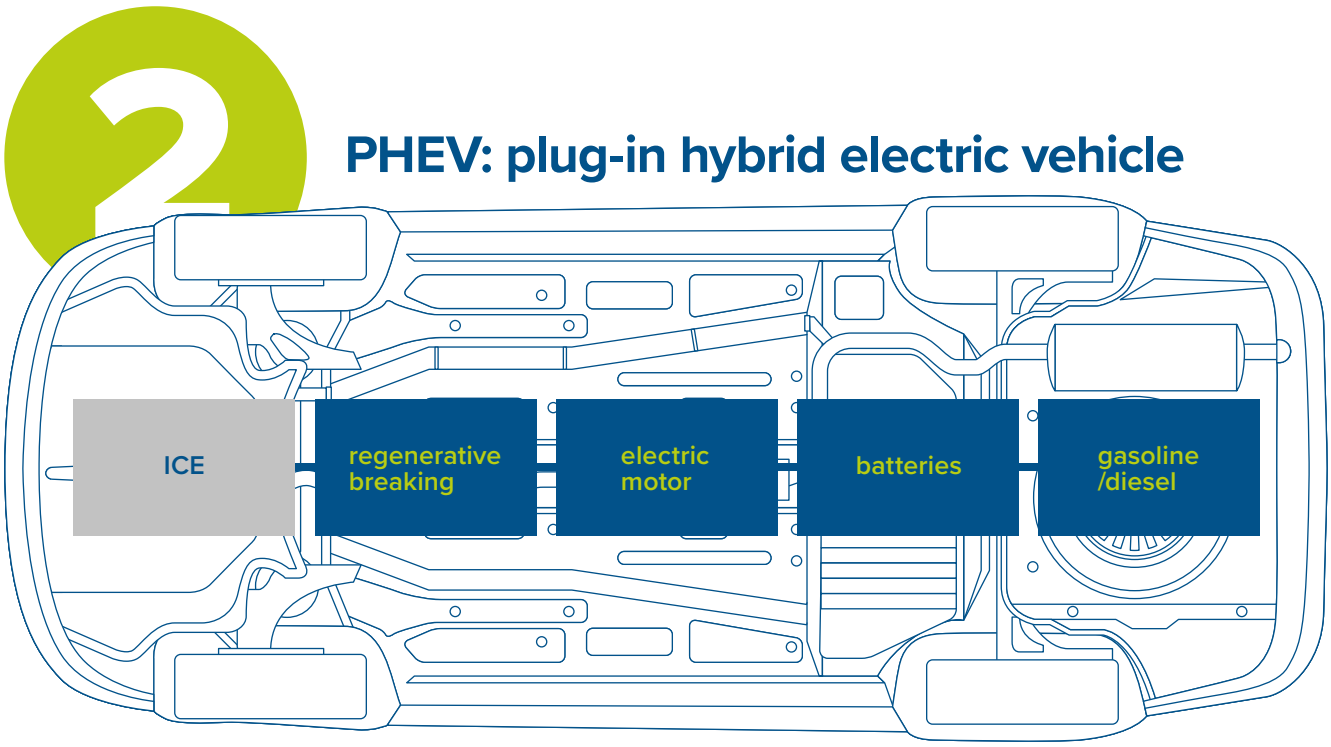


Figure 2

» Plug-in Hybrid Electric Vehicle (PHEV): Shares the characteristics of a conventional vehicle and an all-electric vehicle. It has an internal combustion engine (ICE) powered by conventional or alternative fuels; and the electric motor of an all-electric vehicle, having a plug to connect to the electrical grid.

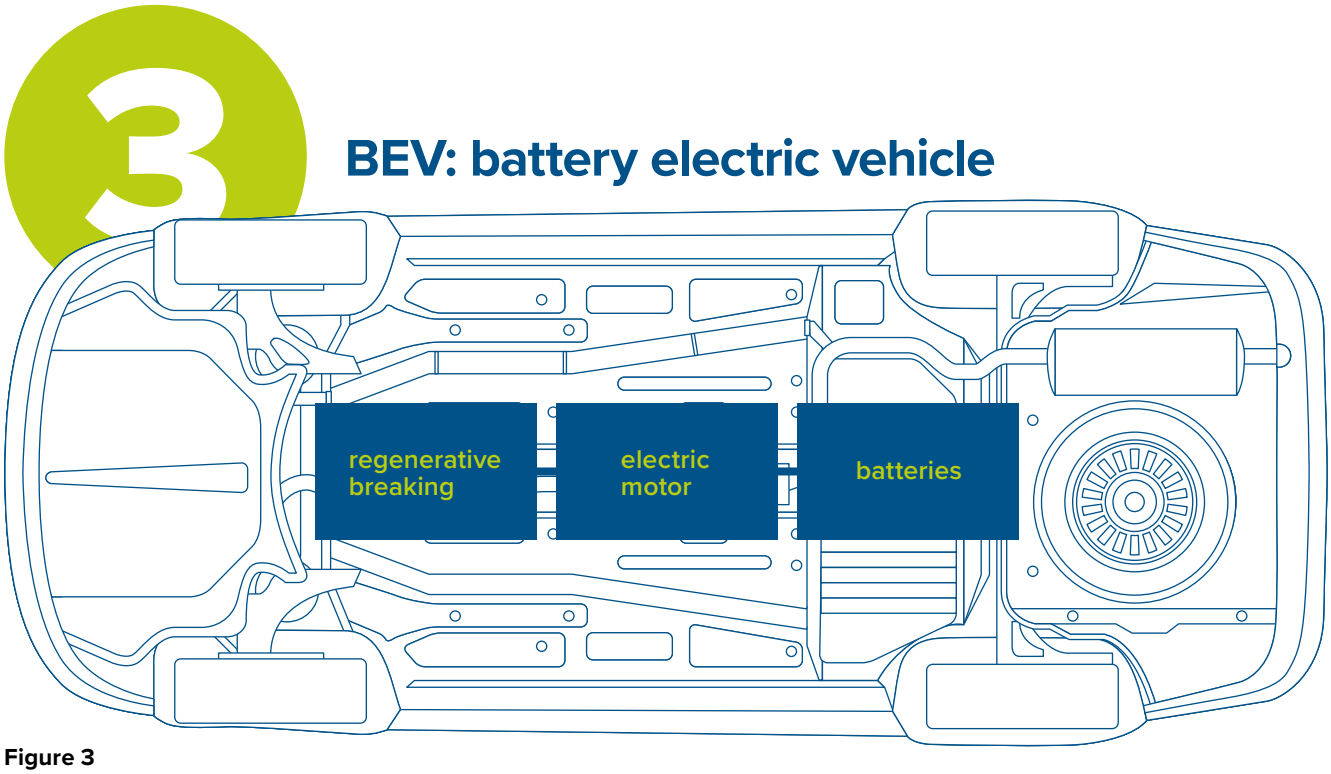


Figure 3

» **Battery Electric Vehicle (BEV):** Uses a relatively large on-board battery to propel the vehicle. The battery being the only source, provides energy for propulsion through an electric traction motor(s) as well as power for all vehicle accessory systems.

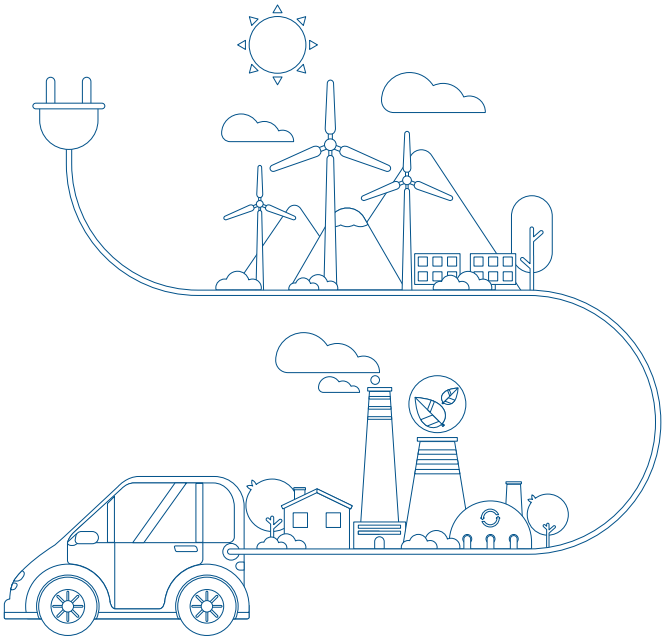
» **Fuel Cell Electrics Vehicle (FCEV)[2]:** A type of electric vehicle which uses a fuel cell, instead of a battery in combination with a battery or supercapacitor power its on-board electric motor. Fuel cells convert fuels directly into electricity via an electrochemical process that does not require combustion.

Electric mobility ecosystem

Implementing electric mobility in cities will require developing an entire ecosystem. Electric mobility brings together two sectors —transport and power, which have conventionally remained standalone. Success of implementing electric mobility will be determined by how efficiently cities are able to integrate these two sectors.

The electric mobility ecosystem includes the government which formulates the guiding policies and regulations, OEMs and suppliers, which design and manufacture vehicles, power and electricity suppliers, which are responsible for electricity generation, transmission and distribution, city-level bodies that can support setting up of charging infrastructure by energy operators/charging solution providers; and end consumers.

There are diverse stakeholders in the electric mobility ecosystem within a city. The end user could be a bus operator, who would need to charge massive batteries in a short time, or it could be a personal vehicle owner who might require charging his/her two-wheeler or a car overnight through an on-street charger or it might be a car ride-sharing provider, who would like the charging to happen rapidly for numerous vehicles simultaneously.



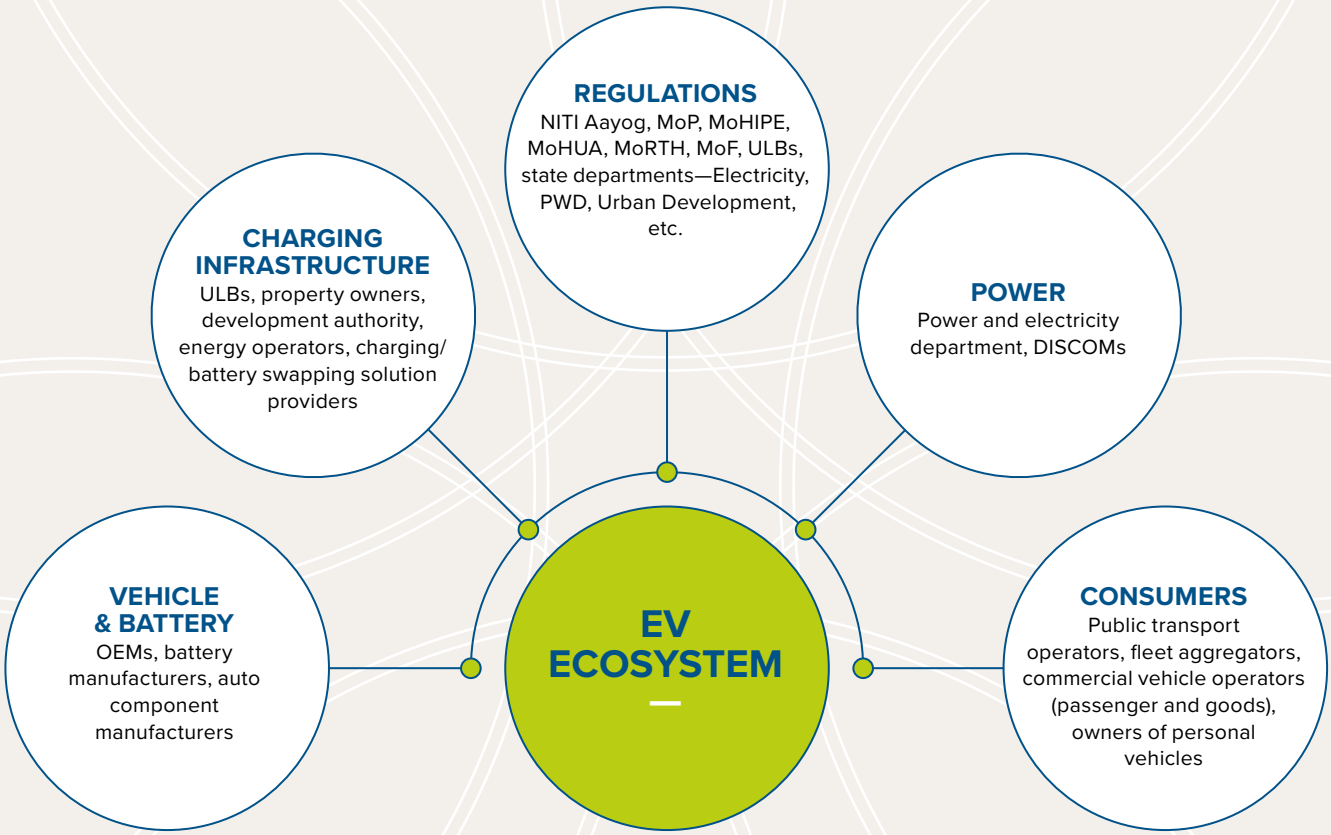


Figure 4: Key stakeholders and components of an EV ecosystem

3.0 What is the global scenario of EV adoption?

As per the estimations made by International Energy Agency (IEA), 2018, globally, the annual sales of new electric cars surpassed 10 lakhs in 2017. The sales of electric buses touched almost 10 lakh and that of two-wheelers, almost 3 crores for the same year (IEA, 2018).

In terms of total EV stock, IEA (2018), estimates more than 30 lakh cars, 3.7 lakh buses and around 25 crore two-wheelers, to be existing globally. Estimates made by Bloomberg New Energy Finance (BNEF, 2017) and ZEV Alliance (2018) also fall within the similar range.

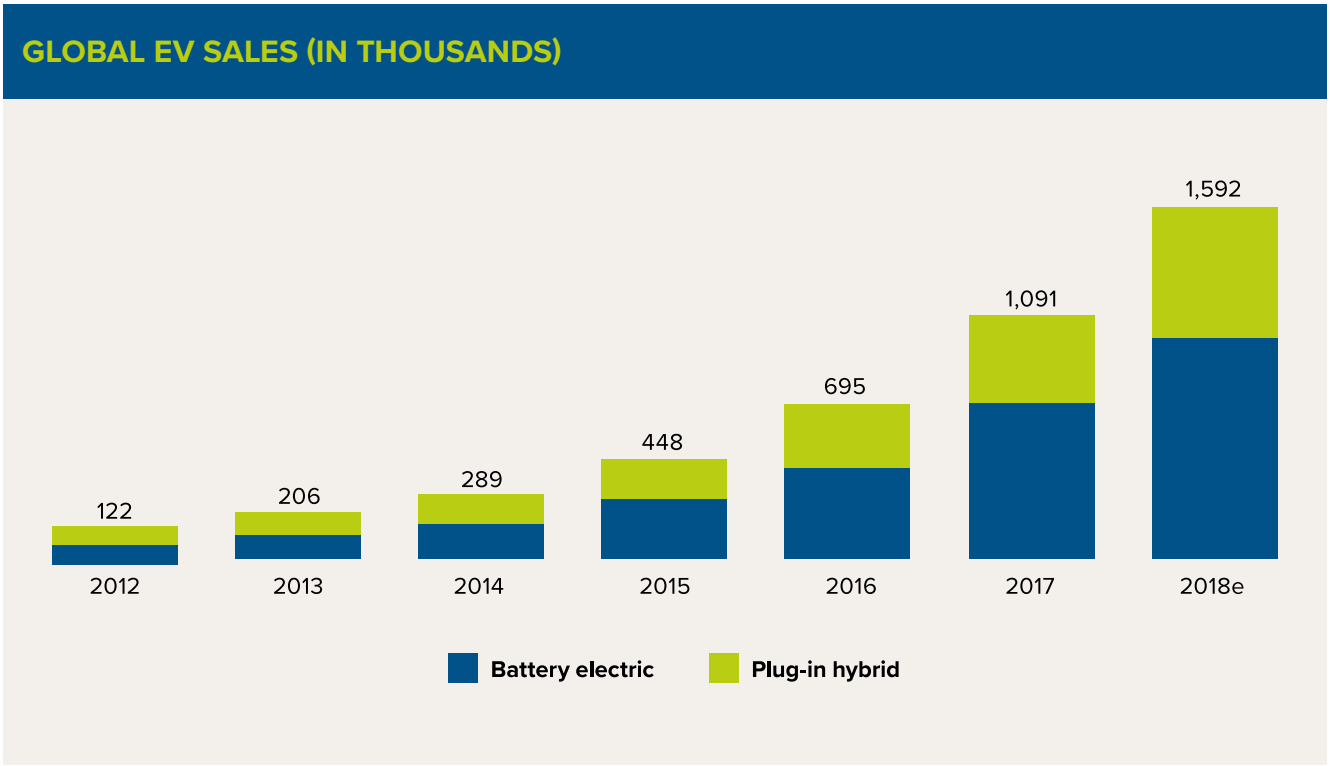


Figure 5: Global passenger EV sales by type as per estimates made by Bloomberg New Energy Finance (2017)
Note: The figure provides only estimated numbers for 2018 (2018e)

GLOBAL EV SALES BY COUNTRY

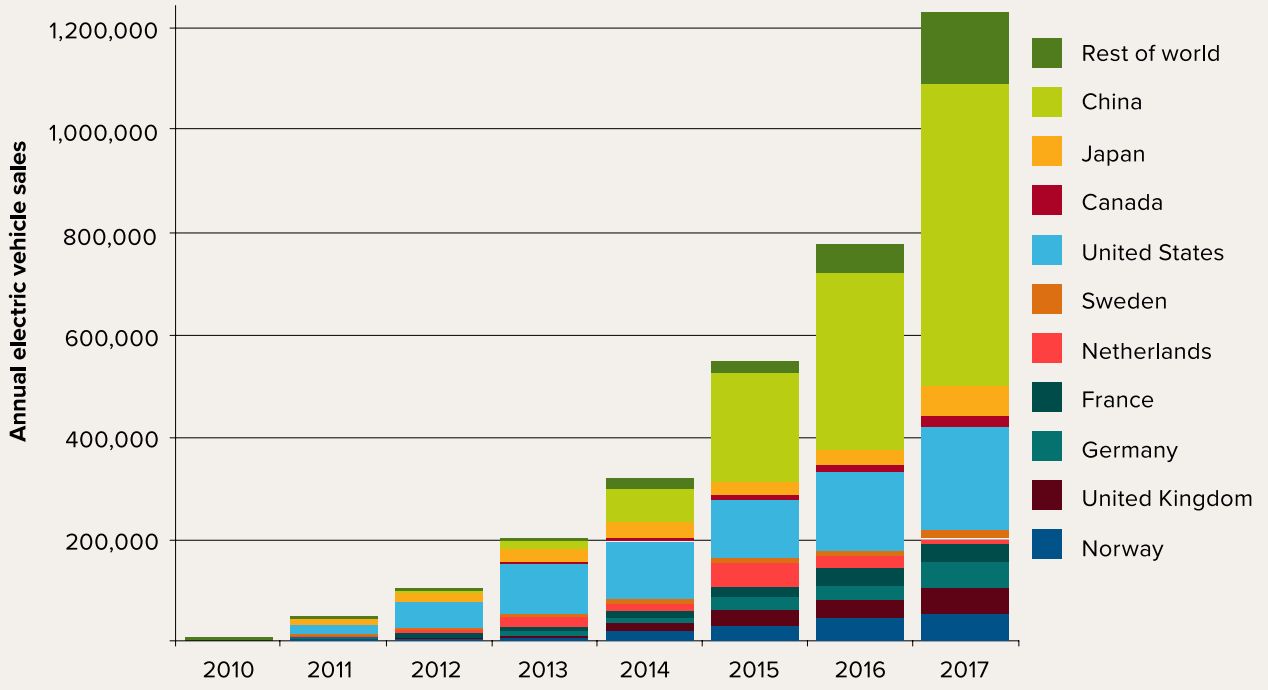


Figure 6: Annual sales of EVs—2010-2017 as per ZEV Alliance (2018)[3] | **Source:** www.forbes.com/sites/energyinnovation/2018/05/30/chinas-all-in-on-electric-vehiclesheres-how-that-will-accelerate-sales-in-other-nations/#9896912e5c1e

4.0 Drivers of electric mobility

Falling battery prices and improvement in battery performance

Cost has been one of the key barriers for the uptake of EVs. With supportive government policies and reduction in battery prices, a significant growth in the EV market is expected. The battery prices, in fact, have witnessed a significant drop; almost 80% in the past seven years (BNEF, 2017). According to BNEF (2017), an average battery pack price was $1,000/kWh in 2010, which reduced to $209/kWh, in 2017. The prices are expected to plummet to $70/kWh by 2030 (BNEF, 2017).

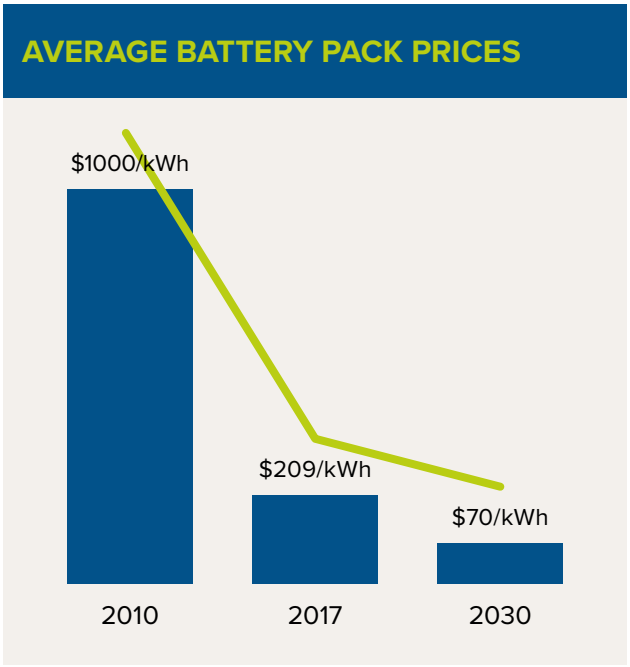


Figure 7 | **Source:** Bloomberg New Energy Finance (2017)

» The battery performance has improved markedly over the years; the average energy density of EV batteries has been improving at around 5–7% per year (BNEF, 2018). «

Government support

Governments around the world have been keen on adopting cleaner modes of transport. There has been extensive support for purchase of EVs, through incentives like purchase subsidy, mandatory EV fleet requirements, strict fuel economy norms, etc.

Action by cities

The growth of EVs is not just driven by national and state level policy support but also aggressive action led by cities. Air quality benefits that EVs offer are becoming a key driver of such action across municipalities, globally.

NATIONAL EV TARGETS SET BY DIFFERENT COUNTRIES FOR 2020–2030

COUNTRY	TARGET
» China	» **New energy vehicle (NEV) mandate:** 12% NEV credit sales of passenger cars by 2020 » **NEV sales share:** 7–10% by 2020, 15–20% by 2025 and 40–50% by 2030
» Finland	» 250,000 EVs by 2030
» Ireland	» 500,000 EVs and 100% EV sales by 2030
» U.S.A.	» **ZEV mandate in ten states:** 22% ZEV credit sales in passenger cars and light-duty trucks by 2025 » 3,300,000 EVs in eight states combined by 2025 » **California:** 1,500,000 ZEVs and 15% of effective sales by 2025 and 5,000,000 ZEVs by 2030
» Korea	» 200,000 EVs in PLDVs by 2020
» Norway	» 100% EV sales in PLDVs, LCVs and urban buses by 2025 » 75% EV sales in long-distance buses and 50% in trucks by 2030

Table 1: National EV targets set by different countries for 2020–2030 | **Note:** NEVs in the Chinese context refers to BEVs, PHEVs and FCEVs; PLDV: passenger light-duty vehicle; LCV: Light commercial vehicle | **Source:** Compiled by IEA (2018)

5.0 Action led by cities

Cities and urban local governments around the world are developing policies to encourage the use of EVs to reduce greenhouse gases, improve air quality and reduce dependence on fossil fuels. EV uptake in 20 global cities, as shown in Figure 8, constitutes about 40% of the world's total EV sales (ICCT, 2017).

The share of EV sales is as high as 36% in Bergen and 33% in Oslo. Cities such as Amsterdam, London, Los Angeles, Oslo, and Beijing have also set targets for adoption of EVs in their respective cities. While Amsterdam is aiming at zero-emission transport by 2025, Oslo is targeting the same but for 2030. New York city is aiming at 20% EV sales share by the same year.

Cities are relying on measures such as restricting movement of ICEVs in certain parts of cities, incentivizing the ownership and use of EVs such as providing purchase subsidy on EVs, and allowing EVs on special lanes, access to free charging, free parking, exemption from toll charges, etc.

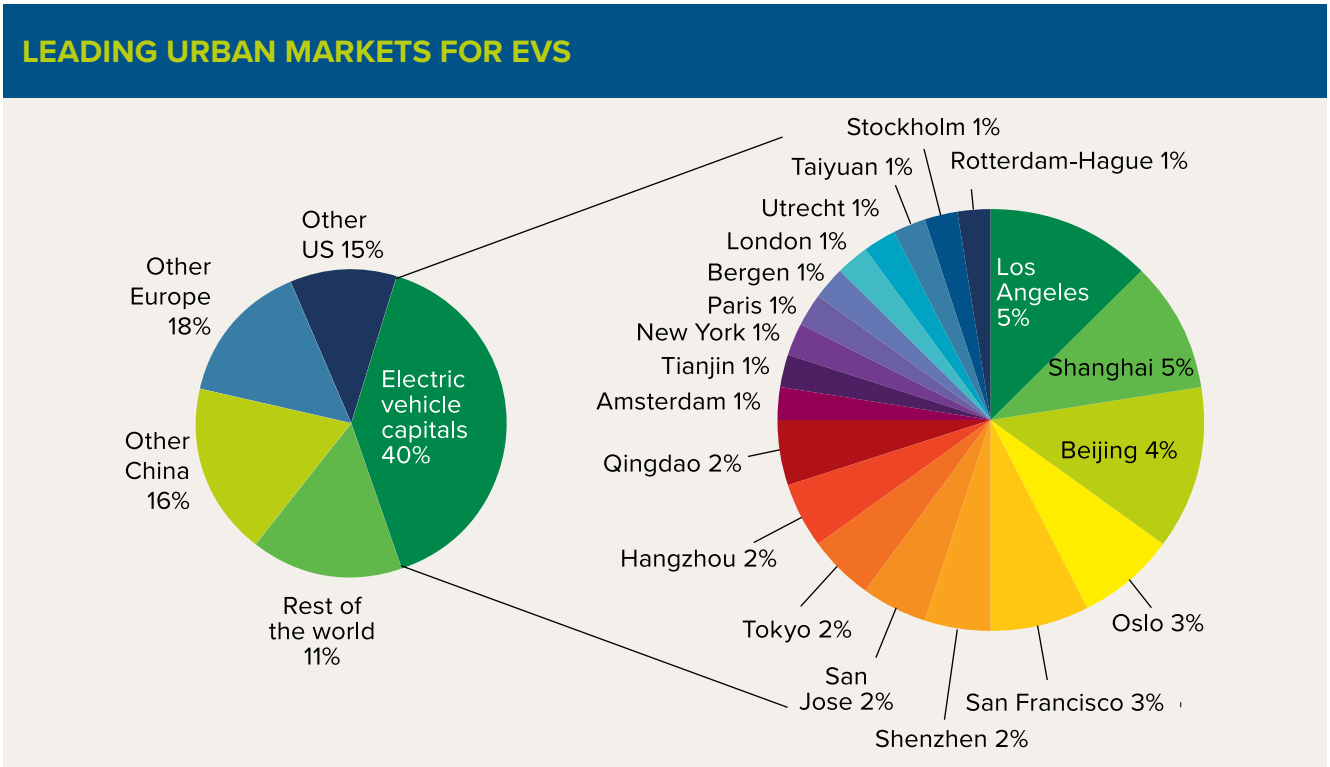


Figure 8: Cumulative EV stock in leading urban markets and other geographies expressed as percentage of global EV stock as in 2016 (estimated values) | **Source:** ICCT (2017)

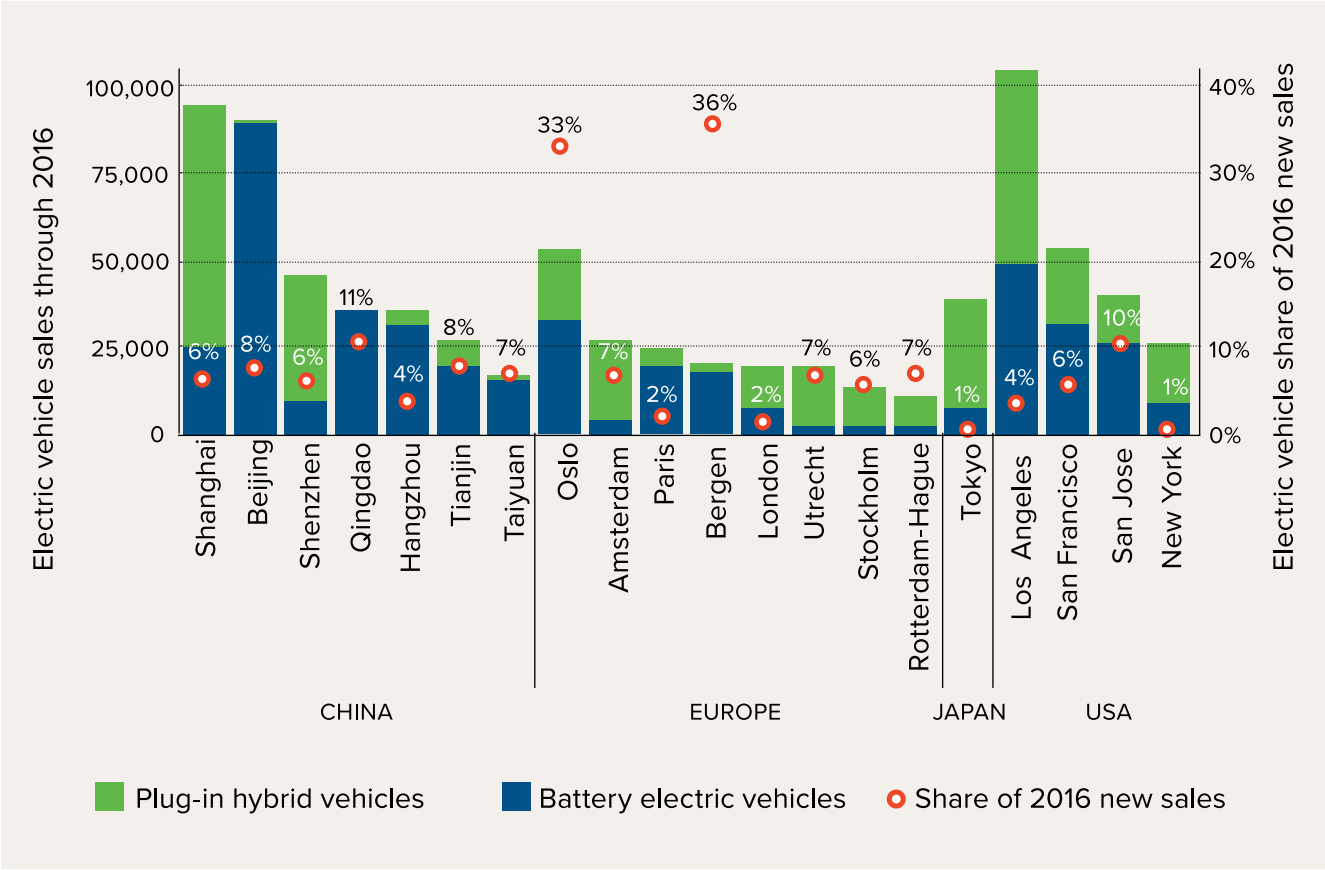


Figure 9: Cumulative EV stock in leading urban markets and other geographies expressed as percentage of global EV stock as in 2016 (estimated values) | **Source:** ICCT (2017)

EV TARGETS ANNOUNCED BY CITIES	
CITY	**TARGET**
Amsterdam	Zero-emissions transport within the city by 2025
London	Procure only zero emission buses from 2025
Los Angeles	10% of vehicle stock electric by 2025; 25% electric by 2035
New York City	20% vehicles sold in the city by 2025 to be EVs Municipal vehicle fleet of 2,000 EVs by 2025
Oslo	Zero-emissions transport within the city by 2030
Shenzhen	120,000 new energy vehicles sold by 2020
Tianjin	30,000 new energy vehicles sold by 2020

Table 2: EV targets announced by cities | **Source:** ICCT (2017), SLOCAT (2018)

6.0 Action led by Original Equipment Manufacturers (OEMs)

Several OEMs have announced targets for the production and sales of EVs; BMW for instance aimat to selling 15–25% EVs of its entire sales by 2025, Honda on the other hand is targeting a massive goal of two-third of its 2030 sales to be EVs. The table provides details of the EV production and sales targets set by some of the leading OEMs, globally.

EV TARGETS ANNOUNCED BY CITIES	
OEM	**ANNOUNCEMENT, AS OF APRIL 2017**
BMW	0.1 million electric car sales in 2017 and 15–25% of the BMW group's sales by 2025
Chevrolet (GM)	30,000 annual electric car sales by 2017
Chinese OEMs	4.52 million annual electric car sales by 2020
Daimler	0.1 million annual electric car sales by 2020
Ford	13 new EV models by 2020
Honda	Two-third of the 2030 sales to be electrified vehicles (including hybrids, PHEVs, BEVs and FCEVs)
Renault-Nissan	1.5 million cumulative sales of electric cars by 2020
Tesla	0.5 million annual electric car sales by 2018 1 million annual electric car sales by 2020
Volkswagen	2–3 million annual electric car sales by 2025
Volvo	1 million cumulative electric car sales by 2025

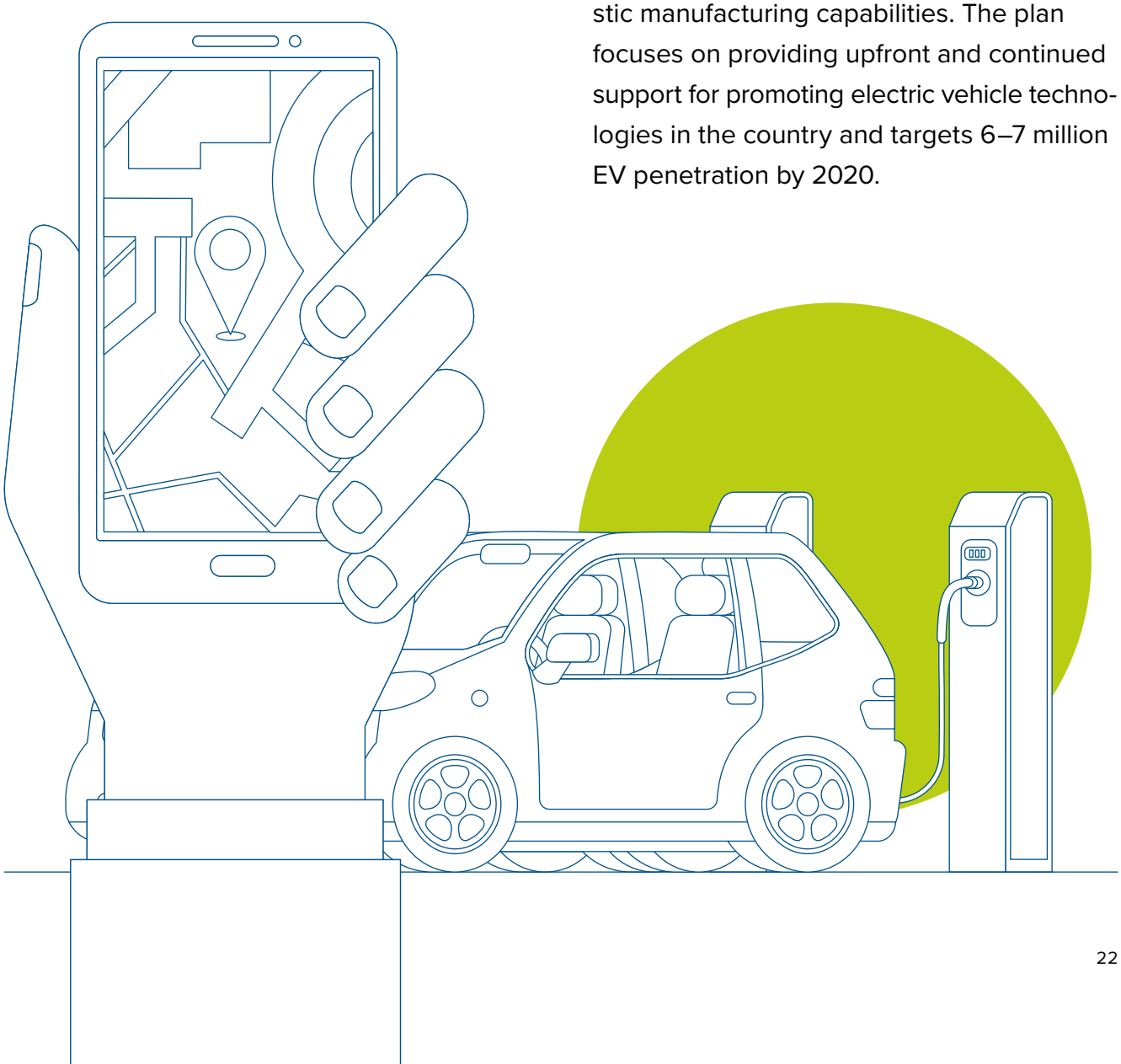
Table 3: Announcements made by different OEMs, as of April 2017 | **Source:** Compiled by IEA, 2017

7.0 Electric mobility in India

Given the massive benefits offered by EVs, India is also turning to EVs as a solution to its transport problems such as fossil fuel dependence, urban air pollution and carbon emissions. India has already mapped its electrification program through adopting the National Electric Mobility Mission Plan 2020 (NEMMP 2020).

National Electric Mobility Mission Plan 2020 (NEMMP 2020)

The NEMMP, 2020 lays down vision and roadmap for EV penetration in India. The plan was adopted by the Government of India in 2013. The plan aims at national energy security, mitigation of adverse impacts of vehicular growth on environment and growth of domestic manufacturing capabilities. The plan focuses on providing upfront and continued support for promoting electric vehicle technologies in the country and targets 6–7 million EV penetration by 2020.



Key interventions proposed under NEMMP 2020

Supply-side incentives: The plan draws up a four-phase approach for building India's EV manufacturing capabilities:

Initial focus on:

- Developing R&D capacities
- Strengthening domestic capabilities
- Initiating localization

Later focus on:

- Creating high capabilities across the value chain, developing indigenized products, sourcing components locally, creating an EV component ecosystem, targeting the export market and investments to enhance capabilities and production plan for exports.

Power and charging infrastructure to build 300–400 charging terminals for buses and for building the overall EV charging infrastructure:

- Estimated investment of 10–20 CR INR
- Estimated requirement of 2–4 MW of extra power generation capacity

The recommendations made under NEMMP have been taken forward by the Government through a scheme called FAME.

» Cities and towns included under the scheme—Smart Cities, metropolitan cities of Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, North Eastern cities and cities with over 1 million population «

FAME, India (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India)

FAME is a demand side incentive scheme under the NEMMP, with a focus on technology development, infrastructure creation and boosting demand through subsidies and pilot projects.

- Implemented since April 2015, extended till 31 March, 2019
- It has an approved outlay of INR 750 million
- Incentives under the scheme are provided in the form of discounts
- The discount amount is about one-third of the difference between the price of an EV and a comparable petrol vehicle
- ~60% of these funds are allocated towards demand incentives

Coverage of the scheme[7]

- Cities and towns included under the scheme—smart cities, metropolitan cities of Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, North Eastern cities and cities with more than 1 million population
- Covers all vehicle segments i.e. two, three and four-wheelers, cars, LCVs, buses, etc.

INCENTIVES FOR DIFFERENT VEHICLE SEGMENTS	
VEHICLE SEGMENT	**INCENTIVES (MIN–MAX)**
Scooter	INR 1,800–INR 22,000
Motorcycle	INR 3,500–INR 29,000
Auto-rickshaw	INR 3,300–INR 61,000
Car	INR 11,00–INR 138,000
LCV	INR 17,000–INR 1,87,000
Bus	INR 300,000–INR 660,000

Table 4: Incentives for different vehicle segments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Incentives for the Smart Cities

Smart cities can also make use of grant funding being made available to them by the Central Government for EV deployment. Advancing the NEMMP, the Government of India has announced that it will provide financial support of up to 1.05 billion as grant funding to Smart Cities for the purchase of EVs for mass public transport for implementing pilot projects under the FAME program. Only cities with populations greater than 1 million can avail this funding.

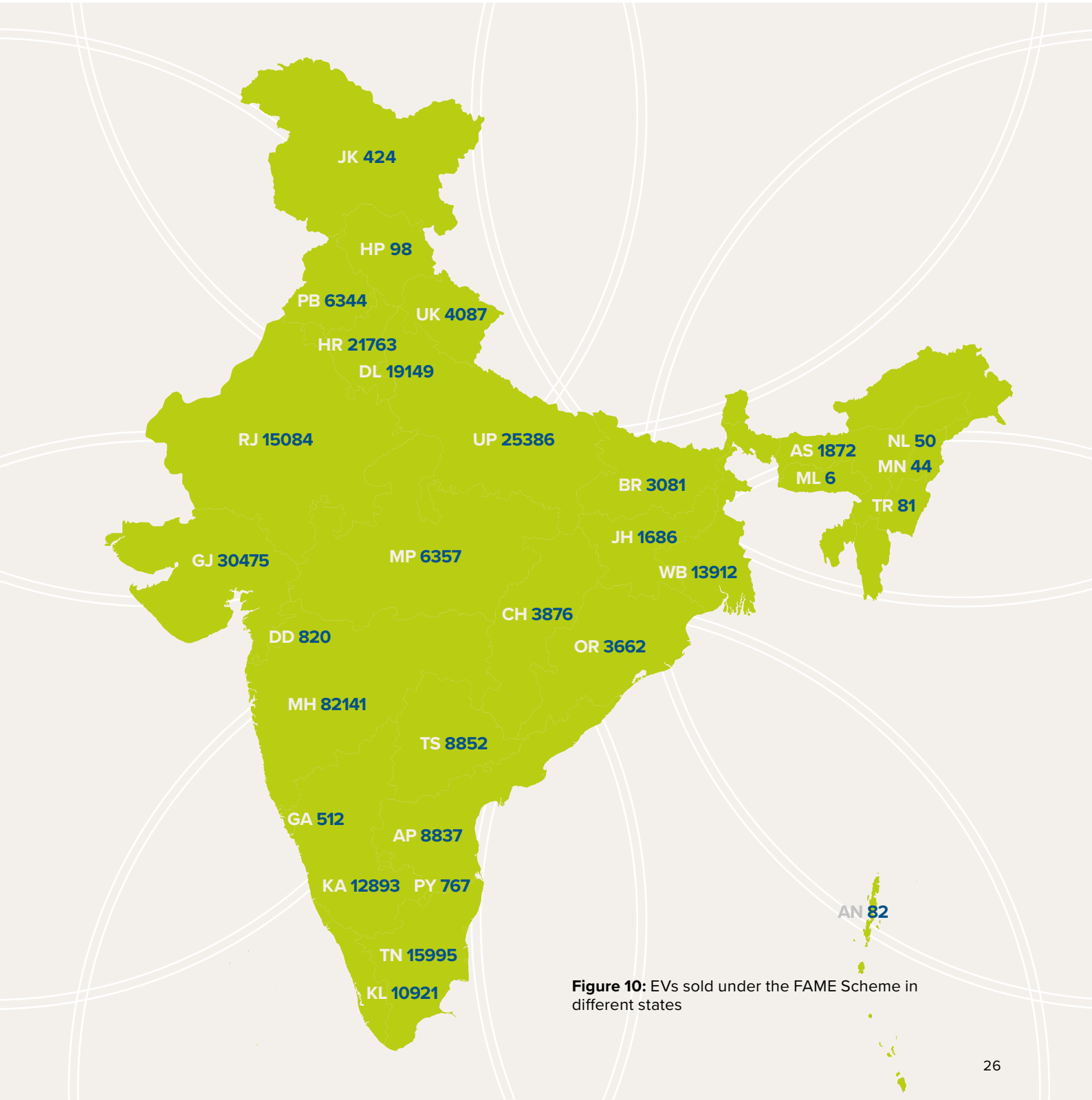


Figure 10: EVs sold under the FAME Scheme in different states

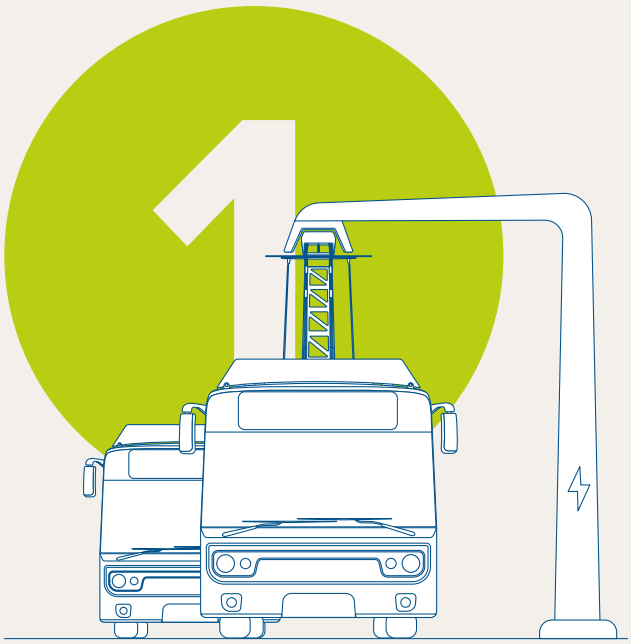
» Implementation of the FAME scheme has led to 77,000 tons of CO_2 emission reduction and 31 million litres of fuel savings—DHI, 2018.[8] «

Key areas of EV funding proposed are[9]:

» The funding support is available only on the composite deployment of electric buses (with a maximum of 100 per city), electric four-wheeler (4-W) passenger cars, and electric three wheelers (3-W)

» The government will also provide financial support towards setting up of charging infrastructure in selected cities with an upper ceiling of INR 150 million per city

» DHI will receive only a consolidated proposal from the city (city size> 1 million eligible). The cities will be responsible for the coordination among city and state level stakeholders such as the state government departments, undertakings, municipal corporations, and public, state transmission utilities, transportation authorities, and 4-W/3-W aggregators, etc.



Financial support for electric buses:

» Electric buses with a minimum of 15% Indian components: 60% of the purchase cost or 10 million

» Electric buses with a minimum of 35% Indian components: 60% of the purchase cost or 15 million

Financial support for electric 4-wheelers:

» Electric 4-W with a length that does not exceed 4m and range of 70km: a grant of INR 76,000

» Electric 4-W with a length that does not exceed 4m and range of 105 km: a grant of INR 1,24,000

» Electric 4-W with a length that exceeds 4m and a range of 70 km: a grant of INR 60,000

» Electric 4-W with a length that exceeds 4m and has a range of 105 km: a grant of INR 1,38,000

Financial support for electric 3-wheelers:

» Electric 3-W with a range of 50 km: a grant of INR 51,000

» Electric 3-W with a range of 80 km: a grant of INR 61,000

» Electric 3-W with a top speed that does not exceed 25km per hour (km/h) and range of 50 km: a grant of INR 37,500

» Electric 3-W with a top speed that is not more than 25km/h and range of 80 km: grant of INR 45,000

Delicensing and standardization of charging infrastructure by GoI

With an aim at accelerating development of charging infrastructure in the country, the Ministry of Power recently delicensed setting up of charging stations for EVs.

The licence requirement had been a major hinderance for market access in setting up charging infrastructure. With delicensing it is expected that a lot of small players will come forward in setting up of EV charging stations. Since it is expected that charging infrastructure will be dominated by large number of small fragmented players, developing standardized protocols for charging stations is important. With an aim at promoting performance and interoperability, the Government has already adopted standard protocols for low and high power AC and DC charging stations in the country.

No licensing requirement to set up charging stations, Ministry of Power[10]

Ministry of Power released a notification on 14 December 2018, stating that charging batteries of EVs through charging stations does not require any license under the Electricity Act.

Standardization of protocol for Charging Infrastructure—Bharat EV Charger AC-001 and Bharat EV Charger DC-001

» Protocol for low power AC & DC charging

stations (for EVs having system voltage less than 100 VDC)

» These standards provide specifications for AC and DC charging for electric vehicles

» For more information on the protocol refer to https://dhi.nic.in/writereaddata/UploadFile/Standardization%20of%20protocol.pdf

Recommendations for high power AC & DC charging stations (for EVs having system voltage over 100 VDC) developed by ARAI

» For the recommendation refer to https://dhi.nic.in/writereaddata/UploadFile/Standardization%20of%20Protocol%20of%20AC63666-2997828194203.pdf

Other initiatives taken up by the Government to promote EVs[11]

Besides providing incentives to the cities and offering demand side incentives to the consumers, there are other steps that the government has taken to provide a thrust to the EV market in the country. Some of these steps/ initiatives have been discussed below.

Reduced GST on purchase of EVs

» Pure BEVs have been placed in a lower GST slab of 12% in comparison to the 28% GST that these vehicles were earlier subject to.

National E-Mobility Programme, MoP

» Implemented by Energy Efficiency Services Limited (a joint venture set up under the Ministry of Power)

National E-Mobility Programme, MoP

» Implemented by Energy Efficiency Services Limited (a joint venture set up under the Ministry of Power)

» Focus on public procurement to facilitate demand creation for EVs in India

» Aim at building bulk procurement and demanding aggregation to procure and deploy electric vehicles to transition the national fleet of government vehicles (about 500,000 cars) to EVs

» The Ministry also announced that it is focusing on creating the charging infrastructure and a policy framework so that by 2030 more than 30% of vehicles in India are electric

Zero-emission corridor, Agra

» Restricts movement of conventional vehicles within a radius of 1.5 km around the Taj Mahal

» Seven-seater electric vans (make: Maximo) are operated by the Agra Development Authority (ADA) for last-mile connectivity (2 km)

Private initiatives

» Fleet aggregator and operator, Ola announced its plans to deploy 5 million e-cars in the next five years

» Uber to explore deployment of Mahindra's e-cars in Delhi and Hyderabad

» Mahindra Electric is providing fast charging support to e-cars deployed by ZoomCar, a car renting company

» Fleet operator and aggregator Meru, and Mahindra Electric announced the launch of a pilot EV fleet in Hyderabad; to be replicated in other cities in India[12]

Bus Pilots[13]

A number of bus pilot projects have also been launched in various Indian cities; some of these are listed below:

» 25 electric buses being launched in Pune, in February 2019

» Electric buses plying in New Town, Kolkata since May 2018

» BYD electric bus trial in Bengaluru by Bengaluru Metropolitan Transport Corporation (BMTC), 2014

» Goldstone-BYD bus trial in Rajkot in 2016

» BYD electric bus trial in Delhi by Delhi Transport Corporation (DTC), 2016

» Goldstone-BYD bus trial by Himachal Road Transport Corporation (HRTC) on Manali-Rohtang Road in 2016; regular e-bus service started in September 2017—25 Goldstone BYD buses in operation

» Ashok Leyland bus trial by HSRTC on Manali-Rohtang Road in 2016

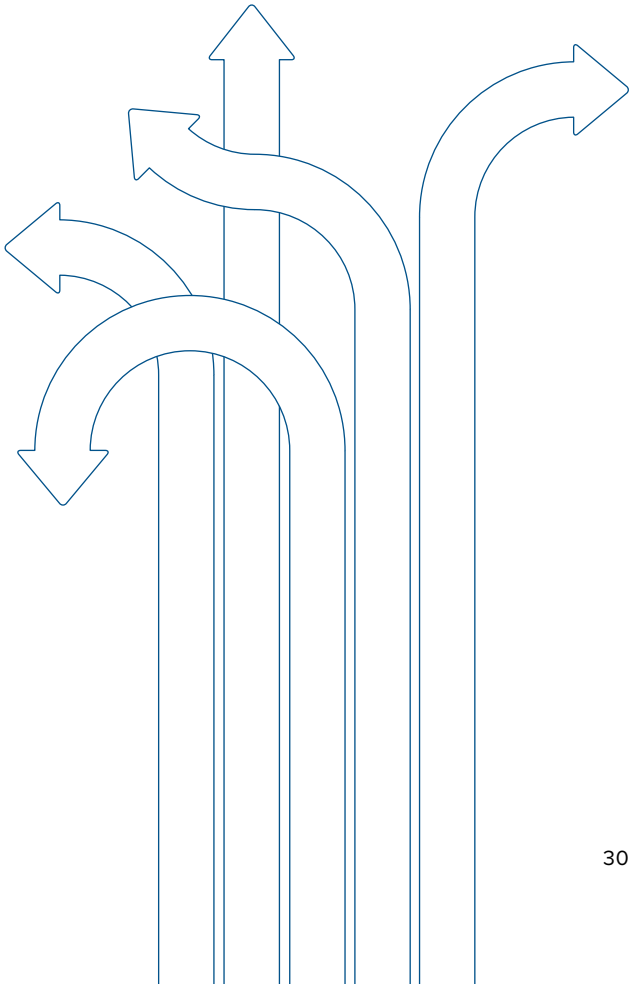
» Tata Motors bus trial in Shimla in 2017

» Tata Motors bus trial in Chandigarh in 2017

» Four Goldstone-BYD buses deployed by Bombay Electric Supply & Transport (BEST), Mumbai in 2017

» Goldstone-BYD bus trial in Goa in 2018

» BYD electric bus trial in Delhi by Delhi Transport Corporation (DTC) in 2016

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Initiative by the State Governments

Karnataka, Telangana, Maharashtra and Uttar Pradesh have launched their respective state EV Policies to promote manufacturing and adoption of EVs. Delhi also released a draft EV policy in December 2018. It is currently in the stage of finalization. Andhra Pradesh has recently announced its plans and targets for adoption of electric vehicles. The box below provides details on the vision, objective and targets set by each state EV policies.

Andhra Pradesh aims at putting 10 lakh electric vehicles on road by 2024. AP government seeks to:

» Have 10 lakh electric vehicles across all vehicle segments in the state by 2024

» Convert the entire fleet of Andhra Pradesh State Road Transport Corporation into electric

» Convert all government vehicles, including corporations, boards and government ambulances to electric vehicles by 2024

» Install 1 lakh slow and fast EV charging stations by 2024

» Government will stop new registration of ICE cars and wants to make Amaravati, an electric-only city

State Government Policies on Electric Vehicles

Karnataka Electric Vehicle and Energy Storage Policy 2017

Vision:

To make Karnataka, a preferred investment destination for manufacturing of electric vehicles by leveraging advantages and opportunities available for sustained development of this promoting segment

Objectives:

» To maintain lead share of Karnataka as preferred destination for attracting investments in manufacture of electric vehicles

» To attract investment of INR 31,000 CR and create employment opportunities for 55,000 persons both from supply and demand sides

» To create a conducive environment to transit from electric to ICE

» To provide opportunities for R&D in e-mobility

Targets:

» 1000 EV buses in poly period

» 100% three-wheelers/four-wheelers moving goods will be encouraged to transit to electric mobility by 2030

» Incentives for first 100 fast-charging stations

For more details on the policy refer to www.investkarnataka.co.in/assets/downloads/Karnataka-State-Electric-Vehicle-&-Energy-Storage-Policy-2017.pdf

Telangana Electric Vehicle Policy Draft 2017

Vision:

To establish Telangana as the benchmark state in India and a model of international standards for electric vehicle adoption across segments (personal, shared and commercial), supported by a world-class infrastructure and ecosystem

Objectives:

» To attract investments worth 3B USD and create employment for 50,000 persons by 2022 through EV manufacturing and charging infrastructure development

» Provide best-in-class ecosystem and infrastructure to make Telangana the EV hub of India

» Develop a proving ground for viable business models through accelerated demand for EVs

» Promote innovation in EVs and other emerging trends such as autonomous/connected mobility

» Make Telangana state the preferred destination for electric vehicle and component manufacturing

» Create a pool of skilled workforce for the industry

» Create a conducive environment for industry and research institutions to focus on cutting edge research in EV technologies

Targets:

» Telangana State Transport corporation to set a target of 100% electric buses by 2030 for intracity, intercity and interstate transport (key milestones—25% by 2022, 50% by 2025 and 100% by 2030)

» Government will set up first 100 fast charging stations in GHMC and other cities in a phased manner

For more details on the policy refer to www.evpedia.in/wp-content/uploads/2017/11/Telangana-Draft-Electric-Vehicle-Policy-_16_10_2017.pdf

Maharashtra's Electric Vehicle and Related Infrastructure Policy 2018

Vision:

Transforming Maharashtra into a globally competitive state for electric vehicle and component manufacturing and maximize the adoption of EV in Maharashtra

Objectives:

» To develop Maharashtra as the leader in EV manufacturing and use

» To create newer employment opportunity

» To promote export of EV, component, battery, charging infrastructure

» To promote R&D and skill development in EV

» To promote sustainable transportation

Targets:

» Increase number of EV registrations in Maharashtra to 5 lakhs

» To generate an investment of INR 25,000 CR in EV

» To create jobs for 1 lakh people

For more details on the policy refer to www.di.maharashtra.gov.in/_layouts/15/doistaticsite/english/pdf/MaharashtrasElectricalVechiclePolicy.pdf

Uttar Pradesh Electric Vehicles Manufacturing Policy 2018

Vision:

To support the expansion of eco-friendly automobile industry in Uttar Pradesh and open the market for electric vehicles manufacturing, supporting the set targets of GoI

Objectives:

» To establish Uttar Pradesh as the preferred destination for attracting investments in manufacturing of electric vehicles (EV)

» To create employment opportunities, both from supply side and demand side

» To create a conducive environment for shift from Internal Combustion (IC) engines to electric vehicles

» To encourage the use of Hybrid EVs in Uttar Pradesh during the transition phase

» To develop human capital and augment the power capacity to meet the needs of the industry promoting electric mobility in the state

Targets:

» **Public transport:** To promote EVs in public transport, 1000 e-buses will be introduced in the state by 2030; 25% in phase I by 2020, remaining 35% in phase II by 2022 and the rest 40% in phase III by 2030. Further, green routes will be identified by 2020 in GB Nagar, Ghaziabad, Lucknow, Kanpur and Varanasi for 100% EV public transportation

» **Private transport:** State government will encourage electric two-wheeler taxis for short distance mobility and existing auto rickshaws will be encouraged to resort to EV technology. Auto rickshaws, cabs, school buses/vans, etc., will also be targeted to achieve 100% electric mobility by 2030 in five cities—GB Nagar, Ghaziabad, Lucknow, Kanpur and Varanasi

» **Goods transportation:** To promote adaptability of EVs in goods transportation, three-wheelers, four-wheelers. Mini-goods vehicles to be encouraged in GB Nagar, Ghaziabad, Agra, Lucknow, Kanpur, Varanasi and Jhansi

For more details on the policy refer to www.niveshmitra.up.nic.in/Documents/DraftPolicies/Uttar_Pradesh_Electric_Vehicles.pdf

8.0 Considerations while promoting electric mobility

Promotion of EVs need not address concerns related to traffic congestion

Though EVs are being hailed as a solution to very many problems, city managers at this stage, must understand that private automobiles, even when they do not emit or use clean source of energy to power themselves, may not address concerns related to increasing congestion in cities.

» Cities should ensure that in the process of encouraging EVs, promoting electric passenger kilometers rather than private EVs should be the aim. «

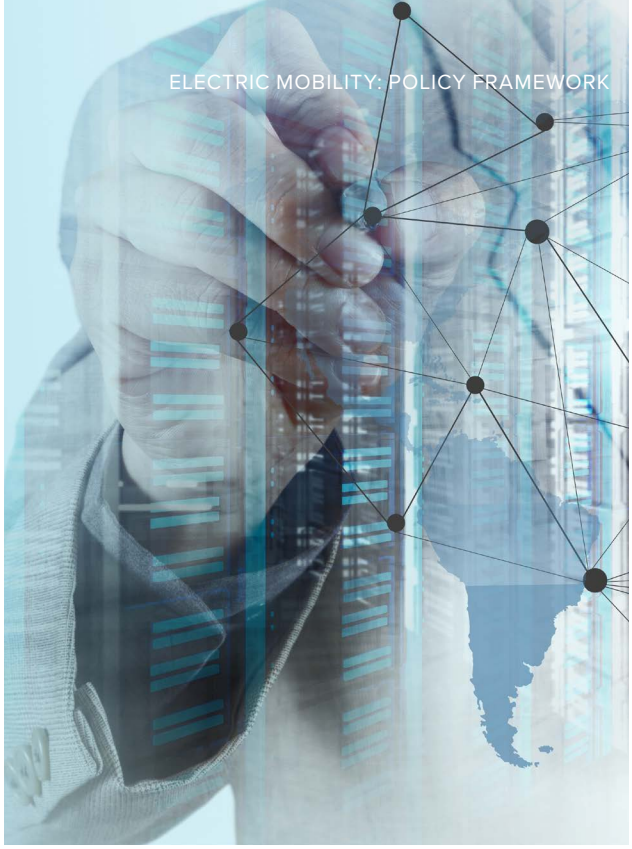
This would imply a focus on the electrification of public transport, shared vehicles, fleet vehicles, and other vehicles deployed in high utilization business models.

Cities should aim at powering EVs with clean electricity

While EVs produce significantly lower or no tailpipe emissions, they still contribute to pollution and emissions considering the electricity they consume. While assessing the emission footprint of EVs, one must account for well-to-wheel emissions, which imply including GHGs and air pollutants that are emitted to produce and distribute the energy being used to power the EVs. Wherever feasible, cities should try to make efforts to utilise clean electricity, generated from renewable sources like wind or solar to power EVs to reduce the well-to-wheel emissions.

Deploying charging infrastructure is important

Availability of public charging infrastructure is considered critical to the deployment of EVs. Setting up an optimum density of public chargers will require availability of accessible and affordable locations. It will also require availability of grid and power infrastructure. There are no tried and tested business models for setting up public charging infrastructure in the Indian market and ensuring safety of the charging infrastructure will be crucial for the success of EV adoption.



Other Barriers

Though operating cost of EVs is competitive or even lower as compared to ICEVs, their high acquisition cost remains a key barrier to widespread uptake of EVs. A comparison of different bus technologies shows that the upfront cost of electric buses is more than double that of typical diesel buses.

While capital costs are high, the total cost of ownership of electric buses is already lower than ICE buses in many markets. Cities and governments are taking a number of measures to reduce the upfront cost of EVs, yet bridging the wide gap in EV capital costs will remain a challenge for some time. Hence, cities must collaborate with different stakeholders to explore business models that unlock the operational savings of EVs.

COMPARISON OF DIFFERENT BUS TECHNOLOGIES				
POWER SOURCE	**ELECTRICITY**	**ELECTRICITY + FUEL**	**BUSES**	**3W**
Diesel or CNG	CNG	Diesel	Moderate	Moderate
Power generator	Battery	IC engine + battery	IC engine	IC engine
Upfront costs (INR)	2.6 crores	>3 crores	20–88 lakhs	20–88 lakhs
Fuel efficiency	1.5 kWh/km7	2.75–4km/L8	2–3 km/kg	2–3 km/LG
Fuel tariff	6.95 INR/kWh10	50 INR/L11	40 INR/kg	50 INR/L
Fuel cost	10/km INR	13–17/km INR	13–20/km INR	15–23/km

Table 5: Comparison of different bus technologies | **Source:** CSTEP, 2016, Report on Electric buses in India

9.0 Key Performance Indicators (KPIs)

Beyond understanding opportunities and challenges in the sector, it is important that city managers pursue strategies that can deliver the impact they wish to create. KPIs, in this respect, will equip city managers to measure their progress and understand the impact of various actions.

KPIs can be a useful tool to enable cities measure their progress. The focus here is to list the key indicators that will help understand how the city is performing in a holistic manner in terms of EV uptake.

The subsequent document, ‘Evaluation Metrics’ will provide a detailed discussion on the following KPIs and ways to measure and utilize them.

Number of EVs in the city:

Parameters

» Buses » Mini buses » Standard

Measure

» Actual numbers/estimated numbers/ qualitative indicators

Data sources

» RTO, fleet operators, fleet operator untions

Number of EVs in the city:

Parameters

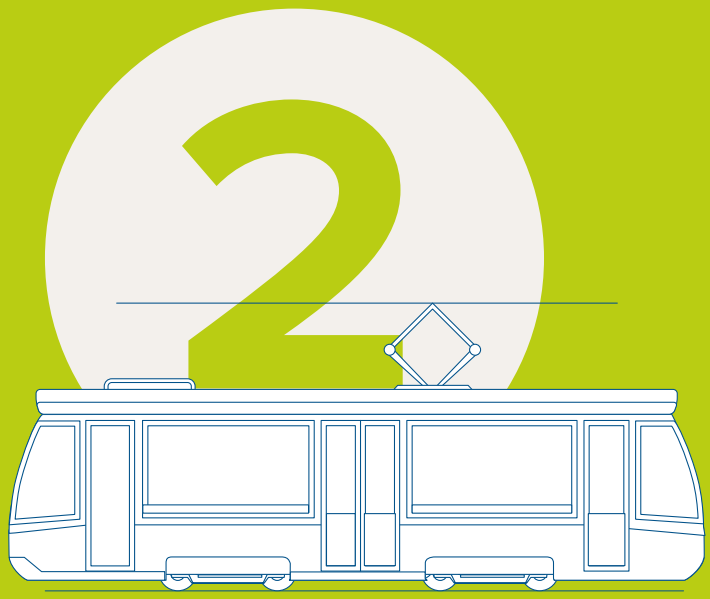
» Rail

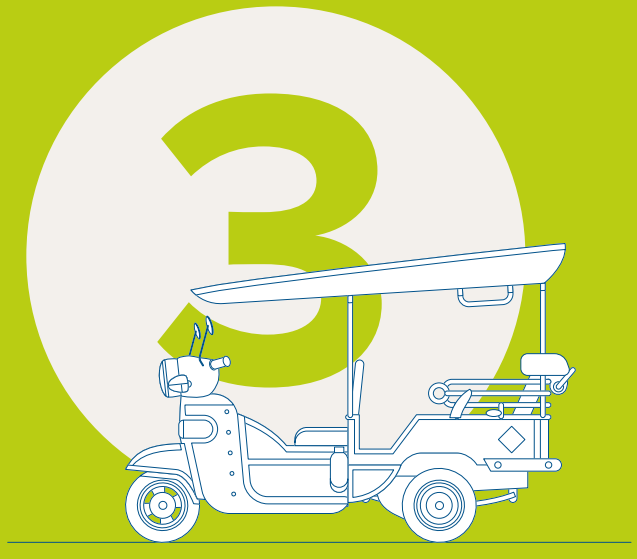
Measure

» Actual numbers/estimated numbers/ qualitative indicators

Data sources

» RTO, fleet operators, fleet operator untions





Number of EVs in the city:

Parameters

» IPT » E-autorickshaw » E-rickshaw

» E-taxis

Measure

» Actual numbers/estimated numbers/ qualitative indicators

Data sources

» RTO, fleet operators, fleet operator untions

Number of EVs in the city:

Parameters

» Personal vehicles » E-cars » LCVs
» E-2-wheelers » E-bicycles

Measure

» Actual numbers/estimated numbers/ qualitative indicators

Data sources

» RTO, fleet operators, fleet operator untions

Number of electric fleet operators:

Parameters

» Buses » Mini buses » Standard

Measure

» Actual numbers/estimated numbers/ qualitative indicators

Data sources

» RTO, fleet operators, fleet operator untions

Number of electric fleet operators:

Parameters

» Rail

Measure

» Actual numbers/estimated numbers/ qualitative indicators

Data sources

» RTO, fleet operators, fleet operator untions

Number of electric fleet operators:

Parameters

» IPT » E-autorickshaw » E-rickshaw » E-taxis

Measure

» Actual numbers/estimated numbers/ qualitative indicators

Data sources

» RTO, fleet operators, fleet operator untions

Electric PKM:

Parameters

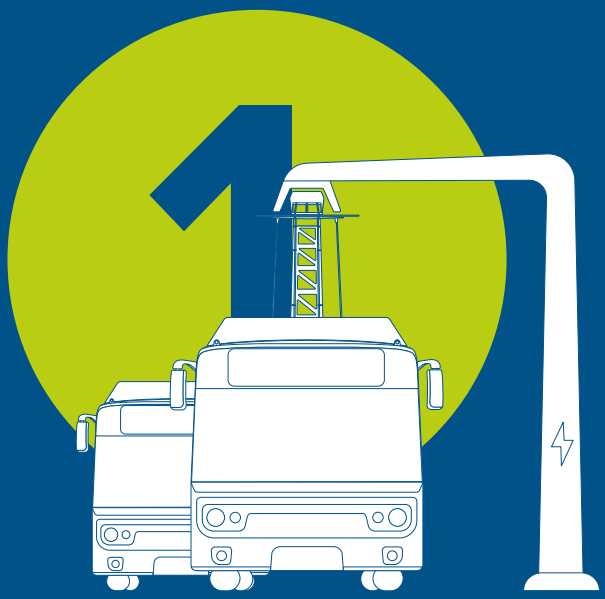
» Buses » Mini buses » Standard

Measure

» Actual numbers/estimated numbers

Data sources

» RTO, fleet operators, fleet operator unions



Electric PKM:

Parameters

» Rail

Measure

» Actual numbers/estimated numbers

Data sources

» RTO, fleet operators, fleet operator unions

Electric PKM:

Parameters

» IPT » E-autorickshaw » E-rickshaw

Measure

» Actual numbers/estimated numbers

Data sources

» RTO, fleet operators, fleet operator unions

Electric PKM:

Parameters

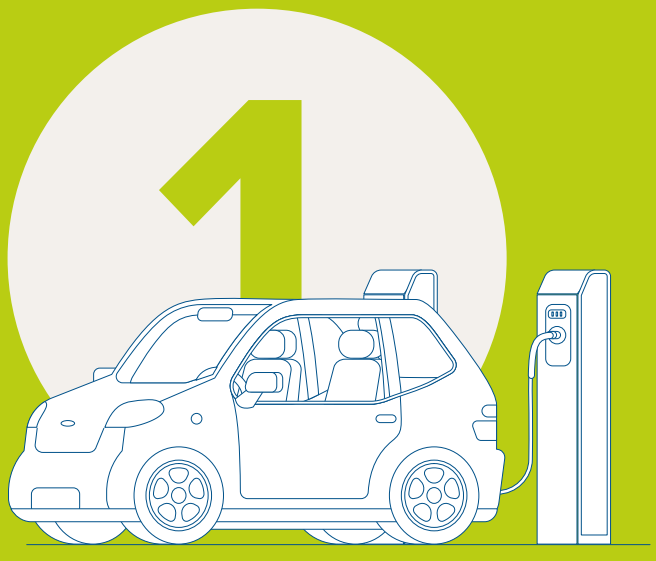
» Personal vehicles » E-cars » LCVs
» E-2-wheelers » E-bicycles

Measure

» Actual numbers/estimated numbers

Data sources

» RTO, fleet operators, fleet operator unions



Number of public EV charging points in the city:

Parameters

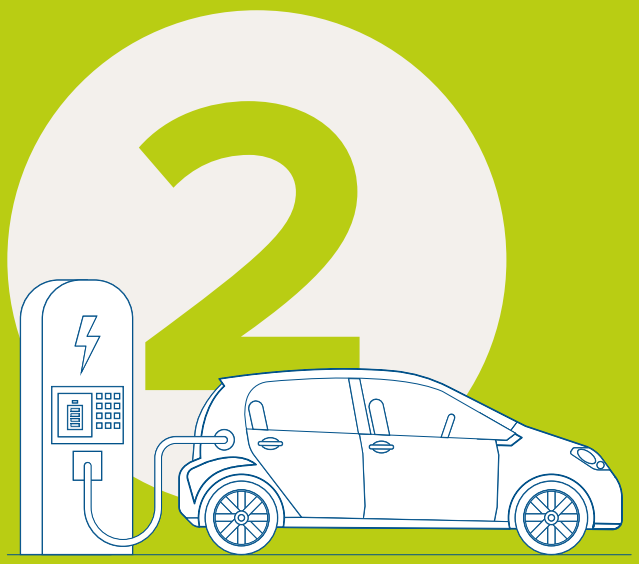
» Level 1

Measure

» Number and location

Data sources

» DISCOM



Number of public EV charging points in the city:

Parameters

» Level 2

Measure

» Number and location

Data sources

» DISCOM

Number of public EV charging points in the city:

Parameters

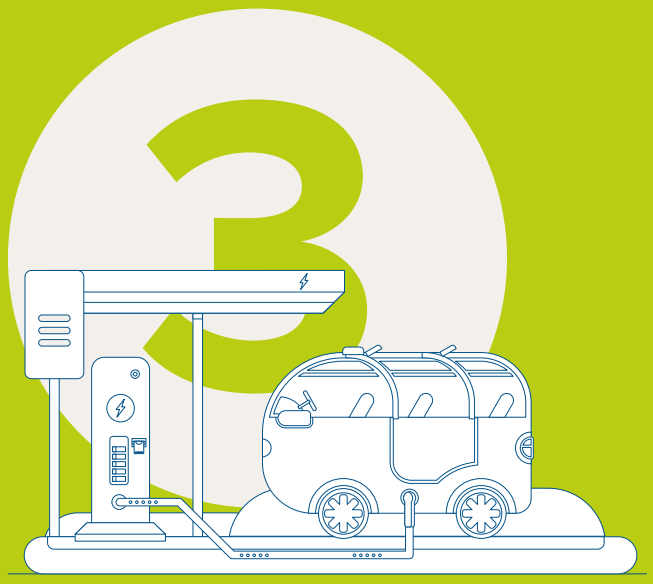
» Level 3

Measure

» Number and location

Data sources

» DISCOM



Investment made on promoting EVs:

Parameters

» Investment on deploying charging infrastructure

» Purchase of EVs

» Deploying monitoring infrastructure such as CCTCs, sensors, etc.

Measure

» Investment made

Data sources

» Municipal body, urban development agency, Department of Transport, Department of Finance, traffic police department

Air quality level:

Parameters

» PM, NO_2, SO_2 levels

Measure

» Air quality levels

Data sources

» Pollution Control Board, Department of Environment

Recognition for e-mobility initiatives:

Parameters

» National

Measure

» Describe

Data sources

» Municipal body, Urban Development Agency, Department of Transportation, Department of Environment, fleet operators

Recognition for e-mobility initiatives:

Parameters

» International

Measure

» Describe

Data sources

» Municipal body, Urban Development Agency, Department of Transportation, Department of Environment, fleet operators

10.0 Way forward

This document provides city managers with an understanding of the electric mobility eco-system, including information on different types of EV technologies, charging infrastructure and the EV landscape globally and in India. The next document in this series will be a guidebook to help cities implement electric mobility. The document will specifically help the city managers with the following:

» Assessing the current status of cities in terms of EV uptake

» Drawing an institutional framework for planning and implementing e-mobility in cities

» Identifying measures and strategies through which cities will be able to approach/promote electrification in transportation sector

» Suggesting how cities can implement the identified measures and strategies

11.0 Resources

Government policy documents and notifications

Ministry of Heavy Industries and Public Enterprises

» Government policies
https://emobility.araiindia.com/government-policies/
  » NEMMP

» Standards
https://emobility.araiindia.com/standards/
  » EVs
  » HEVs
  » Retrofitment standards
  » Traction Battery
  » Charger standard
  » Standard for Pilot Project
  » Standardization of protocol for charging infrastructure
  https://dhi.nic.in/writereaddata/UploadFile/Standardization%20of%20protocol.pdf

» Notifications
https://emobility.araiindia.com/notifications/
  » E-rickshaws
  » EVs
  » HEVs
  » Electric 2-Wheeler Exemption Category (power less than 250W)

» FAME scheme and related notifications
https://fame-india.gov.in/index.aspx

» Link to DST Technology Platform for Electric Mobility (TPEM)
https://dhi.nic.in/UserView/index?mid=2428

Ministry of Power

» Clarification on charging infrastructure for electric vehicles
https://powermin.nic.in/sites/default/files/webform/notices/Clarification_on_charging_infrastructure_for_Electric_Vehicles_with_reference_to_the_provisions_of_the_Electrcity_Act_2003.pdf

» National Automotive Board Portal providing status of FAME scheme and its impact
https://fame-india.gov.in/index.aspx

Documents providing policy direction

» SIAM White paper, 2017
The Indian automotive industry released a white paper proposing a pathway towards all new vehicle sales being all electric by 2047 and 100% of intra-city public transport as all electric by 2030
http://www.siam.in/uploads/filemanager/114SIAMWhitePaperonElectricVehicles.pdf


6c

» Vision document by NITI Aayog & RMI –'India leaps Ahead' https://niti.gov.in/writereaddata/files/document_publication/RMI_India_Report_web.pdf

Interesting readings

Resources from IEA

» Global EV Outlook 2017 https://webstore.iea.org/global-ev-outlook-2017

» Global EV Outlook 2018 https://webstore.iea.org/global-ev-outlook-2018

» IEA tool: Electric vehicles - Tracking Clean Energy Progress https://www.iea.org/tcep/transport/evs/

» Other IEA resources available at https://www.iea.org/publications/freepublications/

Resources from Bloomberg New Energy Finance (BNEF)

» Electric vehicle outlook, 2018 https://about.bnef.com/electric-vehicle-outlook/

Resources from RMI

» Enabling the transition to electric mobility in INDIA, FICCI and RMI, 2017 http://ficci.in/spdocument/20975/RMI-Report-20-Nov.pdf

» Battery technology in India: Challenges and Potential (RMI, NITI aayog)

http://niti.gov.in/writereaddata/files/document_publication/India-Energy-Storage-Mission.pdf

» Potential of feebates (a market based policy for rebate and taxation) for Electric Vehicles in India (RMI, NITI Aayog).
http://niti.gov.in/writereaddata/files/document_publication/Valuing_Society_First_Feebates_Policy.pdf

» Transformative mobility solutions, RMI, NITI Aayog, 2017
http://niti.gov.in/writereaddata/files/document_publication/RMI_India_Report_web.pdf

Resources from India Smart Grid Forum (ISGF)

» Implementation plan for electrification of public transportation in Kolkata, October 2017
http://www.indiasmartgrid.org/reports/Report_Implementation%20Plan%20for%20Electrification%20of%20Public%20Transportation%20in%20Kolkata.pdf

» ISGF White Paper on Electric Vehicle Charging Stations Business Models for India
http://www.indiasmartgrid.org/reports/ISGF%20White%20Paper%20-%20EVSE%20Business%20Models%20for%20India.pdf

» ISGF White Paper- Electric Vehicles: A sustainable Solution to Air Pollution in Delhi
http://www.indiasmartgrid.org/reports/ISGF-Electric%20Vehicles%20for%20Delhi-%20Final.pdf

» Other ISGF resources available at http://www.indiasmartgrid.org/resourcecenter.php

Others

» Report on Zero Emission Vehicles (Zevs): Towards A Policy Framework, Niti Aayog and World Energy
Council, 2018
https://niti.gov.in/writereaddata/files/document_publication/EV_report.pdf

» Report on Electric Mobility Paradigm Shift: Capturing the opportunities, TERI and Yes Bank, 2018
https://invest-india-revamp-static-files.s3.ap-south-1.amazonaws.com/s3fs-public/Electric%20Mobility%20Paradigm%20Shift_0.pdf

» Report on Electrifying India: building blocks for a sustainable EV ecosystem, E&Y and ASSOCHAM, 2018
https://www.ey.com/Publication/vwLUAssets/ey-electrifying-india-building-blocks-for-a-sustainable-evecosystem/$FILE/ey-electrifying-india-building-blocks-for-a-sustainable-ev-ecosystem.pdf

» Electric Buses in India: Technology, Policy and Benefits, CSTEP and GGGI, 2016
http://www.cstep.in/uploads/default/files/publications/stuff/CSTEP_Electric_Buses_in_India_Report_2016.pdf

» Report on Using vehicle taxation policy to lower transport emissions: An overview for passenger cars in Europe, 2017
https://www.theicct.org/publications/using-vehicle-taxation-policy-lower-transport-emissions

» Information note on the role of trade policy in enabling the global diffusion of electric vehicles, 2018 https://www.ictsd.org/sites/default/files/research/climate_and_energy_-_the_role_of_trade_policy_in_enabling_the_global_diffusion_of_electric_vehicles_final.pdf

Online learning

» Certificate course on Electric vehicles by DIYguru. DIYguru is a skill partner for NITI Aayog Electric Vehicle Mobility Vision 2030. It offers a 30-day Electric Vehicle Certification Course: www.diyguru.org/course/electric-vehicle/

» Coursera offers an online course on the basics of electric mobility instructed by researchers from École des Ponts ParisTech, with a focus on evaluation, analysis and implementation of electric vehicles: www.coursera.org/learn/electric-vehicles-mobility

Additional resources to learn more about electric mobility in cities:

» Clean Vehicles—electric vehicles for cleaner cities; EU-SOLUTIONS Project Online course: https://www.mobility-academy.eu/mod/scorm/view.php?id=1005

» Electric Vehicles and Mobility; Groupe Renault and ParisTech schools Online

course: https://www.mooc-list.com/course/electric-vehicles-and-mobility-coursera

» Charging infrastructure for electric vehicles: What kind? Where? How?; EU-TIDE Project Online course: https://www.mobility-academy.eu/course/view.php?id=12

» Electric Cars: Introduction' Delft University of Technology Online course: https://www.edx.org/course/electric-cars-introduction-0

» Electric Cars: Policy, Delft University of Technology Online course: https://www.mooc-list.com/course/electric-cars-policy-edx

» Electric Cars: Technology, Business, and Policy; Delft University of Technology Online course: https://scholarship-positions.com/blog/free-online-course-electric-cars-technology-business-policy/201709/

» Accelerating Worldwide Plug-in Electric Vehicle Market Development: 5 Policy Interventions; Meeting of the Minds, UC Davis

Webinar: www.meetingoftheminds.org/cal/accelerating-worldwide-plug-in-electric-vehicle-market-development-5-policy-interventions

» Electric Mobility and Development: An Engagement Paper from the World Bank and the International Association of Pub-

lic Transport; The World Bank Report: http://documents.worldbank.org/curated/en/193791543856434540

» Electric Vehicle Capitals of the World; ICCT Report: https://www.theicct.org/publications/EV-capitals-of-the-world-2017

» Electric Vehicles for Smarter Cities: The Future of Energy and Mobility; World Economic ForumReport: http://www3.weforum.org/docs/WEF_2018_%20Electric_For_Smarter_Cities.pdf

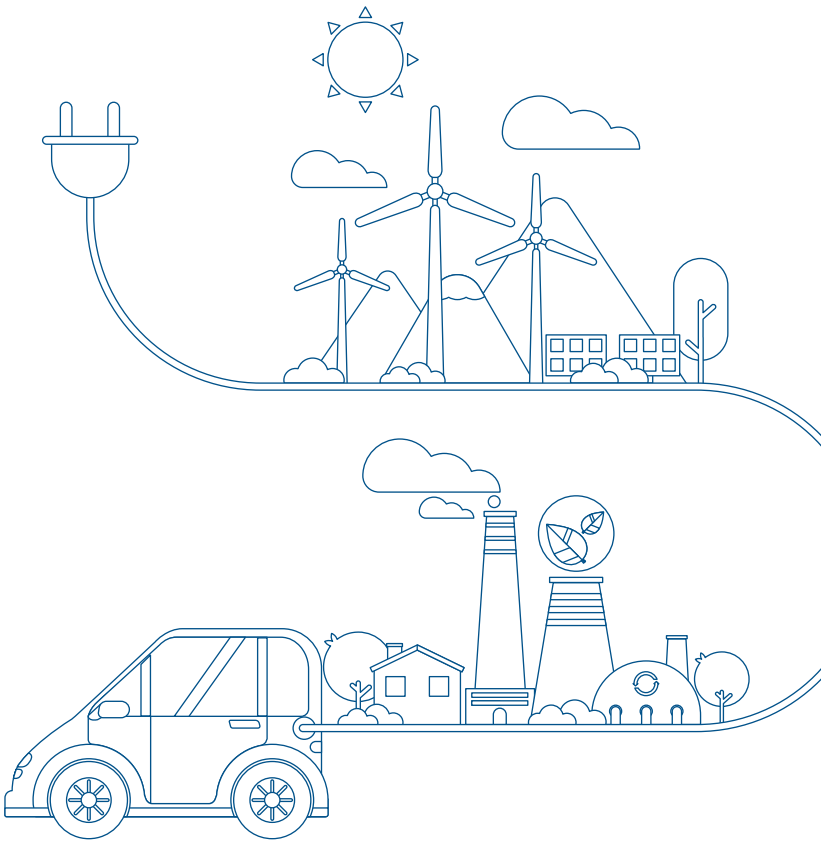
» Enabling Adoption of Electric Mobility in Public Transportation in India; Global Green Growth Institute Case study: http://www.greengrowthknowledge.org/case-studies/enabling-adoption-electric-mobility-public-transportation-india

» The future(s) of mobility: How cities can benefit; McKinsey & Company Article: https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-futures-of-mobility-how-cities-can-benefit

» Leaders in Urban Transport Planning Program; The World Bank Workshop series: http://www.worldbank.org/en/topic/transport/brief/leaders-in-urban-transport-planning

» Powering the Future of Urban Mobility; Siemens Report and tools for cities to forecast infrastructure needs with increased EV adoption: www.w3.siemens.com/topics/global/en/intelligent-infrastructure/Pages/future-urban-mobility.aspx

» Principles for Effective Electric Vehicle Design; ICCT Report: https://www.theicct.org/publications/principles-effective-electric-vehicle-incentive-design



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2. www.cars.kkleads.com/announcements/hybridphevhevbevwhatdoesitallmean

3. Note: FCEVs are not going to be the focus of discussion in this document

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5. www.forbes.com/sites/capitalone/2018/10/24/wholesome-halloween-treats-for-healthy-goblins/#36a58de0b2b5

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12. NEMMP 2020; 2.3, IEA, 2018 CSTEP, 2016, Report on Electric buses in India: www.giz-bot.com/news/electric-vehicles-will-soon-help-india-do-away-from-fossil-fuels-053746.html

13. www.financialexpress.com/auto/car-news/mahindra-e-verito-and-e2o-to-be-part-of-ubers-fleet-in-two-major-cities/945850/

14. www.slocat.net/sites/default/files/e-mobility_overview.pdf

15. www.intelligenttransport.com/transport-articles/67395/electric-buses-fully-electric-fleet-india/

16. www.energysage.com/electric-vehicles/advantages-of-evs/evs-environmental-impact/

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