INDIA EV DIGEST 2023

GOVERNMENT OF INDIA
MINISTRY OF POWER

GO ELECTRIC

Contents

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Abbreviations

2W	Two-wheeler
3W	Three-wheeler
4W	Four-Wheeler
AC	Alternate Current
ACC	Advance Chemistry Cell
ACoS	Average Cost of Supply
AFST	Alternate Fuels for Surface Transportation
AQI	Air Quality Index
BEE	Bureau of Energy Efficiency
BESCOM	Bangalore Electricity Supply Company Limited
BEV	Battery Electric Vehicles
BIS	Bureau of Indian Standards
BPC	Battery Power Centre
BPCL	Bharat Petroleum Corporation Limited
BSS	Battery Swapping Stations
CAGR	Compound Annual Growth Rate
CCS	Combined Charging System
CEA	Central Electricity Authority
CESL	Convergence Energy Services Limited
CG	Charging guns
CHAdeMO	Charge de Move
CMVR	Central Motor Vehicle Rules
CNA	Central Nodal Agency
CNG	Compressed Natural Gas
COP26	Conference of the Parties, 26th summit, the 2021 UN climate change conference
CPCB	Central Pollution Control Board
DC	Direct Current
DCS	Depot Charging station
DEVC	Dynamic Electric Vehicle Charging
DHI	Department of Heavy Industry
DISCOM	Distribution Companies (Electricity)
DTL	Delhi Transco Limited
e-2W	Electric two-wheeler
e-3W	Electric three-wheeler
e-4W	Electric four-wheeler
e-Bus	Electric Bus
EESL	Energy Efficiency Services Limited
EOI	Expression of Interest
EV	Electric Vehicle
EVCI	Electric Vehicle Charging Infrastructure
EVSE	Electric Vehicle Supply Equipment
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicle
FC	Fast Charger
FCEV	Fuel Cell Electric Vehicle
FY	Financial Year
GHG	Green House Gas
GNCTD	Government of National Capital Territory of Delhi
GoI	Government of India
GST	Goods and Services Tax
GW	Gigawatt
GWh	Gigawatt hours
HEV	Hybrid Electric Vehicle
HPCL	Hindustan Petroleum Corporation Limited
HT	High Tension
ICE	Internal Combustion Engine
IEA	International Energy Agency

IEC	Information, Education and Communication
IESA	India energy storage association
IOCL	Indian Oil Corporation Limited
KSEB	Kerala State Electricity Board
KW	Kilowatt
KWh	Kilowatt Hour
LT	Low Tension
MC	Municipal Corporation
MoEFCC	Ministry of Environment, Forest and Climate Change
MoF	Ministry of Finance
MoHUA	Ministry of Housing and Urban Affairs
MoP	Ministry of Power
MoRTH	Ministry of Road Transport & Highways
MoUD	Ministry of Urban Development
MSEDCL	Maharashtra State Electricity Distribution Co Ltd
MSME	Micro Small & Medium Enterprises
MT	Metric ton
$MtCO_2$	Million Tons of Carbon dioxide
MW	Megawatt
MWh	Megawatt hours
NABL	National Accreditation Board for Testing and Calibration Laboratories
NCR	National Capital Region
NH	National Highway
NTPC	National Thermal Power Corporation
OCPI	Open Charge Point Interface
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
PCI	Public Charging Infrastructure
PCS	Public Charging Station
PHEV	Plug-in Hybrid Electric Vehicle
PLI	Production Link Incentive
PSU	Public Sector Undertaking
PV	Passenger Vehicle
REIL	Rajasthan Electronics and Instruments Limited
RO	Retail Outlets
SC	Slow Charger
SDA	State Designated Agency
SDG	Sustainable Development Goals
SERC	State Electricity Regulatory Commission
SH	State Highway
SNA	State Nodal Agency
SUV	Sports Utility Vehicle
TCO	Total Cost of Ownership
UNFCCC	United Nations Framework Convention on Climate Change
UT	Union Territory
V2G	Vehicle to Grid
V2H	Vehicle to Home
V2X	Vehicle to Everything
WSA	Way side Amenities
xEV	Any Electric Vehicle and their extended variants

आर. के. सिंह
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विद्युत मंत्री एवं
नवीन और नवीकरणीय ऊर्जा मंत्री
भारत सरकार
Minister of Power and
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Government of India

MESSAGE

India has emerged as a global leader in energy transition and climate change mitigation. The country has evolved effective strategies to reduce the emissions intensity of its GDP. The rapidly increasing electrification of the economy is one such strategy being pursued by the Government. The Ministry of Power has launched the 'Go Electric' campaign which is a key endeavour in switching over to electric mobility in the road transport sector to promote clean, efficient, and sustainable transportation.

I am happy to note that the Bureau of Energy Efficiency is launching the inaugural edition of this annual publication titled "India EV Digest 2023", which is a compilation of information on all activities to promote e-mobility by all stakeholders, including central and state agencies. I am confident that this compilation will be useful to all EV users and those concerned with its faster adoption in India.

I wish the Bureau of Energy Efficiency success in their efforts to promote energy transition in the key sectors of the Indian economy.

(R. K. Singh)

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FOREWARD

As part of global efforts on climate mitigation, the Energy Sector assumes significance due to its share of 75% emissions in the world. The Road Transport Sector accounts for 9% of India's GHG emission and is the only sector which has registered more than 100% growth since 2005. The GHG mitigation measures in the Road Transport Sector include fuel efficiency standards, modal shift to Rail or Shipping mode and switch to Electric Mobility.

The Government of India has launched many initiatives to promote electric mobility in the country such as FAME (Faster Adoption and Manufacturing of Electric Vehicles) Scheme, PLI Scheme for auto components etc.

Ministry of Power is mandated for developing EV Charging infrastructure in the country and "Guidelines and Standards for EV Charging" were issued by the ministry in December, 2018. These guidelines have enabled basic framework to develop widespread EV public charging stations in different cities Pan India. As per the guidelines, Bureau of Energy Efficiency (BEE) is designated as Central Nodal Agency (CNA) to be supported by State Nodal Agencies (SNAs). BEE has also developed "EV Yatra Web Portal" to disseminate information regarding availability of public charging stations across the country. As we complete 5 years, it is worthwhile to review the progress made as regard to adoption of E-Mobility by different stakeholders.

I am happy to note that BEE has compiled the data in respect of various initiatives taken by Central / State Agencies and other organisations, that clearly indicate satisfactory growth in the adoption of electric vehicles. I am also confident that this inaugural edition of **"EV Digest"** will provide sufficient data for the policymakers to formulate effective policies in coming years.

I would like to express my gratitude to the officers from Bureau of Energy Efficiency for their efforts in promoting e-Mobility in India.

(Pankaj Agarwal)

अभय बाकरे, आईआरएसईई
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(Ministry of Power, Government of India)

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful compilation of this comprehensive report titled 'India EV Digest 2023' providing an insight information on the progress of electric mobility adoption in India.

I would like to acknowledge with profound thanks, the support of **Shri R K Singh, (Hon'ble Union Minister of Power and New & Renewable Energy, Government of India)** for his leadership and guidance in preparation of this report. I would also like to offer my gratitude to **Shri Pankaj Agarwal Secretary, Ministry of Power, Government of India and Shri Ajay Tewari, Additional Secretary** for their focused & invaluable contributions to this report.

Special thanks to the team of **Shri Sameer Pandita, Director, BEE, Shri Rahul Juyal, Sector Expert, E-mobility, BEE and Ms.Tripati Sharma, BEE, Shri Vishwabandhoo Gupta, Shri Devesh Kumar, Shri Rahul Goyal and Ms.S Vidya Lakshmi, PMU, BEE** for their unstinted efforts in coordinating with various state agencies and analysis carried out to prepare state level progress indicators.

I would like to place on record my appreciation for the contributions made by State Nodal Agencies (SNA) and State Designated Agencies (SDA) for their timely contributions and validation of relevant data in preparation of this report. Their constructive inputs and suggestions have greatly improved the overall content with clarity. The collaborative efforts among stakeholders has played a crucial role in shaping up this inaugural addition of the "India EV Digest 2023" which is intended to be an Annual Publication hereon.

I sincerely hope that this report would be able to help EV professionals & Policy makers in identifying areas, learn from peers and accelerate efforts to enhance EV adoption in India in future.

(Abhay Bakre)

Preface

The Inaugural edition of "India EV Digest 2023"is a compilation of various initiatives taken by the Central &State governments to accelerate e-mobility adoption in India. Through this report, an attempt has been made to reflect the progress of EV adoption across the country through efforts made by Central & State governments in making State EV Ready. Assessment of the state level progress is based on various e-mobility related indicators. The report presents current Indian EV market scenario, EV Charging infrastructure specifications, Central and State government initiatives to promote e-mobility, Electricity tariff related promotional provisions introduced by various states, estimates on segment wise EVs expected to join the road transport stock by year 2030 and associated Public charging infrastructure requirement, technology advancements expected and impact on Grid by 2030.

The Report affirms commitment of Ministry of Power to support EV adoption through collaborative efforts of all stakeholders in e-mobility space to ensure energy transition in Indian Road Transport Sector in a sustainable manner.

I place on record my appreciation for e-mobility team at (BEE) which have put in concerted efforts to make this inaugural edition of "India EV Digest 2023" possible &hope the report will be of interest to state agencies and other stakeholders in the Indian e-mobility space.

I sincerely hope that this report would be able to help EV professionals & Policy makers in identifying areas, learn from peers and accelerate efforts to enhance EV adoption in India in future.

Executive Summary

India is currently the world's third largest automotive market and the largest manufacturer of two-wheelers, with over 21 million vehicles produced annually[1]. Indian automotive sector is embracing the paradigm shift in road transport sector with introduction of Electric Vehicle (EV) in the market. The Government of India has taken several concrete steps to support this transition. The flagship scheme, Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME), with Phase I launched in 2015, followed by ongoing Phase II launched in 2019 has provided substantial momentum to EV sales across the country. State governments have made notable contribution in announcing favourable policy & regulatory landscape, as a result 27 states have notified EV policies, focusing on fiscal incentives to fast-track sales, supporting manufacturing EVs and EV components and development of necessary infrastructure for sustenance of EV ecosystem. These combined efforts have resulted in strong EV sales number, ~1.2 million EVs units in the year 2023, a jump of 159% from 2022. The share of electric two wheelers (e-2W) in overall two wheelers' sales in the current year (2023) is around 5%, while the share of electric three wheelers (e-3W) in overall three wheelers' sales has exceeded 50%.

Moreover, the EV market is expected to grow at a CAGR of 49% from 2022-2030, with major contribution from e-2W and e-3W segment. The reduction in upfront costs, uptake both personal and commercial mobility segments, increased awareness about benefits, continued central and state level subsidies are the factors for higher EV sales in e-2W and e-3W segments.

However, the share of EVs in total vehicle sales (as of mid Nov 2023), is below 1%[2]. Thus, the country needs to spruce up the EV adoption, to remain aligned with its target of achieving 30% share of EVs in overall vehicle sales by year 2030.

Recently, the Government of India has taken various progressive steps to accelerate EV adoption, as a result of which country has witnessed growing EV demand, with CAGR of around 50% in last five years. Considering the EV sales penetration targets set by NITI Aayog which include 30% of private cars, 70% of commercial cars, 70% of buses and 100% of two and three- wheelers by 2030, it is expected that there will be ~9 crore EVs on Indian roads by 2030, resulting in reduction of around 28.0 million metric tonnes of carbon emission. Moreover, to support these EVs, around 4.44 lakhs public EV chargers would be required by year 2030. Currently, there are 10,000+ public EV charging stations operational across the country. Supportive policies, technological advancements, falling battery prices, robust public charging infrastructure and supply chain localization are some of the key factors that will come together to power growth of EVs, while ensuring solutions customized for the Indian markets are adopted.

Identifying safe, affordable and, reliable public charging deployment at scale as one of the key bottlenecks in large scale EV adoption, Ministry of Power (MoP), Government of India issued guidelines & standards for public EV charging infrastructure. The issuance of Revised Charging Infrastructure Guidelines & Standards on January 14, 2022 has been a corner stone in the Indian public EV charging paradigm and has brought role of public EV charging to the centre stage of ongoing discourse in the country. In conjunction with MoP guidelines, several

[1] Invest India
[2] VAHAN

state DISCOMs have provided preferential 'EV supply tariff' and have waived off the fixed demand charges to make public EV charging a viable business proposition.

State Government play a pivotal role in creating impact through effective implementation of policies or programmes conducive for adoption of e-mobility in states. Considering the significant number of EVs expected by year 2030 on roads, assessing states based on various provision in respective state EV policy, regulatory and implementation related criteria is critical as it unveils their preparedness towards EV adoption based on as-is scenario and enables them to develop future roadmap for accelerated EV adoption. BEE has examined implementation status of e-mobility programmes at state level, based on 15 criteria. These criteria encompass provisions in the state EV policies, tariff related provisions in state tariff orders, deployment of public EV charging infrastructure, e-mobility awareness activities, as well as promotion of e-mobility in public transportation segment.

Report presents current e-mobility policy & regulatory regime at National and sub-national level, market trends across the e-mobility ecosystem and recommends a way forward for states such as more aggressive role for state nodal agencies such as creation of EV Accelerator Cells to serve as single window entity for coordination & implementation of e-mobility programmes in respective states, creating awareness, managing demand and supply side incentives for e-mobility adoption in accordance with state EV policies, coordinating with state DISCOMs, monitoring timely grant of connection to PCS, etc.

Continued commitment and coordination between the central and state governments and the industry, a self-sustaining EV ecosystem can be developed by bringing technology and incentives together. The current decade seems promising for the adoption of e-mobility in India, with conducive government policies and coordinated implementation of Central and state policies to create adequate number of public EV charging infrastructure across the country.

1. Introduction

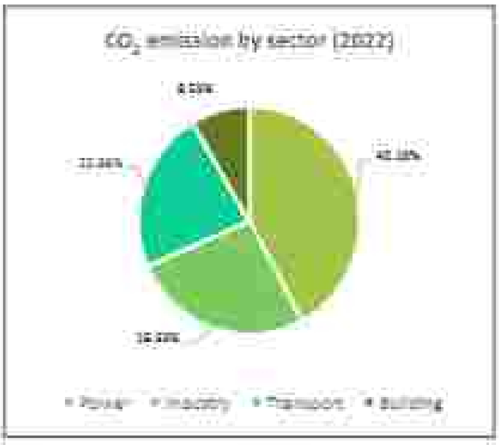
Transport sector plays a pivotal role in the development of economies globally. The role of the transport sector in sustainable development was recognized in 1992 at the United Nations Earth Summit. Since then, sustainable transport has continued to gather attention worldwide as it has led to rapid economic growth and improved environmental resilience.

Global GHG emission from the transport sector grew 1.7% annually between 1990 and 2022, which is equivalent to the emissions from industrial sector during the same period. In the year 2022, global emissions from the transport sector alone grew by 3% compared to that in year 2021[3]. With the rise in urban population and deteriorating local Air Quality Index (AQI) levels, the acceptance of zero-emission mobility modes emerged as an important factor for limiting vehicular emissions.

In the 2030 Agenda for Sustainable Development, sustainable transport is directly linked with Sustainable Development Goal (SDG) 11.2 which includes access to safe, affordable, accessible, and sustainable transport systems for all and expanding public transport. The importance of the transport sector has also been recognised by the United Nations Framework Convention on Climate Change (UNFCCC), as one of the key pillars in achieving the Paris Agreement target. Thus, there is an urgent need to reduce GHG emission from the transport sector.

"Sustainable transport is the provision of services and infrastructure for the mobility of people and goods— advancing economic and social development to benefit todays and future generations—in a manner that is safe, affordable, accessible, efficient, and resilient, while minimizing carbon and other emissions and environmental impacts".

Globally, the transport sector accounts for nearly 25% of total energy consumption and approximately 23% of global CO_2 emissions. In terms of emission from the transport sector, road transport accounts for the highest share, of around 74%. Between 2010 and 2019, emissions from the road transport sector witnessed the highest growth compared to other end-use sectors[4].



Graph 1: CO_2 emission by different sectors

At 26th Conference of the Parties (COP26) held in Glasgow, India committed to contribute towards sustainable development with an ambition to become a Net-Zero economy by the year 2070. In addition, Government of India (GoI) introduced five targets named ***Panchamrit*** at the COP26 Summit [5].

[3] IEA
[4] [illegible]
[5] MEA

Figure 7: Panchamrit of India's Climate action

India being one of the fastest growing economies has several environmental challenges to overcome. Road transport accounts for 12% of India's energy related CO_2 emissions and is a key contributor to air pollution in urban areas[5]. With increasing demand for private mobility and goods transport, energy use and CO_2 emissions could double by the year 2050.

Rise in urban population with subsequent surge in motorisation rates have led to an increase in road transport related energy demand and associated CO_2 emission. In year 2021, road transport sector consumed 14% of total final energy consumption. Further, road transport makes up for 92% of all transport-related energy demand and 94% of transport-related CO_2 emissions, with domestic aviation, rail, and domestic shipping contributing the rest[6]. Therefore, setting a specific goal for decarbonization of India's road transport sector is paramount to meet overall nationally determined contribution (NDC) targets. Further, decarbonizing road transport would provide multiple benefits such as cleaner air and energy security, reduced dependence on imported fossil fuel.

India is aspiring to achieve 30% share of EVs in total vehicle sales by year 2030, and with only 7 years remaining, close coordination is essential between relevant stakeholders in the Indian EV ecosystem. EV adoption in India is still in its nascency, accounting for around 0.80% in total vehicle sales till mid-2023 (VAHAN).

> [illegible]

Currently, the Indian automobile industry relies heavily on vehicles powered by conventional fossil fuel, which has a significant impact on the environment. Also, the percentage of fossil fuel imports was 87.5% in April 2023, compared to 85.4% in April 2022[7]. According to the Census 2011, India's urban population increased from 286 million in 2001 to 377 million in

[5] IEA
[6] IEA
[7] [illegible]

2011. As of 2011, around 31% of India's population resided in urban areas. It is projected that by year 2030, 40% (600 million) of the population will migrate to urban areas and this figure will increase to 850 million by year 2050 which would be 50% of the total population in year 2050[9]. With the increase in urban population, the demand for passenger and commercial mobility will increase in the future contributing further to air pollution level in the urban areas. (India is ranked among top 10 polluted countries and the capital city, Delhi is ranked 2nd in terms of city level air pollution)[10].

To adopt a cleaner and more eco-friendly mode of transport, Government of India introduced several progressive policies to support the smooth transition to EVs. India has witnessed a rapid EV adoption with around 50% compounded annual growth over last 5 years. Some of the steps taken by the government to promote transport electrification are National Electric Mobility Mission Plan (NEMMP), Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme, reduction of Goods & Service Tax (GST) on EVs and its components, income tax exemption on interest payment for EV loans, Production Linked Incentive (PLI) scheme for promoting Make in India initiative in EV value chain. Additionally, delicensing of EV charging services, introduction of Guidelines & Standards for Public EV Charging Infrastructure which includes capping of public EV service charges, discounting supply tariff and service charges during solar hours, creating database for public charging infrastructure & inclusion of EV charging infrastructure in Model Building Bye-Laws to provide impetus to the Indian road transport electrification program.

These initiatives have led to significant growth of the Indian EV ecosystem across various EV segments, Charge Point Operators (CPOs), EVSE manufacturers etc. and has created numerous job opportunities.

EV adoption in India is a low-hanging fruit, considering that emissions from the transport sector are growing rapidly, with emissions from passenger and freight vehicles accounting for more than 92% of the overall emission from the transport sector in year 2020. Electric mobility can significantly reduce these emissions at the local and National levels especially when coupled with renewable energy, making the road transport sector emission free.

Achieving e-mobility targets requires developing a coordinated strategy between central and state administrators, supported by progressive policies & regulations and a concrete action plan for implementation. Additionally, state governments have to recognize the benefits of EV adoption and resolve to decarbonizing the transport sector in respective states. This report presents the initiatives taken at both the central and state levels to support and achieve India's aspirations for the electrification of the road transport sector.

1.1 Relevance of Report for e-mobility stakeholders

The EV ecosystem in India witnessed tremendous growth in recent years due to several policy and regulatory initiatives taken by the Central as well as State governments. As of October

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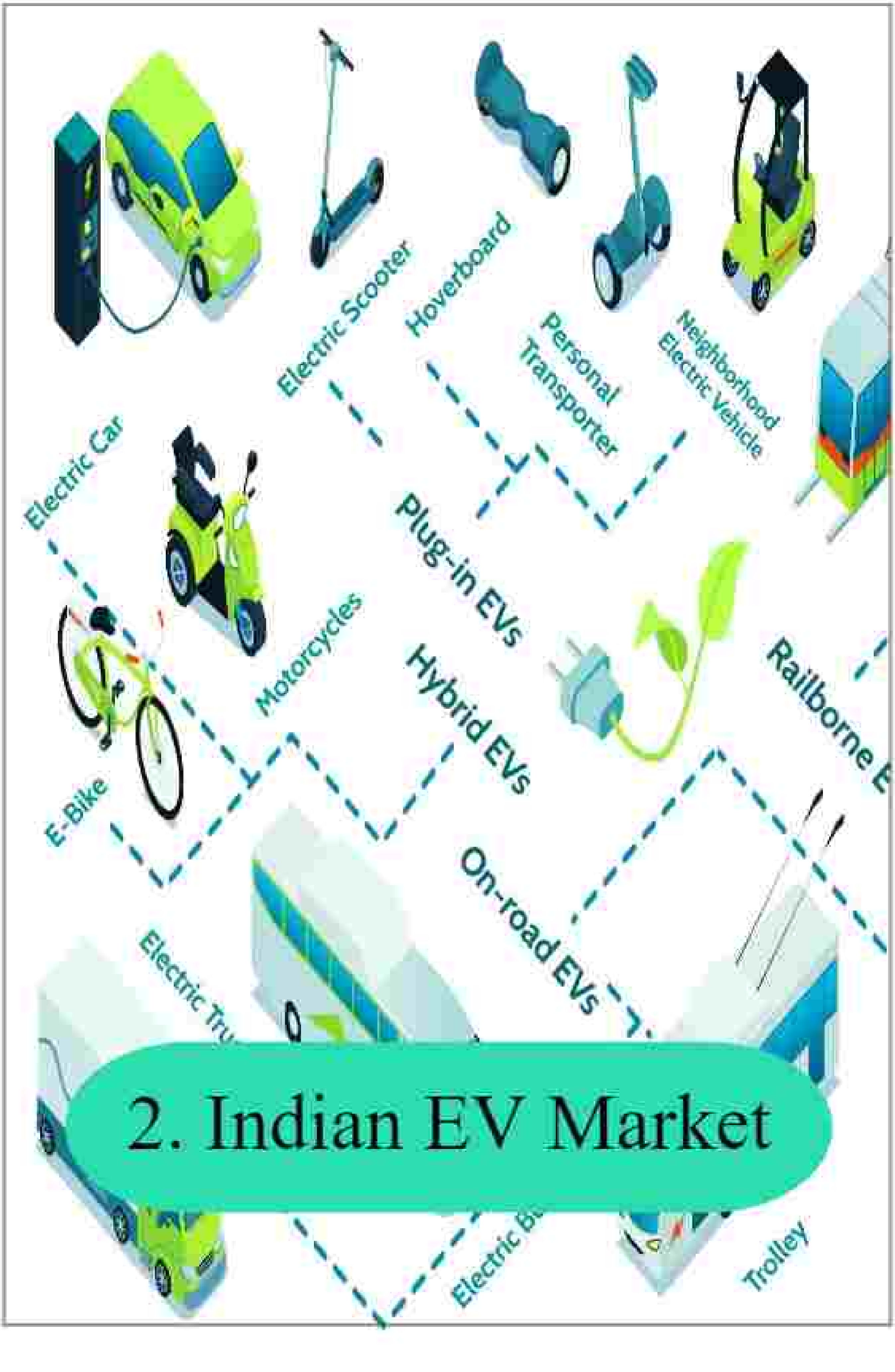
[9] MOUD 2018

[10] [illegible]

2023, 26 states have notified EV policies for promoting e-mobility through demand side upfront incentives and development of adequate charging infrastructure in addition to other benefits. Highlighting the implementation status of electric mobility programs across states and presenting the best practices adopted by states for faster EV adoption is important, considering 9 crore EVs plying across the country by the year 2030.

Making electric mobility a mainstream mode of transport would require dedicated policy initiatives across the country to decouple heavy dependence on fossil fuel and address the challenge of air pollution.



2. Indian EV Market

2. Indian EV Market

The Indian EV market is evolving rapidly with total electric vehicle registrations increasing from around 0.002 million (2,000) in FY 2014 to around 1.1 million in FY 2023[11]. EV registrations witnessed a decline during FY 2021 due to the onset of COVID-19. In private vehicles category, electric two-wheelers (e-2W) accounts for the majority of EV sales in India and in case of the commercial vehicles category, electric three-wheeler (e-3W) are being used extensively. Compared to e-2W and e-3W in India, the penetration of e-4W and e-buses is quite low due to the higher upfront cost of 4W segment compared to other vehicle segments and dependency on availability of adequate public charging infrastructure. The adoption of e-4W and e-buses is expected to grow in conjunction with the development of public and depot charging ecosystem in the country. Graph-2 depicts trend of EV registrations in India annually from FY 2014 to FY 2023.

Source: VAHAN Portal

Graph 2: Annual EV registration in India

As per the report from NITI Aayog, India aspires to achieve an EV sales penetration of 80% in the two and three-wheeler segment, 70% for all commercial cars, 30% for private cars, and 40% for buses by the year 2030. This is in line with India's target to achieve net zero carbon emission by year 2070.

According to the Ministry of Road Transport & Highway (MoRTH), around 1.76 million EVs were registered in India in the last three financial years. In FY 2023, EV sales were highest in the state of Uttar Pradesh, with the number of units sold across all vehicle segments totalling to 1,88,903, followed by Maharashtra with 1,58,626 units and Karnataka with 1,14,014 units. Uttar Pradesh also dominated the sales of the e-3W segment, while Karnataka and Maharashtra are leading the sales of the e-2W and e-4W segments, respectively. Graph-3 indicates cumulative EVs registered in the country (state-wise) by FY 2023.

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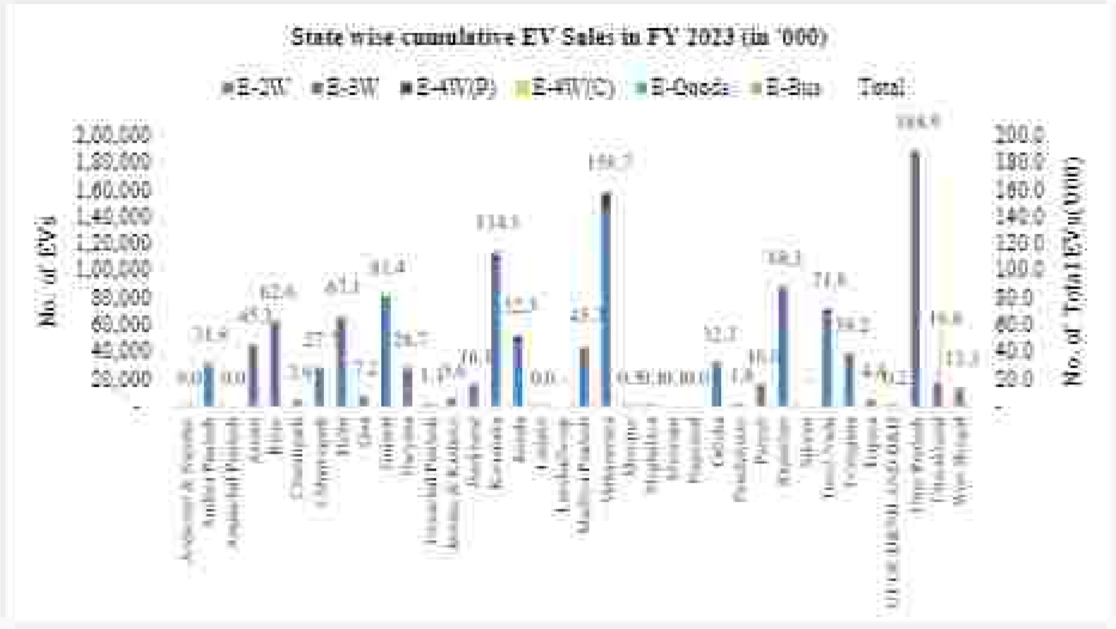
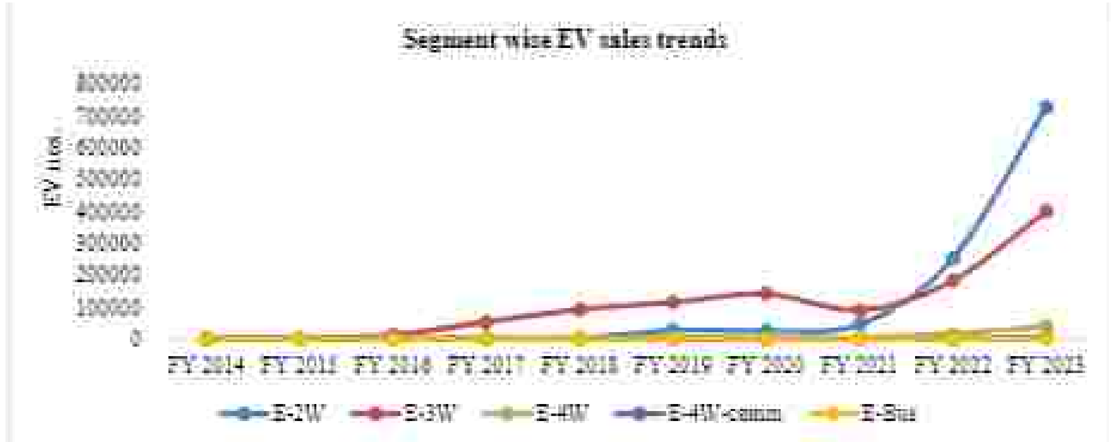
[11] *Source: Vahan Portal*



Graph 3: State wise cumulative EV sales till FY 2023



Graph 4: Vehicle segment wise EV sales trends till FY 2023

2.1 Market Share of EV manufacturers

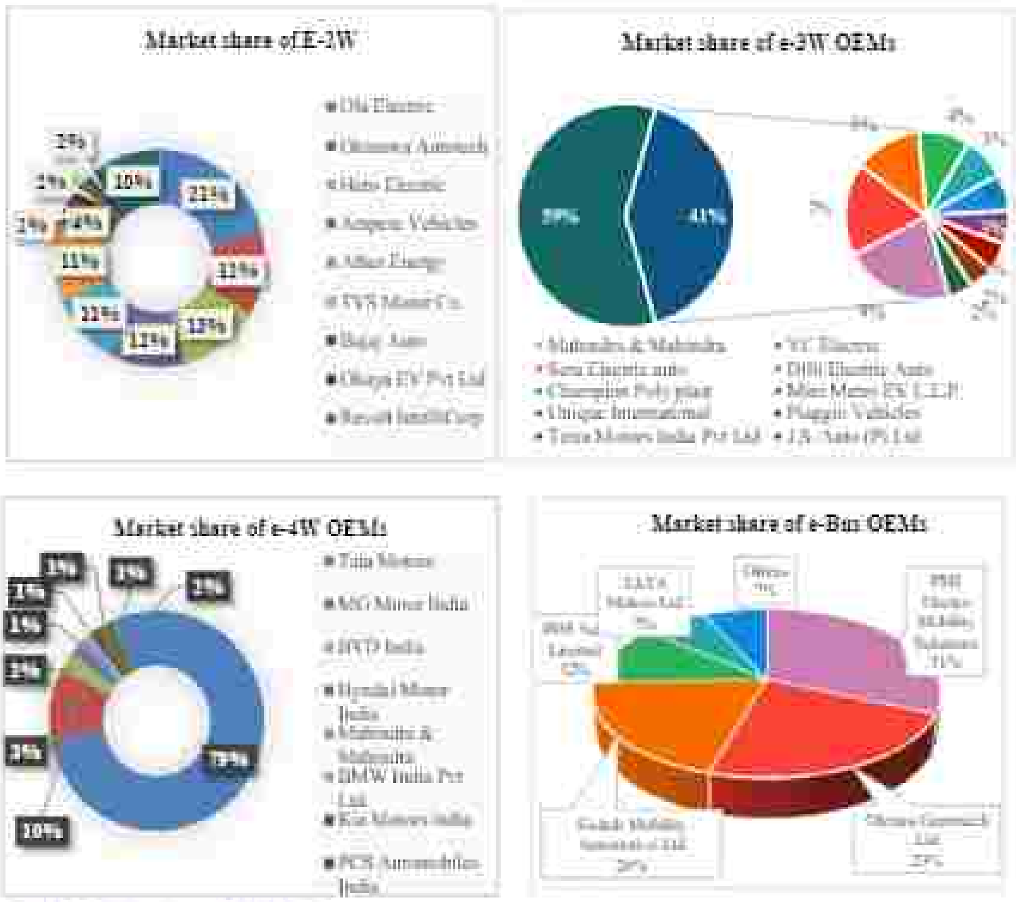
Indian EV market saw many new entrants such as, Okinawa, Greaves Electric Mobility, Ather Energy, Atul Auto, Jitendra New EV Tech, Altigreen, Euler, etc., along with auto manufacturing giants such as Hero MotoCorp, Mahindra & Mahindra, and Tata Motors. As EV adoption increases, several new models are expected to be introduced at competitive prices and with improved features. This section presents the EV market scenario in India including market share of EV OEMs along with models available in the market.

The segment that has witnessed the highest EV adoption is the two-wheeler segment. In the e-2W segment, Ola Electric, Hero Electric and Greaves Electric Mobility Pvt. Ltd (Ampere Vehicles) together account for 58% of market share in FY 2023. Ola Electric leads the e-2W market with around 21% share, followed by Hero Electric with around 12.6% market share.

The three-wheeler segment has also seen growth in FY 2023. In the e-3W passenger vehicle segment, Mahindra & Mahindra holds 9% of the market share and YC Electric Vehicle India holds the second position with a market share of 7%. More than 50% of market share is captured by small manufacturers.

In the e-4W segment, Tata Motors holds a commanding position with a market share of around 79% with two models Tata Tigor and Tata Nexon followed by MG Motor India which captures around 10.38% market share in India.

In the electric bus segment, PMI Electro Mobility System captures the highest market share of around 31.47%, followed by Olectra Greentech. Graph-5 indicates the market share in manufacturers of different EV segments.



Graph 5: Market share of EV OEMs

2.2 EV Models in India

In India, the EV market has expanded rapidly during the last three years, especially in the e-2W and e-3W vehicle segments. These segments commend maximum share in the Indian road transport sector due to their affordable price range as compared to other vehicle segments. Considering the price sensitive Indian automotive market, various EV manufacturers are planning to launch EVs with better features and at competitive prices. Currently, more than 400 EV models from 100+ manufacturers, across all vehicle segments are available in the Indian market. Popular vehicle models across different vehicle segments are as follows:

Table 1: EV models - segment wise

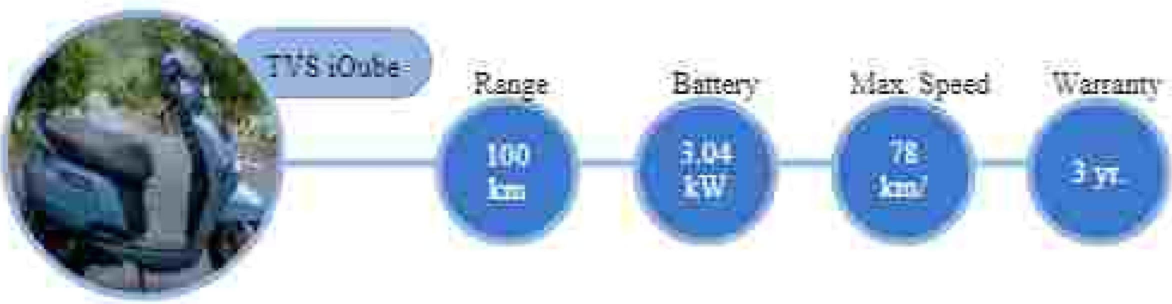
Vehicle Segment	Popular Models
e-2W	Ola S1, Ather 450X, TVS iQube Electric, and Bajaj Chetak
e-3W	Passenger Segments: Bajaj RE Electric, Piaggio Ape E-City Commercial Segment: Mahindra Treo Zor, Altigreen Neev
e-4W	Tata Nexon EV, MG ZS EV, and Hyundai Kona Electric

Electric Two Wheelers in India:

Currently, there are over 300 e-2W models are available in the Indian market, priced between Rs. 40,000 and Rs. 4,00,000[12], with the majority being offered by -Ola Electric, Okinawa, Ather Energy, TVS and Hero Electric.

Some of the best-selling e-2W models in India, are as follows:

Top e-2Ws in India:



[12] https://www.bikedekho.com/electric-bikes

Ola S1

Warranty	Max. Speed	Battery	Range
5 yr.	95 km/	2 kW	141 km

Simple One

Range	Battery	Max. Speed	Warranty
212 km	5 kW	105 km/	3 yr.

Bajaj Chetak

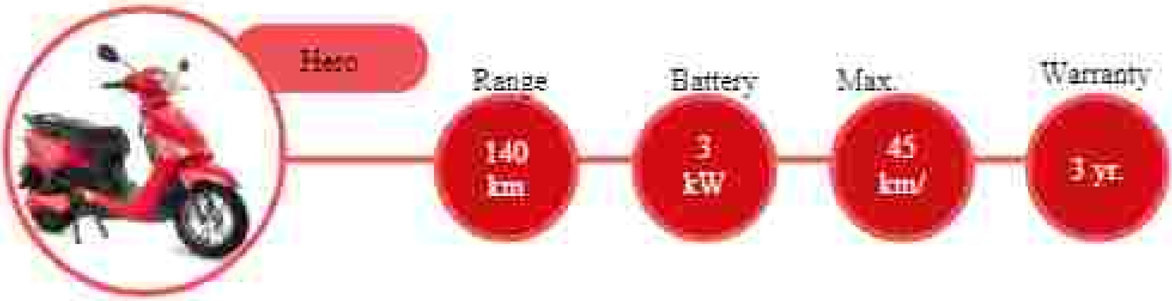
Warranty	Max. Speed	Battery	Range
3 yr.	63 km/	4.2 kW	108 km

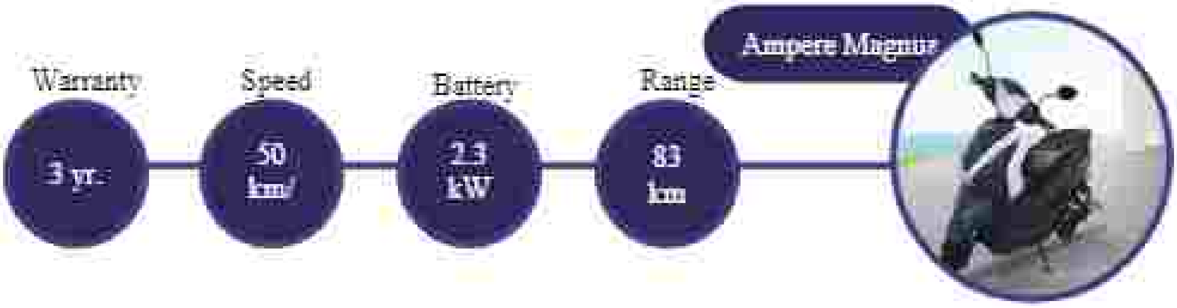
Vida V1

Range	Battery	Max. Speed	Warranty
110 km	3.94 kW	80 km/	3 yr.

Yulu Wynn

Warranty	Max. Speed	Battery	Range
1 yr.	25 km/	1 kW	68 km





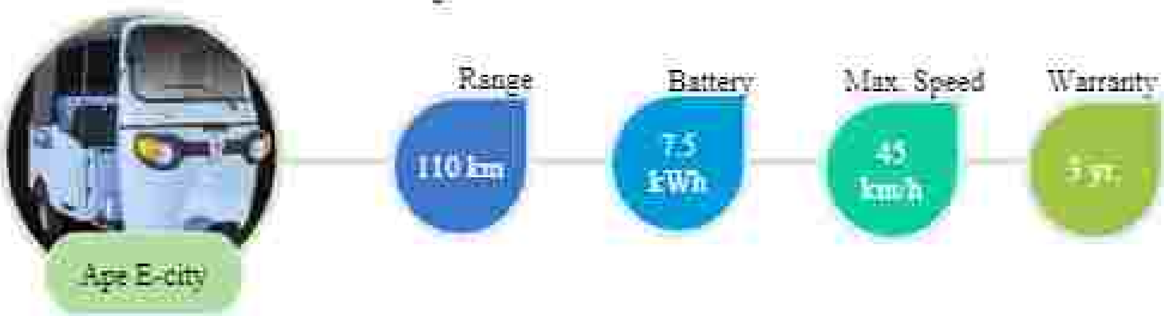
Electric Three Wheelers in India:

Three-wheelers are the most prominent mode of transportation for last mile connectivity in several states across the country. Accordingly, there are more than 170 e-3W models, including e-rickshaws and goods carriers, from 70+ manufacturers are available in the Indian market, priced between Rs. 70,000 and Rs. 4,50,000[11].

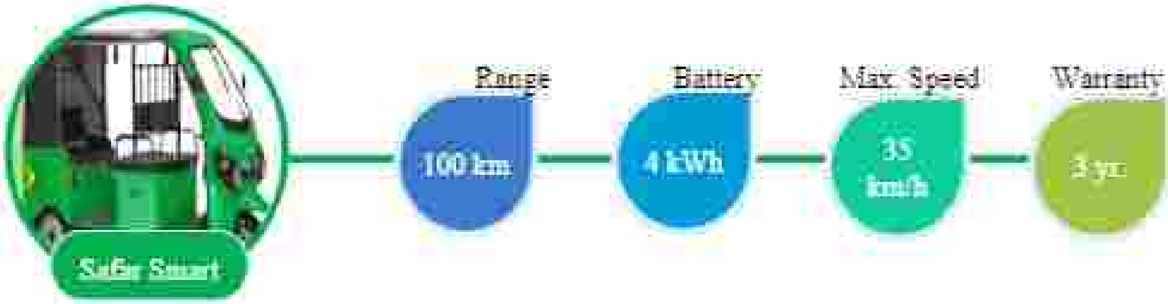
Mahindra & Mahindra leads the e-3W market in India. Other popular e-3W manufacturers include Bajaj Electric, Kinetic Green, YC electric, Saera electric auto, Dilli electric auto, Atul Auto, Altigreen Propulsion Labs, etc.

Some of the popular e-3W models in India include Mahindra Treo, Bajaj RE Electric, Piaggio Ape E-City, and Atul Gem.

Details of some of the best-selling e-3W in India are as follows:



[11] https://e-vehicleinfo.com/electric-three-wheeler-manufacturers/



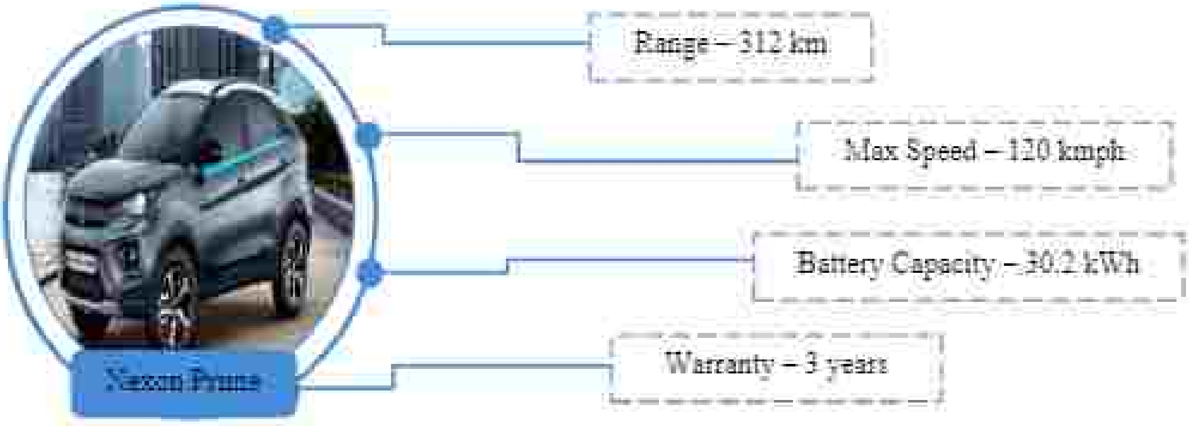
Electric Four Wheelers in India:

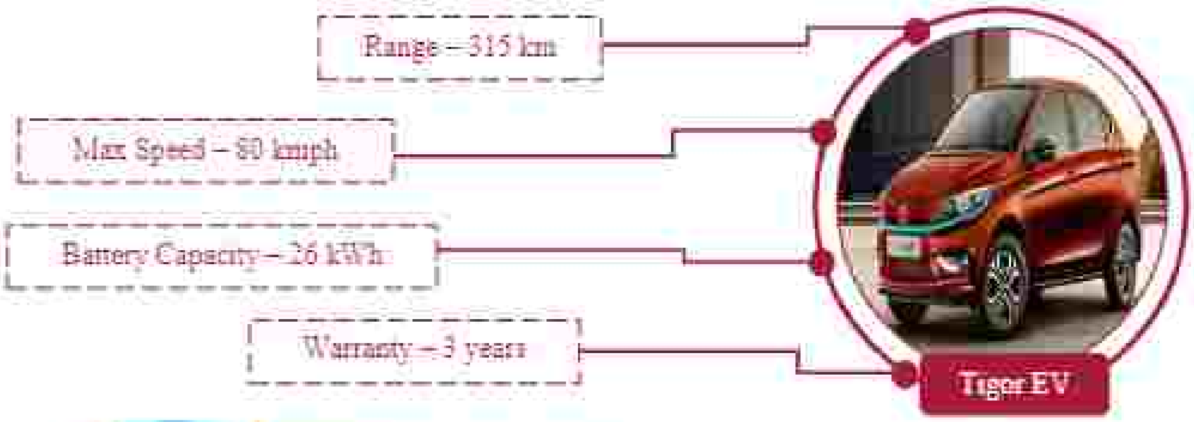
The e-4W vehicle segment has lower penetration compared to e-2W and e-3W. Currently, more than 10 manufacturers have deployed around 30 e-4W models in the Indian market, with prices ranging between Rs. 8.0 lakh and Rs. 2.0 crore[14]. In terms of the data available on VAHAN portal, Tata Motors

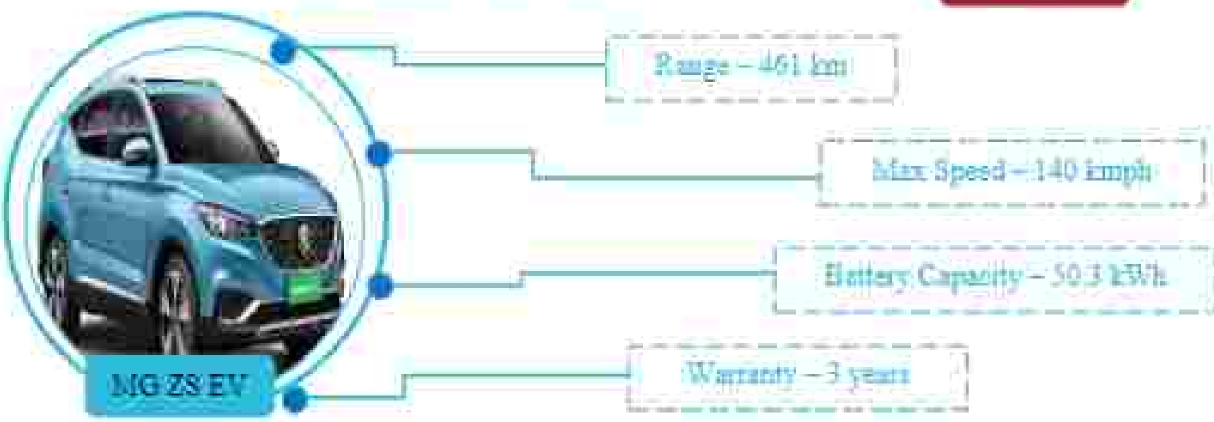
[14] https://www.carwale.com/new/electric-cars/

dominates the e-4W market in India with a market share of around 71%[15]. Other popular e-4W manufacturers in India include MG Motor, Hyundai, and Kia Motors.

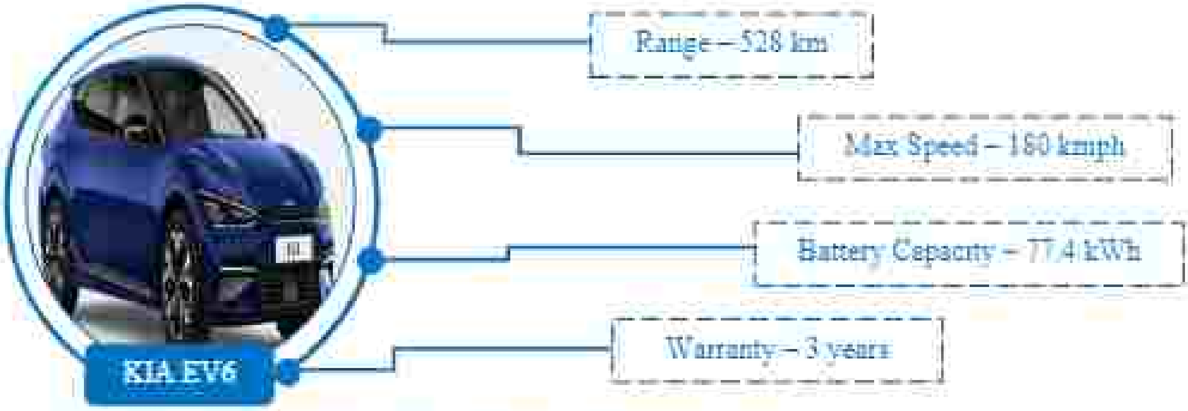
Details of some of the best-selling e-4W models in India are as follows:







[15] https://vahan.parivahan.gov.in/vahan4dashboard/vahan/view/reportview.xhtml



2.3 Total Cost of Ownership (TCO) of Electric Vehicles in India

The adoption of e-mobility in India depends on the Total Cost of Ownership (TCO) throughout a vehicle's lifetime. TCO is the overall cost incurred by the user on purchasing, owning, operating, and maintaining a vehicle during its lifetime. Understanding TCO of electric vehicles plays a vital role in the decision-making process of a prospective buyer. Thus, it is an important yardstick for vehicle users to consider.

Estimating TCO for both electric vehicle and ICE vehicle for different vehicle segments would help any individual, fleet-owning agency and government bodies to compare the benefits of using electric vehicles which would create consumer awareness and encourage them to switch to EVs.

A. TCO Methodology

Total Cost of Ownership (TCO) for any mode of transport is the sum total of its capital, operational costs over the period of its operation and subtraction salvation value of vehicle. The EV models considered for TCO estimation are based on their popularity in respective segments.

The parameters / variables that constitute the TCO calculation are as follows:

a) Capital Cost: Vehicle Cost – Financing Cost – Battery Cost

i) Vehicle Cost
ii) Financing Cost
iii) Battery Cost

b) Operational Cost : Fuel/Electricity Cost – Maintenance Cost – Insurance Cost

i. Fuel/Electricity cost
ii. Maintenance cost
iii. Insurance cost

B. Assumptions

Assumptions for estimating the total cost of vehicle ownership are presented in Figure 2. These assumptions have been arrived at after deliberations with various EV OEMs and EV users which includes vehicle utilization, operational period, resale value of the vehicle, and battery replacement cost.

Note: This methodology takes a realistic approach to estimating vehicle ownership costs. The analysis presented accounts for prevalent capital and operational costs, and it includes sensitivity analysis considering future variations in the cost components and their impact on the TCO.

C. Methodology:

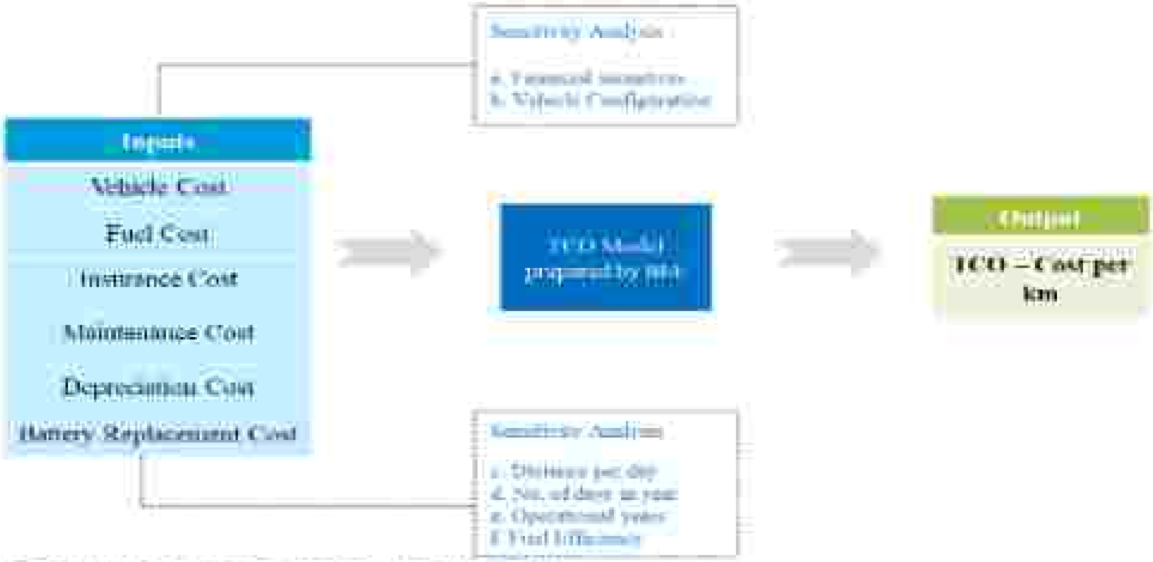


Figure 1: Methodology for estimating Total Cost of Ownership

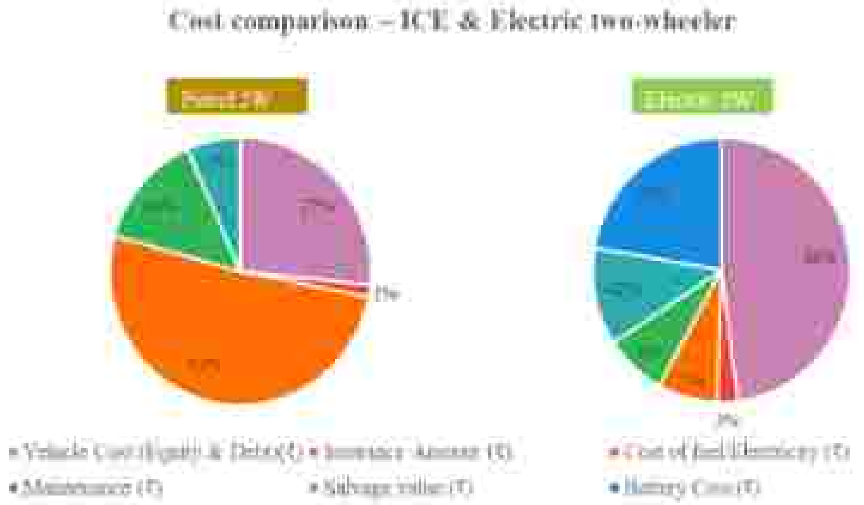
D. Total Cost of Ownership:

- **Two-Wheeler:** For estimating the total cost of ownership of two-wheelers, vehicle models considered are Honda Activa in the ICE category and Ather 450x in the EV category.

Honda Activa 6G
Engine Displacement – 109.51 cc
Max. Power – 7.79 PS @ 8000 rpm
Fuel Type – Petrol
Mileage – 50 kmpl
Fuel tank capacity – 5.3 L

Ather 450x
Range – 146 km
Battery Capacity – 3.7 kWh
Max. speed – 79.3 km/Hr
Acceleration – 2.7 m/s^2
Energy consumption – 4 kWh/100 km
Battery Cycles – 1000 cycles
Battery density – 260 Wh/Kg

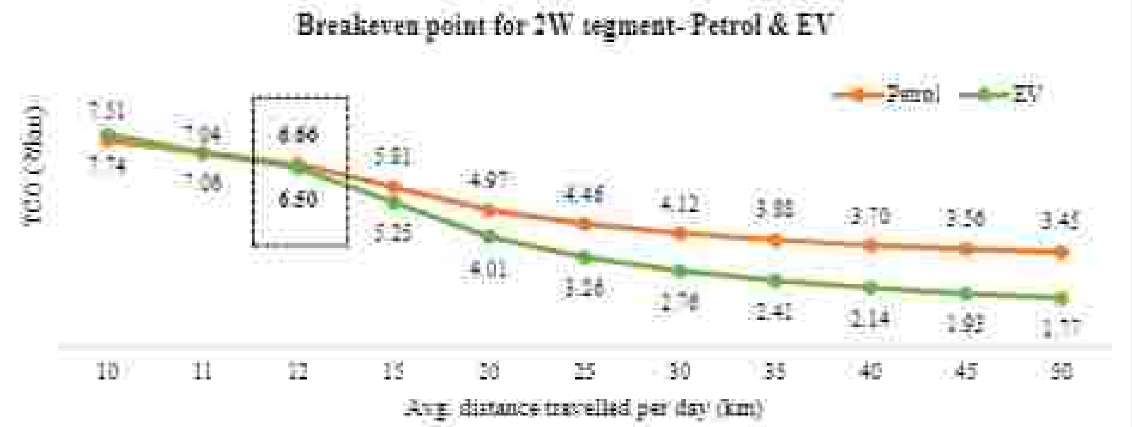
TCO Comparison for Petrol and Electric Two Wheelers:



Graph 6: TCO comparison for electric and ICE 2W

Breakeven point (ICE-EV) based on daily running:

For analysing the breakeven point for conventional and electric two-wheeler, the Total Cost of Ownership (TCO) is presented below. The output indicates that with an average running of 12 km, the TCO of e-2W is lower than its ICE counterpart.



Graph 7: Breakeven point for 2W- Daily running km

E. Three-wheeler:

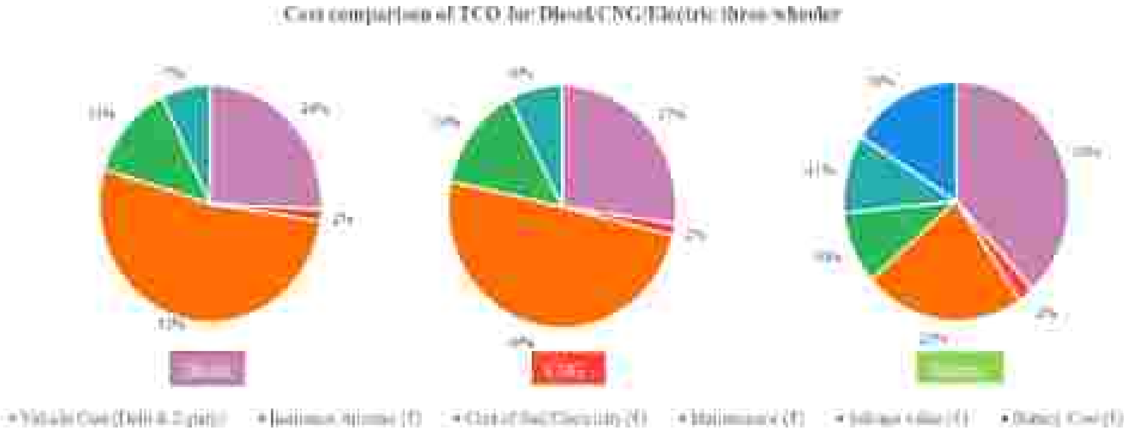
For estimating the TCO for three-wheelers, three models are considered with various fuel types – Piaggio Ape Auto DXL in the Diesel category, Piaggio Ape Auto HT DX in the CNG Category and Piaggio Ape E-Xtra FX PU in the EV category. Specifications of these vehicles as follows:

Piaggio Ape Auto DXL
Fuel type – **Diesel**
Engine – 599 cc
Max power – 9.4 HP
Fuel tank capacity – 10 ltr
Mileage – 30kmpl
Max Speed – 60 km/h

Piaggio Ape Auto HT DX
Fuel Type - **CNG**
Engine – 300 cc
Max power – 11.47 HP
Fuel tank capacity – 40 ltr
Mileage – 38kmpl
Max Speed – 40 km/h

Piaggio Ape E-city
Fuel Type - **Electric**
Battery type – Lithium ion
Max power – 5.44 kW
Battery capacity – 7.5 kWh
Range – 159 km
Max Speed – 45 km/h

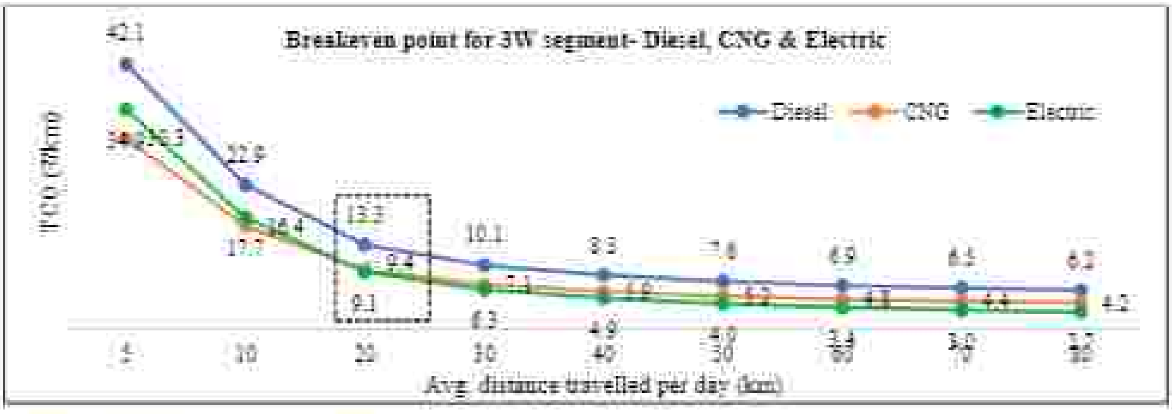
Cost Comparison of different Three Wheelers:



Graph 1: TCO Comparison for 3W

Breakeven point of (ICE-EV) vehicles based on daily running:

For estimating the breakeven point in the Total Cost of Ownership (TCO) for conventional and electric three-wheeler, the TCO output is plotted in the graph below for daily runs ranging from 5 to 80 km. The output indicates that with an average running distance of 20 km, the TCO of the e-3W is lower than its ICE CNG counterpart.



Graph 9: Breakeven for 3W - daily running km

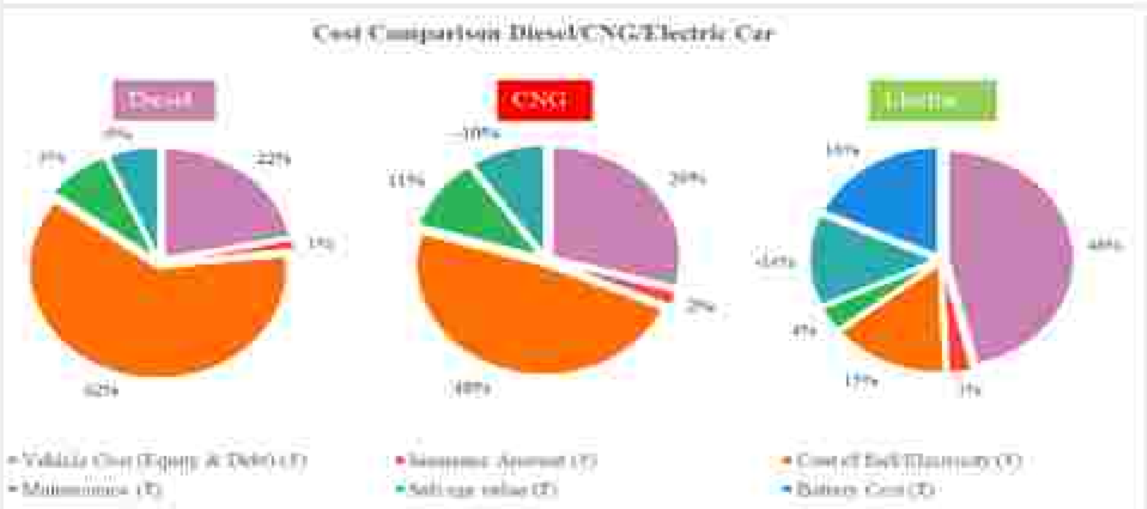
F. Four-Wheeler: For estimating the TCO for four-wheeler, models considered are – Tata Tigor XM-diesel in the Diesel category, Tata Tigor XM-CNG in the CNG category and Tata Tigor XM-EV in the electric category.

Tata Tigor XM-Diesel
Fuel type – Diesel
Engine – 1047 cc
Max power – 69 BHP
Fuel tank capacity – 35 ltr
Mileage – 19.2 kmpl
Max Speed – 166 km/h

Tata Tigor XM- CNG
Fuel Type - CNG
Engine – 1199 cc
Max power – 72.4 BHP
Fuel tank capacity – 60 litres
Mileage – 26.49kmpl
Max Speed – 166 km/h

Tata Tigor XM- EV
Fuel Type - Electric
Battery type – Lithium ion
Max power – 73.75 BHP
Battery capacity – 26 kWh
Range – 306 km
Max Speed – 120 km/h

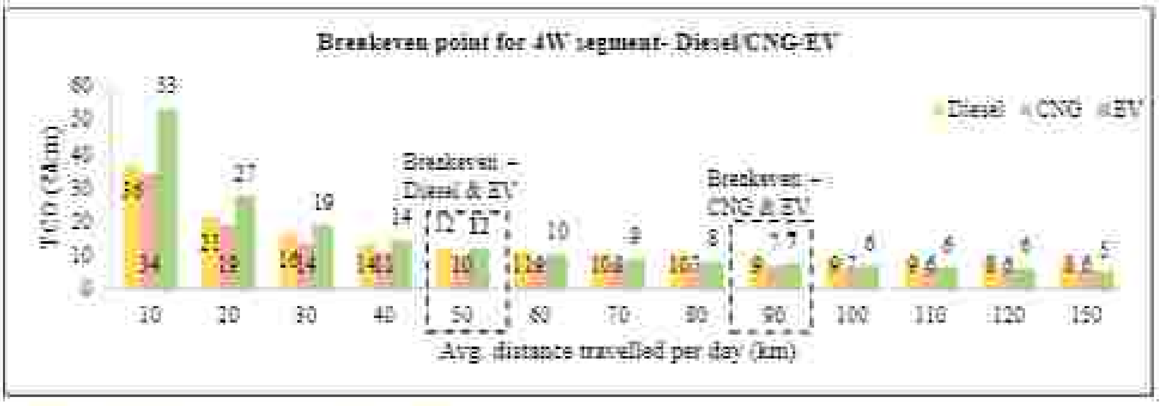
Cost Comparison of different vehicles:



Graph 10: TCO Comparison for 4W

Breakeven point of (ICE-EV) vehicles based on daily running:
For analysing the breakeven point in the TCO for conventional and electric four-wheeler, the TCO output is plotted in the graph below for daily runs ranging from 1 to 150 km.

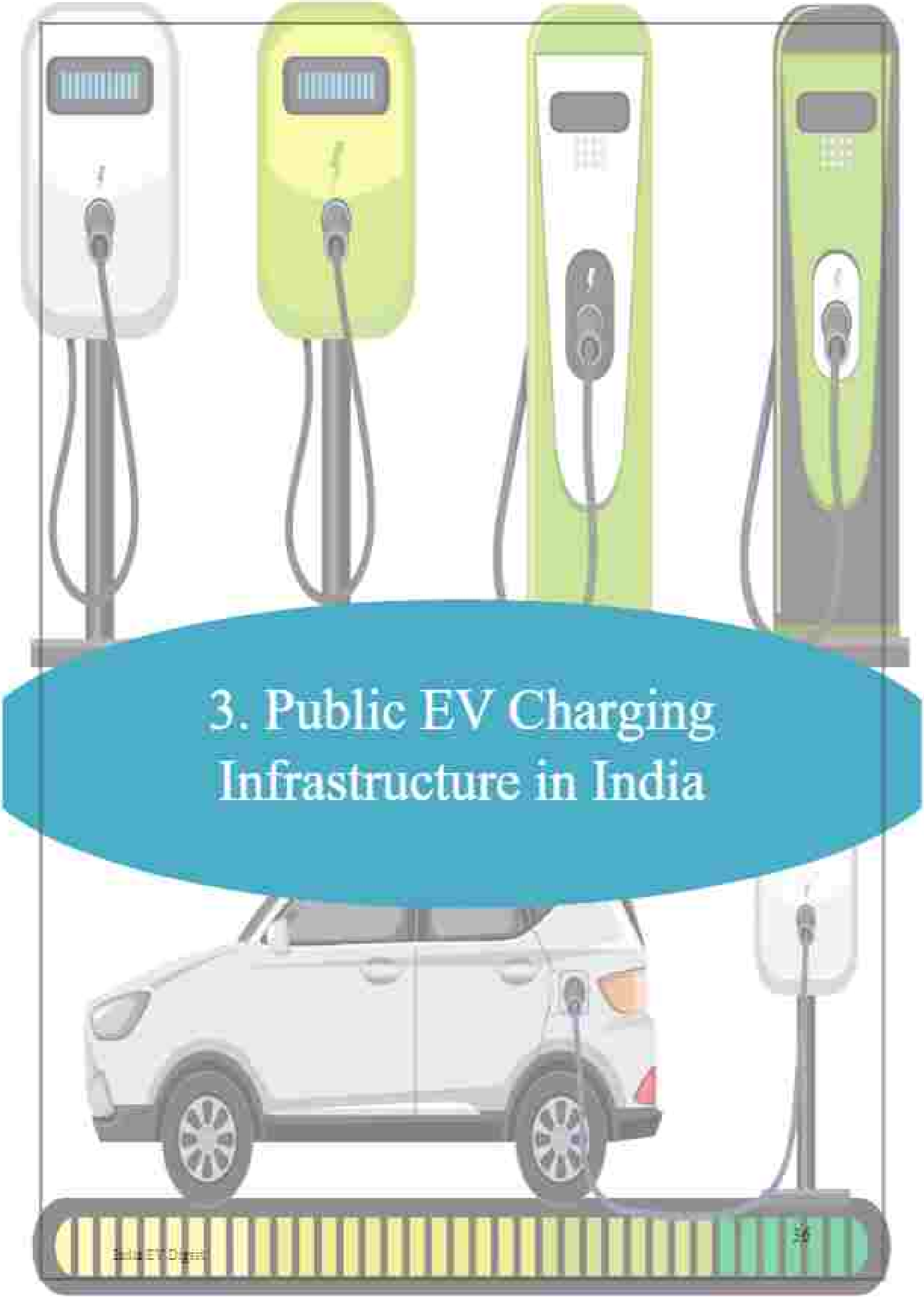
The output indicates that with an average daily running distance of 50 km, the TCO of the e-4W is lower than its ICE diesel counterpart. However, to achieve breakeven with its ICE CNG counterpart, an average running distance of 90 km is required.



Graph 11: Breakeven point for 4W - daily running km

In the future, it is expected that EV prices will trend downward, driven by various factors such as economies of scale, advancements in battery technology, government incentives and regulations, and indigenous manufacturing with a robust local supply chain leading to an increase in the penetration of EVs.

3. Public EV Charging Infrastructure in India



3. Public EV Charging infrastructure in India

India is rapidly developing its Electric Vehicle Charging Infrastructure (EVCI) network to meet the growing demand for electric vehicles. As of August 31, 2023, there are more than 10,000 operational public EV charging stations across the country, offering various specifications and power capacities. These stations are operated by both private and public sector entities. Oil Marketing Companies, namely IOCL, HPCL, BPCL, aim to install around 22,000 public EV charging stations by the end of the year 2024.

The majority of operational EV chargers in India are of the plug-in conductive type. Additionally, battery swapping is gaining steady traction, particularly to meet the demand in the two-wheeler and three-wheeler segments.

Overall, the deployment of public EV charging infrastructure in India is expected to accelerate in the coming years, driven by government initiatives and the rising demand for electric vehicles.

EV Charging Infrastructure and Charging Standards

Electric Vehicle Supply Equipment (EVSE) refers to a set of specialized devices, either singularly or in combination, designed to deliver dedicated functions for supplying electric energy. These functions facilitate the transfer of electrical power from a stationary electrical installation or supply network to an electric vehicle, primarily with the objective of charging its on-board batteries. EVSE can be classified based on power supply (AC or DC), power rating levels, charging speeds, communication, and connector types.

Standardization has been a key consideration for increasing uptake of EVs. Various standardization bodies have identified key global standards for overall safety of charging stations, AC/ DC charging connectors, EV- EVSE communication protocols and Vehicle-to-Grid (V2G).

Key international organizations providing EV charging standards include International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineer (IEEE), the International Organization for Standards (ISO), and the Society of Automotive Engineers (SAE), depending on ongoing trends and technological advancements.

EV charging standards in India have been primarily adopted from international standards. As a member of IEC, India has adopted IEC standards. Specific efforts have been made to harmonize the Indian EV related standards with the global EV industry. In India, EVSE standards are developed by the ETD-51 (Electrotechnology sectional) committee of the Bureau of Indian Standards (BIS), established in 2016.

3.1 Type of EV Chargers

In India, various types of EV chargers are used for charging electric vehicles. These chargers are categorised as slow chargers and fast chargers based on their rated capacities. The Bureau of Indian Standards (BIS) has also established standards for EV chargers, categorizing them into four levels.[7]

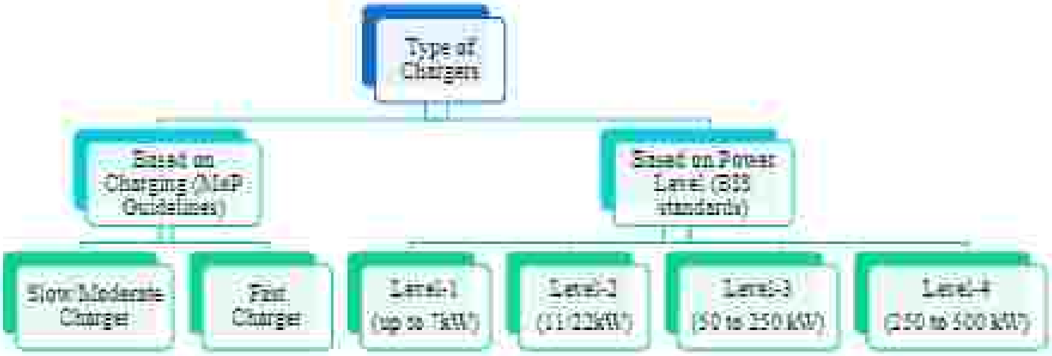


Figure 1: Type of EV chargers

3.1.1 Slow/Moderate Chargers

In terms of the Ministry of Power's revised guidelines & standards for public EV charging infrastructure, slow EV chargers are low-capacity chargers which charges EVs at a slower rate. The capacity of slow chargers goes up to 15 kW for DC charging and up to 22 kW for AC charging. Various types of slow EV chargers are currently being deployed across the country; details are as mentioned below:

i. **Bharat AC001(IS-60309):**

The Bharat AC001 EV charger is a pivotal and pioneering component of the Bharat series, sa comprehensive initiative undertaken by the Government of India (GoI) to promote and facilitate the adoption of electric mobility across the nation.

The Bharat AC001 serves as a basic AC charger capable of concurrently recharging three distinct vehicles simultaneously. Operating at an input voltage of 415 V three phase, each connector delivers a single-phase AC output at 230 V with a current rating of 15A. Notably, the charging rate for each of the three vehicles is meticulously controlled and capped at 3.3 kW. This is typically used to charge light electric vehicles like e-2W, e-3W and e-4W.

Pin Configuration of Bharat AC Charging connector:

S. No.	Position number	Pins	Single/Three Phase	Description
1	PE	Protective Earth	Single Phase	Ground
2	N	Neutral	Single Phase	Neutral
3	L1	Line 1	Single Phase	(AC) Phase

Table 2: Pin configurations of Bharat AC 001 EV charger

ii. LEV AC Charger (IS-60309 & IS 17017 Part22/Sec1:2021)

It is an EV charger capable of supplying alternating current to Light Electric Vehicles. The equipment provides dedicated functions to supply electric energy from a fixed electrical installation or supply network to Light Electric Vahicles for the purpose of charging onboard batteries.

It is a single-connector charger. According to the BIS standard (IS 17017 Part22/Sec1: 2021), it is a basic conductive AC charging option for charging light electric road vehicles with a rated supply voltage 240 V-AC and a current of up to 16 Amps.

The LEV AC charge point has provisions to communicate with a Mobile Application or other user interfaces using Bluetooth Low Energy (BLE) communication protocol. It is possible to start/stop charging operation through a mobile application. The EVSE has a host of features like user authentication, logging of energy consumption, and transferring information to users over mobile phones.

Pin Configuration of LEV AC Charge point

S. No.	Position number	Pins	Single/Three Phase	Description
1	PE	Protective Earth	Single Phase	Ground
2	N	Neutral	Single Phase	Neutral
3	L1	Line	Single Phase	(AC) Phase

Table 3: Pin configuration for LEV AC charge point

iii. LEV DC Charge point (IS-17017-2-6)

LEV DC charger is specifically designed for the supply of DC power to electric 2W and electric 3W. According to the BIS standard (IS-17017 Part2/Sec6) for LEV DC charger, the input is single-phase 230 V nominal voltage, and the output has a rated voltage of up to 120 V and a rated current of up to100 A. The maximum charging rate using a LEV DC charger is up to 12 kW.

Pin & Dimension compatibility for LEV DC vehicle connector and inlet:

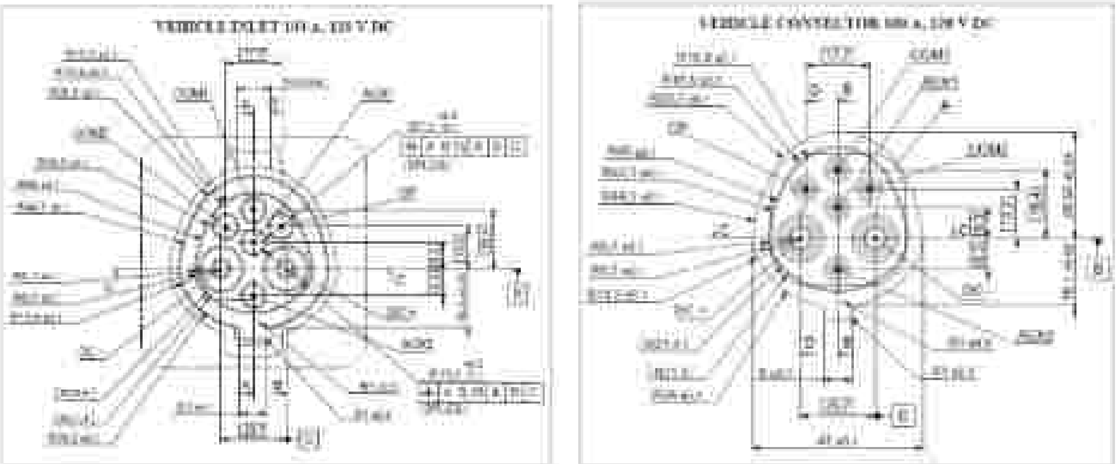


Figure 4: Pin & Dimension compatibility for LEV DC charge point

There are a total of seven pins in the vehicle coupler charger, of which two pins with broader dimensions are used for supplying the DC input power to EV. Details of the functionalities of different pins are mentioned in the table below:

Pin configuration for LEV DC charge point

S. no.	Pins	Voltage (V)	Description
1	DC-	120 (d.c.)	DC Supply
2	DC+	120 (d.c.)	DC Supply
3	CP	30 (d.c.)	Control Pilot
4	COM1	30 (d.c.)	Communication contact (+)
5	COM2	30 (d.c.)	Communication contact (-)
6	AUX1	30 (d.c.)	Auxiliary power supply (+)
7	AUX2	30 (d.c.)	Auxiliary power supply (-)

Table 4: Pin configuration for LEV DC charge point

iv. Combo LEV AC/DC charge point (IS-17017-Part2/Sec7)

The combo charger supplies both AC and DC power from a single connector. The charger input is single phase 230 V or three phase 415 V nominal voltage and the output are as follows:

Output AC power: up to 240V voltage supply and up to 32A current.

Output DC power: up to 120V voltage supply and up to 100A current.

The maximum charging rate possible for vehicle is 7.0 kW during AC charging and 12.0 kW with DC charging. Currently, Ather Energy is using this charger to charge e-2W manufactured by it using Ather Grid network. Ather has also initiated work on enabling interoperability of these chargers so that the charger can be used by user of e-2W & e-3W of other OEMs also.

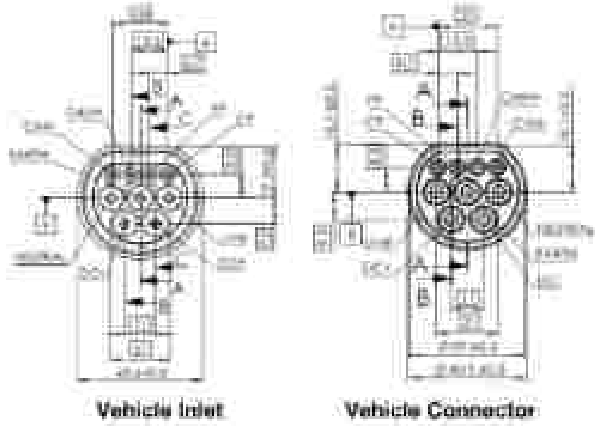


Figure 1: Dimension compatibility for LEV AC/DC combo charge point

Pin & Dimension compatibility for combo vehicle connector & inlet:

The charger contains nine pins for controlling and supplying power to the vehicle. Among nine pins, two pins are used for supplying DC power and two pins are used for supplying single phase AC power. Further, two pins named PP (Proximity pilot) and CP (Control pilot) are used for controlling and while CAN+ & CAN- pins are used for communication between the charger and the vehicle.

The detail of each pin in this connector mentioned in the below table[16]:

Pin configuration of LEV AC/DC combo charge point

S. No.	Symbol	Voltage (V)	Current (A)	Functions
1.	DC +	120 (d.c.)	100	DC supply
2.	DC -	120 (d.c.)	100	DC supply
3.	Live	240 (a.c.)	32	Live (Mains)
4.	Neutral	240 (a.c.)	32	Neutral
5.	Earth	Rated for fault		Protective Earth
6.	CP	30 (d.c.)	2	Control pilot
7.	PP	30 (d.c.)	2	Proximity pilot
8.	CAN+	30 (d.c.)	2	Communication1+ (CAN High)
9.	CAN-	30 (d.c.)	2	Communication1+ (CAN Low)

Table 5: Pin Configuration of AC/DC combo charge point

[16] Bureau of Indian Standard

v. **Bharat DC001:**

The Bharat DC001 charger is tailored to deliver Direct Current (DC) power, making it exceptionally well-suited for efficient EV charging. The charger has a single GB/T vehicle connector at the output.

In the Bharat DC 001 charger, the input is three phase 415 V (5 wire, 3PH+N+PE) nominal voltage and the output is 48V or 72V voltage DC with a maximum current output of 200 Amps.

Pin Configuration of Bharat DC001 Charger (vehicle connector/vehicle inlet)

S. No.	Pin outs	Pin configuration	Description
1	S+ / S-	Charging communication	CAN_H / CAN_L
2	CC1 / CC2	Charging confirmation	post-insertion signalling
3	DC+ / DC-	Main DC power	positive / negative
4	PE	Protective earth	full-current protective earthing system
5	A+ / A-	Auxiliary DC power	+-30V, 20A

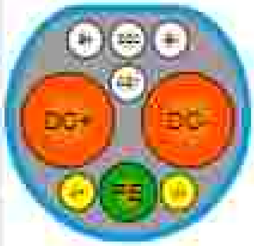


Table 6: Pin Configuration of Bharat DC001 EV charger

Available capacities of Bharat DC001 charger:

At present, two variants of this charger are available in the market for charging the electric vehicles. Technical specifications of these models are mentioned in the following table:

S. No.	Description	15 kW Model[17]	30 kW Model[18]
1.	Phase	Three phase	Three phase
2.	I/P Voltage	415 VAC	415 VAC
3.	O/P Voltage	48/60/72 VDC	48/60/72 VDC
4.	O/P Current	200A max.	200A max.
5.	Vehicles	3W/4W	3W/4W
6.	No. of Guns	Single Gun	Dual Gun

Table 7: Technical specification of Bharat DC001 charger

[17] https://www.indiagosolar.in/shop/e-vehicle/ev-charger/delta-dc001-bharat-ev-charger-15kw/
[18] https://pdf.indiamart.com/impdf/22255679933/MY-9817067/delta-dc-30-kw-electric-vehicle-charger.pdf

vi. **Type-II AC charger (IS-17017-Part2/Sec2):**

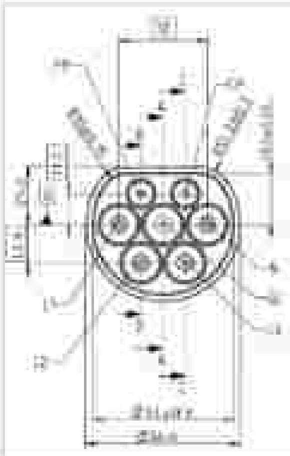
The Type-II AC charger has Mennekes connector and is widely utilized in Europe and other regions, enhancing cross-compatibility for a seamless charging experience.

According to the BIS standard (IS 17017-Part2/Sec2), the Type-II AC charger is operating at input voltages ranging from 230V to 440V and delivers a single-phase/three-phase AC output of 230V/415V with a charging current capacity of up to 32A. Notably, the charging rate for electric vehicles can be controlled and is capped at up to 22 kW.

Pin and Dimension compatibility for charger connector[19]:

Position Number	U_{max}	Three Phase	Single Phase	Functions
	V ac	I_{max} (A)	I_{max} (A)	
1	440	63	70	L1 (mains 1)
2	440	63	-	L2 (mains 2)
3	440	63	-	L3 (mains 3)
4	440	63	70	N (neutral)
5	-	Rated for fault		PE (ground earth)
6	30	2		CP (control pilot)
7	30	2		PP (proximity pilot)

Table 5: Pin configuration of Type-II AC charger



Available charger capacities in market

Description	7.4 kW Model[20]	11kW Model[21]	22 kW Model[22]
Phase	Single Phase	Three Phase	Three Phase
I/P Voltage	190-240 VAC	380-440 VAC	380-440 VAC
O/P Voltage	230 VAC	400 VAC	415 VAC
O/P Current	32 A	16 A	32 A
Vehicles	3W/4W	3W/4W	3W/4W
BIS Standard	IS-17017-2-2	IS-17017-2-2	IS-17017-2-2

Table 6: Technical specifications of Type-II AC charger

[19] Bureau of India Standards
[20] https://www.[illegible].pdf
[21] https://[illegible]/Products/download/21/2101/Catalogue/AC%20MAX Basic_Leaflet_[illegible].pdf
[22] https://[illegible]/product/charging-infrastructure/electric-vehicle-ac-charger-22kw-with-type-2-gun

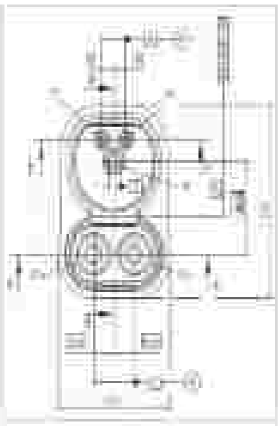
3.1.2 Fast Charger

Fast EV chargers primarily serve the purpose of swiftly topping up Electric Vehicles (EV) batteries on board. This technology employs high-power chargers capable of replenishing an EV's battery to 80% of its capacity in as quickly as 15 minutes. These chargers are characterized by their power rating, typically in the range of 25 to 500 kilowatts (kW). The need for fast charging is particularly pronounced during long-distance journeys along major road networks and highways. The charger unit directly supplies DC power to the EV's on-board controller to expedite the battery charging process. Fast charging is commonly used for four-wheelers, e-buses and trucks.

The charging protocols mainly used for fast charging are **CCS-II, CHAdeMO and Pantograph charging.**

i. **CCS-II (IS 17017-Part2/Sec3):**

The Combined Charging System (CCS-II) is a European protocol for charging e-4W and heavy-duty electric vehicles, allowing high-power DC fast charging.



S. No.	Pin out	Pin Configuration	Description
1	PP	Proximity Pilot	Proximity detection or connection switch contact
2	CP	Control Pilot	Control pilot contact
3	PE	Protective Earth	Ground
4	DC-	D.C. power Contracts	DC Supply
5	DC+	D.C. power Contracts	DC Supply

Table 10: Pin Configuration of CCS-II charger

As per BIS standard IS 17017(Part2/Sec3), the CCS-II charger operates at an input of 415V AC nominal voltage, and the rated operating voltage is up to 1500V DC with rated operating current up to 250A. This charger uses power line communication to communicate with the EV over the control pilot, controlling control energy flow between the EV and the charger during charging.

Pin Configuration & dimension compatibility of charger connector

Available charger capacities in market

Description	25/30 kW Model[23]	50/60 kW Model[24]	100/120 kW Model[25]	200 kW Model[26]

[23] https://[illegible]
[24] https://[illegible]
[25] https://[illegible]
[26] https://[illegible]

Phase	Three Phase	Three Phase	Three Phase	Three Phase
I/P Voltage	380-440 VAC	380-440 VAC	380-440 VAC	380-415 VAC
O/P Voltage	50-1000 VDC	50-1000 VDC	50-1000 VDC	150-1000 VDC
O/P Current	65 A	125 A	200 A	400A
Vehicles	4W	4W	4W/Bus	Bus
BIS Standard	IS-17017-2-3	IS-17017-2-3	IS-17017-2-3	IS-17017-2-3

Table 11: Technical specifications of CCS-II charger

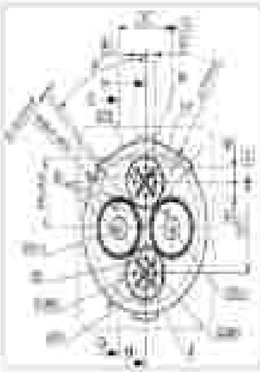
ii. CHAdeMO Charger (IS 17017-Part2/Sec3):

CHAdeMO is a trade name for global quick charging method proposed by CHAdeMO Association as an industry standard in March 2013. The CHAdeMO association was founded by the Tokyo Electric Power Company (TEPCO), Nissan Motors, Mitsubishi Motors, Fuji Heavy Industries and Toyota Motor Corporation. CHAdeMO stands for "CHArge de Move" or "charge for moving". Currently, CHAdeMO chargers are popular in Japan and Europe.

CHAdeMO is a fast DC charging protocol for e-4W and heavy-duty electric vehicles. It enables seamless communication between an EV and the DC charger. As per BIS standard IS 17017(Part2/Sec3), in CHAdeMO charger, the input is 415V AC nominal voltage and the rated output voltage is up to 1500V DC with rated operating current up to 250A.

The CHAdeMO quick charger has a controller that receives EV commands via CAN bus and the quick charger sets the current to meet the EV's command value. Using the mechanism, optimal and fast charging becomes possible with battery performance feedback.

Pin Configuration & Dimension compatibility of CHAdeMO charger (Charger Connector)[27]



S. No.	Pin outs	Pin configuration	Description
1	CP/CP2/CP3	Control Pilot	Control Pilot contact
2	COM1	Communication 1	For Communication
	COM2	Communication 2	For Communication
3	CS	Connection switch	Proximity detection or connection switch contact

[27] Bureau of India Standards

4	IM	Isolation Monitor	Isolation monitor contacts
5	DC+ / DC-	DC supply	DC power contacts

Table 12: Pin Configuration of CHAdeMO charger

Available charger capacities in market

Description	25 kW Model[28]	50 kW Model[29]	100 kW Model[30]
Phase	Three Phase	Three Phase	Three Phase
I/P Voltage	415 VAC	415 VAC	480 VAC
O/P Voltage	200-500 VDC	200-500 VDC	50-1000 VDC
O/P Current	60A max.	125A max.	200A max.
Vehicles	4W	4W	4W
BIS Standard	IS-17017-2-3	IS-17017-2-3	IS-17017-2-3

Table 13: Technical specifications of CHAdeMO charger

3.1.3 EV Charging Standards

Developing standards is necessary for maintaining uniformity, which will help in the easy adoption of Electric Vehicles (EVs) and the development of the EV ecosystem. The Bureau of Indian Standards (BIS), the National agency for framing of standards in India, developed the IS 17017 series of Indian EV Charging Standard in the year 2021 with the objective of enhancing user safety & charger reliability. BIS has developed Indian standards for chargers catering to all segments, defining power levels based on the kW rating of these chargers. The tables below provide details on Indian EV charging standards[31].

Light EV AC Charge Point

Power Level 1	Charging Device	EV – EVSE Communication	Charge Point Plug / Socket	Vehicle Inlet / Connector
Up to 7 kW	IS-17017-22-1	Bluetooth Low Energy	IS-60309	As per EV manufacturer

Light EV DC Charge Point

Power Level 1	Charging Device / Protocol	EV – EVSE Communication	Charge Point Plug / Socket	Vehicle Inlet / Connector
Up to 7 kW	IS-17017-25 [CAN]		IS-17017-2-6	IS-17017-2-6

[28] https://www.indiagoodsale.in/shop/e-vehicle-ev-charger/delta-dc-wallbox-ev-charger-25kw
[29] https://www.deltaelectronicsindia.com/wp-content/uploads/2020/10/50KW-DC-low.pdf
[30] https://filecenter.deltaww.com/Products/Download/06/catalogue/DC%20City%20Charger%20100kW_Leaflet_NA_202101.pdf
[31] Bureau of India Standards

AC/DC Combo

Power Level 1	Charging Device / Protocol	EV – EVSE Communication	Charge Point Plug / Socket	Vehicle Inlet / Connector
Up to 7 kW (AC) or up to 12 kW (DC)	IS-17017-26		IS-17017-2-7	IS-17017-2-7

Parkbay AC Charge Point

Power Level 2	Charging Device / Protocol	EV – EVSE Communication	Charge Point Plug / Socket	Vehicle Inlet / Connector
Normal Power ~11kW/ 22 kW	IS-17017-1	IS-15118 [PLC] for Smart Charging	IS-17017-2-2	IS-17017-2-2

Parkbay DC Charge Point

Power Level 2	Charging Device / Protocol	EV – EVSE Communication	Infrastructure Socket	Vehicle Connector
Normal Power ~11kW/ 22 kW	IS-17017-23	IS-17017-24[CAN] IS-15118 [PLC]	IS-17017-22-2	IS-17017-2-3

DC Charging Protocol

Power Level 3	Charging Device	EV – EVSE Communication	Vehicle Inlet / Connector
DC 50 kW to 250 kW	IS-17017-23	IS-17017-24 [CAN] IS-15118 [PLC]	IS-17017-2-3

e-Bus Charging Station

Power Level 4	Charging Device / Protocol	EV – EVSE Communication	Connector
DC High Power (250 kW --> 500 kW)			
Dual Gun Charging Station	IS-17017-23-2	IS-15118 [PLC]	IS-17017-2-3
Automated Pantograph Charging Station	IS-17017-3-1		IS-17017-3-2

Table 14: EV Charging standards notified by BIS as on 14th Jan 2022

3.2 Operational Public charging stations in India

With support from both the Central and State governments and in response to the growing sales of Electric Vehicles (EVs), the number of Public Charging Stations (PCS) across the country has significantly increased. As of October 31, 2023, more than 10, 000 public charging stations were installed nationwide.

The heat map below illustrates the density of operational PCS in each state in India:

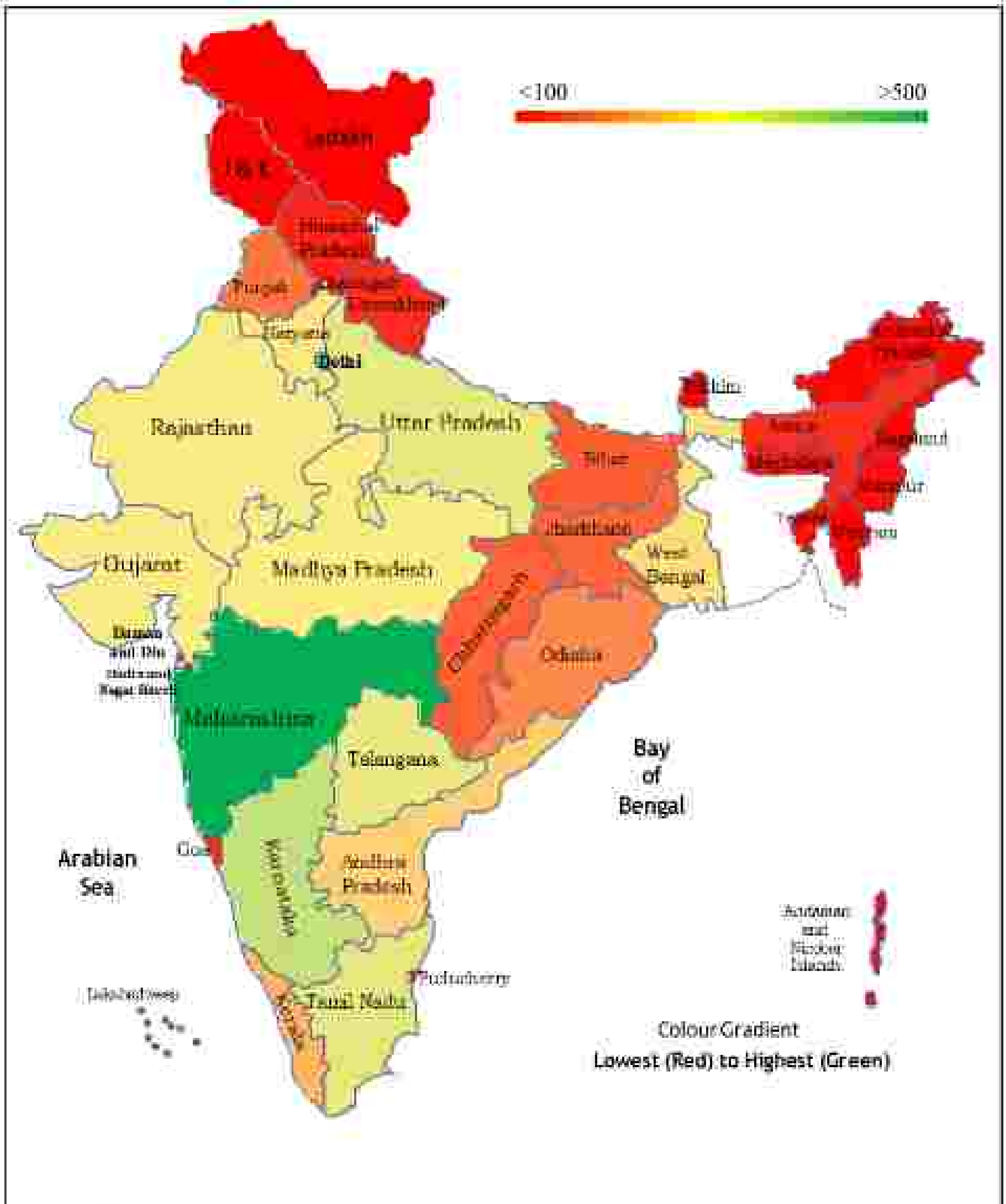
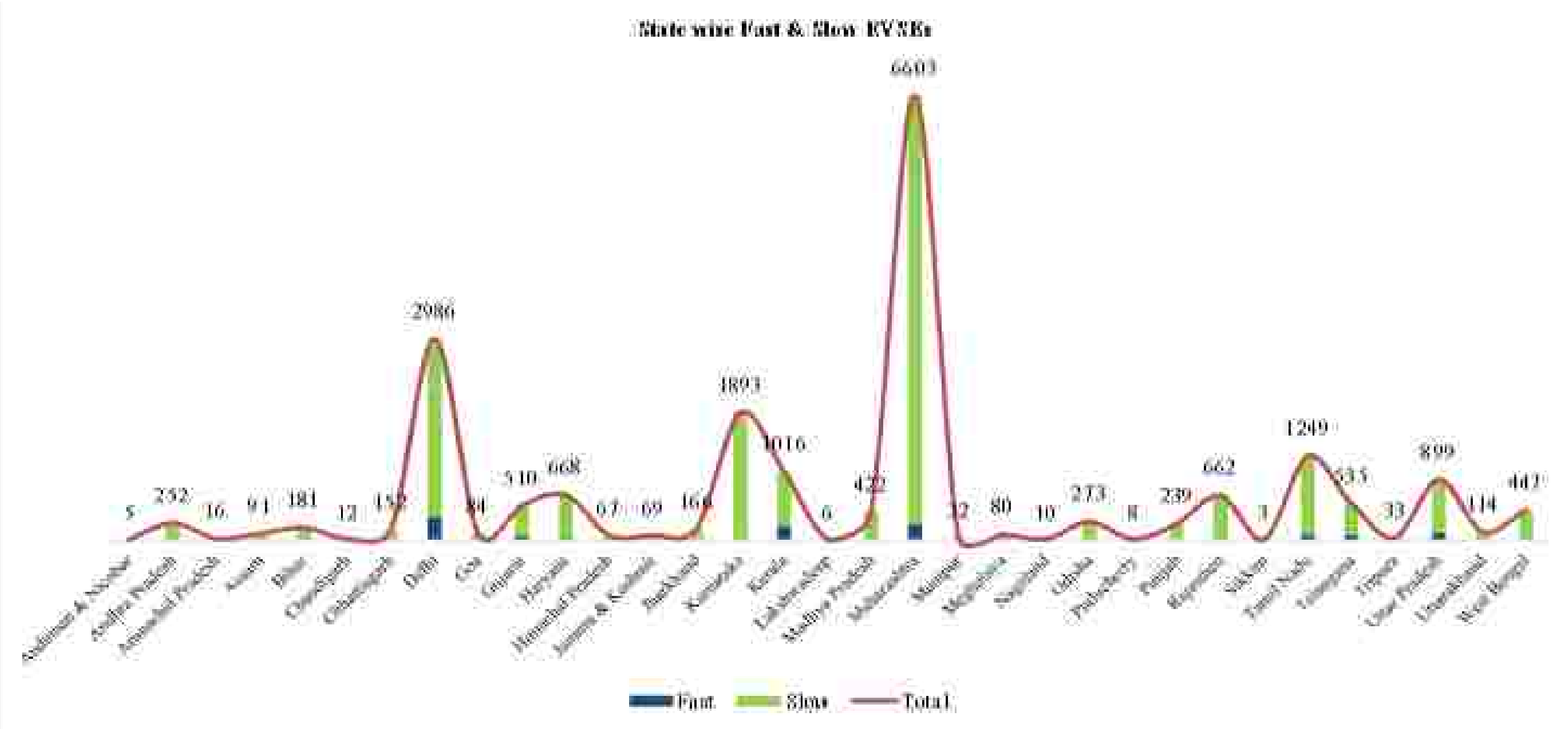


Figure 6: Heatmap of operational PCS in India as on 31st oct 2023

3.3 State wise EV Chargers deployment

India is experiencing an expansion in the Public EV charging network with an increase in the deployment of both slow and fast EV chargers. Slow AC EV chargers are primarily installed at homes and offices where people tend to spend more time, whereas fast EV chargers are deployed at Public Charging Stations. The state-wise distribution of slow and fast EV charging stations is shown below:

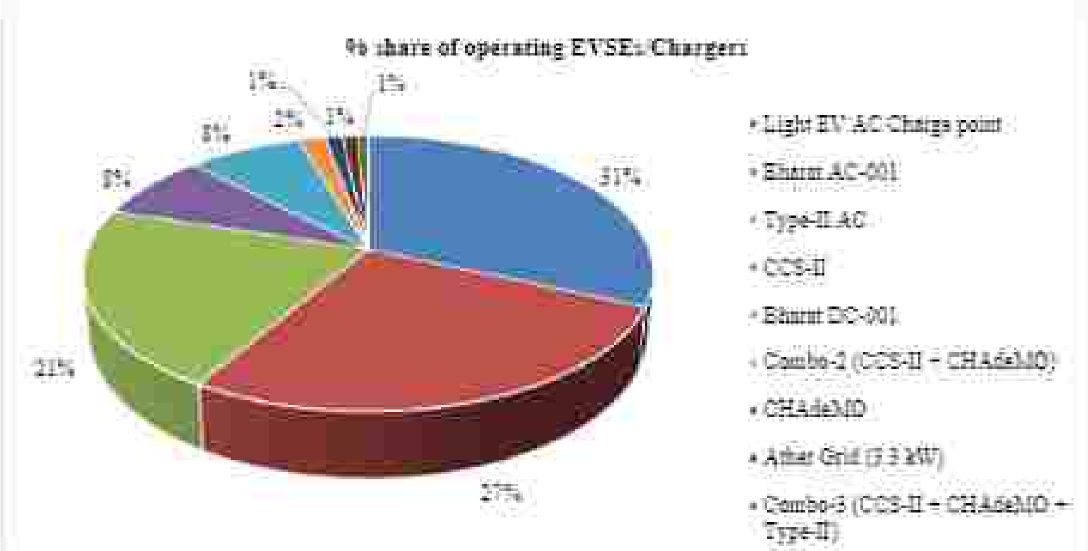


Graph 12: State wise Fast & Slow EVSE in India

3.4 Trends of EVSEs/Chargers

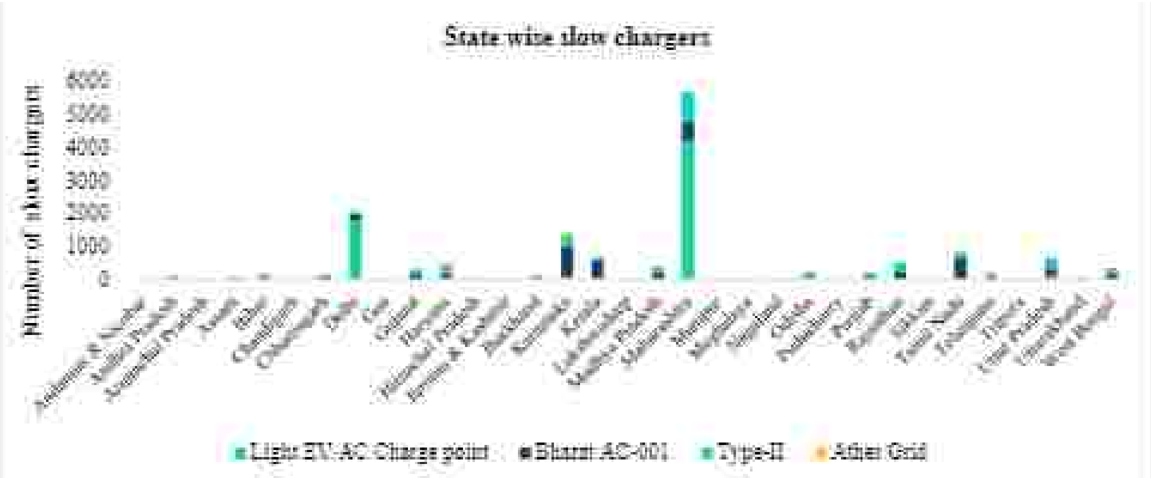
Various Charge Point Operators (CPOs) are installing different types of chargers across the country. According to data available with the Bureau of Energy Efficiency, more than 19,000 chargers are currently operational, with 85% being slow chargers and the remaining 15% being fast chargers.

The distribution of different types of EV chargers is illustrated below:



Graph 23: Percent share of type of operational chargers in India

State wise share of deployed slow EV chargers:



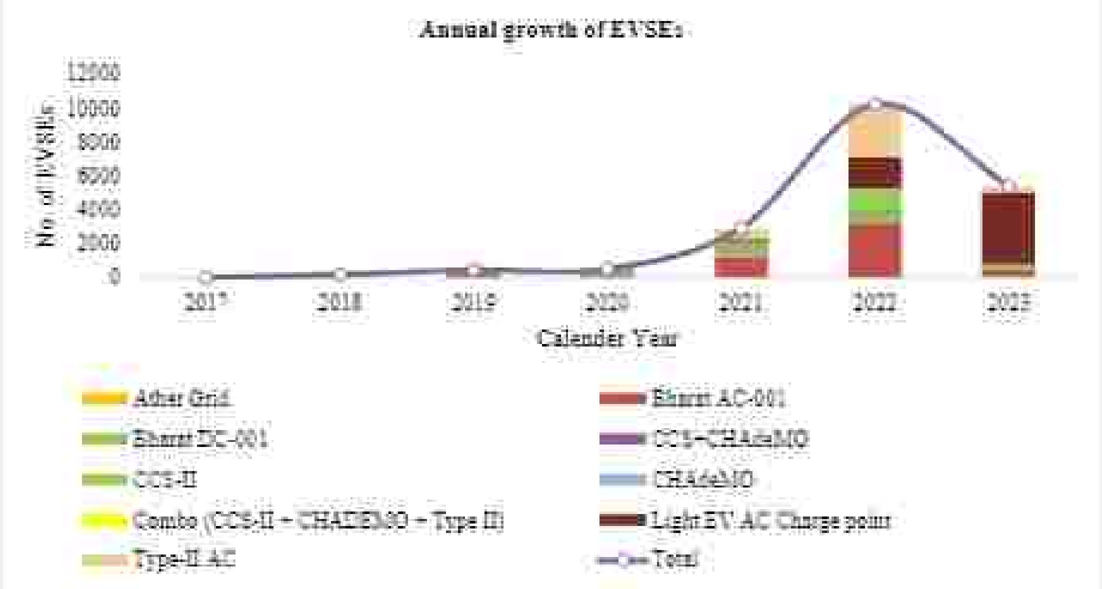
Graph 24: State wise share of slow EVSEs/chargers

Year wise growth trends of EV chargers:

With the increasing adoption of electric vehicles (EVs) in the country, the installation rate of EV chargers is also rising rapidly to meet the growing demand for charging. According to the data available from BEE, the majority of operational EV chargers in India were installed in the year 2022. Currently, the estimated growth rate of the EV charger market in India is 200%.

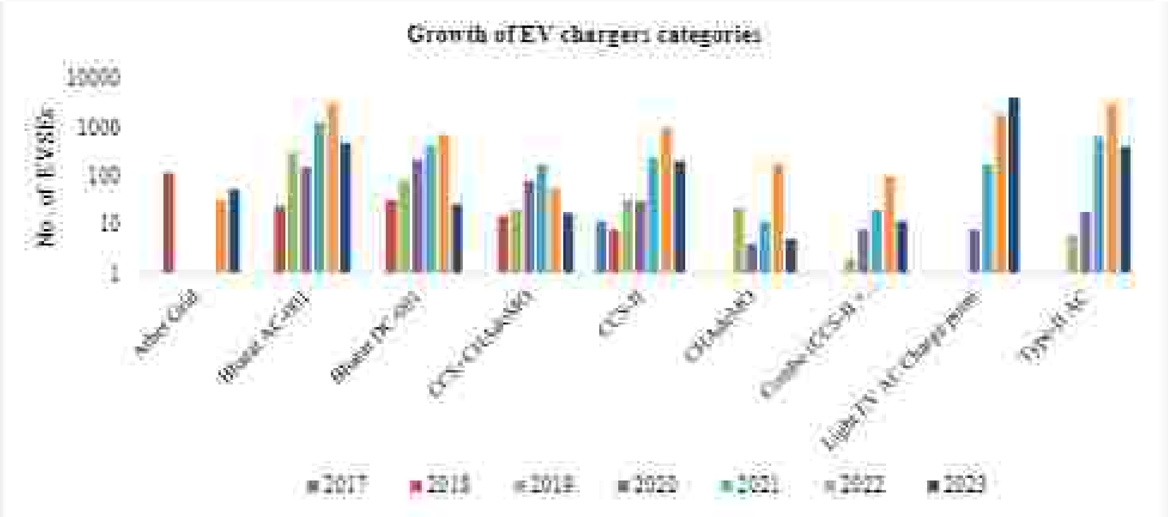
Over the last 5 years, the average growth rate for the deployment of EV chargers has been around 120%. Specifically, the growth for LEV AC chargers is 370%, and for Type-II AC chargers, it has been 360% during this period.

The growth in the number of EV chargers installed in the country, considering 2017 as the base year is illustrated in the graph below:



Graph 15: Growth trends for EV chargers over past 5 years

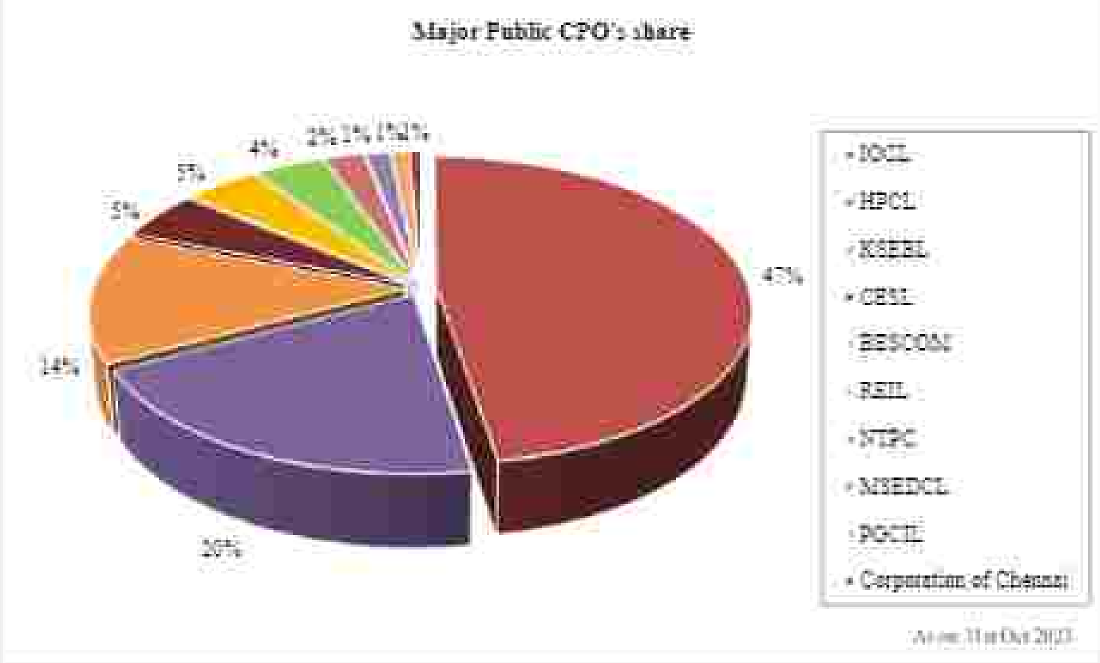
Annual growth trends in EV Charger categories:



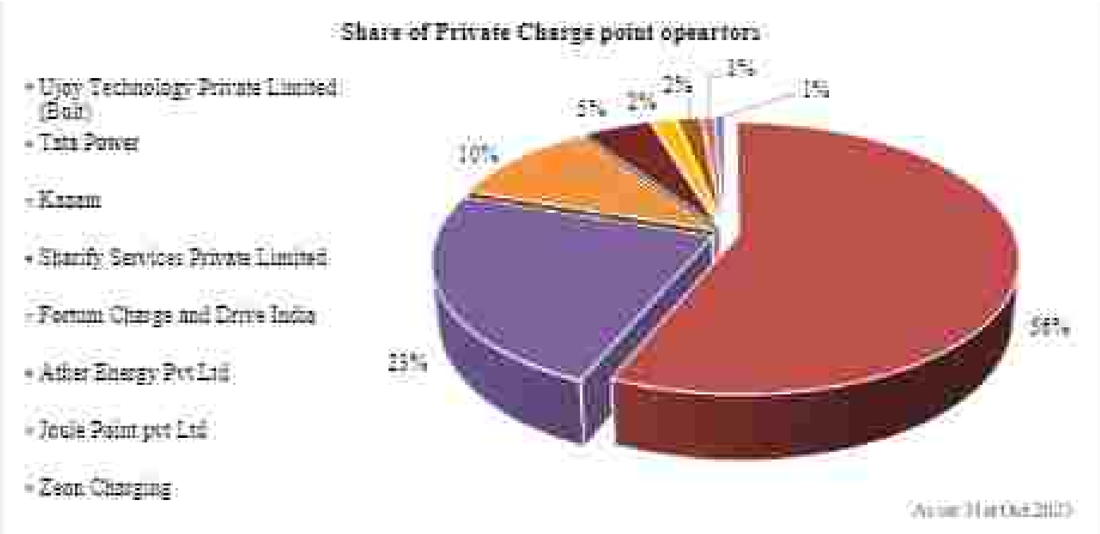
Graph 16: Growth of EVSEs annually

3.5 Market share by Charge point operators (CPOs)

The current Public EV charging market is attracting investments from both public and private organizations. According to data available on the "EV Yatra" portal, over 10,000 PCS were operational as of October 31, 2023. Among these, approximately 5,900 were installed by 43 private Charge Point Operators (CPOs), while around 4,280 PCS were installed by 26 public CPOs.



Graph 17: Share of operational PCS operated by public CPOs



Graph 18: Share of operational PCS by Private CPOs

3.6 Challenges faced by CPOs in installation of PCS and support provide by Government of India

Based on discussions with various stakeholders, including implementation agencies, several challenges hindering the faster deployment of public EV charging infrastructure in the country have been identified. The key challenges are as follows:

Challenges faced by CPOs for installatio

Mandatory requirement for deployment of 6 guns at fast and 10 guns at slow EV charging stations

Lack of provision of subsidy for setting up upstream infrastructure requiring high capital investment by CPO

Lowering the Service Tax for initial years on Charging from existing 18% to 5%

Requirement of multiple clearances for grant of new power connection for PCS

Identification of feasible land packages & supporting power infrastructure for setting up PCS in cities & on highways

Escalation in prices of EV chargers post COVID-19

High cost for land lease

To address the aforementioned challenges and accelerate the deployment of public charging infrastructure across the country, the Government of India has implemented several measures as outlined below:

1. **Reducing the mandatory requirement of charging guns:** BEE/MoP recommended reducing the mandatory requirement of charging guns from 6 to 3 in fast charging stations and from 10 to 5 in slow charging stations under FAME-II.

2. **Subsidy for Upstream Infrastructure:** BEE recommended provision of a subsidy for upstream infrastructure under FAME-II, covering up to 80% of the total upstream infrastructure cost.

3. **Ceiling Limits on Service Charges:** The Ministry of Power specified ceiling limits on service charges levied by public EV charge point operators on the EV customers to recover capital investments (excluding GST). The amendment specifies a ceiling of Rs 2.50 per unit and Rs 3.50 per unit of electricity used for slow AC charging of EVs at PCS during the solar and non-solar hours respectively. Additionally, a ceiling limit of Rs 10 per unit and Rs 12 per unit of electricity used for DC Fast charging of EVs at PCS during the solar and non-solar hours respectively has also been specified.

4. **Compliance Monitoring on EV Yatra Portal:** A feature developed on EV Yatra portal to monitor compliance on grant of electricity connection to public EV Charge Point Operators (CPOs) by the state DISCOMs with respect of timelines stipulated by MoP in its revised Guidelines and Standards

5. **Price Benchmarking and Revenue Sharing Model:** The initiative include price benchmarking for EV chargers of various capacities and the introduction of a Revenue Sharing Model. The Revenue Sharing Model leads to provision of land at promotional rates for public charging stations, with government/public entities, to be provided for installation of Public Charging Stations to a government/public entity on a revenue

sharing basis at a fixed rate of Rs.1/kWh (used for charging), for a period of 10 years. Private entities can obtain land through a bidding process, with a floor price of Rs. 1/kWh.

3.7 Upcoming Public EV Charging stations

As electric vehicle adoption continues to grow in the country, there is an anticipation of the need for a widespread Public EV Charging Infrastructure (EVCI) to meet the future demand for EV charging. The Government of India has undertaken several initiatives to facilitate the deployment of EVCI across the nation. The key steps taken to ensure the rapid deployment of Public Charging Stations (PCS) in India are as follows:

Government Initiatives:

- Under FAME-II, 7,432 public EV charging stations have been sanctioned to Oil Marketing Companies (IOCL, BPCL and HPCL) for deployment at retail outlets[32].
- The Oil Marketing Companies have announced setting up of 22,000 Public EV charging stations in prominent cities and on National highways across the country. Out of the 22,000 stations, 10,000 will be installed by IOCL, 7,000 by Bharat Petroleum Corporation Ltd. (BPCL), and the remaining 5,000 by Hindustan Petroleum Corporation Ltd. (HPCL) by December 2024.[33]
- Wayside Amenities (WSA) are being developed at regular intervals of 30-40 km along Brownfield National Highways and Greenfield Expressways. As of now, 137 WSA facilities have been awarded[34].
- Delhi aims to install around 18,000 public and semi-public EV charging points by 2024.
- KSEB is targeting the installation of 3,000 destination chargers at public/private/buildings[35].
- Chandigarh is targeting the installation of 100 public EV charging stations within the city[36].

Private Initiatives:

- Ather Energy, an EV manufacturer, has announced plans to install over 2,500 charging stations by the end of 2023.[37]
- Electric vehicle (EV) charging solution provider Statiq has unveiled a nationwide plan to install 20,000 electric vehicle charging stations throughout the country in the FY2023, to support faster adoption of e-mobility.[38]

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[32] https://pib.gov.in/[illegible]
[33] https://pib.gov.in/[illegible]
[34] https://pib.gov.in/[illegible]
[35] State Nodal Agency
[36] State EV Policy
[37] https://[illegible]
[38] https://[illegible]

- Tata has announced an ambitious plan to set up electric vehicle charging stations nationwide. The plan outlines the installation of 25,000 EV charging points across the length and breadth of the country over the next five years.[70]

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[70] https://www.theweek.in/news/biz-tech/2023/01/13/tata-plans-to-set-up-ev-charging-stations-across-india.html#:~:text=Tata%20has%20announced%20an%20ambitious%20plan%20to%20set,of%20the%20country%20over%20the%20next%20five%20years.

4. Battery Swapping Stations

4. Battery Swapping Stations

Battery swapping is a technology and service that enables EV owners to quickly replace depleted EV batteries with fully charged ones, providing a convenient alternative to traditional charging, which can be time-consuming. This approach has gained attention as a potential solution to address time and range anxiety for light duty vehicles such as electric two-wheelers and electric three-wheelers. The primary challenge in developing the battery swapping ecosystem is the standardisation of swappable batteries.

Currently, more than 1,000 battery swapping stations are operational in India. The Indian EV battery swapping market reached $10.2 million in 2022 and is projected to reach $61.57 million by FY 2030, growing at a CAGR of 25.20% between FY 2022 and FY 2030.[40]

Overview of battery swapping:

a. How Battery Swapping Works:

Battery swapping stations are equipped with a substantial inventory of fully charged or semi-charged batteries, typically ranging from 12 to 15 batteries per kiosk, specific to various EV models. When an EV user arrives at a Battery Swapping Station (BSS), the depleted battery is replaced with a fully charged battery of similar specification. The process of swapping batteries for electric two and three-wheelers usually takes only a few minutes.

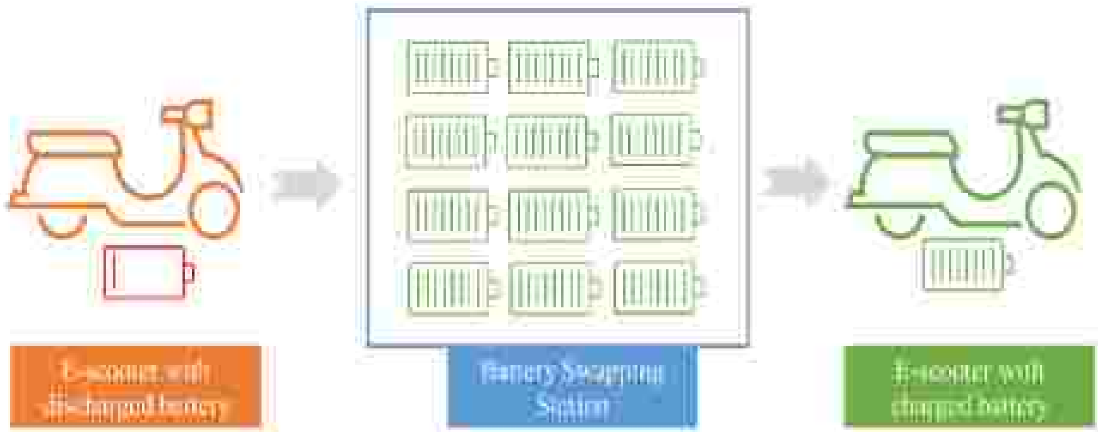

Figure 7: Battery swapping Station process

The EV user removes the drained or empty battery from the vehicle and places it in the designated slot of the battery swapping kiosk. Subsequently, the user takes a fully charged battery from another slot and installs it into the electric vehicle.

[40] https://www.psmarketresearch.com/market-analysis/india-electric-vehicle-battery-swapping-market

b. **Advantages of Battery Swapping:**

Enhanced Convenience	It offers a hassle-free solution for those without access to home charging, urban dwellers, or long-distance travellers.
Reduced Charging time	Battery swapping significantly reduces the time needed to charge an EV, addressing one of the primary concerns of potential EV buyers.
Battery Longevity	Battery swapping services often includes maintenance and monitoring of the battery health, potentially extending their lifespan.
Reduced Battery Degradation	Fast charging, especially at high power levels, can cause battery degradation. Swapping can mitigate this issue.

c. **Challenges for Battery Swapping market:**

Standardization	Manufacturers need to establish common battery form factor connects & communication projects to ensure battery compatibility across different EV models.
Infrastructure Investment	Setting up a network of battery swapping stations requires substantial investment due to high battery costs.
Battery Ownership	Battery ownership, maintenance, and quality control is a challenge considering battery will be used by various EV users.
Limited Model Availability	Battery swapping is currently available for specific EV models or brands, limiting its widespread adoption.

4.1 Government support for promotion of battery swapping

The Government of India has been actively exploring and promoting battery swapping technology as a key strategy to accelerate the adoption of EVs in the country. Battery swapping is an innovative approach that offers a solution to some of the challenges associated with EV adoption, such as range and time anxiety.

The Ministry of Road Transport and Highways permitted sale of e-2Ws and e-3Ws without a battery pack. The measure was intended to improve battery swapping infrastructure and development of 'Battery as a Service' business models, apart from reducing the upfront cost of EVs. The pay-as-you-go model is expected to not only minimize the initial cost of EVs but also drastically reduce the time required to recharge a battery pack of an e-2W or e-3W.

Furthermore, for the promotion of battery swapping, NITI Aayog held an inter-ministerial discussion to formulate a comprehensive Battery Swapping policy framework in February 2022. NITI Aayog also conducted an extensive pre-draft stakeholder discussion with a wide spectrum of stakeholders representing Battery Swapping Operators, Battery Manufacturers, Vehicle OEMs, Financial Institutions, Think Tanks & other experts and released the draft Battery Swapping policy in June 2022.[41]

Additionally, several states are promoting battery swapping through their respective state EV policies. Various fiscal and non-fiscal benefits mentioned in the EV policies of different states across the country are as follows:

S. No.	State Name (Policy status)	Financial benefits for BSS	Non-Financial benefits for BSS
1.	Andhra Pradesh (N)	• All external infrastructures will be provided at 30% of the cost of the infrastructure with limit of Rs. 2 crores per BSS. • Capital subsidy of 25% of Fixed Capital Investment up to a maximum subsidy of Rs. 10 lakhs for 50 BSS. • 100% net SGST reimbursement for purchase of advanced batteries for BEV swapping stations.	• Land across major cities will be allocated. • Facilities will be provided to setup BSS in the form of a kiosk. • Incentive to setup BSS at malls.
2.	Bihar (D)	• Suitable land on lease basis • PPP Model for setting up of charging/swapping stations	• Petrol pumps will be allowed to setup charging/swapping station freely subject to such BSS qualifying fire & safety standard norms. • Robotic Battery Swapping Arm at public bus stations. • Swapping stations at every 25 Km on state highways/ national highways in the state and every 3 km in the city.
3.	Chandigarh (N)	Subsidized EV tariff shall be applicable for BSS too	-
4.	Chhattisgarh (N)	Public & Private operators shall be invited to set up battery swapping stations across all the cities and along the NH & SH in phases by porting and providing locations at bare minimum rental lease.	-
5.	Delhi (N)	• Providing concessional locations at minimum lease rental.	-

[41] https://pib.gov.in/PressReleasePage.aspx?PRID=1815569

S. No.	State Name (Policy status)	Financial benefits for BSS	Non-Financial benefits for BSS
		• 100% of the SGST reimbursement for purchase of advanced batteries.	
6.	Goa (N)	-	• Provide Open Access without the condition of having contracted demand of 1 MW
7.	Haryana (N)	• 100% SGST as reimbursement for purchase of advanced batteries. • Capital subsidy of 25% of Fixed Capital Investment up to a maximum subsidy of 10 lakhs for 50 stations. • Buildings such as malls and other commercial buildings will be incentivized.	• All petrol pumps will be mandated to have charging stations & battery banks. • Land allocation for setting up of BSS • Facilities will be provided in the form of a kiosk to service e-2W and e-3W.
8.	Himachal Pradesh (N)	Subsidized EV tariff will be applicable for BSS.	
9.	Karnataka (N)	• 25% capital subsidy on equipment/machinery up to Rs. 3lakhs for 2W & 3W (100 BSS), up to Rs. 5lakhs for 4W (50 BSS) and up to Rs. 10 lakhs for bus (50 BSS). • Exemption from stamp duty. • Concessional registration charges (0.1%) • 100% of land conversion fee. • 100% exemption of electricity duty/tax on electricity tariff. • 100% of net SGST sanctioned as interest free loan.	• Provide land on long lease for setting up of BSS. • To facilitate EVs on highways, BSS will be provided at every 50 km.
10.	Kerala (N)	Capital Subsidy of 25% up to 10 lakhs for first 50 stations.	150 BSS for 2W & 3W shall be set up in 3 major cities.
11.	Madhya Pradesh (N)	-	• PCS must have standalone BS facility • At identified locations, EOIs will be invited through bidding to set up BSS • Open access & Net Metering for BS Station with RE integration.

S. No.	State Name (Policy status)	Financial benefits for BSS	Non-Financial benefits for BSS
12.	Maharashtra (N)	Demand incentive up to 50% shall be provided to the battery swapping energy operator.	-
13.	Odisha (N)	Location will be provided at minimum rental lease 100% SGST reimbursement for purchase of batteries	-
14.	Punjab (N)	Providing locations at concessional rate for setting up Swapping Infra.	-
15.	Tamil Nadu (N)	• The first 200 public battery swapping stations set up shall be eligible for a capital subsidy of 25% on the cost limited to Rs. 2 lakh per station. • Subsidised EV tariff shall be applicable for battery swapping stations	-
16.	Telangana (N)	-	Swapping station for every 50 km within state boundaries on highways.
17.	Tripura (N)	-	Government land on lease or rent will be available for BSS
18.	Uttar Pradesh (N)	Capital investment (excluding land cost) of up to Rs. 20 lakhs.	Swapping station for every 50 km within state boundaries on highways
19.	West Bengal (N)	Providing concessional locations for battery swapping stations	DISCOM shall release supply to battery swapping stations within 48 hours of application.

Note: N – Notified and D - Draft

Public & Private Sector collaboration on BSS

- Formation of a Joint Venture Company for battery swapping business in India as a Private Limited Company with 50:50 collaboration between Indian Oil and Sun Mobility Pvt. Ltd, Singapore (SMS) with Indian Oil's equity investment of Rs.1800 crore till financial year 2026-27.[42]

- Bharat Petroleum Corporation Limited (BPCL) has collaborated with battery-as-a-service (BaaS) start-up, VoltUp, to establish 650 swapping stations with over 7,800 charging docks across 50 cities over the next three years.[43]

[42] https://iocl.com/admin/img/UploadedFiles/IntimationStockExchanges/ca5230c9fb784a8a896ac7898cf44f33.pdf
[43] https://www.thehindubusinessline.com/companies/bpcl-voltup-to-set-up-650-battery-swapping-stations-across-50-cities/article66520794.ece

- Hindustan Petroleum Corporation Limited (HPCL) and Honda Power Pack Energy India Private Limited (HEID), the subsidiary of Honda Motor Co. Ltd., a global mobility giant, launched their first e-swap station at HPCL's company operated outlet at Old Airport Road, Bengaluru.[44]

- Delhi Metro Rail Corporation (DMRC) and Sun Mobility are working together to improve emission-free last-mile connectivity. DMRC has granted Sun Mobility permission to use land at the Janakpuri West, Dwarka, and Dwarka Sec-21 metro stations for setting up its battery swapping stations.[45]

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[44] https://hindustanpetroleum.com/NewsroomDetails/374
[45] https://www.financialexpress.com/business/express-mobility-dmrc-sun-mobility-flag-off-electric-3ws-with-swappable-batteries-in-delhi-2721297/

4.2 Battery swapping operators in India

Battery swapping operators in India are companies that provide a unique charging solution for electric vehicles (EVs) by offering battery swapping services. These operators focus on establishing a network of swapping stations strategically located to provide timely and convenient battery exchanges for EV owners. The battery swapping model aims to address the challenges of long charging times and limited charging infrastructure, providing a swift and efficient alternative.

Some of the major battery swapping players are as follows:

S. No.	Company Name	Battery swapping business (since)	Offered battery swapping for Vehicles
1	SUN MOBILITY	2017	2W & 3W
2	BatterySmart	2020	2W & 3W
3	gogoro	2023	2W, Mopeds
4	LITHION	2016	2W, 3W
5	VOLT UP	2019	2W, 3W
6	esmito	2018	2W, 3W
7	chargeup	2019	3W
8	RACE energy	2019	2W, 3W
9	BatteryPool	2018	3W

Table 11: List of Battery swapping operators in India

i) SUN Mobility:

SUN Mobility's vision is to create a universal network of interoperable energy infrastructure to accelerate mass adoption of electric mobility. The approach of separating batteries from vehicle through the quick battery swapping model addresses the key issues facing electric vehicles – high upfront cost, range anxiety and long charging time. The revolutionary digitally enabled 'Pay-as-you-go' system for battery usage offers an extremely convenient way to refuel EVs, thus fostering adoption.

ii) Battery Smart:

Battery Smart is India's largest and fastest-growing Battery Swapping Network for electric two and three-wheelers. Launched in June 2020, their aim is to revolutionize the EV sector by making electric mobility simple, economical, and accessible through a unique partner-led model.

iii) Gogoro:

Gogoro is a Taiwanese company that developed a battery-swapping refuelling platform for urban electric two-wheeled scooters, mopeds and motorcycles. It also develops its own line of electric scooters and offers its own vehicle innovations to vehicle maker partners like Hero, Yamaha, Aeonmotor, PGO, eReady, and eMOVING.

iv) Lithion Power:

Lithion Power provides an Intelligent Energy platform for battery swapping infrastructure. It focuses on providing swapping solutions for electric 3Ws and 2Ws. It claims to be India's largest "Battery as a service" operator and provides charged Li-ion batteries via its network of Lithion Swapping Points in Delhi and in adjacent areas of Haryana under NCR. Each swapping takes less than 3 mins.

v) VoltUp:

Voltup is a prominent battery swapping company in India, specializing in providing efficient and convenient battery exchange services for electric vehicles. With a well-established network of swapping stations, Voltup offers EV owners the ability to quickly replace depleted batteries with fully charged ones, minimizing charging downtime.

vi) Esmito:

Esmito is one of the leading battery swapping companies in India which offers Smart Swappable battery, Smart BMS & Vehicle IoT systems for Electric 2-wheelers and Electric 3-wheelers. Esmito offers a B2B SaaS platform for EV Infrastructure management including battery swapping management. The cloud-based platform enables real-time monitoring, control, and management of EV Infrastructure, as well as the capability to battery performance analytics and can effectively integrate with third-party systems.

vii) E-Chargeup:

E-Chargeup solutions operates Battery Swapping Stations for electric 3Ws through its dealer network. The start-up offers 'Battery as a service' to electric 3W drivers. They are building a Driver First platform which will enable higher earnings, access to credit and a sustainable livelihood.

viii) RACE Energy:

RACE is a deep-tech battery swapping company which is building advanced swappable batteries and smart swapping network for use across all segments of EVs. RACE Energy has a grand vision of powering the world's largest battery swapping network. As a go-to-market strategy, RACEnergy is establishing the demand for swapping solutions by retrofitting ICE 3 Wheelers into electric.

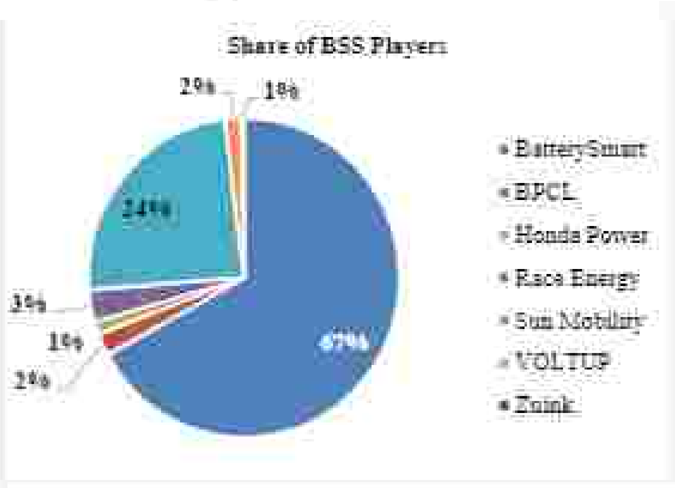
ix) Battery Pool:

BatteryPool provides IoT-enabled, battery agnostic swapping stations and an API-first software ecosystem that fleets can integrate into existing software ecosystems. The company also works with battery manufacturing partners to provide an integrated solution to operators needing battery packs with the station.

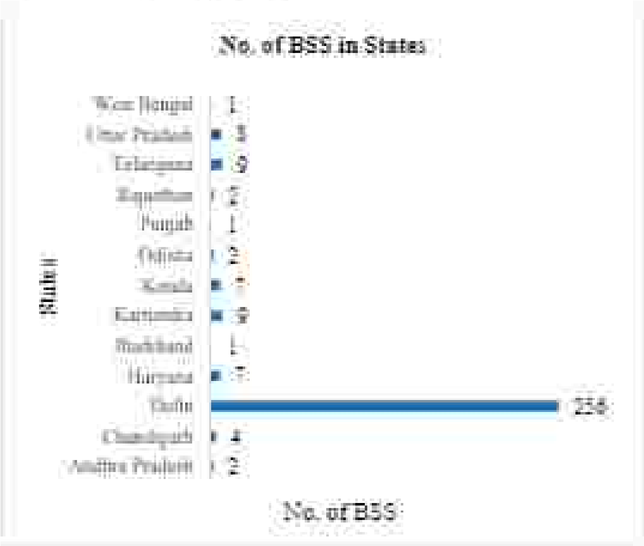
4.5 Operational Battery Swapping Stations

According to the India Energy Storage Alliance (IESA), there are more than 20 active battery-swapping operators in the country, operating approximately 1,000-1,100 swapping stations with over 1.5 lakh batteries.

Details of operational battery swapping stations operational in different states along with share of different BSS operators is as follows:



Graph 19: Battery Swapping Players market share



Graph 20: Operational BSS in different states

As mentioned above, there are several battery swapping operators providing solutions for e-2W and e-3W users. However, manufacturers utilize various battery chemistries and form factors to create packs that meet their specifications, leading to complexity in battery standardization. Therefore, prioritizing battery standardisation has the potential to be a game-changer for the battery-swapping market in India.

4.4 Standardisation of Swappable Battery

EV Battery standardization involves the development and implementation of common technical and design specifications for EV batteries. This standardisation aims to ensure compatibility, safety, and efficiency across different EV brands and models. Some of the key benefits of battery standardisation are as follows:

i. **Increased Consumer Confidence:** Standardization enhances consumer confidence in EV technology. Buyers can trust that they won't face compatibility issues or safety concerns when using standardized batteries.
ii. **Reduced Costs:** Standardized batteries can lead to economies of scale in production, resulting in lower manufacturing costs. This cost reduction can potentially be passed on to consumers, making EVs more affordable.
iii. **Faster Technological Advancements:** Battery standardization can drive innovation in battery technology as manufacturers focus on improving standardized components, resulting in more efficient and cost-effective batteries.
iv. **Environmental Benefits:** Standardization can lead to the recycling and repurposing of used batteries more effectively, reducing waste and minimizing the environmental impact of battery disposal.
v. **Resale Value:** EVs with standardized batteries may have higher resale value since potential buyers can be assured of easy battery replacement and maintenance.

Battery standardization is crucial for the growth and acceptance of electric vehicles, as it addresses many of the challenges related to EV battery technology. It fosters a more mature and robust ecosystem, ensuring that EVs are practical and convenient for consumers while supporting the transition to more sustainable transportation solutions. Some of the key aspects related to EV battery standardization are mentioned below:

- **Battery Form Factor:** Standardization involves defining common physical dimensions, connectors, and mounting mechanisms for swappable batteries. This ensures that batteries from different manufacturers or providers are compatible with a wide range of EVs.

- **Voltage and Capacity:** Establishing standardized voltage levels and capacity ranges for swappable batteries helps to ensure its usage in various types of EVs without the need for any modifications.

- **Communication Protocols:** Standardized communication protocols between the battery and the vehicle is essential for seamless integration. These protocols enable EVs to communicate with the battery to monitor its state, manage charging and discharging, and ensure safety.

- **Safety Standards:** Safety is paramount in battery swapping. Standardization includes safety features such as thermal management, overcharge protection and prevent accidents and ensure the integrity of swappable batteries.

- **Interoperability:** Interoperability is a key goal of battery standardization. It ensures that batteries from one manufacturer or provider can be used with EVs from different brands or models, enhancing the flexibility and convenience of battery swapping.

- **Testing and Certification:** Standardization typically involves rigorous testing and certification processes to ensure that swappable batteries meet established safety, performance, and compatibility standards.

- **Industry Collaboration:** Achieving battery standardization requires collaboration among EV manufacturers, battery manufacturers, technology providers, and regulatory bodies. Industry-wide agreements and consensus play a crucial role in setting and implementing standards.

Standardization efforts are ongoing, and they are essential for the widespread adoption of battery swapping. Standardization would simplify the logistics of battery swapping networks, reduce costs, and make EVs more affordable, attractive & convenient for consumers. As the EV industry continues to grow, standardization of battery packs & swap station is likely to remain a focal point for enhancing the efficiency and effectiveness of battery swapping solution.

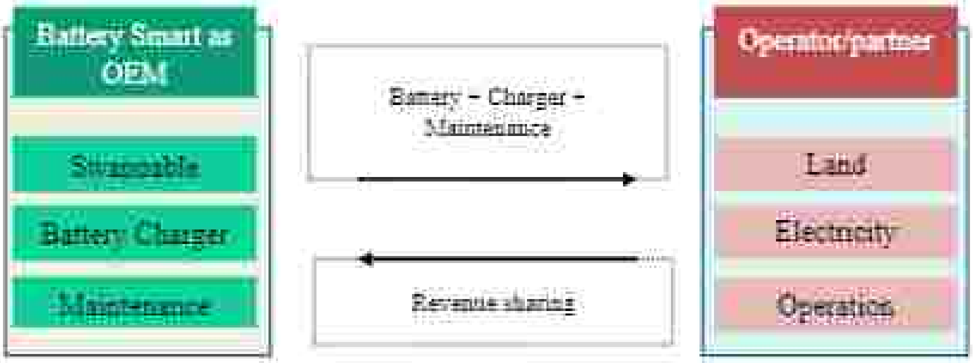
4.5 Existing Battery Swapping Business models

The battery swapping business model involves providing a service where EV owners can swap their discharged batteries for fully charged ones at designated swapping stations. This model offers a solution to address the limitations of EV charging infrastructure, such as long charging times and limited availability of charging stations. Various business models being used to promote Battery Swapping in India are as follows:

a. Partnership model:

In this model, the OEM provides the batteries and charger at subsidized rate to the operator partner while the cost of land and the operation cost is borne by partner. Maintenance of Battery & chargers is borne by the OEM. This model provides lowest CAPEX and OPEX for the operator.

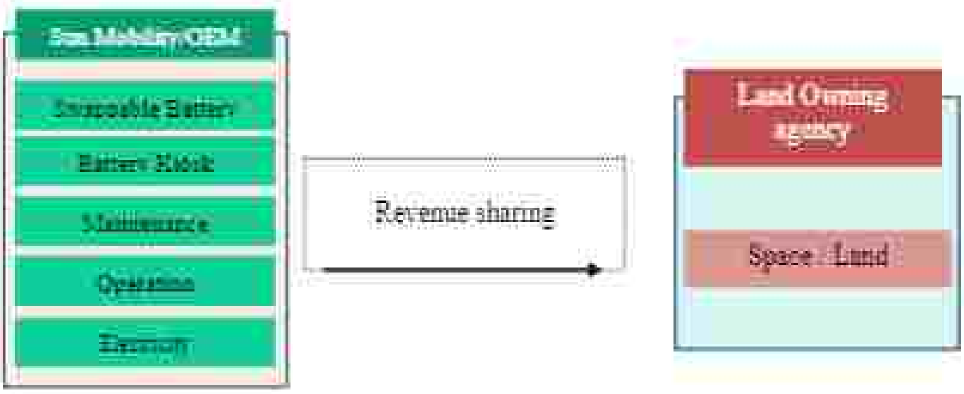
For example, Battery Smart a battery OEM has adopted this model, and is offering its product to interested partners. This business model is also known as battery-as-a-service (BaaS).



b. Revenue sharing model:

In this arrangement, the Battery Swapping Operator/OEM possesses and oversees the charger and batteries while being responsible for their operation and maintenance. The land is supplied by a land-owning agency, and the OEM splits & shares the revenue with the land-owning agency, revenue is determined by the earnings from battery swapping business. In this model, both the capital expenditure (CAPEX) and operational expenditure (OPEX) are shouldered by the battery swapping operator.

For example, this model is adopted by Sun Mobility for its battery swapping stations in India.

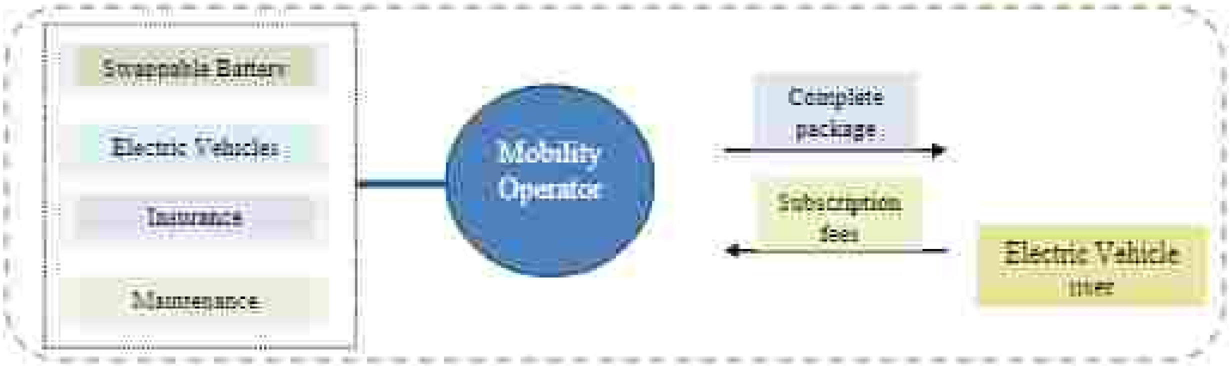


c. Services offering for EV users by Battery swapping operators

Battery swapping operators in the market are offering two types of services to EV users: Battery as a service (BaaS) and Mobility as a service (MaaS) which differ in terms of the included products.

i) Mobility as a Service:

In the Mobility as a Service model, the battery is included with the vehicle, along with additional services such as insurance and maintenance. This comprehensive subscription-based solution empowers clients, particularly in the B2B sector, to decrease the assets managed by business proprietors.



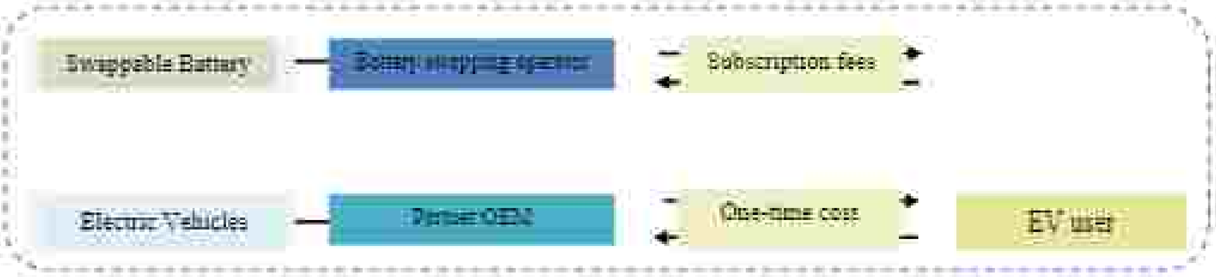
Advantages: Mobility as a service brings players seeking asset light solutions to the market; it increases the number of customers.

Disadvantages: Mobility as a service players acquire ownership of the vehicle, the CAPEX and inventory increase, and high vehicle utilization is required to ensure return on investment.

Players: Three major players are providing this service – Bounce Infinity, Zypp and Sun Mobility

ii) Battery as a service:

Battery as a Service exclusively furnishes the battery to users through subscription or pay-per-use/charge arrangements, primarily targeting the B2C sector, where individual users or fleet operators maintain ownership or leasing of their respective vehicles or fleets.



Advantages: Reduced capital expenditures for Battery Service Operators compared to Mobility as a Service, given that vehicle ownership remains with the user.

Disadvantages: Limited reach within B2B customer base

Players: Two major players are providing this service – Battery Smart and Sun Mobility

4.6 Futuristic prospects of battery swapping in India

As discussed above, battery swapping solution provides an innovative approach for large scale EV adoption. This section outlines a future prospect of battery swapping in India, with the aim of revolutionizing the e-mobility landscape and accelerating the EV adoption.

i) Robust Infrastructure Development:

- Establishing a network of battery swapping stations across major cities, highways, and transportation hubs would ensure accessibility and convenience for EV users.
- Collaboration with public and private stakeholders to invest in infrastructure development, including land acquisition, construction, and deployment of battery swapping stations will be the key for development of battery swapping.

ii) Standardization and Compatibility:

- Develop industry-wide standards for battery modules and connections to ensure interoperability among EV manufacturers and battery swapping service providers.
- EV manufacturers may be encouraged to adopt standardized battery designs and compatible interfaces to facilitate seamless battery swapping across different vehicle segments and brands.

iii) Automated Battery Swapping Process:

- Implement automated and efficient battery swapping systems that minimize the time required for swapping, ensuring a hassle-free experience for EV users.
- Utilizing robotic technologies and artificial intelligence to enable fast and accurate battery swapping, which would reduce the need for manual intervention.

iv) Renewable Energy Integration:

- Incorporate renewable energy sources, such as solar or wind at battery swapping stations to reduce dependence on the grid.
- Implement energy storage solutions to store excess renewable energy and provide a reliable and uninterrupted power supply to the battery swapping station.

v) Battery Lifecycle Management:

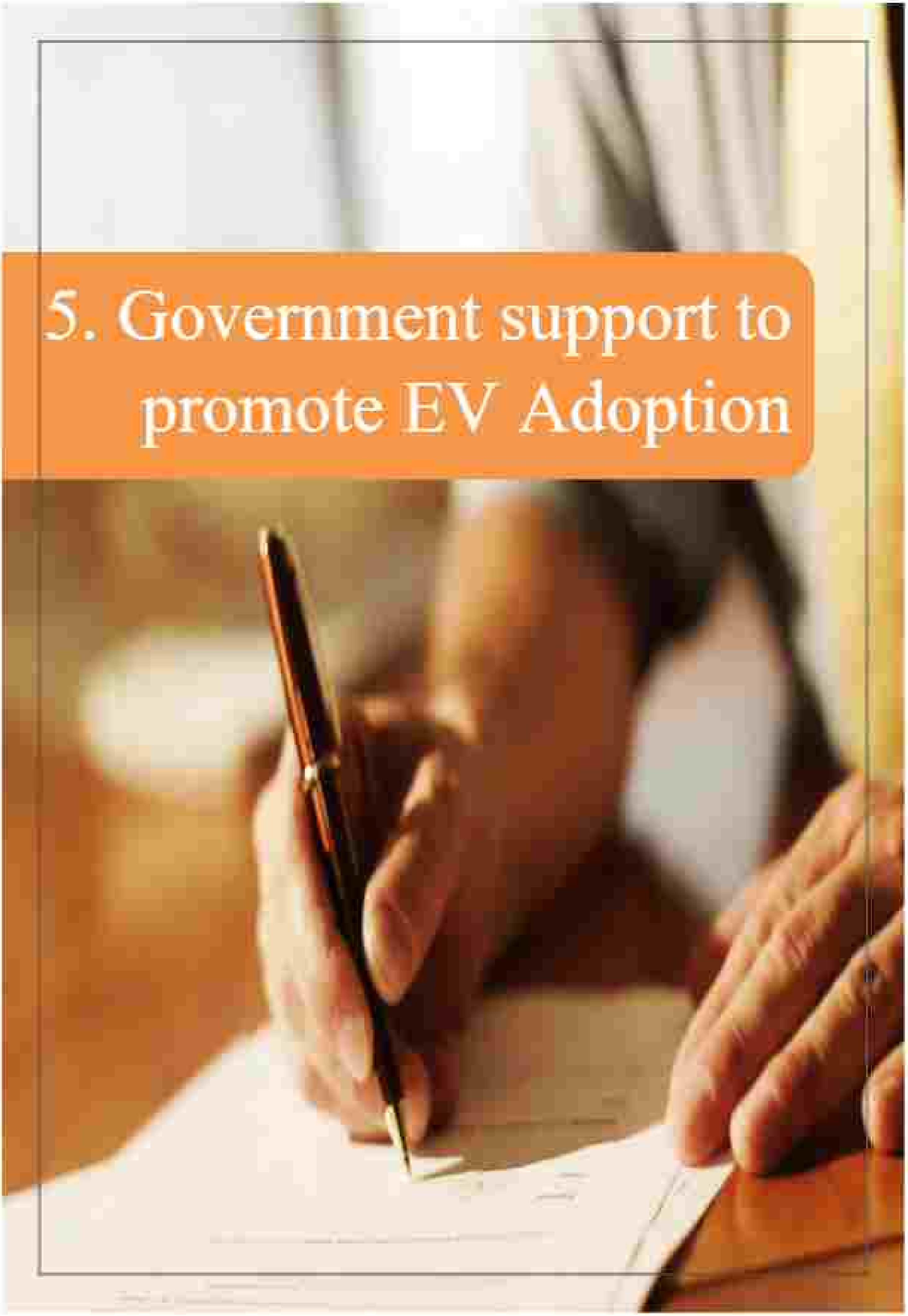
- Establish a comprehensive system for battery lifecycle management, including battery monitoring, maintenance, and recycling.
- Implement efficient battery monitoring systems to track battery health, performance, and degradation, enabling proactive maintenance and replacement, if required.
- Develop partnerships with recycling firms to ensure responsible and environmental-friendly disposal of end-of-life batteries.

vi) Collaborative Approach:

- Foster collaboration between EV manufacturers, battery technology providers, infrastructure developers, and government agencies to drive the widespread adoption of battery swapping in India.
- Establish public-private partnerships to overcome challenges related to funding, regulatory frameworks, and technology advancements.

By embracing futuristic vision, India can transform its e-mobility sector, making EVs a viable and sustainable transportation choice specially for e-2W and e-3W segment.

5. Government support to promote EV Adoption



5. Government support to promote EV adoption

Government of India (GoI) has been promoting electric mobility for more than a decade now however, the EV adoption gained significant momentum in recent past with the introduction of progressive policies and regulations by the Central as well as the State Governments. With evolution of technology and introduction of conducive policies, EVs are now at par with their ICE counterpart and are even superior to ICE vehicles in terms of lower cost of ownership, reduced dependence on crude oil and does not pollute the environment. EVs offer a wide spectrum of benefits including economic, environmental, and operational benefits over the conventional fossil fuel-powered vehicles. With introduction of progressive policies, EV sales in India witnessed a CAGR of more than 30 % over the last 5 years.

During COP26, India has committed to reduce its emission intensity (of its Gross Domestic Product) by 45% from the 2005 level by year 2030. To reduce emissions from the road transport sector, Government of India has undertaken various proactive steps / initiatives in the recent past and through its ministries has initiated coordinated action plan to develop e-mobility ecosystem in the country by introducing fiscal and non-fiscal incentives for manufacturing and adoption of EVs.

5.1 Current Indian policy and regulatory regime for promotion of EVs

Progressive EV policies at Central and State level ensured accelerated adoption across the country in the last decade. The illustration below provides the list of policies and regulations notified by the Government of India to accelerate adoption of electric mobility in the country:

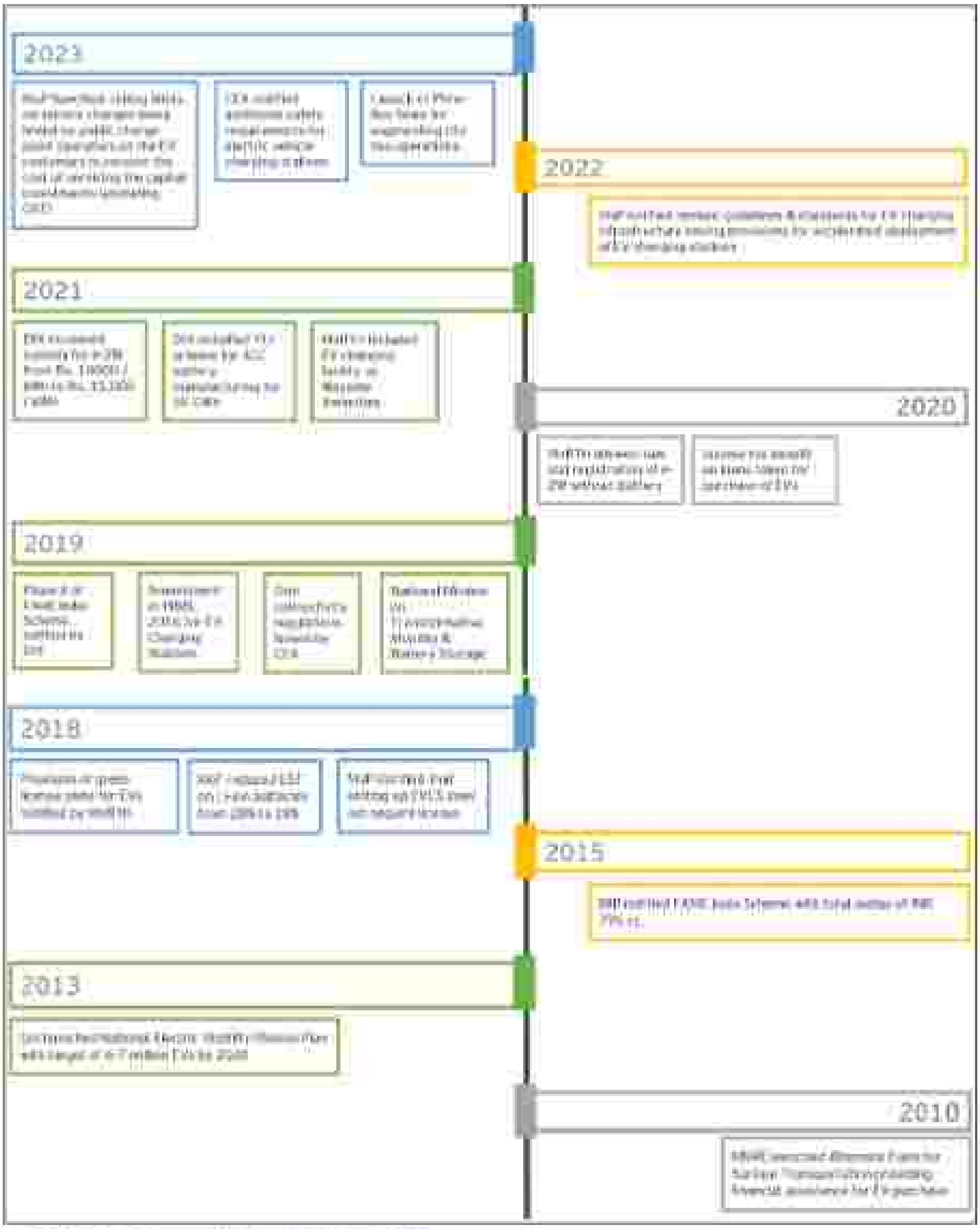


Figure 5: Central Government Initiatives for e-mobility

5.2 Central Government Initiatives

5.2.1 Ministry of Heavy Industries (MHI):

The Department of Heavy Industry (DHI), under Ministry of Heavy Industries (MHI), launched the National Electric Mobility Mission Plan (NEMMP) 2020 in the year 2013 with an objective of achieving national fuel security by promoting hybrid and electric vehicles in the country.

The target of NEMMP was to achieve 6-7 million sales of hybrid and electric vehicles by year 2020.

FAME India Scheme

As part of NEMMP 2020, the Department of Heavy Industry notified Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme in year 2015 with total financial outlay of Rs. 795 cr. for a period of 2 years which was later extended till 31st March 2019, the scheme focused on four areas, namely, Technology Development, Demand Creation, Pilot Projects, and Charging Infrastructure.

The demand incentive was extended to xEV buyers in the form of subsidy on the purchase price of EVs to encourage wider adoption. Additionally, grants were sanctioned for Pilot Projects, R&D/Technology Development and Public Charging Infrastructure under the scheme. In the first phase of scheme, about 2.80 lakh xEVs were supported with a total demand incentive of Rs. 359 Cr. Furthermore, 465 buses were sanctioned to various cities/states under this scheme.

In March 2019, DHI notified Phase II of FAME India scheme, with total budgetary outlay of Rs. 10,000 Cr. (with Rs. 366 Cr. committed expenditure of Phase –I) for a period of 3 years (2019-22), which was later extended till 31st March 2024.

The objective of the scheme is to provide upfront incentives on the purchase of EVs, support development of EV charging infrastructure and create awareness on benefits of EV adoption.

The scheme is administered through three components namely:

- Demand incentives
- Charging Infrastructure
- Administrative Expenditure including Publicity, IEC activities.

The scheme aims to deploy around 15.62 lakhs EVs across all vehicle categories. The category wise EVs to be supported, subsidy being provided, and the total fund support for different segments of electric vehicles are illustrated below:

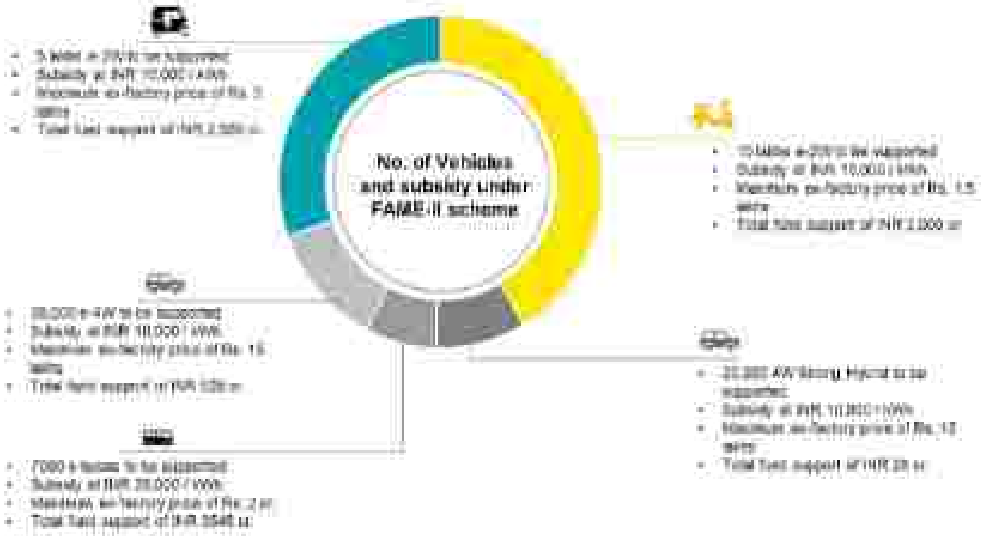


Figure 8: FAME-II scheme components

Furthermore, to sanction, implement and monitor projects under the FAME-II, an inter-ministerial panel titled "Project Implementation and Sanctioning Committee" (PISC) was established by DHI in March 2019. The PISC is chaired by Secretary (MHI) and includes members such as the CEO of NITI Aayog, secretaries of various ministries namely MoP, MNRE, Finance, MoRTH, financial advisors and directors of various association[60]. The PISC plays an important role in performing the following functions:

- Sanctioning projects under the FAME II scheme.
- Modifying the coverage of various components and sub-components of the scheme.
- Modifying limits for fund allocation under the scheme.
- Annually reviewing the demand incentive under the scheme.
- Annually reviewing vehicle-wise capping of incentive; and
- Deciding other scheme parameters to ensure smooth implementation.

To support the deployment of public EV charging infrastructure within cities and on connected Highways/Expressways, DHI issued two EoIs through which 2,877 public EV charging stations were sanctioned in 68 cities and 1,576 public EV charging stations were sanctioned across 16 national highways and 9 expressways.

The development of public EV charging infrastructure within cities focuses on the deployment of both slow and fast charging stations while on highways and expressways, the focus was to provide access mainly to fast-charging stations. The tables below provide the minimum number of public charging points/guns required per charging station to qualify for subsides under the scheme:

[60] https://heavyindustries.gov.in/writereaddata/UploadFile/Fame%20Memorandum.pdf

Table 16: PCS specification for cities under FAME-II

Type of Charging Stations	Minimum Number of Charging guns	Minimum number of EVs to be charged simultaneously	Mandatory Chargers
Slow Charging Stations	10	5	• Bharat AC 001 10 kW (3 Guns of 3.3 kW each) • Type-2 AC Charger (minimum 11 kW)
Fast Charging Stations	6	3	• CCS II (50 kW or higher capacity) • Bharat DC 001 (15 kW)

Table 17: PCS specification for highways & expressways under FAME-II

Type of mandatory EV chargers at each PCS (at least one at every 25 kms on both sides of Highway/Roads)	Type of optional EV Chargers
Fast chargers - At least one CCS II (Minimum 50 kW) or CHAdeMO (Minimum 50 kW) or higher capacity and one DC 001 (15 kW)	• Bharat AC-001 (10 kW) • Type 2 AC (22 kW)

As of December 2022, according to the data available on the MHI dashboard, 83 public EV charging stations are operational in 12 cities. Additionally, around 13 lakhs EVs have been supported through the scheme.[47]

To expedite deployment of public EV charging stations, MHI amended provisions in FAME-II scheme. In this context, 7,432 nos. public EV charging stations have been sanctioned to Oil Marketing Companies under FAME-II (IOCL-3438, BPCL-2334 and HPCL-1660). Additionally, subsidy (up to 80%) is also being provided for upstream infrastructure.

Production Linked Incentive (PLI) Scheme

The Production Linked Incentive (PLI) scheme offers financial incentives to boost domestic manufacturing of Advanced Automotive Technology products and attract investments in the automotive manufacturing value chain. Prime objectives of the scheme include overcoming cost disabilities, creating economies of scale, generating employment, building a robust supply chain in areas of Advanced Automotive Technology products and facilitating the Automobile Industry to move up the value chain into higher value-added products.

Production Linked Incentive (PLI) Scheme was introduced for manufacturing of Advance Chemistry Cell (ACC) to reduce import dependence on ACC batteries. The scheme foresees setting up of a cumulative ACC manufacturing capacity of 50 GWh for ACCs and an additional

[47] https://dash.heavyindustries.gov.in/dhiev

cumulative capacity of 5 GWh for Niche ACC Technologies, with a budgetary outlay of INR 18,100 crore.

Phased Manufacturing Programme:

The PMP Scheme was launched with the objective of domestic manufacturing of EVs, related parts and assemblies to increase domestic value addition and capacity building within the country.

- The Phased Manufacturing Programme for xEV parts was launched on 6th March 2019, and further revised on 29th April 2019, 13th May 2020 and 29th Sep 2020 with an objective of promoting domestic manufacturing of EVs, its assemblies / sub-assemblies and parts / sub-parts. The PMP scheme for xEVs included across all segments (e-2W, e-3W, e-4W, e-bus, e-trucks, Li-ion cells, Battery packs, and 18 parts including circuit breaker, on-board charger, charging inlet, vehicle control unit, traction battery pack, etc.
- The Phased Manufacturing Programme for xEV charger parts was launched on 2nd November 2021 and was revised on 07th November, 2023, with an objective to develop indigenous manufacturing of EV chargers, its assemblies / sub-assemblies, and parts / sub-parts for eligibility under FAME-II scheme. The scheme includes 12 items with minimum 50% of domestic value addition in manufacturing and effective indigenization date starting 1st December 2021.

5.2.2 Ministry of Power (MoP):

The Ministry of Power is the nodal ministry for deployment of charging infrastructure across the country. In terms of various stakeholder consultations, charging infrastructure was identified as one of the major barriers in large scale EV adoption. MoP, clarified in 2018 that charging EV batteries through charging station does not involve any of the activities namely transmission, distribution, or trading of electricity. Therefore, it does not require any license under the provisions of Electricity Act, 2003. This initiative formed the backbone of rapid deployment of public charging infrastructure across the country.

Furthermore, MoP issued guidelines & standards for Public Charging Infrastructure for EVs on 14.12.2018. These guidelines were subsequently revised / amended on 01.10.2019, 08.06.2020, 14.01.2022, 07.11.2022 and 27.04.2023. A summary of the latest consolidated guidelines & standards issued by MoP is as follows:

1) EV Charging business has been declared as a **de-licensed activity**[43].
2) **Setting up of charging stations does not require any license** under the provisions of Electricity Act, 2003.
3) **EVs owners can charge their EVs at residence/offices** using their existing electricity connections.

[43] [illegible]

4) DISCOMs are obligated to provide electricity connection to Public Charging Station (PCS) **within stipulated timelines** as mentioned in Electricity Rights of Consumer Rules (2020). PCS shall be provided connection within **seven days in metro cities, fifteen days in other municipal areas and thirty days in rural areas**. Within these timelines the distribution licensees shall provide new connection or modify an existing connection.

5) DISCOMs are permitted to **leverage funding from Revamped Distribution Sector Scheme** for general upstream infrastructure augmentation.

6) **The creation of web portal and mobile application for database** of public EV charging stations in India.

7) The Bureau of Energy Efficiency has been nominated as Central Nodal Agency for the rollout of public EV charging infrastructure.

8) **A single part EV tariff for public charging stations, where the supply tariff to PCS** shall not exceed Average Cost of Supply (ACoS) till 31st March 2025. The same tariff shall be applicable for Battery Charging Station (BCS).

9) **The tariff applicable for domestic consumption shall apply for domestic charging.**

10) **Introduction of the Revenue Sharing Model** (Rs. 1/kWh for Govt. entities & Rs.1/kWh as floor price for private entities) to address the land availability concern for setting up public charging infrastructure.

11) Specifying ceiling limits on service charges being levied by public EV charge point operators on the EV customers to recover the cost of servicing the capital investments (excluding GST) made by it in setting up the PCS. The amendment specifies a **ceiling of Rs 2.50 per unit and Rs 3.50 per unit of electricity used for slow AC charging of EVs at PCS during the solar and non-solar hours respectively.** Additionally, **a ceiling limit of Rs 10 per unit and Rs 12 per unit of electricity used for DC Fast charging of EVs at PCS during the solar and non-solar hours respectively** has also been specified.

12) The cost of supply by DISCOMs to a public EV charging station shall be 0.8 times ACoS during solar hours and 1.2 times ACoS during non-solar hours.

These provisions in the Revised Charging Infrastructure Guidelines & Standards, has been a corner stone in the Indian public EV charging paradigm and has brought public EV charging to the centre stage of ongoing discourse on public EV charging ecosystem in the country.

In addition to above guidelines, **Bureau of Energy Efficiency launched "GO ELECTRIC" Campaign in Feb 2021**, to educate the public about the benefits of e-mobility and electric cooking and make the potential EV owners aware about the Government incentives for faster EV adoption.

BEE also launched 'EV Yatra'[49] web-portal, website & mobile application on 14th December, 2022 with the objective of creating awareness and to promote e-mobility in the country. The portal has been developed to evolve as a National online database of operational public EV charging stations, in the country. The detailed features of 'EV Yatra' web portal, website and mobile application is mentioned in the below section.

Additionally, BEE as CNA has taken the following initiatives for accelerated deployment of public EV charging infrastructure across the country:

- Developed Action plans for accelerated deployment of Public EV Charging Stations in 9 mega cities having population of 4 million plus namely Delhi, Bengaluru, Surat, Ahmedabad, Pune, Mumbai, Chennai, Kolkata, and Hyderabad
- BEE is supporting State Nodal Agencies in creation of EV Accelerator Cell in seven states (Maharashtra, Delhi, Tamil Nadu, Telangana, West Bengal, Gujarat, and Karnataka) under "GO ELECTRIC" Campaign. Currently, Maharashtra, Telangana, West Bengal and Tamil Nadu have established EV Accelerator Cell while setting up of EV Accelerator Cell in rest 3 states is under progress.
- BEE developed a Guidebook on EV Charging Infrastructure in India for the use of States, State Nodal Agencies, and other State Agencies with the objective of highlighting the Central and State Level initiatives requiring harmonization to accelerate deployment of public EV charging infrastructure in India.

5.2.3. Ministry of Housing & Urban Affairs (MoHUA):

- The Ministry of Housing & Urban Affairs played a key role in amending building bye-laws to fast-track the development of charging facilities in commercial and residential building complexes. MoHUA amended Model Building Bye-Laws 2016 in year 2019, specifying that 20% of total parking facilities in residential and commercial complexes must be allotted to EV charging facilities. Additionally, building premises should have an additional power load, equivalent to the power required for all charging points (in a PCS) to be operated simultaneously, with a safety factor of 1.25 times. MoHUA has also amended the 'Urban and Regional Development Plans Formulation and Implementation Guidelines– 2014' to include the formulations of norms and standards for charging infrastructure in city infrastructure planning.
- To increase the modal share of electric bus (e-bus) based public transport in Indian cities, MoHUA launched 'PM-eBus Sewa' scheme in August 2023. The scheme will augment city e-bus operations by extending Central Assistance (CA) for 10,000 electric bus operation on Public Private Partnership (PPP) model, develop bus depot including behind-the-meter power infrastructure.

[49] evyatra.beeindia.gov.in/

5.2.4 Ministry of Finance (MoF):

To support the 'Make in India' initiative of the Government of India, the Ministry of Finance rationalised customs duty for various vehicle categories battery packs and cells in year 2019. The MoF also reduced GST rates on the purchase EVs from 18% to 5% and announced income tax rebate on loan repayment taken for purchase of EVs. Additionally, MoF, reduced GST on Lithium-Ion batteries from 28% to 18%.

5.2.5 Ministry of Environment Forest & Climate Change (MoEFCC):

The Ministry of Environment, Forest and Climate Change notified Battery Waste Management Rules, in year 2022, to strengthen the ecosystem for handling and disposing of batteries across India. These rules operate on the principle of Extended Producer Responsibility which aims to establish accountability every player in the value chain, including central and state authorities, ensuring the collection and recycling/refurbishment of waste batteries and the use of recovered materials from waste into new batteries. It aims at creating an effective mechanism for the disposal of batteries and ensure public safety.

5.2.6 Ministry of Road Transport & Highways (MoRTH):

The Ministry of Road Transport & Highways holds the responsibility for formulating policies and regulations related to road transport. It actively contribute to the promotion of EVs by introducing non-financial incentives, such as reducing road tax, improving parking infrastructure and granting priority lane access, among others. MoRTH introduced the following initiatives to promote electric mobility in the country:

- Exemption of EVs from requirement of passenger transport permit
- Introduction of a Green license plate mark for all EVs
- Advised States to minimize road tax on EVs
- Permitted sale of e-2W and e-3W without battery pack
- Amended Central Motor Vehicles Rules (CMVR), 1989 to allow license to drive Gearless Electric Scooters and bikes up to 4.0 kWh on board battery size for 16-18 years age groups.
- Released policy guidelines for development of wayside amenities along national highways & expressways including electric vehicle charging stations.

5.2.7 Ministry of Petroleum & Natural Gas (MoPNG)

MoPNG, responsible for distribution of fossil fuel across the country started promoting alternate fuels and has committed to reduce oil import dependency. Below are the initiatives taken by MoPNG:

- The Ministry of Petroleum and Natural Gas (MoPNG) revised the guidelines for authorization to market transportation fuels, aiming to promote ease of doing business and encourage private investment in the retail sector. In addition to conventional fuels, the authorized entities are required to install facilities for marketing at least one new generation alternate fuels such as Compressed Natural Gas (CNG), biofuels, Liquefied Natural Gas (LNG), electric vehicle charging points etc. at their proposed retail outlets (RO) within three years of operationalization of the said outlet, subject to the entity complying with various other statutory guidelines.
- Oil Marketing Companies (IOCL, BPCL and HPCL) have undertaken a commitment to establish 22,000 EV charging stations in prominent cities and National Highways across the country by December 31, 2024. The proposed distribution of these stations includes 10,000 installations by Indian Oil Corporation Ltd. (IOCL), 7,000 by Bharat Petroleum Corporation Ltd. (BPCL), and the remaining 5,000 by Hindustan Petroleum Corporation Ltd. (HPCL).

5.2.7 'GO ELECTRIC' Campaign

Realizing the importance of awareness for large scale EV adoption in the country, MoP launched a nationwide awareness campaign, 'GO ELECTRIC' on 19th Feb 2021.

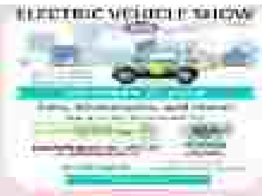
The primary objective of the 'Go Electric' campaign is to create awareness among masses about the benefits of transitioning to Electric Vehicles (EVs), including various initiatives undertaken by both the Central and State Governments to enhance acceptability of EVs, and Electrical Cooking. 'GO ELECTRIC' campaign is being implemented through State Nodal Agencies (SNAs) designated by respective States to coordinate activities related to rolling out Public Charging Infrastructure. Under this campaign, Workshops, Webinars, Technical talks, Seminars and road Shows are being organized to connect with the masses and spread the message of going electric. The reduction in the import bill of crude would be the outcome of the campaign as more and more consumers adopt EVs as a preferred choice when buying new vehicles over the next decade.

The Bureau of Energy Efficiency (BEE) has been designated as the Central Nodal Agency (CNA) to facilitate the deployment of charging infrastructure across the country, provide financial support to State Designated Agencies (SDAs) for implementing consumer awareness programmes under 'GO ELECTRIC', and coordinate with relevant stakeholders at both the central and state levels.

'GO ELECTRIC' Activities conducted by States:

EV road shows

GO - ELECTRIC Campaign



Pamphlets Distribution

Promotional Videos

Quiz Competition

Webinars

EV Exhibition and Carnival

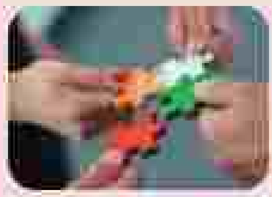
Extreme Speech Competition

Hoardings

FM Radio Jingles

Street Play

Advertisement



Collaborations

Awareness Programs

Placards

Posters

Brochures

Workshop

Pictorial representation 'GO ELECTRIC' activities

5.2.8 'EV Yatra'

The Hon'ble President of India launched 'EV Yatra' website, web-portal & mobile application on December 14, 2023 with the objective of creating awareness among the EV users and masses at large to promote e-mobility in the country. The portal has been developed to serve as a National online database, offering information on operational public EV charging stations, in the country. EV users can conveniently check the availability of the nearest compatible EV charger for their EVs, along with assessing other related services.

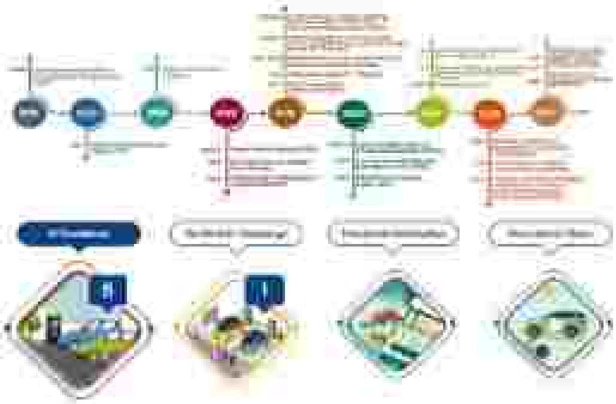
Features of 'EV Yatra'

Some of the notable features of EV Yatra are:

- Single point for locating operational PCS across the country
- Seamless registration of CPO
- Comprehensive dashboard
- Single point access for Central and State Government Schemes for e – mobility
- Various tools and calculators for EV Users
- Route Planner for locating EV Users along the route
- Reviews and feedback

'EV Yatra' Website:

Through 'EV Yatra' website, users can view the currently operational public EV charging stations across the country, along with their details such as connector type, availability status, contact person, while navigating to a particular charging station. The web portal highlights initiatives taken by the Central as well as State Government along with the various activities being undertaken by the states under 'GO ELECTRIC' campaign. Additionally, various tools / calculators available on the portal can be utilized to estimate running cost (cost / km), energy cost, comparison of vehicles, and the overall ownership cost of an electric vehicle.

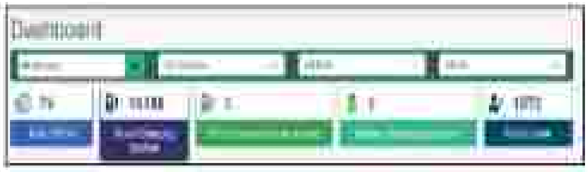


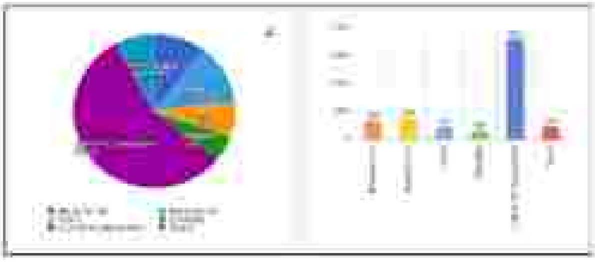
'EV Yatra' Web-Portal:

'EV Yatra' portal and website serve distinct roles in the EV ecosystem. The 'EV Yatra' Portal is a exclusively designed for Charge Point Operators (CPOs) to register their operational charging stations. In the portal, CPOs can easily register and input necessary information about their network of Public Charging Stations (PCS), with the flexibility to update this data periodically. This process is facilitated through the use of the Open Charge Point Interface (OCPI) or open APIs, which are conveniently accessible and downloadable from the web portal.

A standout feature of the 'EV Yatra' Portal is its capability to streamline administrative processes for CPOs. For example, when a CPO applies for an electrical connection for its PCS, they can directly upload electricity connection receipts/demand notes obtained from Distribution Companies (DISCOMs) onto the portal. Furthermore, the portal allows CPOs to track the status of their application submissions with DISCOMs, establishing a seamless and transparent communication channel.

Moreover, the portal offers a comprehensive dashboard. Through this dashboard, both State Nodal Agencies (SNAs) and Charge Point Operators (CPOs) after securely logging into their account can efficiently oversee the operational public charging stations located within their respective states. This centralized monitoring system enhances the overall management and coordination of charging infrastructure, promoting the widespread adoption of electric vehicles in the region.





'EV Yatra' Mobile Application:

'EV-Yatra' mobile application, developed by the Bureau of Energy Efficiency (BEE), serves as a valuable tool for EV users, offering in-vehicle navigation to the nearest public charger.

The application utilizes GPS coordinates to provide real-time data on the types of chargers available at the station, charger availability, prevailing EV charging tariffs, service fees, and other relevant information. Currently available in English and Hindi, the application undergoes frequent updates and acts as a platform to gather consumer feedback for continuous improvement and enhancement of its features.

6 State E-mobility Index

6. State e-mobility index

The adoption of electric mobility in India has witnessed a significant upswing in recent years. The introduction of various policies & regulatory initiatives by both the Central and State Governments, along with fiscal and non-fiscal incentives, has provided a substantial boost to EV demand in the country. Favourable government policies supporting the growth of EVs, coupled with decreasing EV battery costs, are expected to drive exponential expansion in EV adoption across India.

As EV adoption increases, there is a need for a supportive policy framework and regulatory regime. This includes the provision of safe, accessible, and affordable EV charging infrastructure, implementing a mass awareness campaign on benefits of e-mobility and adoption of best practices from leading states for rapid EV adoption in India. States and UTs, being responsible for creating an impact through the successful implementation of any program, must assess their preparedness to become EV Ready.

In view of the above, BEE has assessed the implementation status of e-mobility programs at the state level, based on 15 criteria. These criteria encompass various aspects, including provisions in state EV policies, tariff related provisions in state tariff orders, the deployment of public EV charging infrastructure, e-mobility awareness activities, and the promotion of e-mobility in public transportation. Some of the identified criteria that would promote the development of EV charging infrastructure within states are mentioned below:

a. **Availability of concessional land for PCS deployment:**

The cost of acquiring land is a significant factor that impacts the financial viability of operating an EV charging station. Identification of feasible locations for deployment of public EV charging infrastructure is a key challenge particularly in the urban areas. Providing safe, reliable, and accessible public EV charging infrastructure is crucial for alleviating the perception of range anxiety among EV users.

As per the revised guidelines & standards issued by MoP dated January 14, 2022, for Public Charging infrastructure, land available with government/public entities shall be provided for installation of Public EV Charging Stations to a government/public entity on a revenue sharing basis at a fixed rate of Rs.1/kWh. Additionally, in case of government land being provided to a private entity for PCS installation, the land will be provided through a bidding process with a floor price of Rs.1/kWh.

In view of this provision being introduced by the MoP, Government of India, initiatives taken to facilitate development of public EV charging stations at feasible locations have been examined.

b. **Levy of demand Charges by DISCOMs:**

Fixed or demand charges for an electricity connection is levied based on the sanctioned load by DISCOMs on consumers. This charge is paid irrespective of the actual energy usage. Considering the low demand for EV charging during the early phase of EV adoption, exemptions of demand charge for EV charging connections may enhance the business case for setting up public charge points.

In this context, Ministry of Power through its revised guidelines & standards for EV charging infrastructure dated January 14, 2022, notified provision of single part tariff (waiving off fixed demand charges) for public EV charging stations and battery swapping stations till 31st Mar 2025.

Through this criterion, the compliance by the state government in waiving off fixed electricity demand charge for public EV charging stations has been examined.

c. EV supply tariff:

Most of the State Electricity Regulatory Commission have created new tariff category for EV charging stations in their respective tariff orders.

MoP through revised guidelines and standards for EV charging infrastructure, specified that tariff for supply of electricity to PCS shall not exceed Average Cost of Supply (ACoS), till 31.03.2025. The same tariff shall also be applicable for Battery Charging Stations.

Assessing compliance of states with MoP guidelines & standards is essential as providing subsidised EV charging tariff would reduce operational cost of EVs, thus encouraging widespread EV adoption.

d. LT load limit for EV Charging Stations:

Currently, the LT load limit in the country vary from 50 kW to 160 kW. Increase in the LT load limit would be beneficial for the EV charge point operator as this would allow them to install fast EV chargers without the need of infrastructure augmentation. This highlights the states that offer a more favourable landscape to charge point operators in terms of higher LT load limit.

e. Availability of operational PCS in urban area / 9 sq. km:

According to the MoP revised guidelines & standards, there should be at least 1 charging station within a grid of 3 km x 3 km in urban area. This criterion analyses the states' preparedness in catering to the charging demand of existing and upcoming EVs and thus compliance with the MoP guidelines.

f. Availability of number of operational PCS on highways / 25 km:

National Highway in India spans approximately 1,44,955 kms. With the continuous expansion of the highway network, the strategic placement of PCS at appropriate locations becomes essential for addressing the perception of range anxiety for EVs.

MoP, through revised guidelines & standards, specified that at least 1 charging station shall be available at every 25 km on both sides of highways / roads. Additionally, for long range EVs and / or heavy duty EVs like buses / trucks, etc. there shall be at least 1 fast charging station at every 100 km, one on each side of the highway / roads.

Furthermore, MoRTH considered EV charging stations as one of the way-side amenities to be set up along National Highways. Additionally, under FAME-II scheme, 1576 PCS are sanctioned on 16 national highways and 9 expressways across the country.

g. Ratio of EV and EV charger (slow and fast):

The deployment of an adequate number of public EV charging stations is essential for the widespread adoption of electric vehicles. In 2022, India witnessed a rapid increase in the deployment of public EV charging infrastructure, with 10,249 PCS deployed, compared to 2926 PCS in the preceding year.

Fast EV chargers are more effective in catering to a larger number of EVs compared to slow EV chargers, primarily due to their higher kW capacity. Moreover, fast EV chargers address the time anxiety of EV users, as slow EV chargers, with their lower current handling capacity, take more time to charge an EV. Therefore, more weightages has been assigned to this criterion. To further analyse the ratio of EVs to deployed public chargers, the criteria have been subdivided into two parts: the ratio of EVs to Slow chargers and the ratio of EVs to Fast chargers.

h. 'GO ELECTRIC' Campaign:

Awareness is critical for large scale EV adoption and in this direction, the Ministry of Power launched a nationwide awareness campaign, 'GO ELECTRIC' in the year 2021. The objective of the campaign is to create awareness about e-mobility benefits among public and various state agencies through EV roadshows / rallies, webinars for relevant e-mobility stakeholders, technical talks for knowledge sharing on e-mobility, audio, and print media such as distributing pamphlets, radio jingles, etc. As of March 2023, 450 number of activities have been conducted by states across the country.

This criterion is essential, as states play a pivotal role in implementation of 'GO ELECTRIC' Campaign to ensure it reaches to masses in the urban as well as rural areas.

i. Subsidy for PCS deployment:

The deployment of public charging infrastructure requires significant investment. To facilitate charge point operators in deploying PCS, subsidy of Rs. 1000 crore was sanctioned under the FAME-II scheme. Additionally, various state government have included provisions for fiscal incentives for the deployment of both slow and fast public EV charging stations in their respective state EV policies. This criterion compares states based on the total subsidy provided for the deployment of both slow and fast PCS.

Further, to analyse the subsidy for PCS deployment, the criteria has been sub-divided into two parts namely, subsidy for deployment of slow PCS and subsidy for deployment of fast PCS.

j. PCS sanctioned under FAME-II:

Under FAME-II scheme, 2877 public EV charging stations were sanctioned to 68 cities. However, only 83 public EV charging stations were deployed till Dec 2022. Considering the slow progress of public charging infrastructure, Government of India sanctioned 7,432 PCS to Oil Marketing Companies. This criteria has been considered based on the number of public EV charging stations to rank states.

k. Share of electric buses in state transport fleet:

Considering the Government of India's focus on electrification of public transport bus fleets and the recent announcement of PM e-bus sewa scheme, this criteria has been taken into consideration for comparing the initiatives of states based on the percentage share of e-buses in the overall bus fleet deployed by the respective States.

l. Presence of a State Nodal Agency for EV Charging Infrastructure:

Having an institutional structure is necessary for accelerated deployment of evolving technology such as electric mobility. In terms of MoP revised Guidelines & Standards, BEE has been nominated as the Central Nodal Agency for rollout of public EV charging infrastructure in India. Similarly, state shall nominate a Nodal agency responsible for deployment of public EV charging infrastructure across the state and to act as single window entity for providing necessary clearances to CPOs from concerned state agencies.

Using this criterion, states are ranked basis availability of SNA for EV charging infrastructure.

m. Share of EV sales in total vehicle sales (last 2 years, i.e., FY2021-22 and FY2022-23)

Notification of FAME India Scheme Phase II removed the challenge of high upfront cost of EVs among public, and subsidy being provided by various state government over and above the FAME subsidy resulted in 3x growth in EV sales numbers in FY2022-23 as compared to year before. This is one of the key criteria as states play a crucial role in creating favourable environment for large scale EV adoption.

For assessing this criterion, the EV sales number in last 2 years (post COVID sales figure) has been considered.

6.1. Selection criteria and data collection

The criteria for establishing readiness index of states were selected to cover policy, regulatory and implementation aspects for EV adoption. Subsequently, a questionnaire was developed and circulated to State Nodal Agencies (SNAs) and State Designated Agencies (SDAs) of all states and Union Territories. For most of the criteria, information provided till FY2022-23. The weightage assigned to each criteria is such that higher weightage is given to those related to implementation compared to the one related to policy & regulatory criteria.

The final score is the summation of the weighted values assigned to each criteria. The scoring for each criteria is determined based on the score range of each state (ranked from 0 to 5, 5 being the best performance).

The scoring methodology is at **Annexure A**.

Table 11: Criteria and Weightage for ranking

S.No.	Criteria for evaluation	Weightage
i)	Share of EV sales in total vehicle sales (last 2 years, i.e., FY2021-22 and FY2022-23)	7.00
ii)	Nominated SNA for EVCI deployment & act as a single window clearance agency	8.00
iii)	Share of e-buses in total state bus fleet	8.00
iv)	No. of PCS sanctioned under FAME-II	6.00
v)	Capital subsidy for deployment of fast PCS (Rs.)	5.00
vi)	Capital subsidy for deployment of slow PCS (Rs.)	2.00

S. No.	Criteria for evaluation	Weightage
vii)	Share of GO ELECTRIC activities	7.00
viii)	EV / EVSE ratio (fast PCS)	20.00
ix)	EV / EVSE ratio (slow PCS)	2.00
x)	Ration of PCS deployed on highways every 25 km	5.00
xi)	Ratio of operational PCS in urban area / 9 sq. km	6.00
xii)	Higher LT load limit threshold	3.00
xiii)	Availability of EV Charging tariff in State tariff order	8.00
xiv)	Demand charges waiver (Rs. / kW or KVA)	6.00
xv)	Provision to facilitate availability of concessional land parcels in state EV policy for PCS deployment	5.00
	Total	**100**

Missing Values

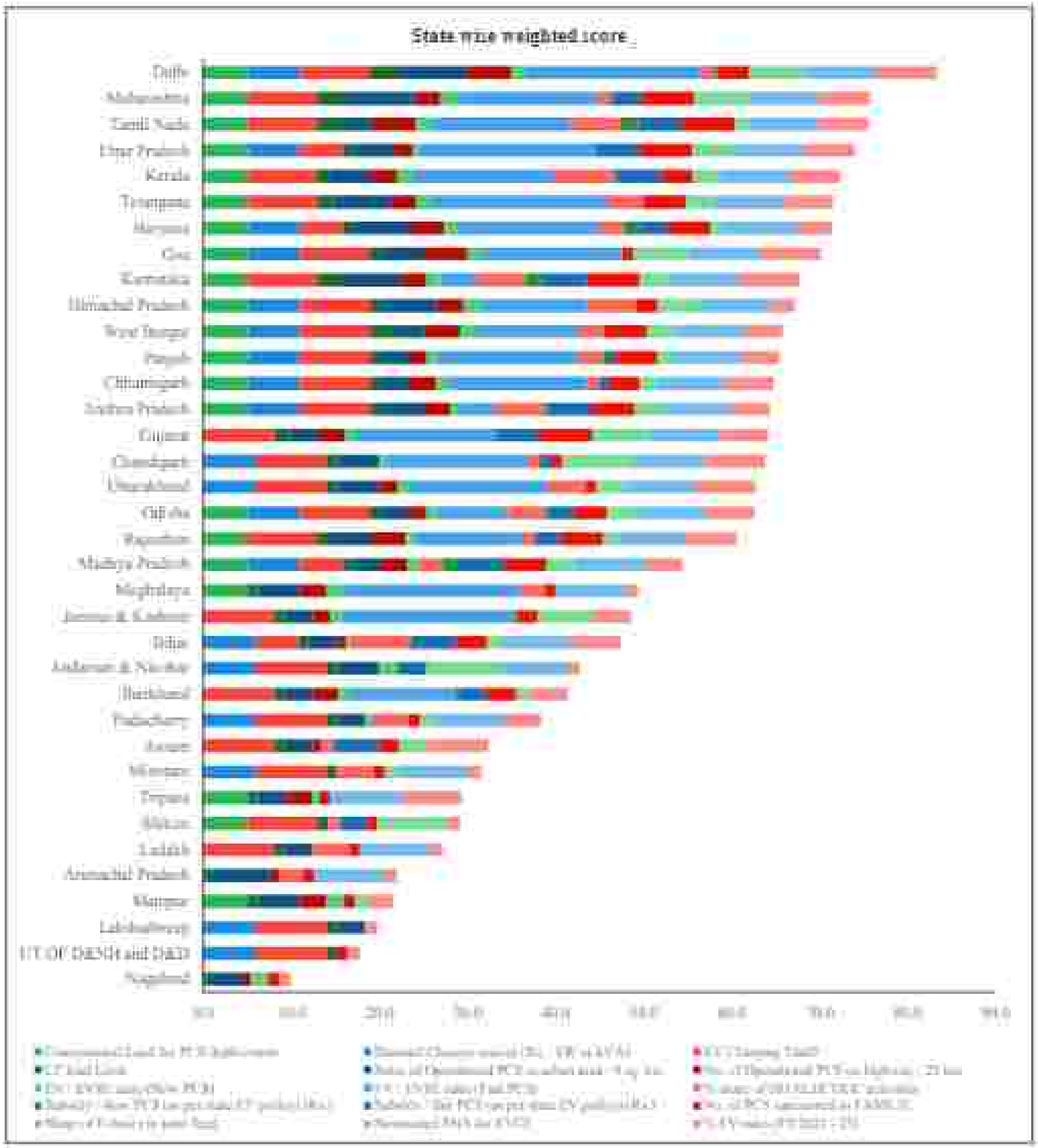
For some of the criteria, adequate information was not available through primary discussion with the states and union territories. Therefore, states and union territories are encouraged to provide necessary data in a timely manner for them to improve during future analysis.

Additionally, we have not considered some of other fiscal and non-fiscal incentives such as registration and road tax exemption, parking fee waiver, toll fee waiver, preferential treatment on roads, etc. being provided by states, due to lack of data availability. List of such criteria is provided at **Annexure B**.

6.2 State level analysis

Considering the initiatives taken by the Government of India to promote electric mobility across the country, it is imperative to assess the implementation of the e-mobility programs and how they are translating into action at ground level. Therefore, a state level analysis would help in highlighting the strength and areas where the states need to make focused efforts based on the selected criteria.

The graph below summarizes the assessment of states on each criteria, a detailed analysis of each state is presented in the subsequent sections.



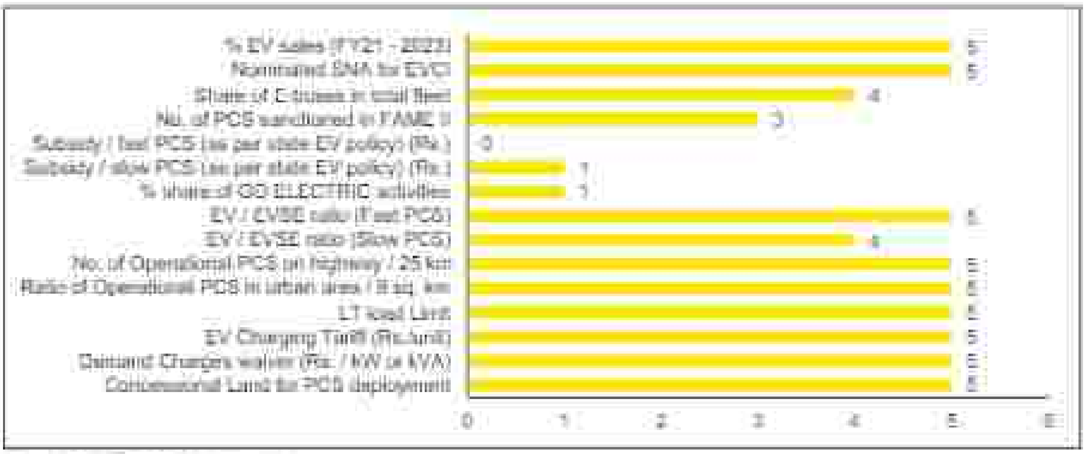
Graph 21 : State wise weighted score

6.3. State E-Mobility Index (Detailed Analysis)

Delhi E-Mobility Index

Figure 15: Snapshot of Delhi EV policy

Graph 22: *Annual EV Sales - Delhi*

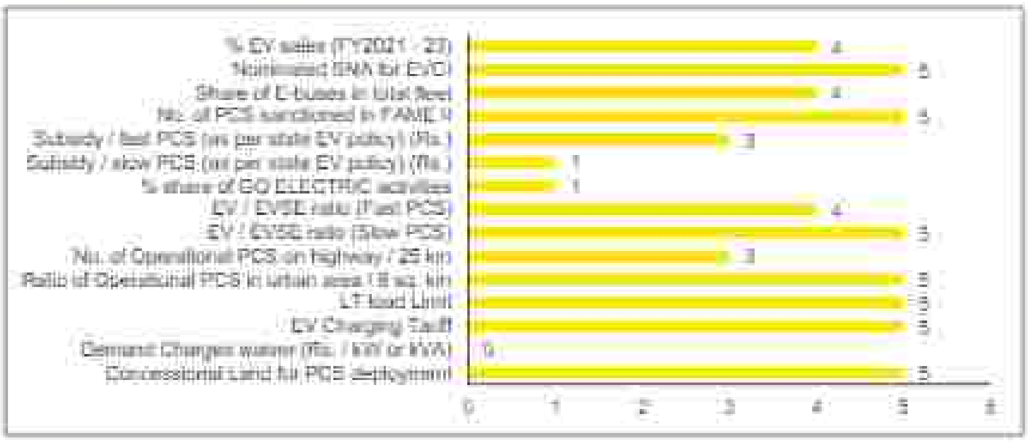


Graph 23: *Delhi E-Mobility index*

Maharashtra E-Mobility Index

Figure 11: Snapshot of Maharashtra EV policy

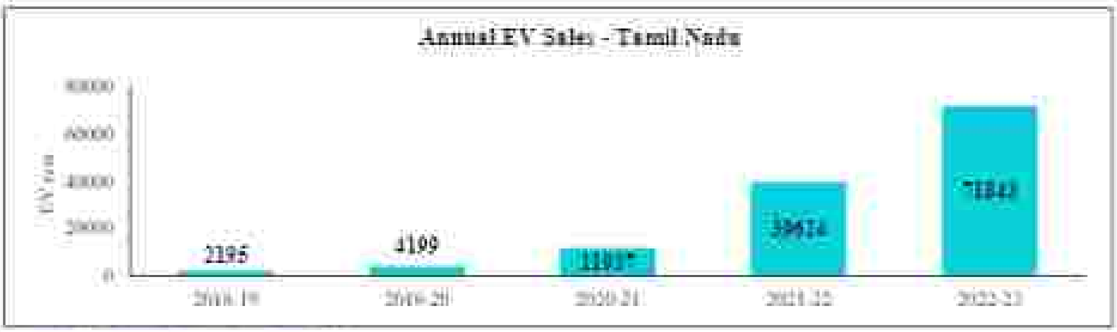
Graph 23: Annual EV sales - Maharashtra



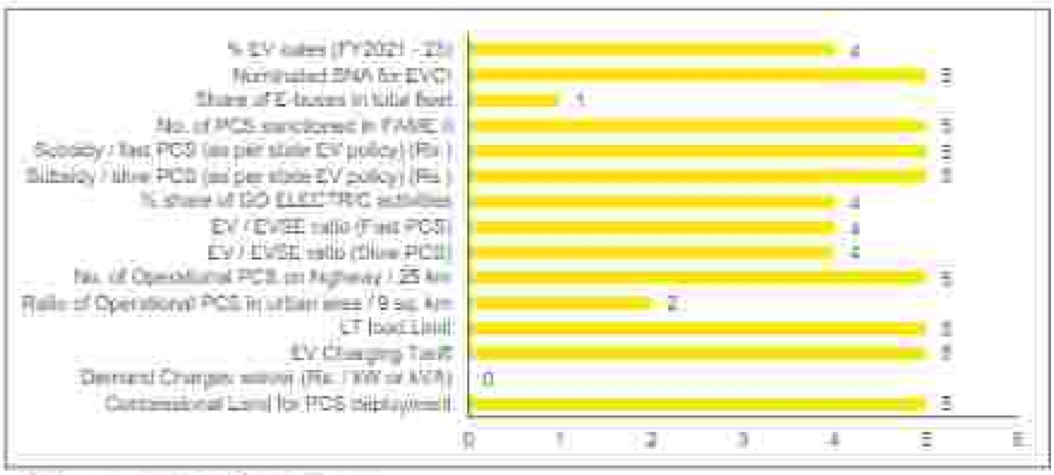
Graph 24: Maharashtra e-mobility index

Tamil Nadu E-Mobility Index

Figure 27: Snapshot of Tamil Nadu EV policy



Graph 27: Annual EV sales - Tamil Nadu



Graph 28: Tamil Nadu E-Mobility index

Uttar Pradesh E-Mobility Index

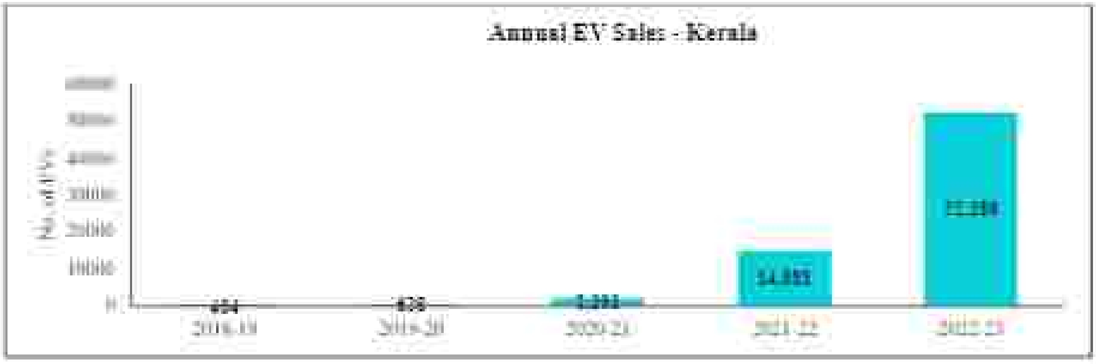
Figure 11: Snapshot of UP EV policy

Graph 28: Annual EV sales - UP

Graph 29: UP e-mobility index

Kerala E-Mobility Index

Figure 24: Snapshot of Kerala EV policy



Graph 30: Annual EV sales - Kerala

Graph 31: Kerala E-Mobility Index

West Bengal E-Mobility Index

Notification Date:

Policy Term: 5 years

Electric Vehicle

- 10 lakhs EVs (across all segments) to be deployed across the state

EV Ecosystem development

- EV Accelerator Cell to facilitate ICE vehicle phase out plan
- EV Forum within EV Accelerator Cell for facilitating EV transition
- Creation of EV Charging Infrastructure Working Group to facilitate faster creation of charging infrastructure network

Targets

- Target is to have 10 lakh EVs, combined across all segment of vehicles, during the policy implementation.
- Target to have 1,00,000 public, semi-public charging stations during the policy implementation
- Achieve an Electric Vehicle/Electric charge point ratio of 6 by the implementation of the policy
- Create robust infrastructure for electric vehicles including adequate power supply and network of charging points with favourable power tariff

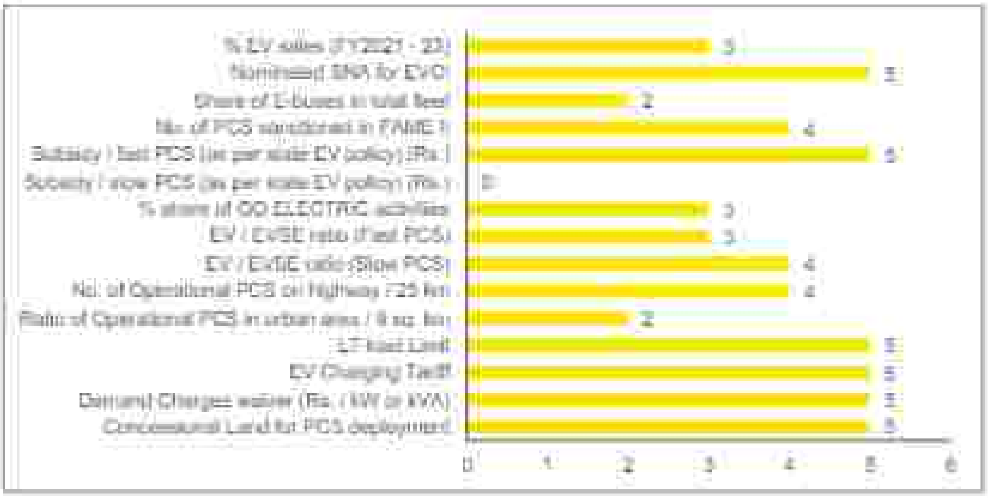
Charging Infrastructure

Other provisions

- EV Innovation Centre for focus on industry-oriented research on battery technologies, battery management system, charging infrastructure, efficient controllers and powertrains
- Set up Battery Industrialization Hub to fast track development of batteries

Figure 15: Snapshot of EV policy - West Bengal

Graph 32: Annual EV Sales - West Bengal

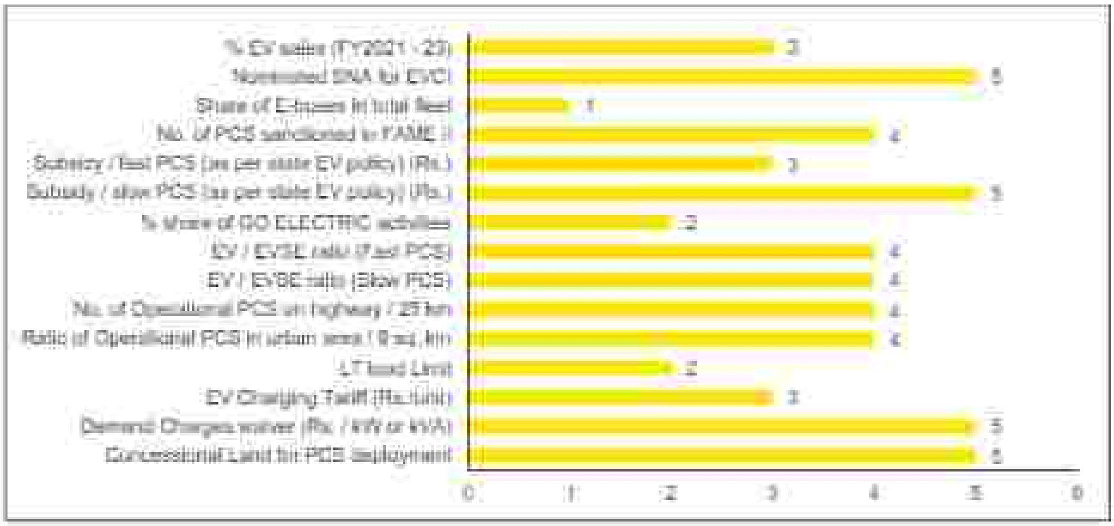


Graph 33: West Bengal E-Mobility Index

Haryana E-Mobility Index

Figure 16: Snapshot of Haryana EV policy

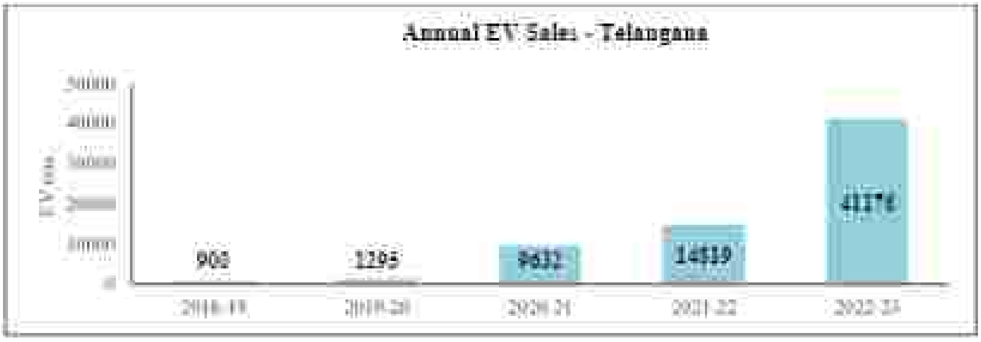
Graph 14: Annual EV Sales - Haryana



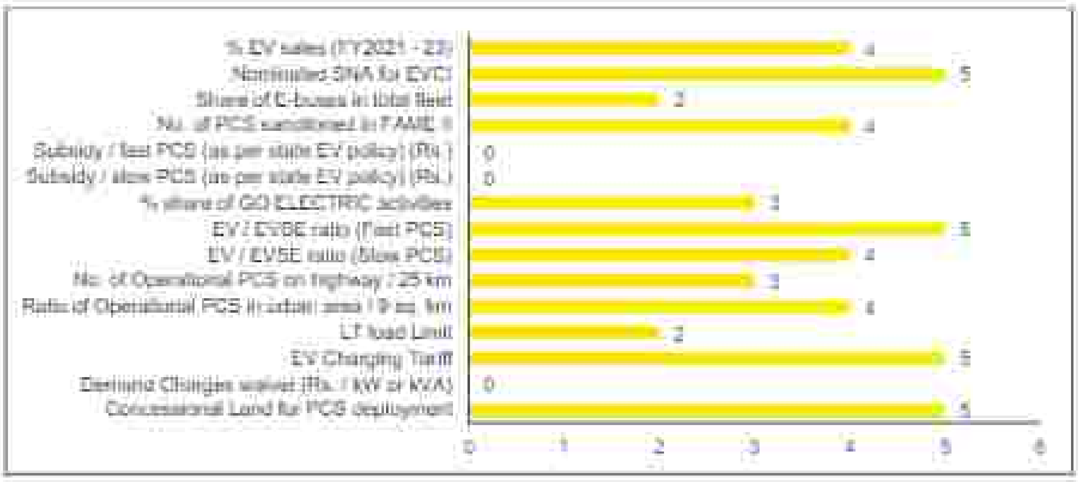
Graph 15: Haryana E-Mobility Index

Telangana E-Mobility Index

Figure 17: Snapshot of State EV policy



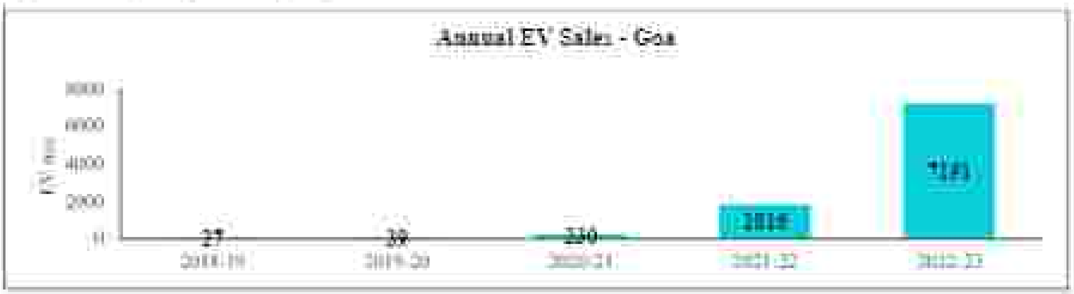
Graph 36: Annual EV Sales - Telangana



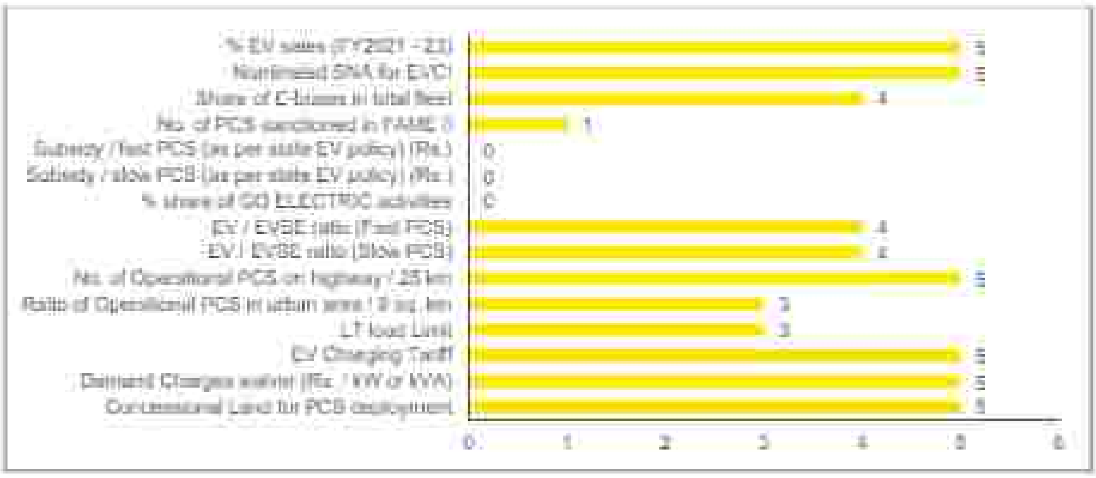
Graph 37: Telangana E-Mobility index

Goa E-Mobility Index

Figure 36: Snapshot of Goa EV policy



Graph 38: Annual EV Sales - Goa



Graph 39: Goa E-Mobility Index

Karnataka E-Mobility Index

Figure 39: Snapshot of Karnataka EV policy

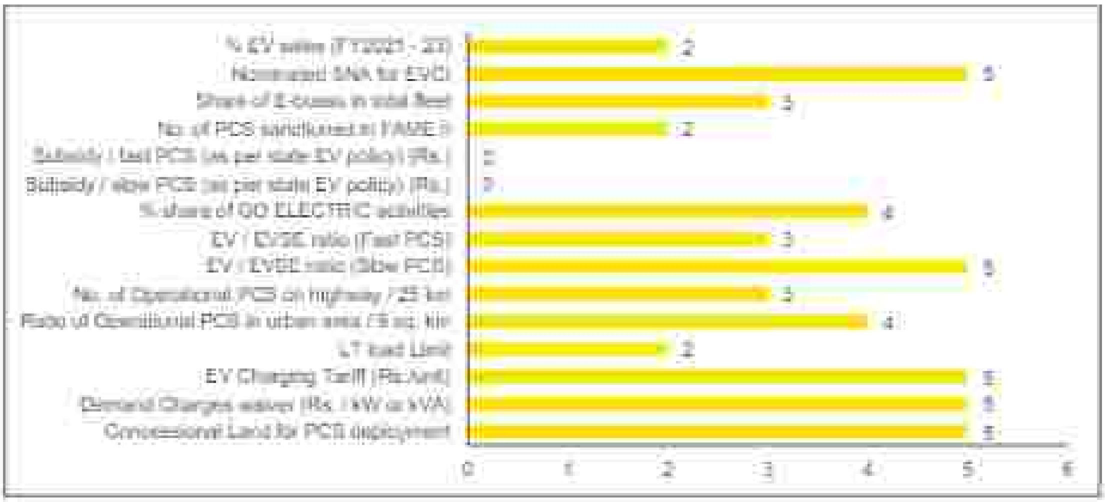
Graph 40: Karnataka annual EV sales

Graph 41: Karnataka E-Mobility index

Himachal Pradesh E-Mobility Index

Figure 26: Snapshot of state EV policy

Graph 42: Annual EV Sales - Himachal Pradesh

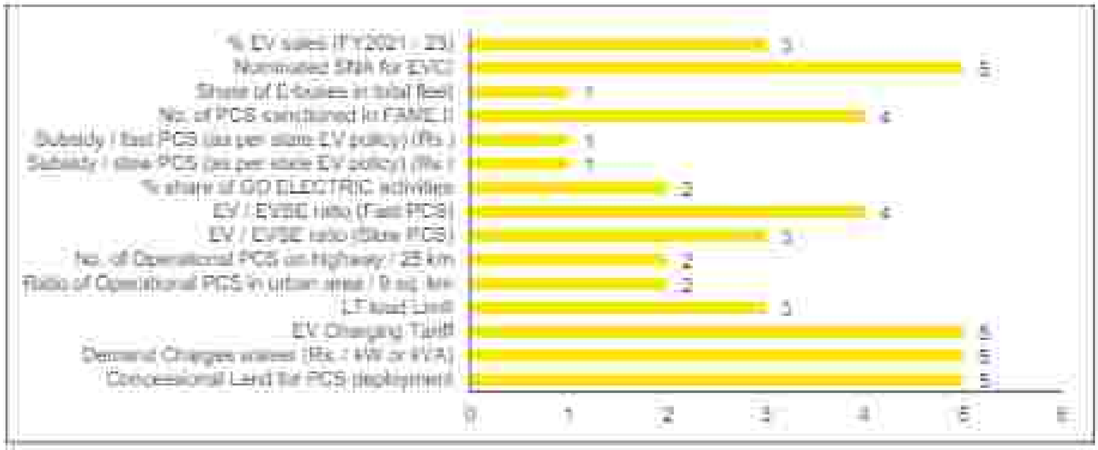


Graph 43: Himachal Pradesh E-Mobility Index

Punjab E-Mobility Index

Figure 21: Snapshot of Punjab EV policy

Graph 44: Annual EV sales - Punjab

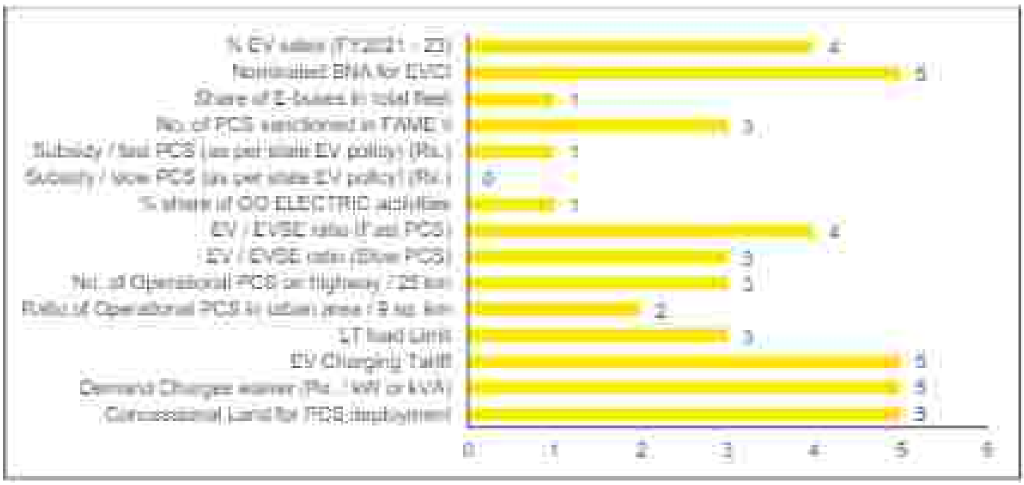


Graph 45: Punjab E-Mobility Index

Chhattisgarh E-Mobility Index

Figure 22: Snapshot of Chhattisgarh's EV policy

Graph 46: Annual EV Sales - Chhattisgarh



Graph 47: Chhattisgarh e-mobility index

Andhra Pradesh E-Mobility Index

Figure 23: Andhra Pradesh EV policy

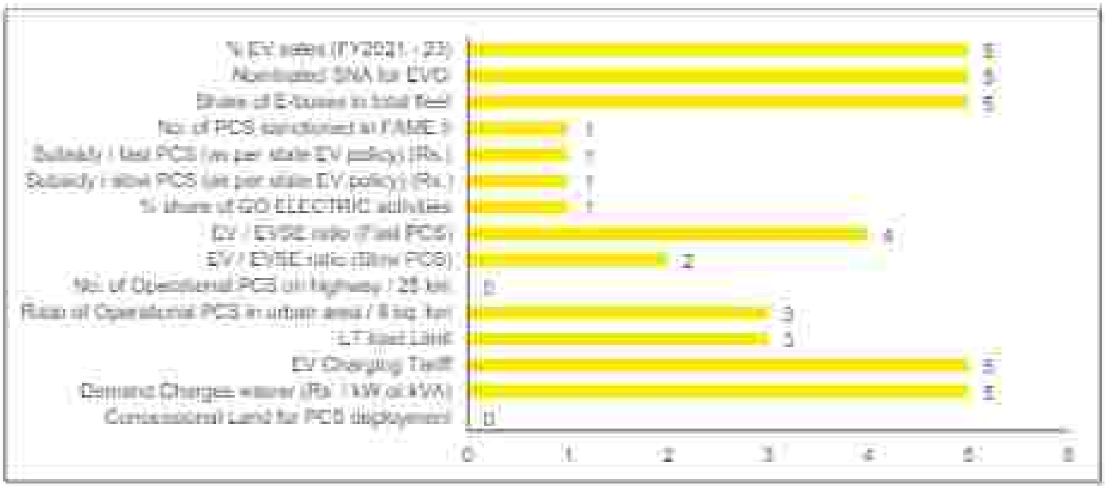
Graph 48: Annual EV Sales – Andhra Pradesh

Graph 49: Andhra Pradesh E-Mobility Index

Chandigarh E-Mobility Index

Figure 24: Snapshot of Chandigarh EV policy

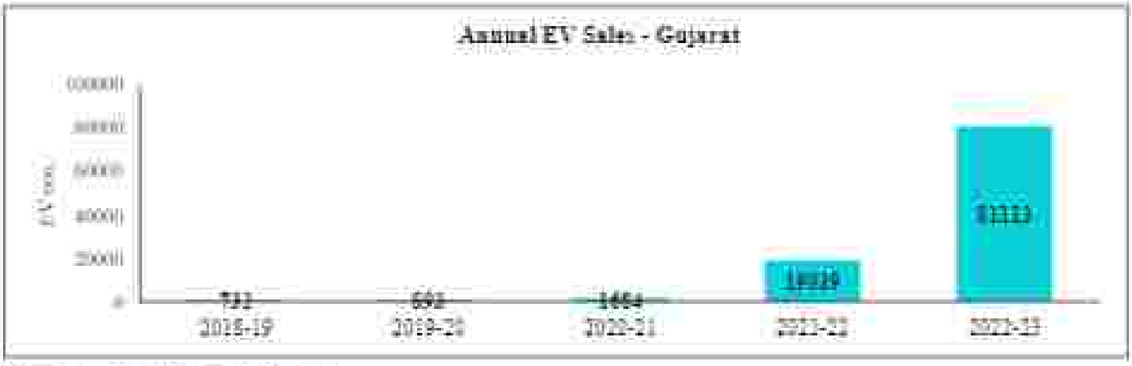
Graph 30: Annual EV sales - Chandigarh



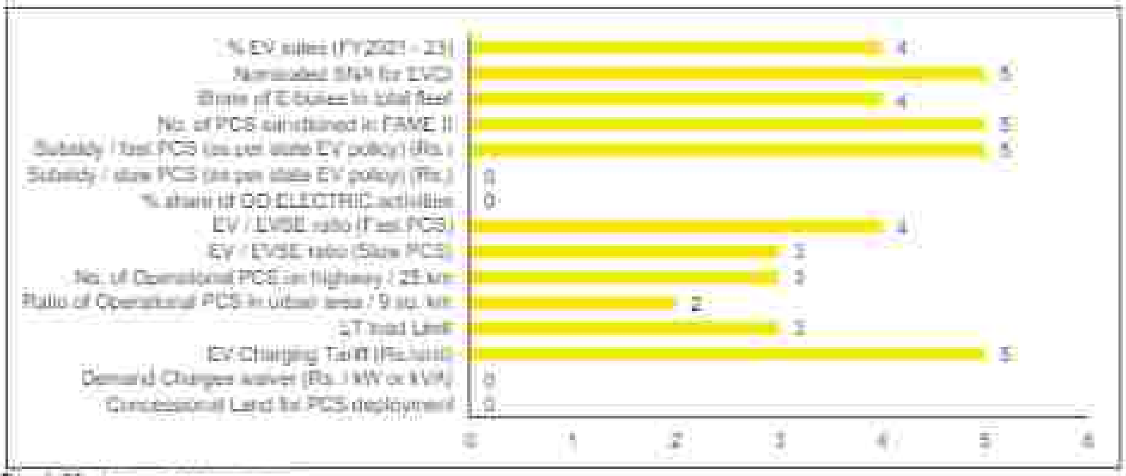
Graph 31: Chandigarh E-Mobility Index

Gujarat E-Mobility Index

Figure 25: Snapshot of Gujarat EV policy



Graph 32: Annual EV sales - Gujarat

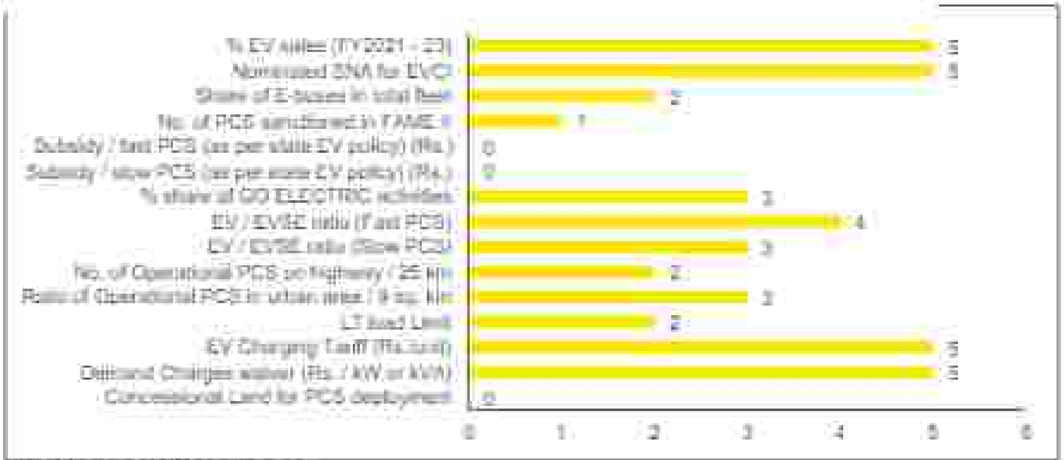


Graph 33 : Gujarat E-Mobility Index

Uttarakhand E-Mobility Index

Figure 26. Snapshot of Uttarakhand EV policy

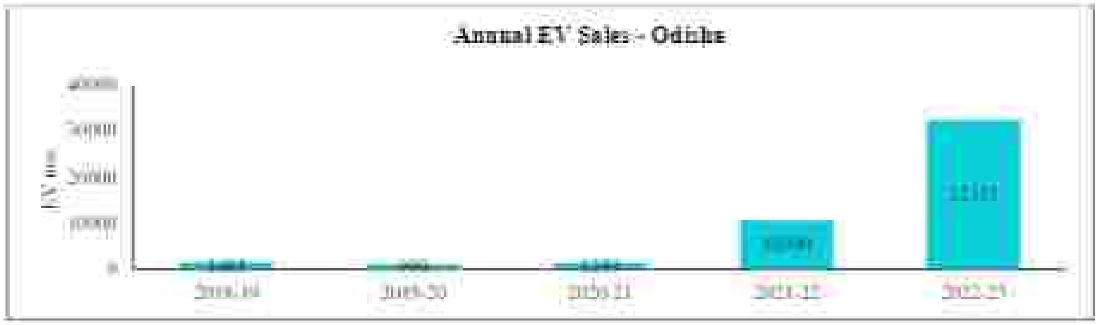
Graph 34. Annual EV sales - Uttarakhand



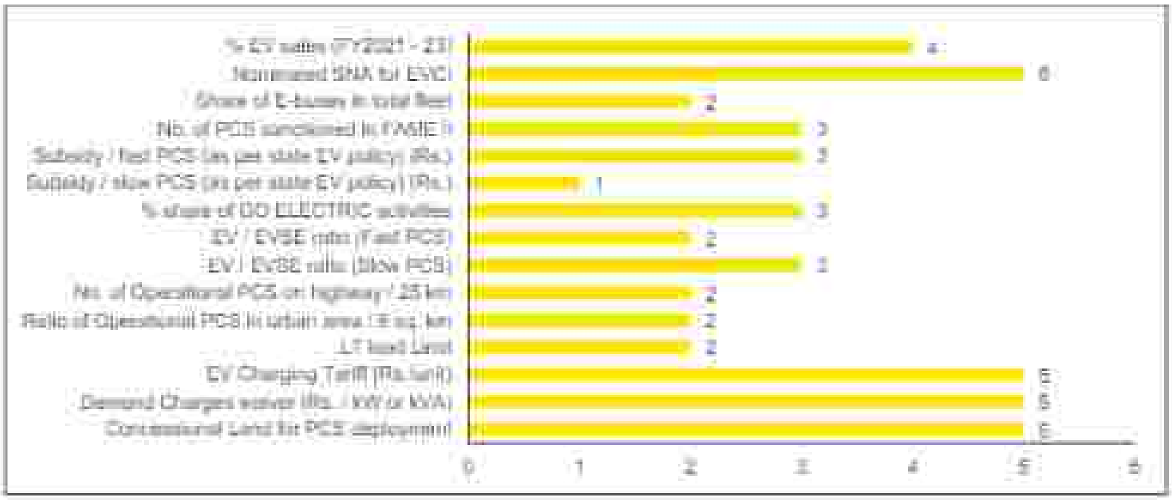
Graph 35 : Uttarakhand E-Mobility Index

Odisha E-Mobility Index

Figure 27: Snapshot of Odisha EV policy



Graph 56: Annual EV sales - Odisha

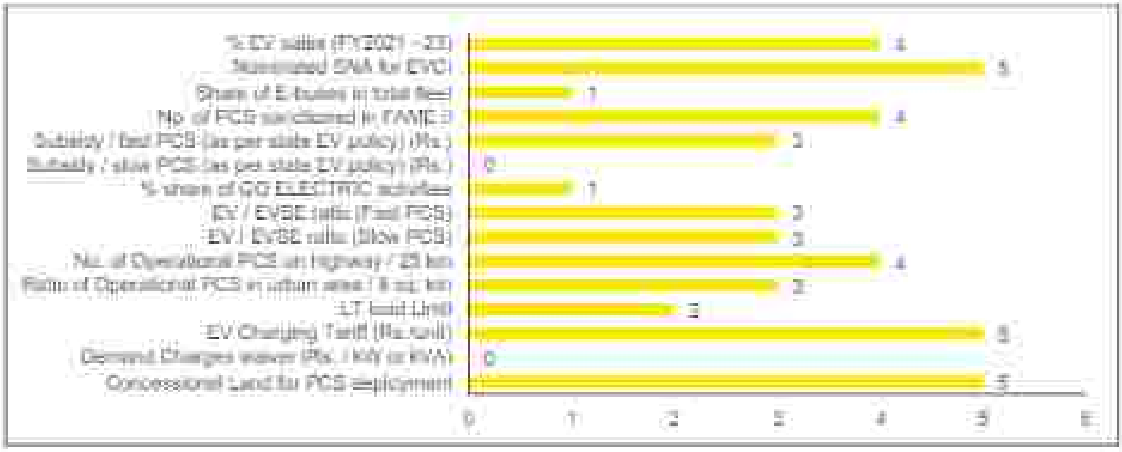


Graph 57: Odisha E-Mobility Index

Rajasthan E-Mobility Index

Figure 21: Snapshot of Rajasthan EV policy

Graph 59: Annual EV sales - Rajasthan

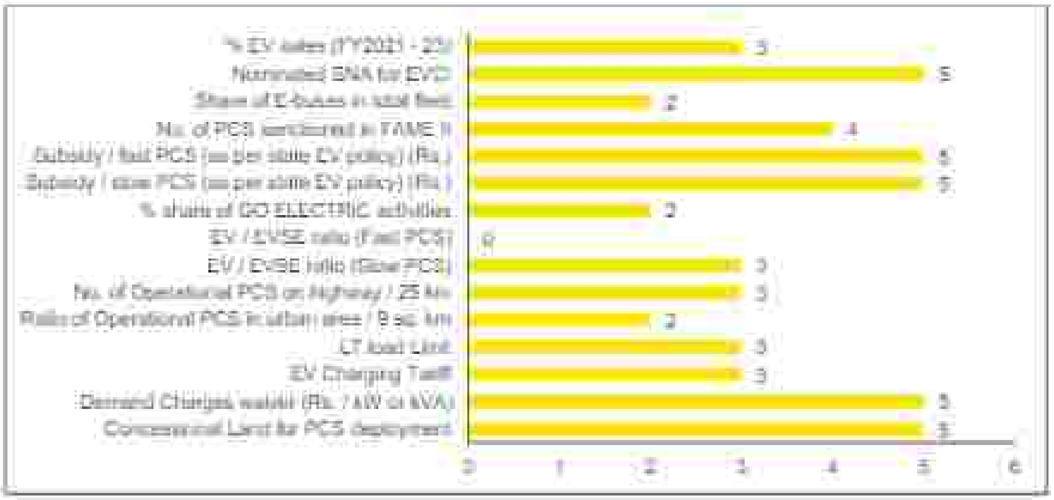


Graph 60: Rajasthan E-Mobility Index

Madhya Pradesh E-Mobility Index

Figure 28: Snapshot of MP EV Policy

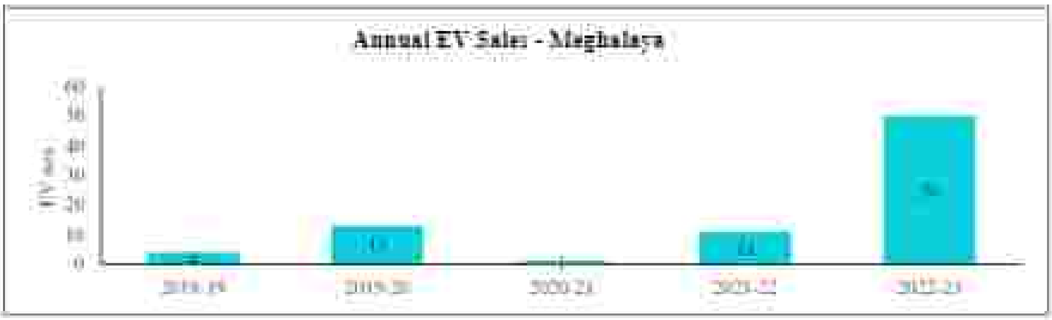
Graph 61: Annual EV Sales - Madhya Pradesh



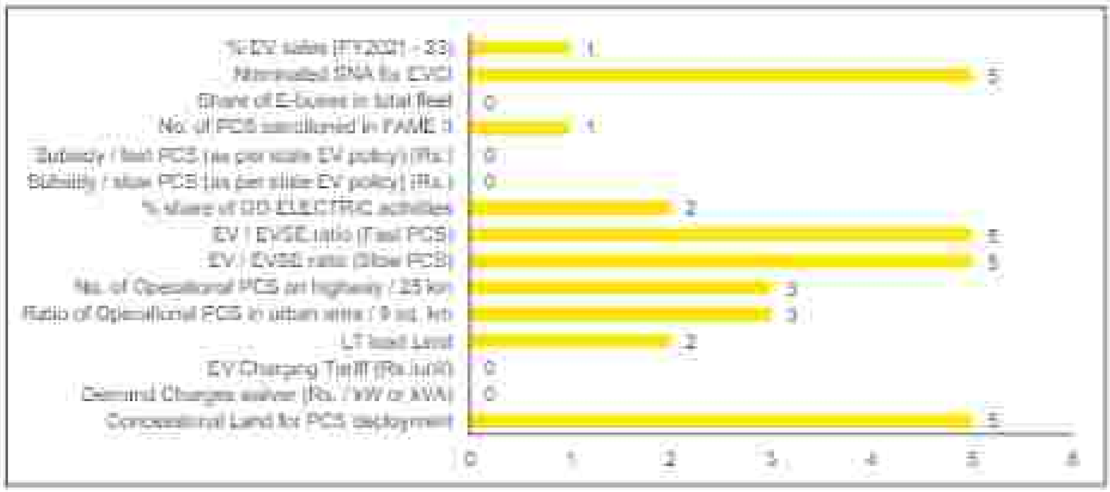
Graph 62: Madhya Pradesh E-Mobility index

Meghalaya E-Mobility Index

Figure 30: Snapshot of Meghalaya EV policy



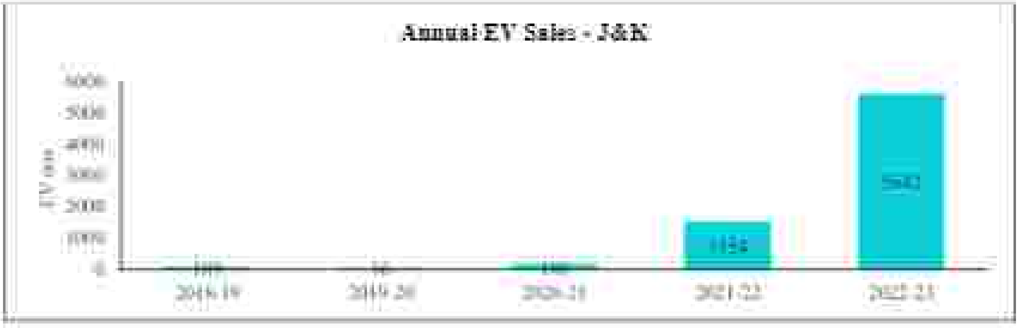
Graph 63: Annual EV sales - Meghalaya



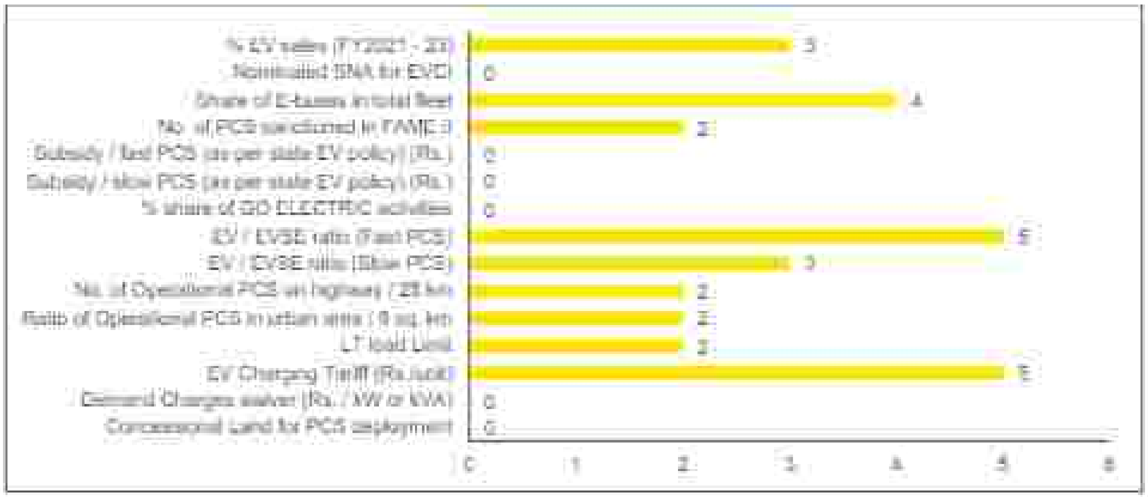
Graph 64: Meghalaya e-mobility index

Jammu & Kashmir E-Mobility Index

Jammu & Kashmir is yet to draft the state EV policy.



Graph 65: Annual EV Sales - J&K



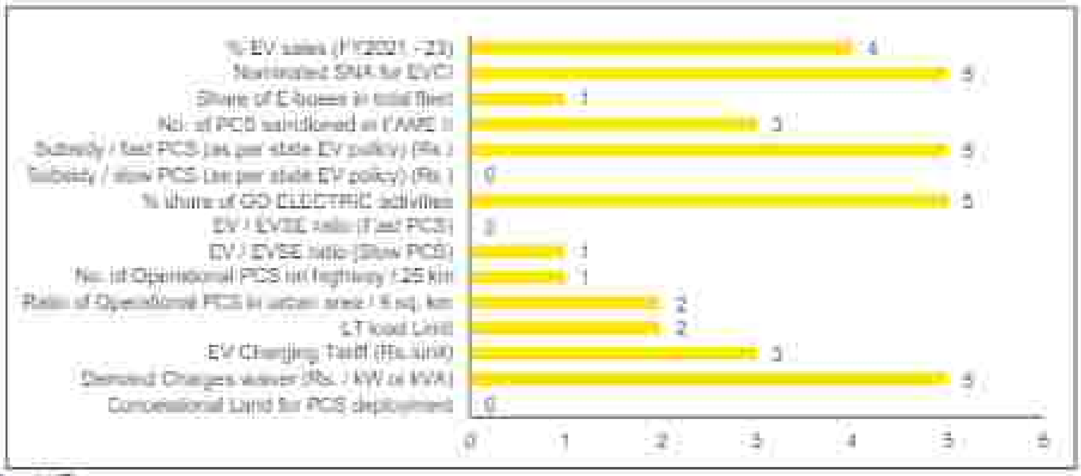
Graph 66: Jammu & Kashmir E-Mobility Index

Bihar E-Mobility Index

Bihar is yet to notify the state EV policy. Below figure provides the provisions as defined in draft EV policy.

Figure 51: Snapshot of Bihar EV policy

Graph 66: Annual EV sales - Bihar



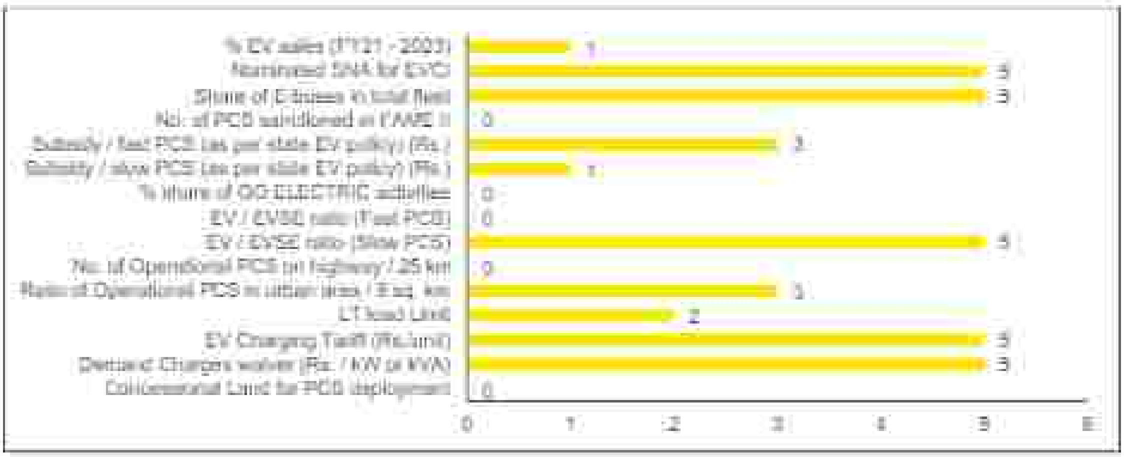
Graph 67: Bihar E-Mobility Index

Andaman & Nicobar Islands E-Mobility Index

Andaman & Nicobar Islands is yet to notify the state EV policy. Below figure provides the provisions as defined in draft EV policy.

Figure 31: Snapshot of A&N EV policy

Graph 69: Annual EV Sales - A&N

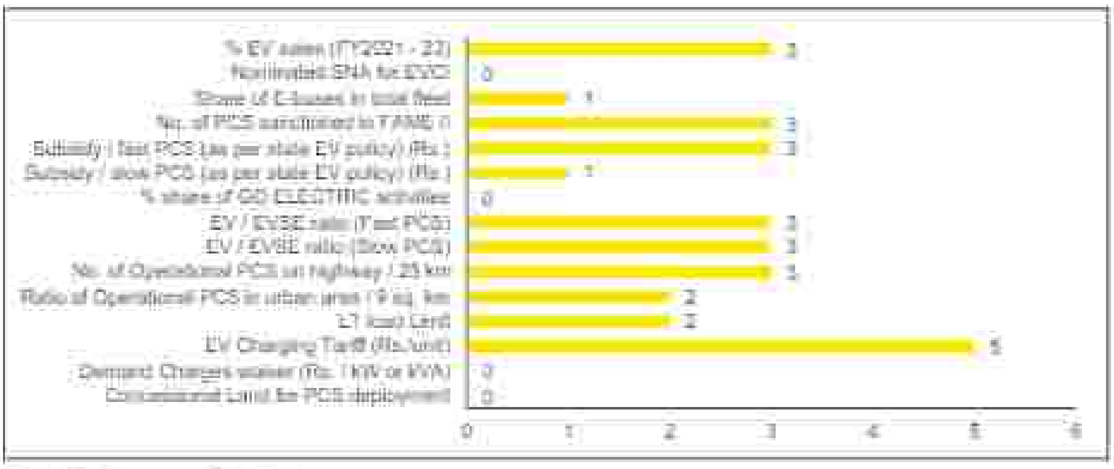


Graph 70: A&N E-Mobility Index

Jharkhand E-Mobility Index

Figure 33: Snapshot of Jharkhand EV policy

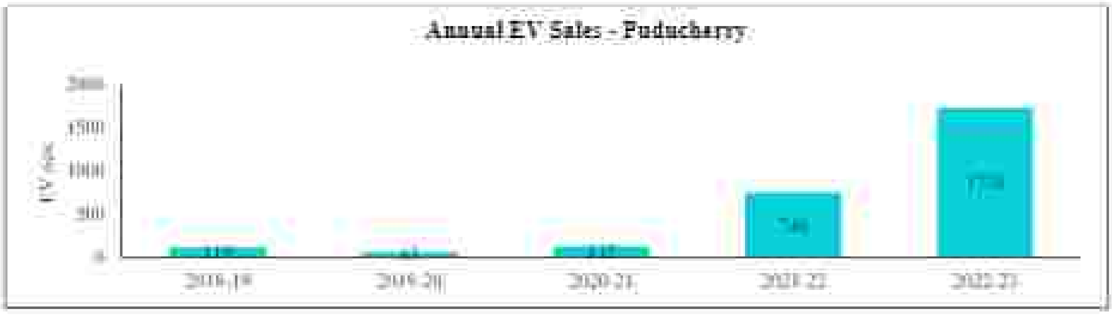
Graph 71: Annual EV sales - Jharkhand



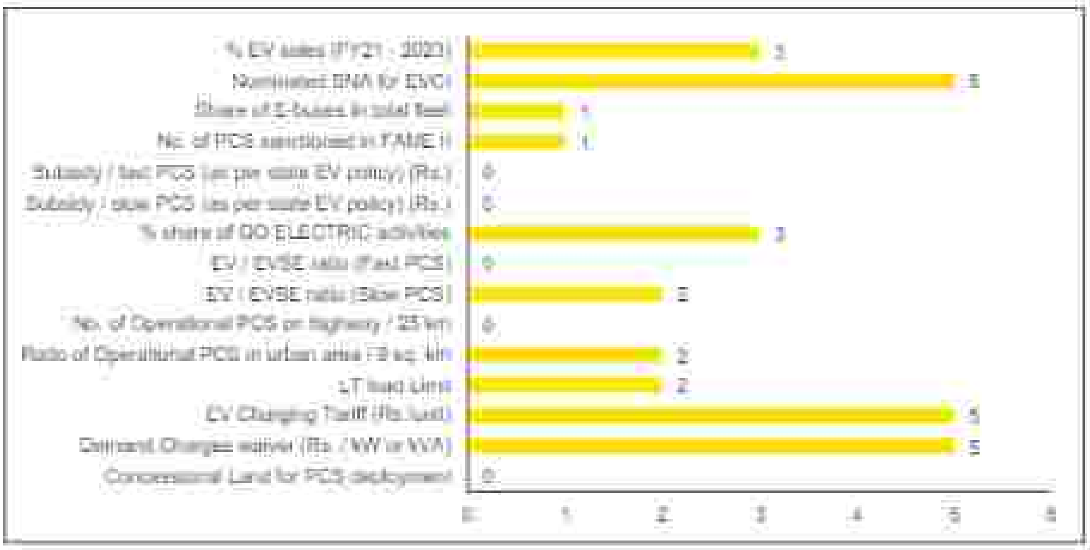
Graph 72: Jharkhand E-Mobility Index

Puducherry E-Mobility Index

Puducherry is yet to draft the state EV policy.



Graph 73: Annual EV sales - Puducherry

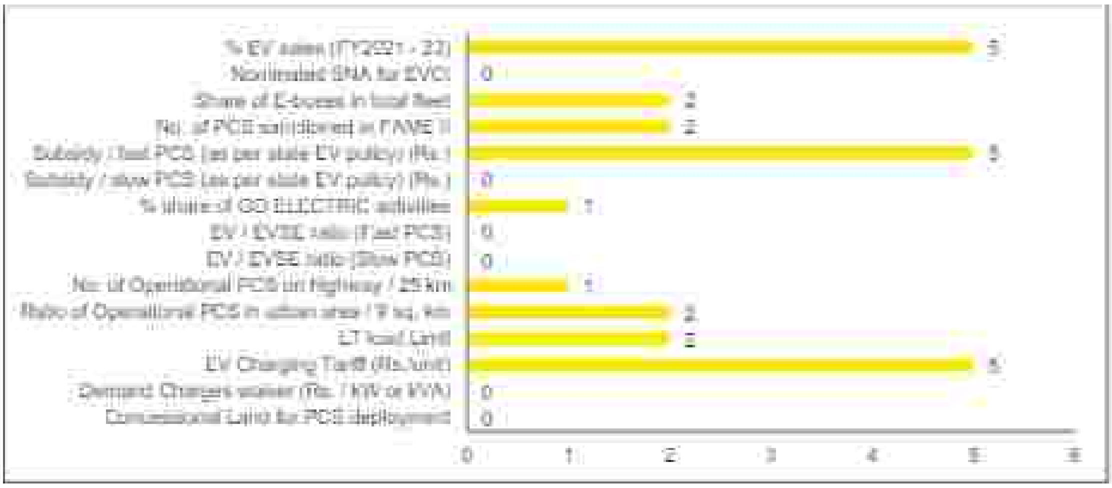


Graph 74: Puducherry e-mobility index

Assam E-Mobility Index

Figure 34: Snapshot of Assam EV policy

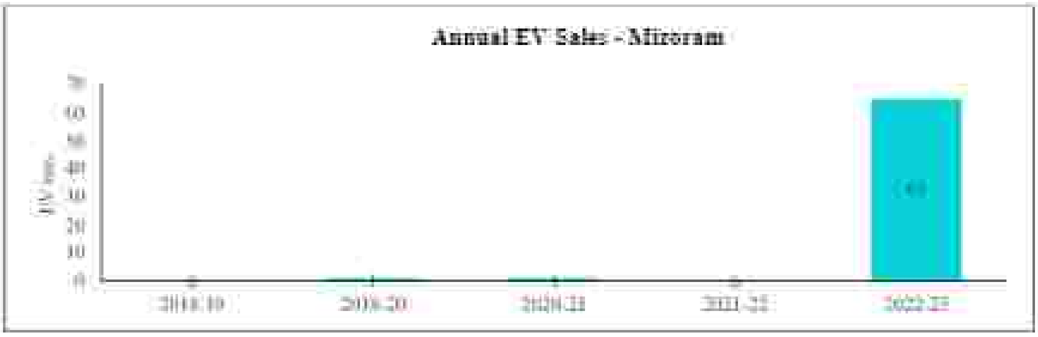
Graph 73: Annual EV sales - Assam



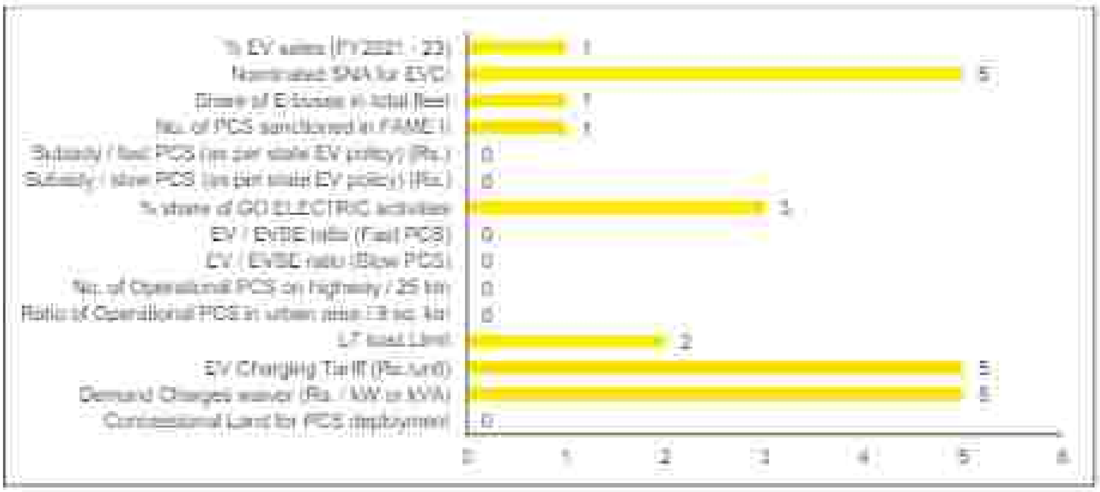
Graph 74: Assam E-Mobility Index

Mizoram E-Mobility Index

Mizoram is yet to draft the state EV policy.



Graph 77: Annual EV sales - Mizoram

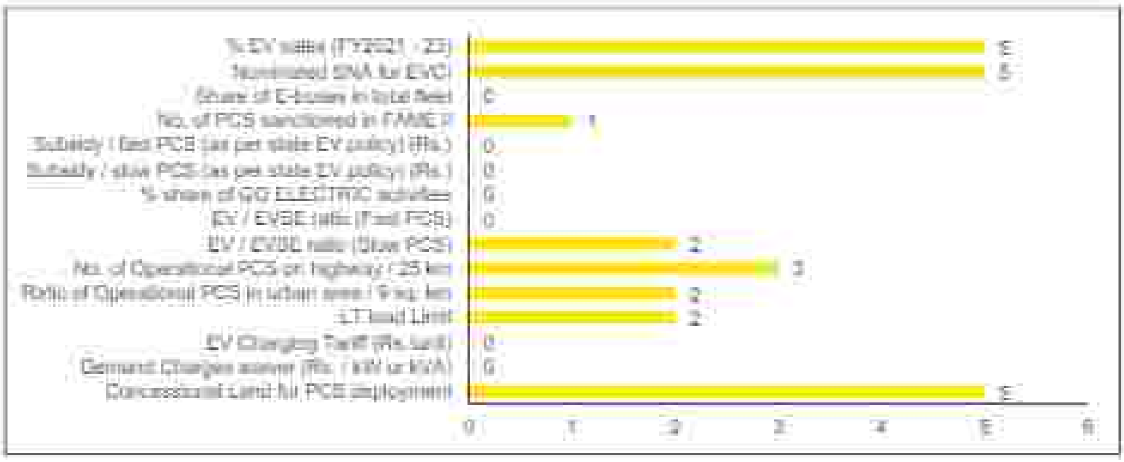


Graph 78: Mizoram E-Mobility Index

Tripura E-Mobility Index

Figure 35: Snapshot of Tripura EV policy

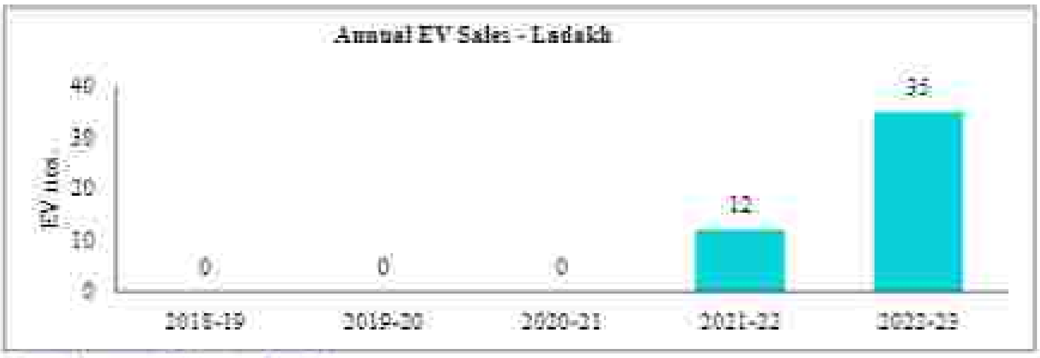
Graph 79: Annual EV Sales - Tripura



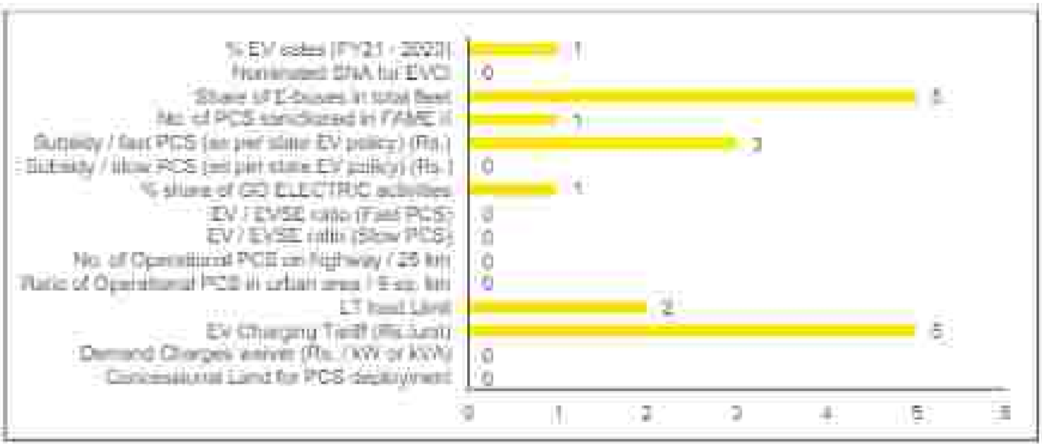
Graph 80: Tripura E-Mobility Index

Ladakh E-Mobility Index

Figure 56: Snapshot of Ladakh EV policy



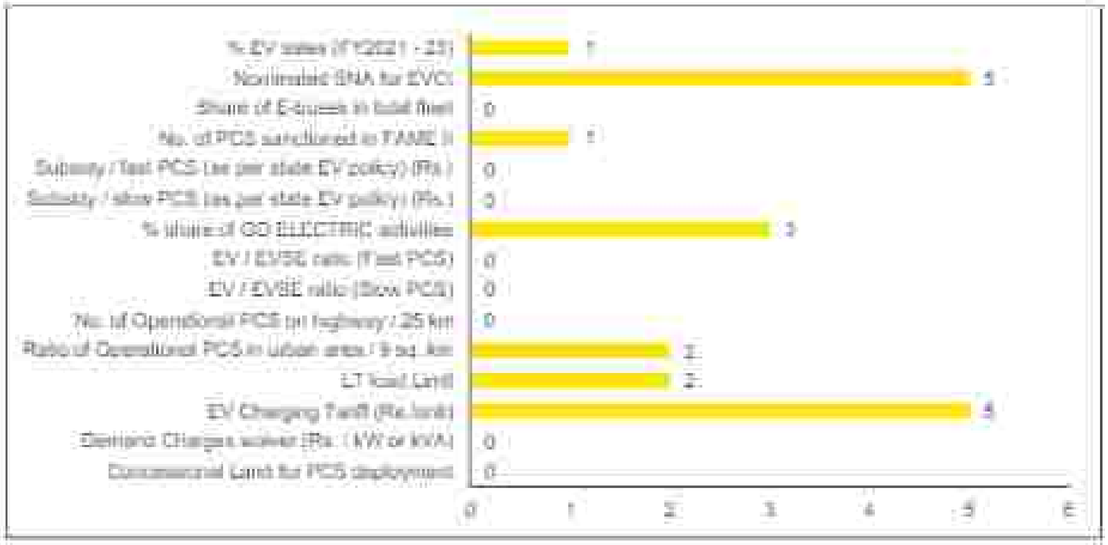
Graph 61: Annual EV sales - Ladakh



Graph 62: Ladakh E-Mobility Index

Sikkim E-Mobility Index

- Sikkim is yet to draft the state EV policy.
- No EVs got registered in last five financial years (FY2018-23) in the state of Sikkim.

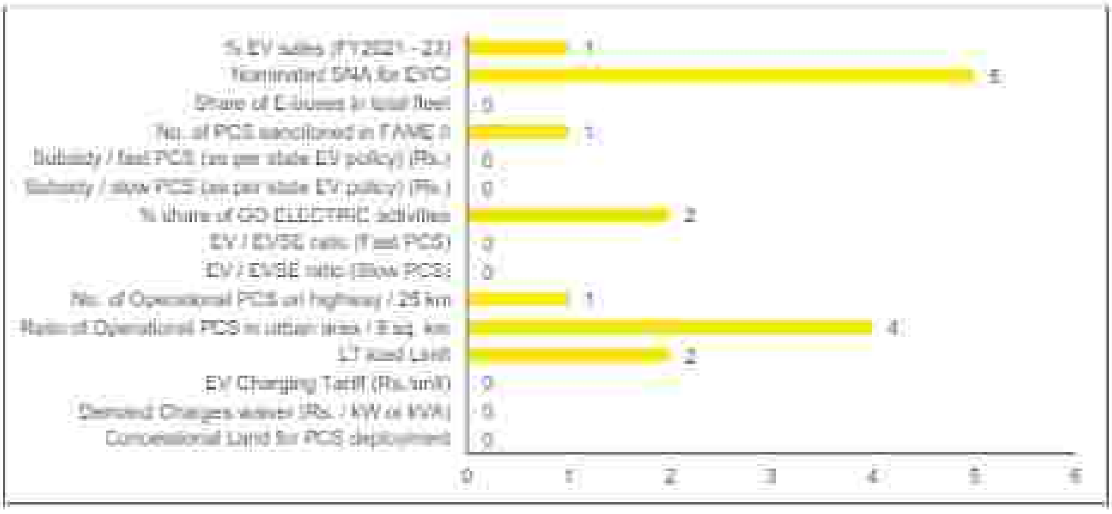


Graph 83: Sikkim E-Mobility Index

Arunachal Pradesh E-Mobility Index

Figure 37: Snapshot of Arunachal Pradesh EV policy

Graph 34: Annual EV sales - Arunachal Pradesh

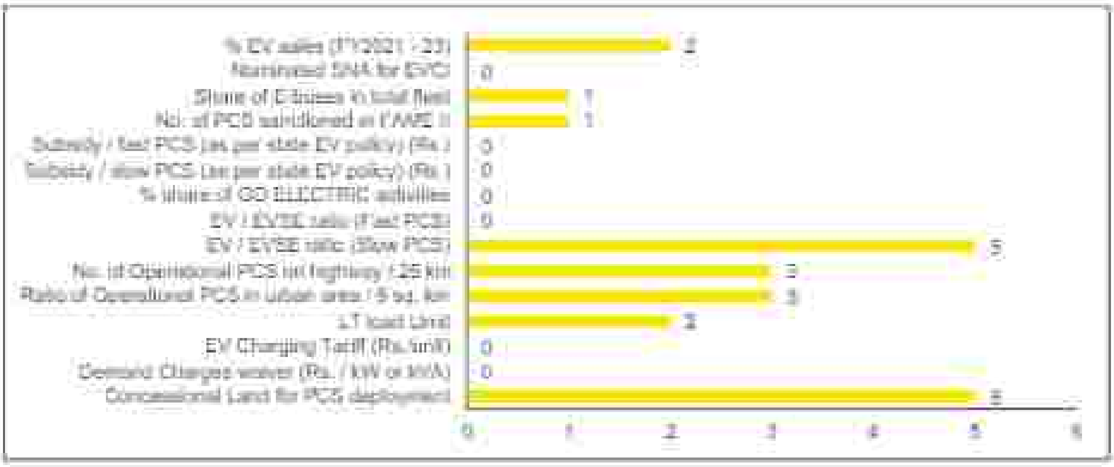


Graph 35: Arunachal Pradesh E-Mobility index

Manipur E-Mobility Index

Figure 38: Snapshot of Manipur EV policy

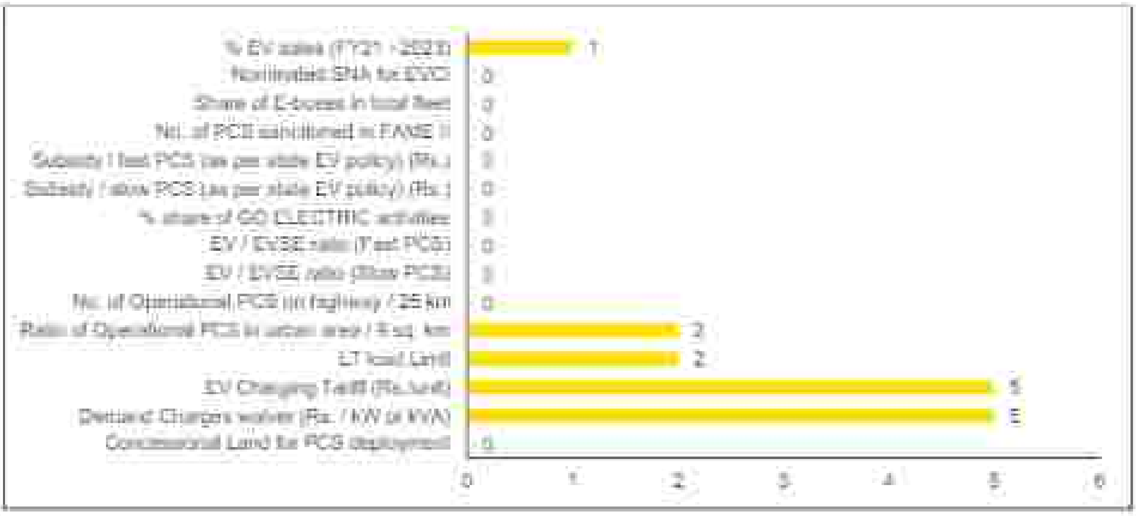
Graph 26: Annual EV sales - Manipur



Graph 27: Manipur E-Mobility index

Lakshadweep E-mobility index

Lakshadweep is yet to draft the state EV policy.

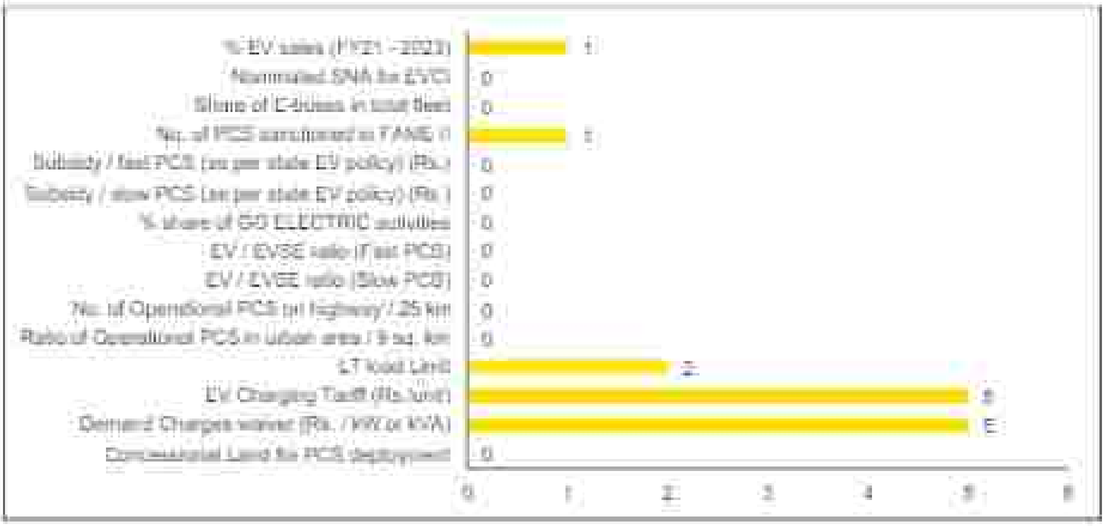


Graph 55: E-mobility index - Lakshadweep

Union Territory of Dadar & Nagar Haveli and Daman & Diu E-Mobility Index

Union Territory of Dadar & Nagar Haveli and Daman & Diu is yet to draft the state EV policy.

Graph 89: Annual EV sales - D&NH and D&D

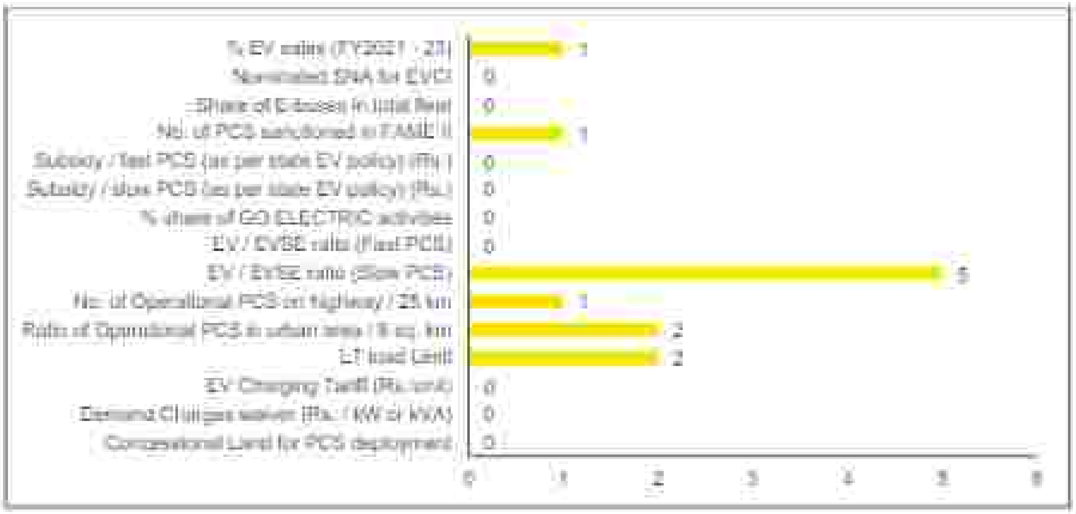


Graph 90: D&NH and D&D E-Mobility index

Nagaland E-Mobility Index

Nagaland is yet to draft the state EV policy.

Graph 91: Annual EV sales - Nagaland



Graph 92: Nagaland E-Mobility Index

In addition to various initiatives by state government for promotion of e-mobility in respective states, additional announcements for developing e-mobility ecosystem in the respective state is provided as Annexure C.

The objective of developing a state level e-mobility index is to assess the preparedness of states in promoting EV adoption by year 2030.

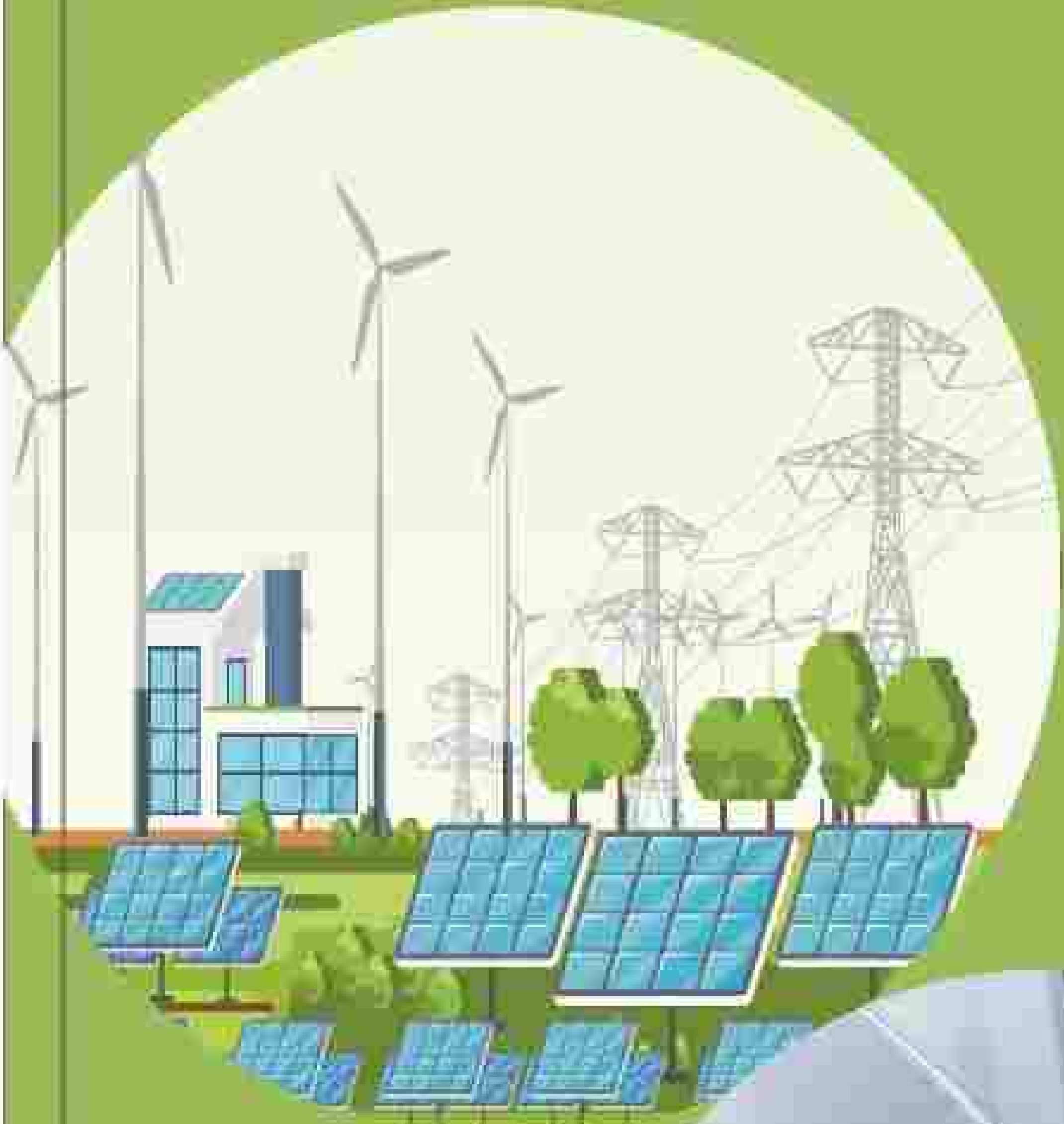
Several states have developed a conducive environment to establish themselves as EV hubs; however, the adoption rate of EVs in several states is still at a nascent stage. Based on the information received from SNAs and SDAs of various states, the following section provides some of the best practices and way forward for states for accelerated adoption of e-mobility:

Best Practices adopted by States:

- **Single window facility** for EV charger procurement and installation
- **Empanelment of CPOs** for faster rollout of public charging infrastructure
- **Guidebook for deployment of EV chargers** in Malls, RWA, Government offices
- **Setting up EV Accelerator Cell,** acting as a single window entity for implementation of e-mobility programs across the state / city
- **Roadmap / action plan for EV charging infrastructure** and assessing impact of EV charging on grid infrastructure
- **Implementation of pilot programs** such as solar based EV charging stations, EV charging hubs
- Deployment of **pole-mounted EV chargers**
- **Providing concessional land** for deployment of public EV charging stations
- **Providing subsidy** for upstream infrastructure

In addition to the above practices that can be adopted by the states, the following section outlines the way forward for states to further enhance EV adoption:

- **Finalizing draft EV policies** may provide an impetus of EV adoption and the deployment of necessary infrastructure.
- **Formation of EV Accelerator Cell** as a single window entity for all implementation of e-mobility programs.
- **Promotion of 'EV Yatra' Portal** developed by Bureau of Energy Efficiency may enhance visibility of government policies and regulations for the promotion of e-mobility in India. Additionally, through the portal, EV users can check availability of the nearest compatible EV charger for complaint with their EVs in addition to other services.
- **Providing regular update on EV Yatra portal** related to operational public EV charging stations which may create more visibility of public EV chargers.
- **Facilitating CPOs in the deployment of public EV charging stations**, such as identification of land and location assessment.
- **Ensuring compliance with Tariff related provisions** of MoP Guidelines & Standards dated 14th Jan 2022 and its subsequent amendments
- **Designate State Nodal Agencies** for EV charging infrastructure and act as a single window clearance entity
- **Providing subsidy** for upstream infrastructure.



7. Tariff Provisions for EV Charging

7. Tariff related provisions for EV charging

EV charging tariffs play a crucial role as a fiscal and regulatory tool for the accelerated deployment of the e-mobility ecosystem in India. It impacts the commercial viability of the EV charging business and the total cost of EV ownership for vehicle users. Since EV charging represents an additional power demand for Distribution Companies (DISCOMs), it can lead to increased revenue due to additional electricity sales.

The development of EV charging infrastructure, connecting mobility and the energy sector, not only revolutionizes the transportation industry but it also has the potential to transform the power distribution paradigm. The interplay between electric mobility and the power grid makes the role of DISCOMs crucial. Although development of EV Charging Infrastructure (EVCI) will provide an opportunity for DISCOMs to scale up their revenue by earning through additional sale of electricity to EV charging stations, it may also amplify the peak load of the DISCOMs and impact the network management, grid augmentation and power procurement strategies. In this context, EV charging tariffs becomes a critical fiscal and regulatory instrument.

EV charging tariffs must be established in such a manner that the DISCOMs can recoup its expenses while making EV charging cost-effective for EV users and develop financially viable public EV charging business.

To address the variation in charging tariffs across states, the Ministry of Power (MoP) has introduced provisions in its revised guidelines and standards for EV charging infrastructure. According to these guidelines, the EV supply tariff is defined as a single-part tariff not exceeding the Average Cost of Supply until March 31, 2025. This means that no fixed or demand charges shall be applicable for public EV charging connections during this period. The aim is to harmonize EV charging tariffs, making them more consistent across different states.

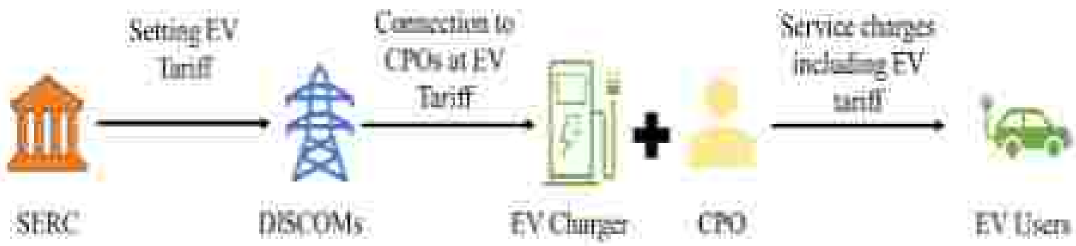


Figure 39: EV charging tariff network

To make Public EV charging a feasible business proposition, the supply tariff for EV charging has been specified under Clause 7 of the MoP's revised guidelines and standards dated January 14, 2022, which was subsequently amended in April 2023 with introduction of renewable based EV charging tariff. These provisions are expected to make public EV charging more affordable for users, thereby fostering an environment conducive to the accelerated adoption of electric vehicles in the country.

Ministry of Power through revised guidelines & standards introduced tariff related provisions as follows:

1. **The tariff for supply of electricity to PCS shall be a single part tariff not exceeding the "Average Cost of Supply" till 31st March2025. The same tariff shall be applicable for Battery Charging Station (BCS).**

   In terms of the tariff order issued by SERC/JERC of states and UTs, exclusive energy charges for supply of electricity to EV charging station has been notified vide respective Tariff orders. Prevalence of high EV supply tariff for Public EV charging stations, lack of uniformity in EV tariff across the states and imposition of high fixed demand charges by state DISCOMs impacts the commercial viability of the Public EV Charging stations. To address this concern and to make Public EV charging a viable business proposition, the supply tariff for EV charging has been specified as a single part Tariff not exceeding Average Cost of Supply, till 31.03.2025 under Clause 7 of the revised Guidelines and standards issued by MoP on 14th Jan 2022. This initiative is expected to make public EV charging affordable for the EV customers and accelerate uptake oof electric vehicles in the country.

2. **The tariff applicable for domestic consumption shall be applicable for domestic charging**

   Keeping similar tariff for domestic consumption and domestic EV charging would enable EV users carry out slow charging of EVs at their residences. This type of charging shall typically be slow AC charging and is expected to take place during the daytime or night using slow AC EV chargers not exceeding 7.0 kW capacity. Separate metering connection may be availed by the EV users from the DISCOMs at homes for availing the benefit of this preferential EV charging tariff notified by State Electricity Regulatory Commission.

3. **The separate metering arrangement shall be made for PCS so that consumption may be recorded and billed as per applicable tariff for EV charging stations.**
   The provision for separate metering has been introduced to provide benefit of preferential EV supply tariff to the EV users who are willing to charge EVs at public charging stations. The chargers at public charging stations are typically DC fast chargers with capacities in excess of 50 kW and may be used by EV users for topping up EV Batteries within short duration.

4. **The cost of supply of electricity by DISCOM to a PCS will be 0.8 times of Average Cost of Supply (ACoS) during solar hours and 1.2 times ACoS during non-solar hours.**
   Additionally, Ministry of Power (MoP) specified ceiling limits on service charges being levied by public charge point operators on the EV customers to recover the cost of servicing the capital investments (excluding GST) made by it in setting up the PCS. The amendment specifies a ceiling of Rs 2.50 per unit and Rs 3.50 per unit of electricity used for slow AC charging of EVs at PCS during the solar and non-solar hours respectively. Additionally, a ceiling limit of Rs 10 per unit and Rs 12 per unit of electricity used for DC fast charging of

EVs at PCS during the solar and non-solar hours respectively has also been specified vide the amendment. Further, it is recommended that all State Governments may adopt the ceiling limit recommended by the Ministry of Power to make public EV charging affordable for EV customers.

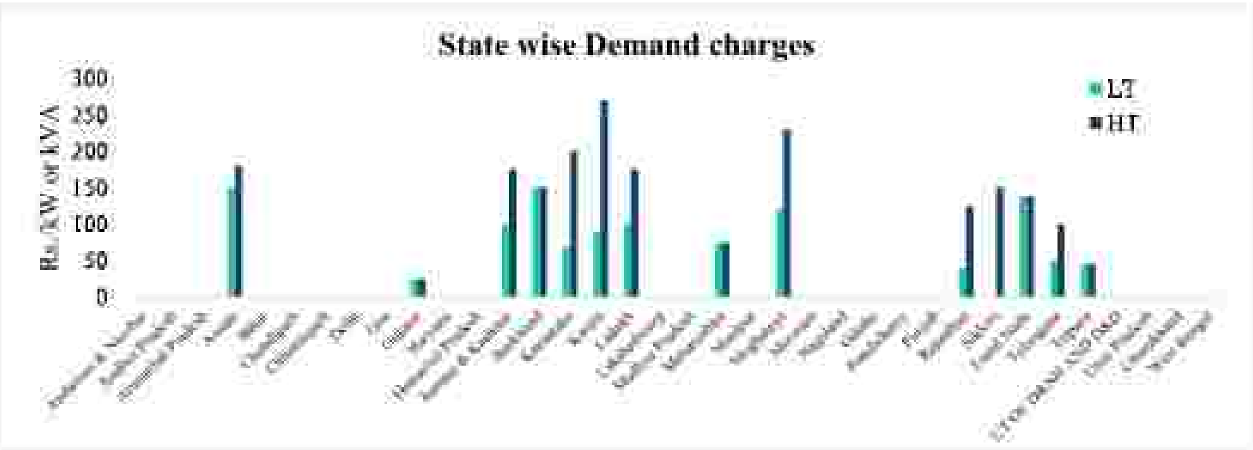
7.1 State wise tariff for electric vehicles

This section provides details about state wise fixed / demand charges and energy charges for EV charging category. The section also provides about non-compliance by state agencies with respect to tariff related provisions specified by Ministry of Power in its revised guidelines & standards dated 14th Jan 2022.

a) State wise Demand Charges:

The fixed or demand charge for an electricity connection is levied on the sanctioned load for the connection or the maximum power demand registered during the billing period, which must be paid irrespective of the actual energy usage.

Demand Charges depend upon sanctioned load limit. Under EV charging category, several states have exempted the fixed / demand charges, while few states still continue to levy demand charges for EV charging connection. Details of State wise demand charges for EV category is mapped below:



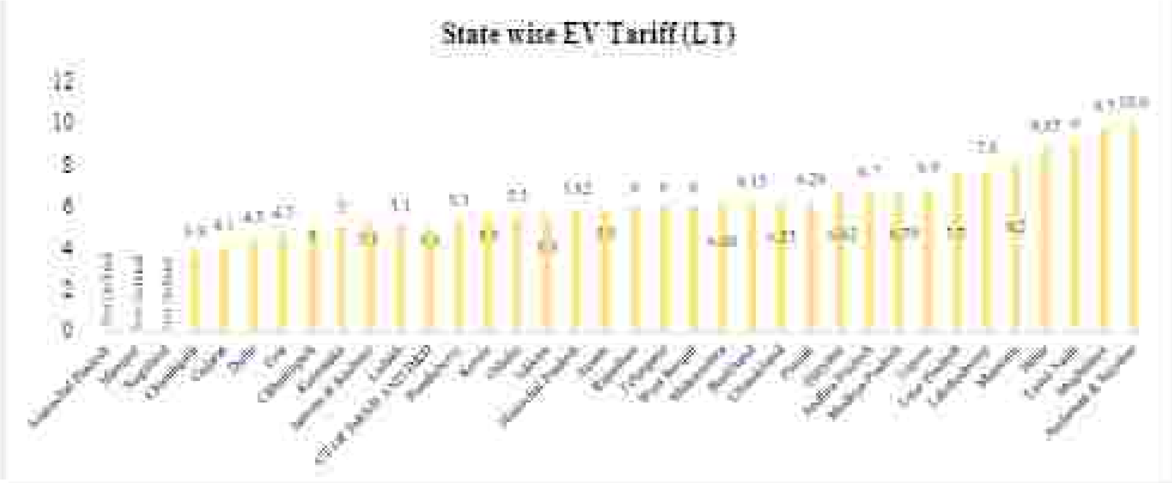
Graph 93: State wise fixed charges under EV Category

It is seen from Graph 93 that demand charges vary in the range of Rs. 25 / kVA to Rs. 270/kVA.

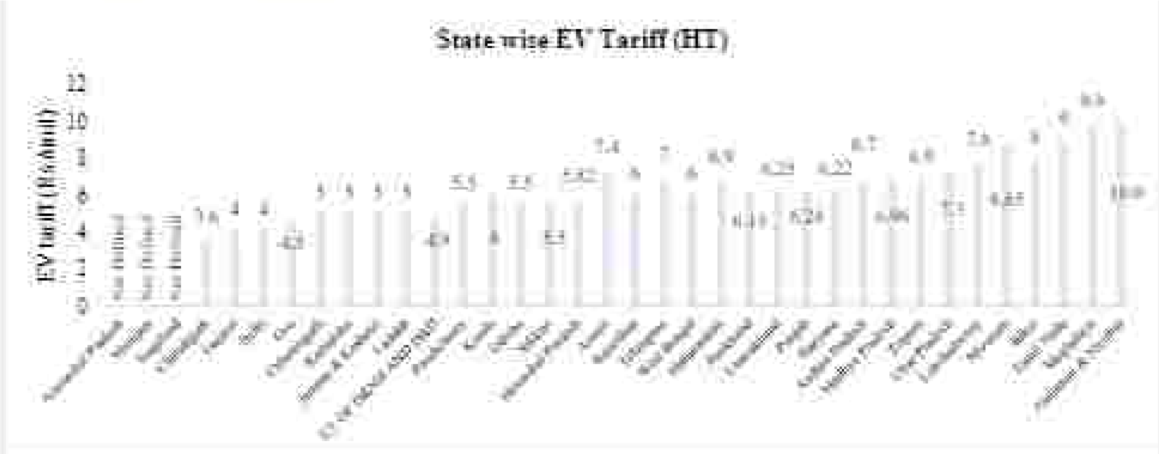
b) State wise Energy Charges

Energy charges are the variable component of an electricity tariff, applied on the total volume of energy/electricity consumed during the billing period.

Most of the state and UTs regulatory commissions have announced special energy charges for EV charging. However, the considerations related to EV specific tariff are not the same across the states. State wise energy charges for EV charging illustrated below:



Graph 94: State wise EV charging tariff (LT)

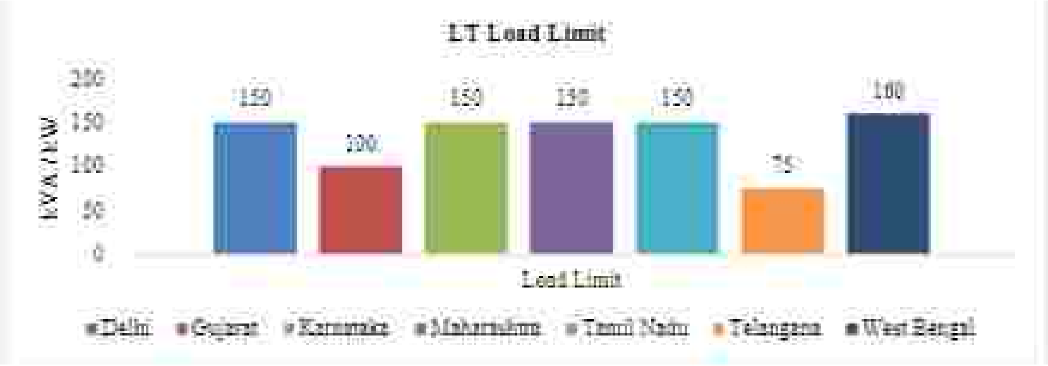


Graph 95: State wise EV charging tariff (HT)

It is seen from Graph 94 that LT energy charges for EV segment in the country varies from Rs. 3.80 / kWh in the UT of Chandigarh to Rs. 10.0 / unit in UT of Andaman & Nicobar Islands for low tension. Similarly, Graph 95 exhibits a variation in HT energy charges which varies from Rs. 3.60 / kWh in the UT of Chandigarh to Rs. 10 / kWh in the UT of Andaman & Nicobar Islands.

c) Low Tension (LT) Load Limit:

LT load limit is defined by respective state and UTs regulatory commissions such that sanctioned load below this limit will not require augmentation of upstream infrastructure while the load above this limit will be categorized as High Tension (HT) load for which existing infrastructure needs to be upgraded, thus requiring significant investments. Few states majorly those having mega cities with 4 million plus population, have considered higher LT connections limit. The LT load of some of the states with higher load limit is mentioned in Graph 96:



Graph 56: State wise LT Load limit

Further, figure below provides details on state wise EV charging tariff, and deviation from tariff provisions defined in revised guidelines & standards issued by MoP on 14th Jan 2022. Additionally, tariff comparison of domestic, commercial and EV charging category is also provided in this section.

The details on state wise ACoS, EV supply tariff and fixed charges for EV charging station category are in Annexure D.

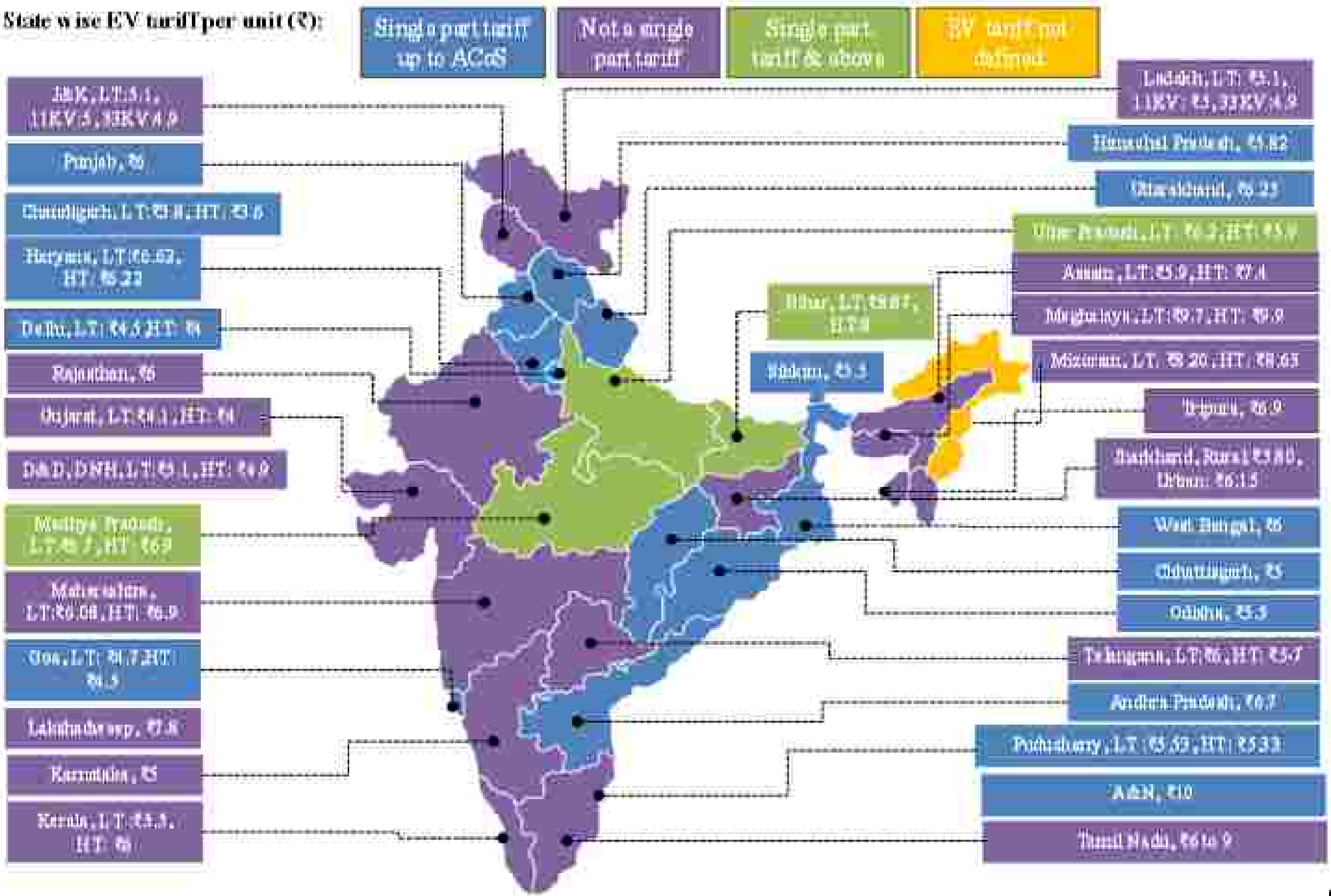


Figure 40: State wise notified EV tariff (LT & HT)

7.2 Highlights of state specific EV tariff frameworks

Most of the regulatory commissions of states and UTs have already announced EV specific rates in their respective tariff orders. However, considerations related to EV specific tariff are uniform across states. Some states introduced a separate category called Public EV Charging stations (such as Goa, Punjab and UTs) which is distinct from existing consumer categories. On the other hand, some other states have considered tariffs for EV charging under the existing consumer categories such as non-domestic or non-commercial categories (such as Andhra Pradesh, Chhattisgarh and Punjab). Jharkhand is the only state which has introduced EV tariff under the commercial category.

It is worth mentioning here that there is also a significant variation across states in terms of tariff design. Out of 36 states & UTs, 33 states notified EV tariff. Out of 33 states, 16 states have introduced demand charges & energy charges which include Gujarat, Rajasthan, Karnataka, Maharashtra, etc., while 14 states have notified only energy charges up to average cost of supply, such as Andhra Pradesh, Delhi, Haryana, Chhattisgarh, Uttarakhand, etc. Three states have notified energy charges above average cost of supply.

Single Part tariff up to ACoS

a. Lowest EV supply tariff in LT category ₹3.8/unit in Chandigarh

b. Lowest EV supply tariff in HT category ₹3.6/unit in Chandigarh

c. Max. subsidized single part tariff as compared to ACoS – 16% of ACoS in Lakshadweep

Two-part tariff up to ACoS

a. Two-part tariff including fixed charges defined by SERCs

b. Lowest EV tariff & fixed charges in LT category ₹4.1/unit & ₹25/kVA in Gujarat

c. Max. fixed charges in LT category: ₹150/kVA in Assam and Jharkhand

d. Max. fixed charges in HT category: ₹270/kVA in Assam and Jharkhand

Single part tariff above ACoS

a. Three states – Uttar Pradesh, Madhya Pradesh, Bihar

b. Bihar – EV tariff in LT category ₹8.87 above ACoS ₹8.3/unit

c. Madhya Pradesh - EV tariff in HT category ₹6.96 above ACoS ₹6.79/unit

d. Uttar Pradesh - EV tariff in LT category ₹7.7 above ACoS ₹7.3/unit

Such categorisation of EV tariffs has an implication on the commercial viability of EV charging business as electricity rates under commercial category are considerably higher than the residential or domestic category as shown in the table below:

7.3 Comparison of Domestic tariff, Commercial tariff and EV Tariff[50]

S. No.	State Name	DISCOMs	Domestic Tariff		Commercial Tariff		EV Tariff	
			Energy Charges (Rs. /Unit)	Fixed charges	Energy Charges (Rs. /Unit)	Fixed charges	Energy Charges (Rs. /Unit)	Fixed charges
1	Andaman & Nicobar	Electricity Dept. – A&N	2.50 to 9.20/kWh	15/kW/month	9.25 to 16.50	35/kVA	10	0
2	Andhra Pradesh	APCPDCL, APEPDCL, APSPDCL	1.90 to 9.75/kWh	10/kW/month	5.40 to 10.15	75/kW	6.7	0
3	Arunachal Pradesh	Dept. of Power - AP	LT: 2.65 to 4/kWh HT: 3.25 to 3.40/kWh	-	LT: 5.00/kWh HT: 4.00 to 4.20/kWh	-	Not defined	0
4	Assam	APDCL	5.70 to 7.90/kWh	70/kW/month	LT: 7.90, HT: 8.00	LT: 150/kW, HT: 210/kVA	LT: 5.90, HT: 7.40	LT: 150, HT: 180
5	Bihar	NBPDCL, SBPDCL	7.57 to 9.16/kWh	40 to 80/kW/month	LT: 7.88(<100 units), 9.08(>100 units), HT: 7.90 to 8.13	LT: 300/kW, HT: 550/kVA	LT: 8.87, HT: 8.00	0
6	Chandigarh	Electricity Department, Chandigarh	2.75 to 4.65/kWh	15/kW/month	LT: 4.50 to 5.00, HT: 4.50	100 kW/month	LT: 3.80, HT: 3.60	0
7	Chhattisgarh	CSPDCL	3.70 to 7.90	20/kW to 40/kW	LT: 6.85 to 7.55, HT: 7.25 to 7.45	LT: 120/kW to 200/kW, HT: 190/kVA to 375/kVA	5	0
8	Delhi	BRPL, BYPL, TPDDL, NDMC	3 to 8	20 to 250/kW	8.5	250/kVA	LT: 4.50, HT: 4.00	0

[50] State tariff order

S. No.	State Name	DISCOMs	Domestic Tariff		Commercial Tariff		EV Tariff	
			Energy Charges (Rs. /Unit)	Fixed charges	Energy Charges (Rs. /Unit)	Fixed charges	Energy Charges (Rs. /Unit)	Fixed charges
9	Goa	Electricity Department-GOA	1.75 to 5.10	20/kW	LT: 3.60 to 5.30/kWh, HT:5.25/kVAh	LT: 70/kW, HT: 250/kVA	LT: 4.70, HT:4.50	0
10	Gujarat	DGVCL MGVCL PGVCL UGVCL	3.05 to 5.20	15 to 70	LT: 4.35 to 4.65, HT:4.6	LT: 30 to 85/kW, HT: 90 to 265/kW	LT: 4.10, HT: 4.00	LT:25/installation/month, HT: 25/kVA/month
11	Haryana	DHBVNL UHBVNL	2/kWh to 7.10/kWh	70/kW to 125/kW	LT: 6.35 to 6.65/kVAh, HT 6.25 to 6.65/kVAh	LT: 185/kW, HT:165/kVA	LT: 6.62, HT 6.22	0
12	Himachal Pradesh	HPSEBL	3.72 to 5.87/kWh	85/kW	Single Part: 5.21/kWh Two Part: 5.31/kVAh	Single Part: 145/kVA Multi Part: 170/kVA	5.82	0
13	Jammu & Kashmir	JPDCL KPDCL	2/kWh to 3.80/kWh	8 to 1400 per Month	3.10/kWh to 5.10/kWh	50/kW to 120/kVA	LT: 5.1, 11KV: 5, 33KV 4.9	LT:100/KW, 11KV: 175/KW, 33KV: 150/KW
14	Jharkhand	JBVNL	7/kWh to 7.50/kWh	75/kW to 100/kW	7.50/kWh	75/kW to 300/kW	Rural: 5.80, Urban - 6.15	Rural: 50/KW, Urban - 100/KW
15	Karnataka	BESCOM CESCOM GESCOM HESCOM MESCOM	4.75 to 7.00/kWh	110 to 210/kW	LT:8.50/kWh HT: 9.25/kWh	LT:200 to 320/kW/month HT: 375/kVA/month	5/kWh	LT: 70/kW to 170/kW, HT 200/KVA
16	Kerala	KSEBL	LT: 1.50 to 8.50 HT:6.15/unit	LT: 35-225/kW HT 425/kVA	LT:5.30-9.40 HT:6.70-7.90	LT:50- 100/kW HT:490/kVA	LT: 5.30, HT: 6.00	LT: 90/KW, HT: 270/KVA
17	Ladakh	LPDD	2/kWh to 3.80/kWh	8 to 1400 per Month	3.10/kWh to 5.10/kWh	50/kW to 120/kVA	LT: 5.1, 11KV: 5, 33KV 4.9	LT:100/KW, 11KV: 175/KW, 33KV 150/KW
18	Lakshadweep	Electricity Dept.-Lakshadweep	1.75/kWh to 7.75/kWh	20/kW/month	8/kWh to 12/kWh	30/kW/month	7.8	0

S. No.	State Name	DISCOMs	Domestic Tariff: Energy Charges (Rs. /Unit)	Domestic Tariff: Fixed charges	Commercial Tariff: Energy Charges (Rs. /Unit)	Commercial Tariff: Fixed charges	EV Tariff: Energy Charges (Rs. /Unit)	EV Tariff: Fixed charges
19	Madhya Pradesh	MPMKVVCL MPPKVVCL MPWKVVCL	4.27/unit to 6.80/unit	Rural: 26/0.1kW Urban: 27/0.1kW	L.T: 6.30 to 8.70/unit, HT:5.95 to 7.70/unit	LT:125 to296/kW, HT:348 to 593/kVA	L.T: 6.79, HT: 6.96	0
20	Maharashtra	AEML BEST MSEDCL Tata Power	4.41 to 15.57/kWh	116 to 385/month	LT: 8.27 to 14.90/kWh, HT:12.93/kVAh	LT:470/kVA/month, HT:499/kVA/month	LT: 6.08, HT: 6.9	LT:75/KW, HT 75/KVA
21	Manipur	MSPDCL	5.10 to 6.75/kWh	65/kW/month	LT: 6.55 to 7.65/kWh, HT: 8.20/kVAh	LT:85/kW/month, HT:105/kVA/month	Not defined	Not defined
22	Meghalaya	MePDCL	LT:4.50 to 6.70/kWh, HT:6.90/kVAh	LT: 80/kVA, HT:300/kVA	LT:6.70 to 7.80/kWh, HT:7.40/kVAh	LT: 140/kW/month, HT: 300/kVA/month	LT: 9.70, HT: 9.90	LT - 120/KVA, HT - 230/KVA
23	Mizoram	Power Dept.- Mizoram	4.90 to 8.20/kWh	50/kW/month	8.20 to 8.45/kWh	80/kW/month	LT:8.20/kWh, HT:8.65/kVAh	LT:75/kW/month, HT: 75/kVA/month
24	Nagaland	Dept. of Power- Nagaland	Rs 3.55 to 7.10/kWh	10/month	7.40 to 9.00/kWh	15/month	Not defined	Not defined
25	Odisha	TPCODL TPNODL TPWODL	3 to 6.20/kWh	20/kW/month	LT:5.90 to 7.60/kWh, HT: 4.70 to 5.85/kVAh	LT:30/kW/month, HT:250/kVA/month	5.5	0
26	Puducherry	ED-Puducherry	2.25 to 6.80/kWh	30/kW/month	LT:6.00 to 7.80/kWh, HT: 5.60/kVAh	LT: 75/kW/month, HT: 420/kVA/month	HT:5.33, LT:5.53	0
27	Punjab	PSPCL	4.19 to 7.75/kWh	50/kW to 140/kVA	6.91 to 7.75/kWh	70/kW to 140/kVA	6.28/kVAh	0
28	Rajasthan	JVVNL JDVVNL AVVNL	LT: 4.75 to 7.95/unit, HT: 7.15/unit	LT: 230 to 400/month, HT: 250/kVA/month	LT: 7.55 to 8.95/unit, HT: 8.85/unit	LT: 300 to 460/month, HT: 270/kVA/month	6	LT: 40/HP, HT: 135/kVA

S. No.	State Name	DISCOMs	Domestic Tariff		Commercial Tariff		EV Tariff	
			Energy Charges (Rs. /Unit)	Fixed charges	Energy Charges (Rs. /Unit)	Fixed charges	Energy Charges (Rs. /Unit)	Fixed charges
29	Sikkim	Sikkim Power Dept.	1.10 to 4.10/unit	50 to 200/month	3.10 to 6.40/unit	200 to 500/month and 60 to 100/kVA/month	5.5	500/month below 4.5 kW, 150/KVA above 4.5 kW
30	Tamil Nadu	TANGEDCO	4.60 to 11.25	NA	LT: 6.15 to 9.70/kWh, HT: 8.70/kWh	LT: 102 to 562/kW/month, HT: 562/kW/month	LT: 6 to 9 HT: 6 to 9	LT: 25 to 1380/kVA, HT: 1380/kVA
31	Telangana	TSNPDCL / TSSPDCL	LT: 1.95 to 10/unit	LT: 10/kW/month	LT: 7 to 11/unit; HT: 7.30/unit	LT: 60 to 70/kW, HT: 260/kVA	LT: 6.00, HT: 5.00 - 7.00	LT: 50/kW, HT: 100/KVA
32	Tripura	TSECL	4.23 to 7.20/kWh	20/month to 55/kW/month	6.23 to 8.06/kWh	30/month to 55/kW/month	6.9	Rs. 50/KW
33	UT OF D&NH AND D&D	ED-D&NH	1.60 to 3.40/kWh	10/kW/month	LT:3.25 to 4.35/kWh	LT: 20/kW/month	LT: 5.10, HT: 4.90	0
34	Uttar Pradesh	DVVNL / KESCO / MVVNL / PAVVNL / PUVVNL / NPCL	3.00 to 7.00/kWh	50/kW to 110/kW/month	LT:5.50 to 8.75/kWh, HT:8.12 to 8.32/kVAh	LT:110/kW/month to 450/kW/month; HT:400 to 430/kVA	LT: 6.2, HT: 5.9	0
35	Uttarakhand	UKPCL	1.75/kWh to 6.25/kVAh	18/month to 100/kVA/month	5.40/kWh to 7.50/kWh	80/kW to 120/kW	6.25	0
36	West Bengal	WBSEDCL	4.10 to 6.89/kWh	20/kVA/month	4.21 to 4.98/kWh	30/kVA/month	6	0

Table 19: State wise comparison of tariff in various categories

Considering the importance of EV tariff in overall ownership of EV and large-scale EV adoption, it is critical to give shape to the EV charging tariff structure in respective states such that is in compliance with related guidelines of Ministry of Power such that a conducive regulatory environment can be developed.

7.4 Advantages of EV tariff for CPO & EV consumer

a) For Charge Point Operators:

States have defined subsidized EV tariffs to accelerate the adoption of EVs. The Ministry of Power has specified service charges for Charge Point Operators (CPOs) granted connections under the public EV charging category, with a ceiling limit for service charges to cover capital expenditure—up to ₹3.5/unit for slow charging and up to ₹12/unit for fast charging. A comparison between the service charges in the Delhi city, charged by CPOs under EV tariff category and commercial tariff category at PCS is as follows:

S. No.	Description	EV tariff	Commercial tariff	Unit
1	Connected load	50	50	kW
2	Energy Consumption/month	1000	1000	kWh
3	Energy Charges	4.5	8.5	₹/unit
4	Fixed charges	0	250	₹/kVA
5	Total Charges (Energy + Fixed)	4,500	21,000	₹/month
6	Average charges/unit	4.5	21	₹/unit
7	Ceiling limit for service charges	12	12	₹/unit
8	Service charge/unit	**16.5**	**33**	₹/unit

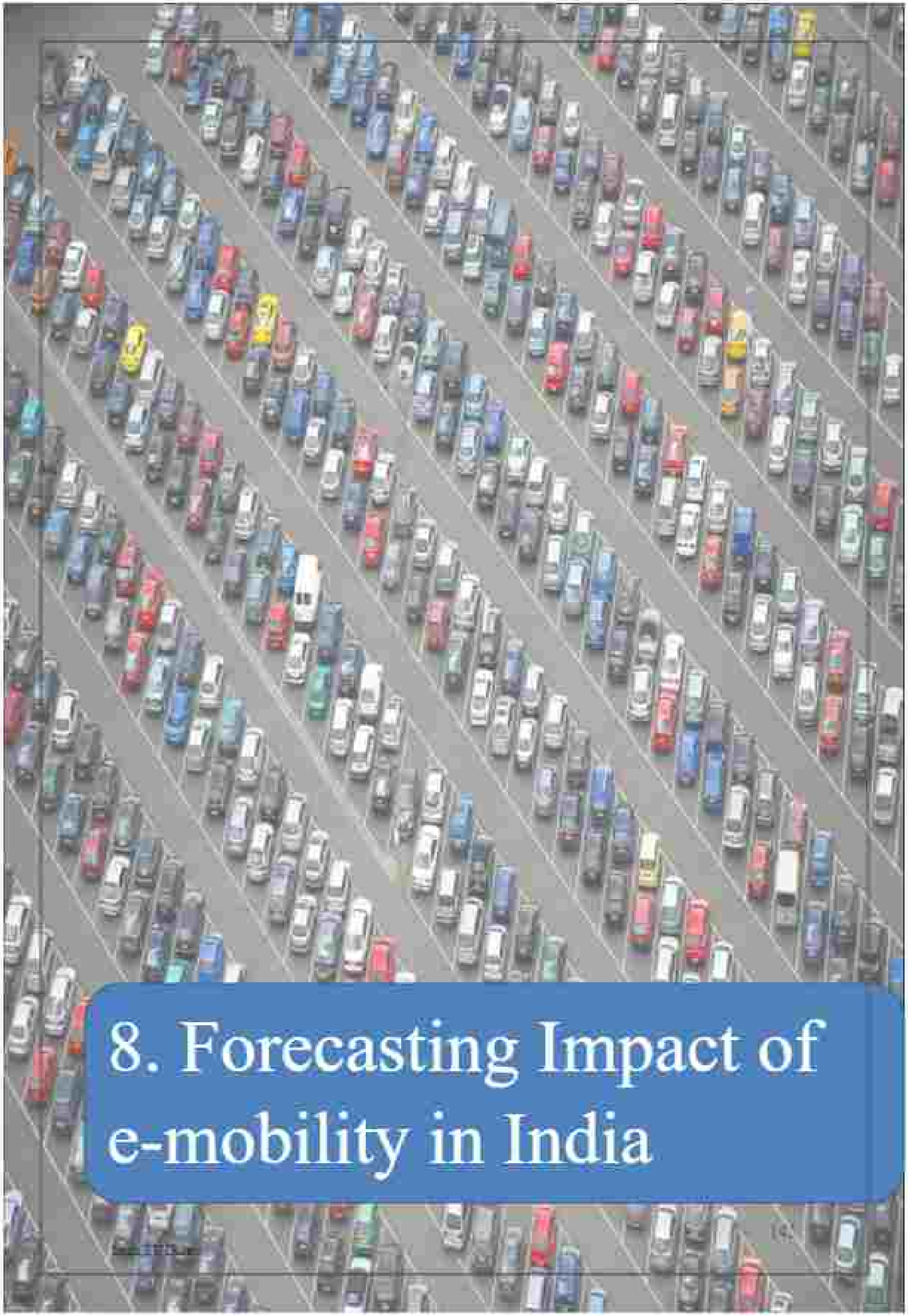
As can be seen from above, considering the EV supply tariff at PCS, service charge would be ₹16.5/unit only, which may be 50% cheaper as compared to service charge including commercial tariff. Lowest service charge shall make charging affordable & attract more consumers.

b) EV User:

In terms of revised consolidated guidelines & standards regarding charging infrastructure for Electric vehicles issued by Ministry of Power, tariff applicable for domestic consumption shall be applicable for domestic charging. A domestic consumer can also apply for EV connection with separate metering and avail the benefit of subsidised EV tariff. A comparison prepared for a domestic consumer residing in Delhi having e-4W is as follows:

S. No.	Description	EV tariff	Domestic tariff	Unit	Remarks
1	Connected load	10	10	kW	As per BRPL's tariff order, energy charges@₹6.5/unit for more than 400 units consumed monthly and ₹100/kVA for above 5 kW connection.
2	Energy Consumption/month for EV Charging	300	300	kWh	
3	Energy Charges	4.5	6.5	₹/unit	
4	Fixed charges	0	100	₹/kVA	
5	Total Charges	270	2,850	₹/month	
6	**Average charge/unit**	**4.5**	**9.5**	**₹/unit**	

In terms of above comparison, an EV user opting for EV tariff through separate metering, gets a benefit of around ₹5.0 per unit and monthly saving of up to ₹1500.



8. Forecasting Impact of e-mobility in India

8. Forecasting impact of e-mobility in India

Forecasting the impact of EV adoption on the grid and the environment in India involves examining various factors and projecting EV numbers based on current EV sales and EV adoption targets until FY 2030. The growth in EV sales is estimated by considering historical sales of Internal Combustion Engine (ICE) vehicles and the targeted EV penetration for different vehicle segments under the Business as Usual (BAU) scenario. The forecasting has been carried out to estimate the following:

- EV Sales projections (segment wise)
- Number of public EV chargers required
- Number of Captive EV chargers (for EV fleets) required
- Number of Battery swapping kiosk for e-2Ws and e-3Ws required
- Number of Depots charging stations for e-buses operated by state entities
- Impact of EV charging on electricity grid
- Carbon emission reduction possible from EV adoption

It's important to note that estimating the impact of EVs involves inherent uncertainties. Factors such as technological advancements, policy shifts, and market dynamics may impact significantly adopt EV adoption. Thus, forecasts should be periodically evaluated and adjusted based on the evolving landscape of e-mobility.

8.1. EV Sales projections

EV sales are projected based on historical sales of all vehicle segments and target EV penetration (segment wise) as prescribed by NITI Aayog. The following steps have been undertaken for estimating EV sales growth:

Step 1: Data collection of different vehicle segments based on secondary research

In terms of vehicle sales data available on VAHAN portal & data received from various state agencies, segment wise registration of vehicles sales for a period from FY 2016 to FY 2023 is indicated in table below:

Vehicle Category	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023
2W	1,62,35,901	1,74,95,217	1,93,28,629	2,02,87,647	1,97,51,210	1,38,47,787	1,40,66,646	1,66,35,288
3W	5,13,792	5,52,871	6,70,192	7,91,311	8,23,502	2,95,032	4,23,817	7,98,109
4W(P)*	30,53,333	32,63,057	36,52,190	37,22,658	35,06,457	34,17,518	37,51,958	44,33,031
4W(C)*	3,49,953	3,06,293	2,48,835	2,92,327	2,51,901	70,324	1,69,064	2,87,887
Bus	53,333	63,254	48,793	48,853	60,583	8,600	15,727	36,372
Total	**2,01,06,312**	**2,16,86,692**	**2,39,48,639**	**2,51,42,781**	**2,43,93,653**	**1,76,39,261**	**1,84,25,212**	**2,21,90,687**

Table 20: Sales of vehicles from FY2016 to FY2023

4W(P): Four wheeler (Private); 4W (C): Four wheeler (Commercial). Figure does not include vehicle registration for UT of Lakshadweep.

Step 2: CAGR estimation of different vehicle segments

Based on historical vehicle sales, CAGR for different vehicles segment has been estimated.

Graph 87: Growth of all vehicle segment

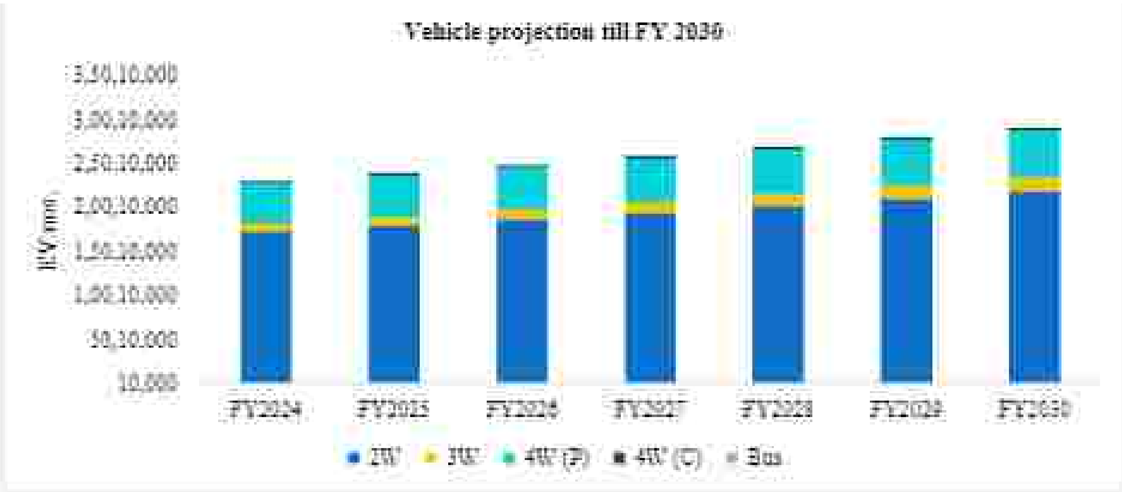
CAGR estimation of different vehicle segments has been carried out considering vehicle sales from FY 2016 to FY 2020 (Pre-COVID) era.

Step 3: Projecting total vehicles stock till FY2030

Based on the growth rate estimated for 2W, 3W, 4W(P), 4W(C) and Buses, below table provides the category wise vehicle sales projections:

Table 21: Annual vehicle sales projections till FY 2030

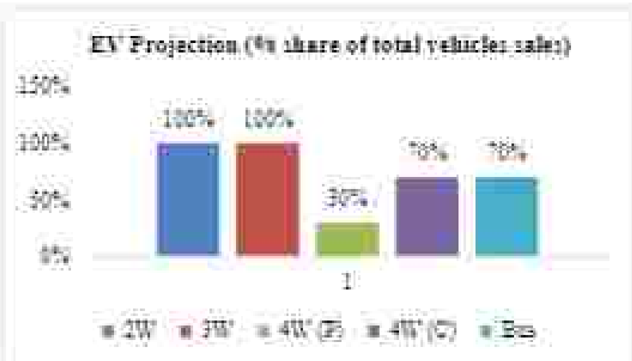
Vehicle Category	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030
2W	1,73,00,306	1,79,91,909	1,87,11,160	1,94,59,164	2,02,37,070	2,10,46,074	2,18,87,419
3W	8,77,077	9,63,858	10,59,226	11,64,030	12,79,203	14,05,772	15,44,865
4W (P)	45,57,426	46,85,312	48,16,786	49,51,950	50,90,906	52,33,762	53,80,627
4W (C)	2,88,334	2,88,782	2,89,231	2,89,681	2,90,131	2,90,581	2,91,033
Bus	37,311	38,274	39,263	40,276	41,316	42,383	43,477
Total	**2,30,60,456**	**2,39,68,136**	**2,49,15,666**	**2,59,05,100**	**2,69,38,627**	**2,80,18,573**	**2,91,47,421**



Graph 98: Projection of growth in vehicles sales till FY 2030

Step 4: Projecting new EV sales till year 2030

In terms of projections made by NITI Aayog segment wise EV penetration expected in FY 2030 is illustrated in given graph:

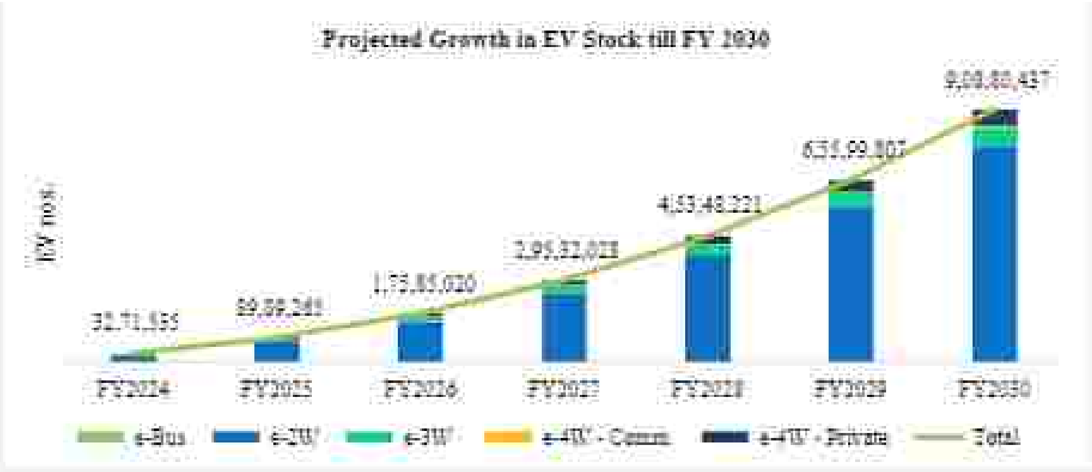


Graph 99: Share of EVs in overall vehicles sales in FY 2030

Based on above assumption the segment wise EV projection are as follows:

S. No.	Vehicle Category	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030
1	e-2W	25,62,173	47,10,282	72,38,348	1,01,84,926	1,35,85,145	1,74,80,868	2,18,87,419
2	e-3W	4,89,146	5,94,700	7,22,710	8,77,213	10,62,890	12,85,157	15,44,865
3	e-4W(P)	1,85,943	3,52,335	5,44,297	7,63,591	10,12,072	12,91,693	16,14,188
4	e-4W(C)	29,758	52,816	78,268	1,06,110	1,36,361	1,69,031	2,03,723
5	e-Bus	4,515	7,594	11,135	15,168	19,724	24,837	30,434
Total		32,71,535	57,17,730	85,95,758	1,19,47,008	1,58,16,192	2,02,51,587	2,52,80,629

Table 22: Projections of EV sales till FY 2030



Graph 100: Projection of EV Stock growth till FY 2030

8.2 Estimating Public EV Chargers requirement

For estimating number of public EV chargers, charging demand for different vehicle segments is estimated. EV charging demand has been estimated as below:

Step 1: Estimation of daily energy requirement for Electric Vehicles

Daily energy demand of EV stock shall depend on several factors as follows:

a) Share of EV in different vehicle segments (category)
b) Share of vehicle using at public charging to top up charge batteries
c) Specific energy consumption of each vehicle segment (kWh/km)
d) Average daily running km for each vehicle segment

For estimating the daily energy demand of public EV chargers, following assumptions have been taken in consideration:

Table 23: Share of vehicle expected in PCS, Captive, Depots & BSS

S. No.	Vehicle Category	Public charging	Home Charging	Captive Charging/Office Charging	Depots	Battery Swapping
1	E-2W	10%	80%	-	-	10%
2	E-3W	20%	30%	-	-	50%
3	E-4W(P)	20%	70%	10%	-	-
4	E-4W(C)	20%	-	80%	-	-
5	E-Bus	10%	-	-	90%	-

Table 24: Vehicle models considered for each category

Vehicle Type	e-2W	e-3W	e-4W Commercial	e-4W Private	E-Bus
Vehicle Model	Ola S1[51]	Mahindra Treo Yaari SFT	Tata Tigor EV XM (26 kWh)	TATA NEXON EV XZ+	Tata Starbus – 12m low floor AC electric bus[52]
Performance and Efficiency of vehicle					
Range (km)	141	129	314	312	200
Max. Speed (km/h)	75.3	0	116.5	80	70
Acceleration (m/s^2)	1.32	0	1.4	1.7	0.8
Warranty (years)	3	3	3	3	5
Battery specifications					
Battery Technology	Nickel Manganese Cobalt Oxide	Lithium ion	Lithium-Ion Iron Phosphate	Lithium Iron Phosphate	Lithium ion
Battery Capacity (kWh)	2.98	3.7	26	30.2	250
Battery Density (Wh/Kg)	289	129.2	179	179	-
Battery cycle (No. of Cycles)	2000	2000	1200	1200	-
Energy Consumption					
Electric Energy consumption (kWh per 100 km)	3.3	3.41	11	10.6	125
Electric Energy consumption (kWh per km)	0.033	0.0341	0.11	0.106	1.25
Daily running km (avg.) assumed	30	80	100	50	200

Top selling EV models in each category has been considered for assessment.

[51] https://fame2.heavyindustries.gov.in/ModelUnderFame.aspx
[52] https://tatatrucks.tatamotors.com/auto-expo-trucks/pdf/STARBUS_EV.pdf

Daily charging energy requirement of different EV segments is as follows:

Graph 101: Projection of daily energy requirement of each category of vehicles till FY 2030

Step 2: Estimating Public EV charging demand

For estimating the public EV charging demand, % utilization of public EV charger is considered as 7% in FY2023 expected to reach 23% in FY2030 as number of EVs increases.

Graph 102: Projection of annual power demand (MW)

Step 3: Estimating number of public EV chargers

Based on annual power demand estimated for public EV charging in step 2, the requirement of public EV chargers have been estimated till FY2030. Type of EV chargers and share of EVs to charge at public charging stations assumed for estimating number of public EV chargers.

Table 25: Share of EVs expected to charger at public chargers

S. No.	Vehicle Category	Type of EV Charger	Minimum rated capacity (kW)	% share of EV at public charger
1	e-2W	Type-II AC	7.4	100%
2	e-3W	Type-II AC	7.4	100%
3	e-4W(P)	Type-II AC	22	30%
		CCS-II	60	70%
4	e-4W(C)	CCS-II	60	100%
5	e-Bus	CCS-II	120	100%

Based on assumption in table 24 above EV charger type and charger capacity, growth in number of different types of public EV chargers required at PCS is estimated as follows:

S. No.	Type of EV Chargers	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030
1	Type-II AC (7.4 kW)	34,769	43,484	50,328	55,816	60,380	64,346	67,815
2	Type-II AC (22 kW)	2,657	4,145	5,275	6,132	6,792	7,312	7,781
3	CCS-II (60 kW)	1,676	2,561	3,218	3,704	4,066	4,341	4,574
4	CCS-II (120 kW)	131	220	322	439	571	719	881
	Total (no.)	**39,232**	**50,409**	**59,143**	**66,091**	**71,808**	**76,717**	**81,050**

Table 26: Estimated Public EV Chargers till FY2030

Graph 103: Cumulative Projections of Public EV chargers till FY 2030

6.3 Projection of Captive EV Chargers

Captive EV charging stations are infrastructure facilities dedicated to serving EV fleets for captive purposes; primarily catering to commercial ride-hailing companies such as Ola Green, Blu Smart, Uber etc.

Captive charging stations typically consists of several EV chargers to enable the simultaneous charging of multiple EVs within the fleet. These charging stations are typically installed at locations owned or leased by the fleet operators.

In addition to facilitating the simultaneous charging of multiple EVs, captive EV charging stations offer various benefit:

- **Cost Control:** EV fleet operators can manage EV charging costs by potentially leveraging renewable energy sources for charging, leading to better cost control.
- **Reduced vehicle downtime:** Captive charging stations minimize the downtime of vehicle fleet as they are located strategically, reducing the need for drivers to rely on public charging infrastructure.
- **Convenience and Efficiency:** Captive charging stations provide convenience and address concerns related to range anxiety for EV fleet operators and drivers by ensuring dedicated charging facilities reducing reliance on public charging networks.

Some of the other salient features of captive charging stations are as follows:

- **Tailored Infrastructure:** Captive charging stations can be customized based on the specific needs of an organization's fleets, considering factors like charging capacity, charging speed, and compatibility with the EV models.
- **Dedicated Power Supply:** These charging stations may have a dedicated power supply maybe through renewable source ensuring a reliable power supply and reducing dependence on the power grid.
- **Fleet Management Integration:** Captive charging stations can be integrated into fleet management systems to monitor charging activity, track usage, and optimize charging schedules based on the operational requirements of the fleet.

Status of Captive Chargers in India:

Captive charging stations in India are not expected to set up chargers as required by MoP guidelines or have mandate NSP connectivity. However, they need to meet the safety & quality requirements specified by MoP and BIS.

1. BluSmart operates around 190 captive chargers at four locations across Delhi NCR[11].

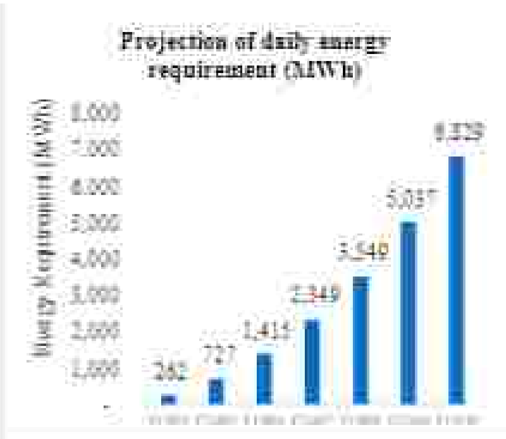
[11] https://www.wbcsd.org/contentwbc/download/10238/153424/1

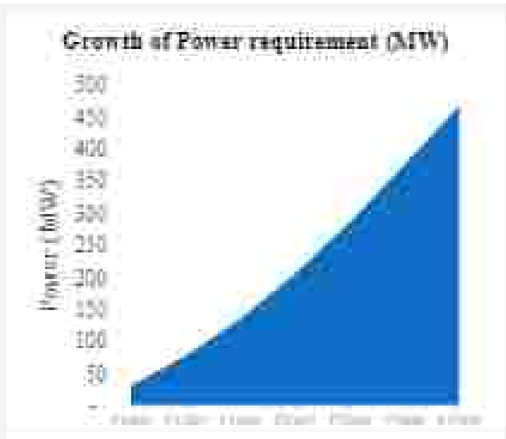
2. Uber has entered into an agreement with BP Pulse, allowing Uber to utilize the charging facilities of BP Pulse for its EV fleets. Currently, BP Pulse has more than 1000 charging points in India.

3. EVRE has been operating more than 550 captive chargers in 12 cities.

Estimation of Energy & Power requirements for Captive Chargers

The number of captive EV chargers is expected to cater to commercial electric 4Ws segment only. Based on the assumptions made in preceding section, daily energy requirement and power demand for captive EV chargers is estimated as follows:





Graph 104: Projection of Energy & Power requirement for Captive chargers till FY 2030

The EV chargers considered for projecting number of captive EV chargers are as below:

S. No.	Min. Charger Capacity	Charger Connector type	Assumed vehicle share at chargers (%)
1	3.3	Bharat AC001	50%
2	30	Bharat DC001	10%
3	60	CCS-II	40%

Table 37: EVSE type & capacities assumed for captive chargers

In terms of the above assumptions, the projected captive EVSE till FY2030 is as below:

Graph 105: Projection of EVSE for Captive Charging stations

8.4 Projection of Battery Swapping Kiosks

Step 1: Projection of energy requirement for battery swapping

Currently, battery swapping kiosks are projected to cater to meet energy demand of electric two-wheeler and three-wheelers, considering, battery swapping facility in India is available for e-2W and e-3W segment only. Based on assumptions provided in table 24, daily energy requirement is projected for battery swapping kiosks as below:

Graph 106: Projections of daily energy requirement for BSS till FY 2030

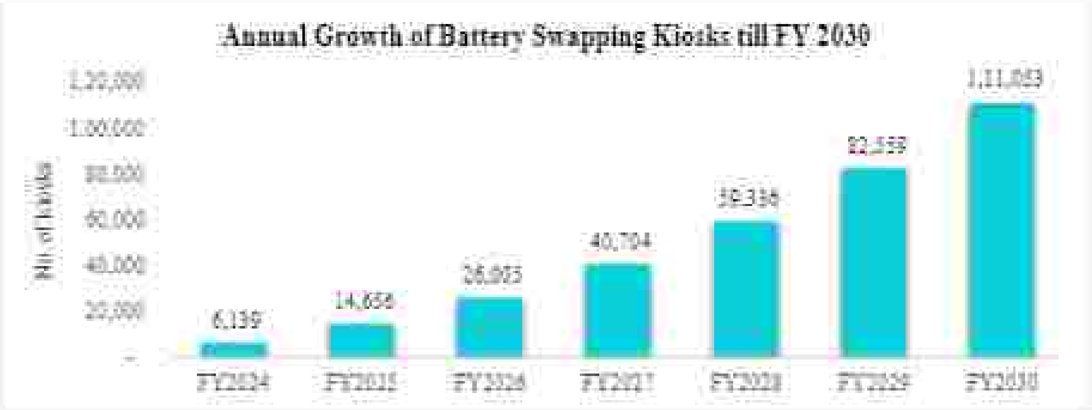
Based on the current market scenario, table 27 provides assumptions for estimating the number of battery swapping kiosks required to cater to demand of e-2W and e-3W in FY 2030.

Particulars	Value	Unit
Swappable battery capacity	1.5	kWh
No. of batteries in one kiosk	14	No.
No. of battery swaps in a day kiosk	100	No.

Table 28: Assumption batteries in each kiosk

Step 2: Projection of number of battery swapping kiosks:

Based on above assumptions, graph 105 provides the requirement of projected number of battery swapping kiosk required till FY 20230.



Graph 107: Projection of cumulative Battery swapping kiosks requirements till FY 2030

8.5 Projection of Electric Bus Depot Charging stations

Depots chargers are dedicated for charging electric buses, these chargers have high-capacity of around 250 kW. Electric bus depot charging stations play a pivotal role in the successful operation of electric bus fleets deployed and operated by various state transport units across the country.

Depot charging has multiple benefits compared to public charging stations. Some of the salient features are as follows:

- **High-capacity EV chargers:** Bus depot charging are equipped with high-capacity DC fast chargers with a minimum capacity of 250 kW, catering to high-capacity battery requirement of e-buses
- **Smart Grid Integration**: Advanced systems are integrated in depot charging stations to manage power distribution efficiently and enable dynamic load balancing

- **Safety measures:** Requirement of robust safety features, including fire suppression systems and emergency shutdowns, ensure safe charging operations for bus fleets
- **EV charger downtime:** Captive or dedicated charging for e-buses reduces downtime of EV chargers

The government is also supporting in the upgrade of existing conventional buses to electric buses, as well as the installation of the charging stations for e-Buses in State transport depots.

Under FAME scheme, it is proposed to provide one slow charger per e-bus and one fast charger for every 10 electric buses, funded for the charging of electric buses.

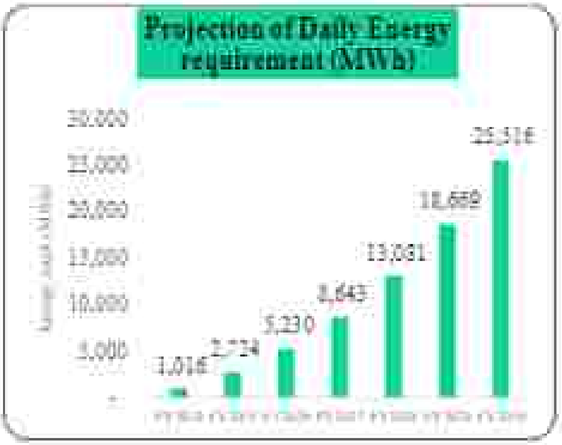
The Union Cabinet, chaired by Prime Minister Narendra Modi, has approved a bus scheme "PM-eBus Sewa" for augmenting city bus operation by 10,000 e-buses on the PPP model. The Scheme would have an estimated cost of Rs.57,613 crore, out of which support of Rs.20,000 crore will be provided as central assistance[54].

The PM e-BUS sewa scheme envisages green initiatives like bus priority, infrastructure, multimodal interchange facilities, NCMC-based Automated Fare Collection Systems, Charging infrastructure, etc. in 181 cities under Green Urban Mobility Initiatives (GUMI).

Depot captive charging stations are projected as based on following:

Step 1: Projection of Energy requirement & Power requirement

Based on assumptions provided in table 24, projected daily energy requirement & daily power requirement is presented in graph 105



Graph 105: Projection of energy & daily power requirement for DCS

Assumptions considered for projecting number of e-bus chargers is as below:

S. No.	Particulars	Units
1	Min Charger Capacity (CCS-II)	100 kW
2	No. of e-bus in Depot	100 nos.
3	No. of EVSE/Depot	14 nos.

Table 25: Assumed no. of EVSE & capacity of EVSE for DCS

[54] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/aug/doc2023824243601.pdf

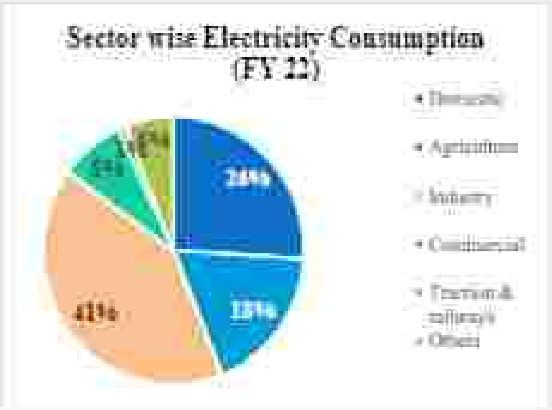
Step 2: Estimation of depot charging stations and number of EV charger

Based on assumption of number of EVSE in a bus depot and e-bus projections, projected number of depot charging stations (DCS) and EV chargers are as presented in Graph 109.

Graph 109: Projection of EVSE & DCS till FY 2030

8.6 Overall impact of EV charging on electricity grid

With the increasing adoption of EVs, there will be a significant impact on power demand, primarily driven by the enhanced requirement for EV charging. The growing EV charging load poses several challenges for the electricity distribution system. Charging EVs during peak hours will contribute to an additional during peak load periods, necessitating the augmentation of existing grid infrastructure. The increased demand has the potential to overload distribution transformers, leading to degrading of their lifespan.

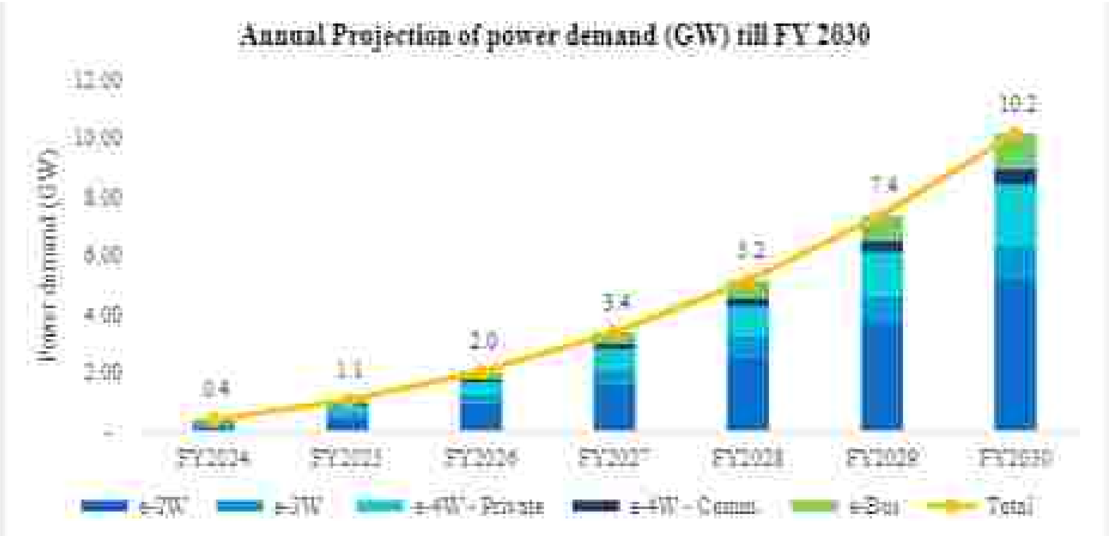


Graph 110: Sector wise electricity consumption in FY22

To mitigate the impact of EV charging on grid infrastructure, power utilities need to strategically plan the timely upgrade of distribution infrastructure. This proactive approach ensures that the additional load resulting from the increasing share of EVs can be effectively managed, and the peak demand on the grid can be handled without compromising reliability and efficiency.

According to the Ministry of Statistics & Programme Implementation (MOSPI), in FY 2021-22, the industrial sector had the highest share in total energy consumption, followed by the domestic sector.[55] The peak demand during this fiscal year exceeded 200 GW, with EV charging contributing 1% to the peak demand.

Based on the estimated EV sales until FY 2030 and related daily power requirements, pan India EV charging power demand has been projected and presented in the graph below:

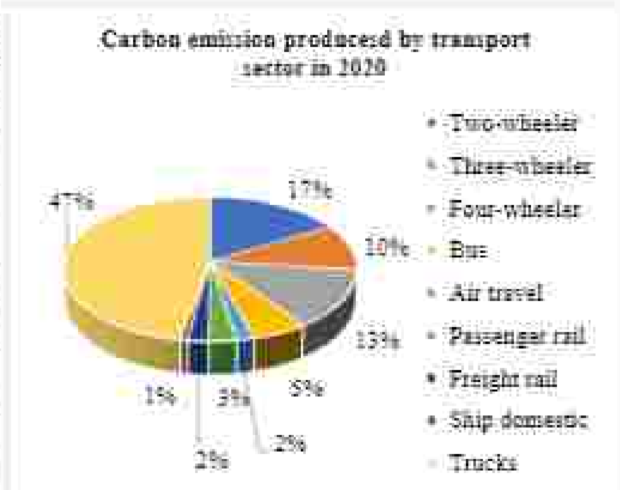


Graph 111: Projection of power demand for EVs till FY 2030

According to the 20th Electric Power Survey published by the Central Electricity Authority (CEA), the total peak demand is projected to be 334.8 GW in FY 2029-2030. The estimated EV charging demand is expected to be around 3% of the total peak demand.

6.7 Carbon emission reduction due to EV adoption

Transportation sector emissions represent the energy consumed by various means of passenger and freight transportation. Direct emissions (tailpipe emissions) from the transport industry (excluding international aviation and shipping) were 272 million tonnes of CO_2 ($MtCO_2$) in 2020 in India. The road transport sector, comprising passenger and freight transport, accounts for more than 92% of total transport sector emission[56]. With the rise in the urban population and increasing aspirations, vehicular emissions are expected to rise substantially.[57]



Graph 112: CO2 emission from transport sector

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[55] https://www.mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2023/EnergyStatisticsIndia2023.pdf
[56] https://www.ceew.in/publications/india-transport-energy-use-carbon-emissions-and-decarbonisation
[57] CEEW analysis

With increasing acceptability of EVs across the country, tail pipe emission in urban areas is expected to reduce drastically. This section highlights the overall reduction in carbon emission due to EV adoption compounded by reduction in Indian grid emission factor due to integration of renewable in the grid.

According to the Central Pollution Control Board (CPCB), the emission factors vary with vehicle type and age of vehicle. Table 29 below provides the emission factors by vehicle segments[76].

Vehicle	2W	3W	4W(P)	4W(C)	Bus
Tail pipe Co2 emission (g/km)	29	78	140	140	788

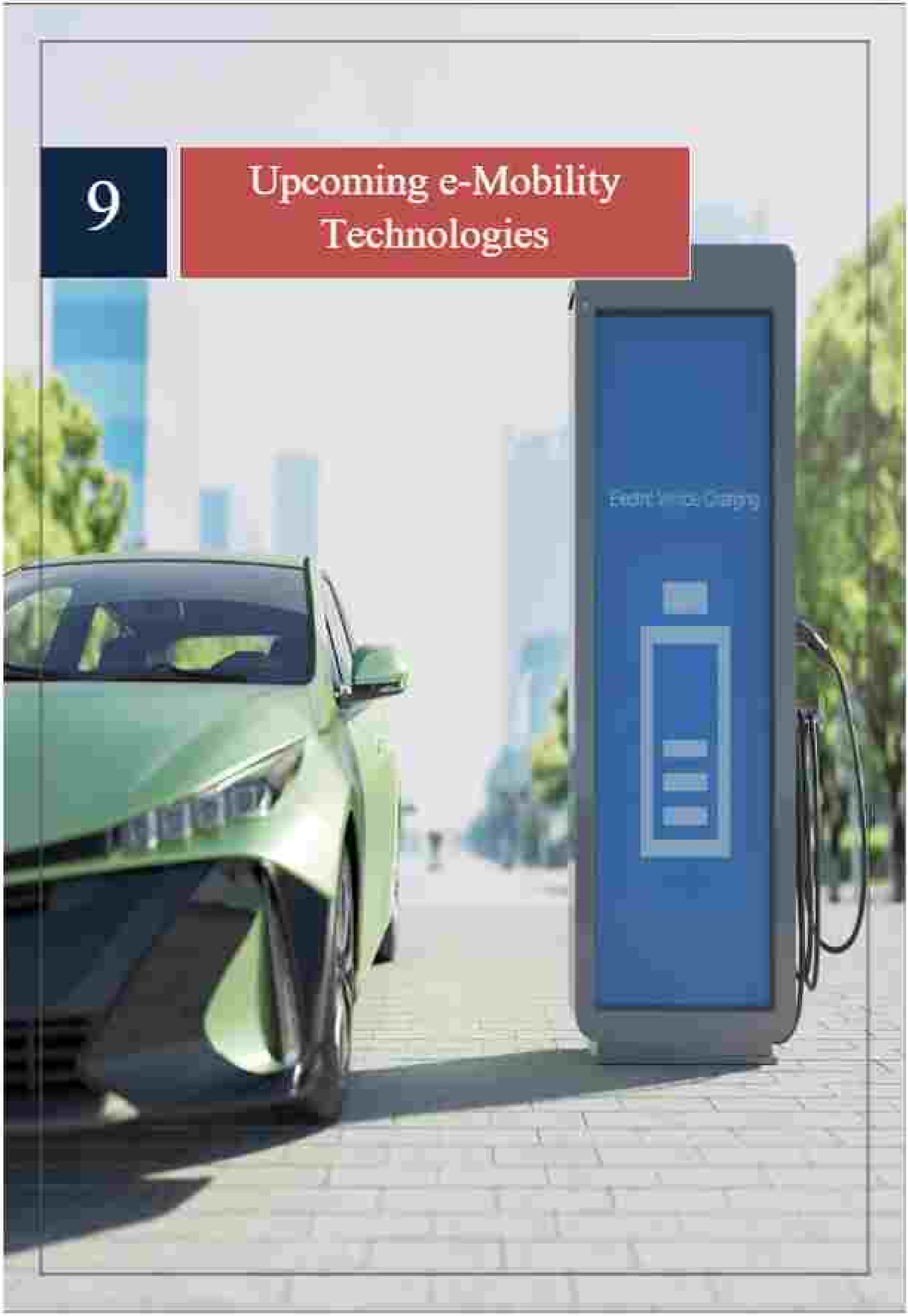
Table 30: Co2 emission by conventional vehicles

Basis the assumption considered in below table, estimated CO2 emission reduction are presented in graph 110 below. Year wise Grid emission factor has been referred from National Electricity Plan published by CEA[77]. In FY 2030, carbon emission reduction is estimated to be around 28 million ton through EV adoption.

Graph 111: Projections of Co2 emission reduction till FY 2030

[76] [illegible]
[77] NEP_2022_32_FINAL_GAZETTE-1.pdf (cea.nic.in)

9 Upcoming e-Mobility Technologies



9. Upcoming e-mobility Technologies

9.1 Introduction

While EVs are gaining popularity across the globe, there are several challenges that persists. Addressing these challenges will pave the way for making EVs as mainstream mode of transport across all vehicle segments. The following section highlights the challenges persisting in the e-mobility industry:

- **Range Anxiety:** Despite improvements in EV range and efficiency, prospective users still experience anxiety about the limited driving range, especially for long-distance travel.
- **Charging Speed and Time:** The time required to recharge EV batteries is significantly higher compared to refuelling traditional internal combustion engine (ICE) vehicles.
- **Charging Infrastructure:** The availability of a reliable, accessible, and affordable charging infrastructure is crucial for widespread EV adoption. Developing a robust EV charging network, including fast-charging stations along roads and highways, is necessary to support the increasing number of EVs on the road.
- **Cost and Affordability:** EVs generally have a higher upfront cost compared to traditional vehicles powered by fossil fuels, which may discourage some consumers from making the transition to electric.
- **Battery Technology and Lifespan:** EV batteries, constituting a significant portion of the total vehicle cost, need replacement after 5-7 years based on usage, posing a challenge to the economic feasibility of EV ownership.

To address these existing barriers in EV adoption, the industry has introduced various technological advancements, which might boost confidence among potential EV users. It's important to note that some of these technologies are still in the development or testing stage, and it might take a while before they become widely accessible. Further, continuous research and innovation in the e-mobility industry offer promising solutions in the near future:

9.2 Upcoming EV Charging Technologies

9.2.1 High-Power EV Charging

High power EV charging refers to the technology and infrastructure that facilitates fast charging of EV batteries by providing higher charging capacity. Key aspects of high-power EV charging include:

High Power DC Fast Charging: This technology utilizes high-powered DC (direct current) chargers to charge the EV batteries, bypassing the vehicle's onboard charger. These chargers can provide charging speeds of 250 kW or more, significantly reducing charging durations compared to lower power level EV chargers.

Increased Charging Speed: High power EV charging allows EVs to extend their range significantly within a short time, depending on the vehicle's capabilities.

However, High Power EV Charging has several constrains.

Charging Station Infrastructure: High power charging stations require robust electrical infrastructure to handle the increased electrical demand. This involves higher voltage and current carrying capabilities, upgraded electrical transformers, and thicker power cables. These stations typically feature multiple charging connectors accommodating several EVs simultaneously.

Compatibility: Not all EVs are capable of handling high power charging. Some vehicles may not be compatible and might require modifications or upgrades to fully utilize this technology.

Cooling and Battery Management: High power charging generates excess heat, which can impact battery performance and lifespan. Advanced thermal management systems are often incorporated in high power charging systems to reduce heat generation, ensuring optimal charging and preserving battery health. This is especially crucial for repeated fast charging cycles.

High power EV charging is essential for enabling long-distance travel, minimizing charging delays, and encouraging widespread adoption of electric vehicles. Continuous advancements in technology and infrastructure will enhance the charging experience and make high power charging more accessible.

9.2.2. Vehicle technologies have indeed seen significant advancements over the past few decades, leading to improved technical efficiency. However, the overall impact on fleet-level fuel economy may not be as pronounced. This is because the improved technical efficiency of vehicles is countered by increased vehicle power, size and weight as manufacturers and users trade off these characteristics against increased fuel economy.

1) E Vehicles Battery Capacity available in the Indian Markets are as follows:

a) 2 Wheelers ~2-5kwh
b) 3Wheelers ~ 3-10kWh
c) Cars ~ 30-80kWh
d) Buses ~ 80-400kWh

2) Battery capacity and vehicle mass relation:

10 kWh increase in battery capacity have approximately the following impact on EVs:

- Increases EV mass by an estimated 15 kg
- Increases Drive range by an estimated 40–50 km
- Increases Energy consumption by approximately 1.0 kWh/100 km.

Since mass-related efficiency trade-offs in electric vehicles are significant, in addition to CO_2 labelling, a dedicated energy label is required. Energy efficiency labelling helps in making informed electric vehicle purchases. Energy from charger is lost in thermal cooling of battery, conversion of AC to DC at on-board charger etc. Generally, the ambient temperature, EV battery cell aging and the general temperature of relevant powertrain components (e.g., electric motor, battery, transmission oil) plays a significant role in the resulting energy efficiency of eV in addition to conversion losses. Global studies conclude that in a vehicle, a minimum level of discharging around 20%, and a maximum level of charging between 80% and 90% is the best SoC range.

3) Efficiency of Charging equipment

Home charging generally happens at about 85% efficiency and fast charging at about 90% efficiency. EV charging exhibit highest efficiency at the top region of their rated power and low efficiencies at power levels less than half of their rated power. Again, as a good no. of the EV chargers are typically in a standby mode for about 85% of the lifetime of the product, the no vehicle mode power requirement is the key factor to be considered by any EVSE owner to achieve good overall EVSE efficiency. No Vehicle Mode power allowance for the network connection (in use Wi-Fi/ ethernet interface/LAN interface) with wake capability, allowance for a High-Resolution Display (Screen area, Luminance of display) etc. are understood to be the culprits.

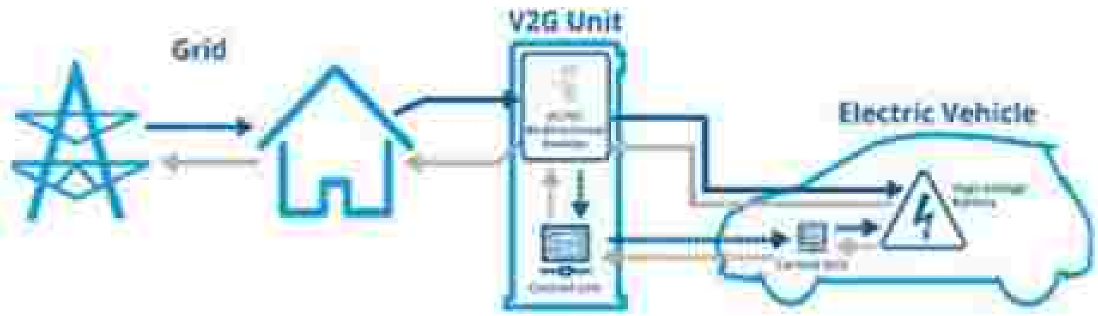
9.2.3 Vehicle-to-Everything (V2X) Charging

V2X (Vehicle-to-Everything) EV charging refers to EV battery's ability not only to receive energy from the grid or charging stations but also to provide unutilized energy back to various external systems. V2X charging facilitates bidirectional power flow, allowing EVs to serve as energy source, storage units and grid balancing assets for various applications. Some of the aspects of V2X EV charging are:

Vehicle-to-Grid (V2G):

V2G technology refers to the process of putting the energy stored in EV batteries into the electricity grid while the EV is parked.

This bi-directional flow helps in balancing the power grid by utilising EV batteries as distributed energy storage units. V2G technology supports managing peak loads, reducing electricity costs, enhancing grid stability, and integrating renewable energy sources effectively.



Vehicle-to-Home (V2H): V2H charging allows EVs to supply energy from their batteries to homes during emergencies, such as during grid outages or to manage peak demand. In V2H systems, EVs connect to a home's electrical system, providing backup power, utilising stored energy for self-consumption, and participating in demand response programs.

Vehicle-to-Building (V2B): Like V2H, V2B charging enables EVs to provide energy to commercial or industrial buildings. This helps businesses reduce electricity costs, providing backup power and load balancing solutions.

Vehicle-to-Device (V2D): V2D charging uses EVs to directly power various devices or equipment. This includes applications like outdoor events, construction sites, or remote locations where EVs serve as mobile power sources.

The advantage of V2X EV charging is manifold. It enhances energy efficiency, boosts grid stability, optimizes renewable energy use, and reduces dependence on the grid during peak demand. Additionally, V2X charging can create revenue opportunities for EV owners by participating in demand response programs.

However, widespread adoption of V2X charging encounters challenges, such as technological standardization, regulatory frameworks, and the development of intelligent energy management systems. Thus, deployment of V2X infrastructure requires compatibility between vehicle and charging device, which is an ongoing effort.

In conclusion, V2X EV charging holds the potential to transform the energy sector by harnessing electric vehicles' capabilities to support clean energy integration, enhance grid reliability, and contribute to a more sustainable energy future.

9.2.4. Catenary EV charging

Catenary EV charging, also referred as overhead electric charging or electric road systems, is a technology that enables electric vehicles to charge continuously while in motion. This method utilizes overhead wires or cables to supply power to the vehicles through a pantograph or a similar mechanism[60].

<table>
<tr><td></td><td></td></tr>
<tr><td>Energy supply System
The energy supply system relies on established technology used in railroad electrification. The system utilises a two-pole catenary system to provide a reliable energy supply for the electrified-highway. This catenary system results in a level contact wire ensuring stable current transmission, even at high speeds. The overhead contact lines receive energy from substations equipped with:

• Medium voltage switchgear
• Power transformers & Rectifiers
• Controlled inverters (to manage the electric energy generated by the vehicles' regenerative braking and provide feedback)</td><td>Pantograph
The active pantograph transfers energy from the overhead contact lines to the electric motor of the electrified highway. It can be smoothly attached or detached from the contact wire, with speeds ranging from 0 to 90 km/h. This process occurs either automatically or through a button. Steering an electric-highway truck connected to the overhead contact lines feels the same as driving a diesel truck because the active pantograph adjusts for any shifts in position within the lane. In case of evasive manoeuvres or when the indicators are used, the pantograph disconnects automatically.

When an electric vehicle equipped with the necessary receiving equipment like a pantograph, enters a road section with overhead wires, the pantograph connects to these overhead cables. This connection enables the vehicle to draw power and charge its battery while driving, ensuring, continuous charging without the need for frequent stops at charging stations.</td></tr>
</table>

Catenary charging offers several potential advantages:

Extended driving range: Continuous charging while driving can significantly extend the driving range of EVs, making them more suitable for long-distance trips without the need for frequent charging stops.

[60] https://www.mobility.siemens.com/global/en/portfolio/road/ehighway.html

Reduced battery size: With catenary charging providing continuous power from the grid, vehicles can have smaller and lighter onboard batteries, potentially reducing vehicle cost.

Flexibility for electric fleets: Catenary charging is especially beneficial for electrified fleets, such as buses or delivery trucks. It allows these vehicles to operate continuously without prolonged charging periods or battery swaps.

However, catenary charging also presents challenges. The installation of the necessary infrastructure can be costly and requires extensive coordination and planning for implementation on public roads. Further, it limits vehicle flexibility since only vehicles equipped with the necessary charging equipment can use the system.

Catenary charging is still an emerging technology, and several pilot projects are currently underway to test its feasibility and scalability. Despite challenges, its potential benefits including extended range and continuous charging make it an intriguing solution for specific transportation applications.

9.2.5 Dynamic Wireless Charging

Dynamic wireless charging, also known as dynamic electric vehicle charging (DEVC), is a technology that enables electric vehicles to charge wirelessly while in motion. Unlike traditional wireless charging, where the vehicle must be stationary on a charging pad, dynamic wireless charging allows continuous charging as the vehicle moves along a roadway or designated path.

Some of the key aspects of dynamic wireless charging is mentioned below:

Inductive Power Transfer (IPT): Dynamic wireless charging typically employs inductive power transfer technology, transferring power wirelessly between coils in the charging infrastructure embedded in the road and the receiving unit installed on the underside of the vehicle. This connection allows continuous charging while the vehicle is in motion.

Embedded Charging Infrastructure: Dynamic wireless charging necessitates the installation of charging infrastructure in the roadway or specific charging lanes. This infrastructure includes power transmitting coils embedded in the road, generating an alternating electromagnetic field. Vehicles equipped with the receiver coils can convert this energy into electrical power to charge their batteries.

Alignment and Efficiency: Proper alignment between the vehicle and the charging infrastructure is vital for efficient charging. Advanced alignment and positioning technology, such as GPS and sensors ensures effective power transfer minimizing energy loss during motion.

Adaptability and Scalability: Dynamic wireless charging can be designed to accommodate various types of electric vehicles, including cars, buses, trucks, and even electric motorcycles. The technology is scalable, allowing for deployment across major road networks and high-traffic areas.

Enhanced Range and Convenience: Dynamic wireless charging extends the range of electric vehicles by providing continuous charging, eliminating the need for frequent stops at stationary charging stations. It offers convenience for long-distance travel, allowing EVs to gain additional energy during their journey, like refuelling at a traditional gas station.

Challenges and Considerations

Despite its potential, dynamic wireless charging faces challenges such as high installation costs, standardization, and regulatory issues, consistent power transfer across different road conditions and weather scenarios is crucial. Additionally, addressing Interoperability issues and ensuring compatibility with various vehicle models are necessary for widespread adoption of dynamic wireless charging technology.

9.2.6 Solar Powered EV Charging (for remote locations)

A solar EV charging station for remote locations offers an innovative solution by integrating solar power generation with electric vehicle charging infrastructure. This setup provides renewable energy for EV charging in areas where traditional grid connections are scarce or unavailable. Additionally, solar based EV charging stations could be cost effective for both the operator and EV user.

Several key considerations for setting up a solar EV charging station in remote locations are outlined below:

Solar Panels: The station would incorporate solar panels to capture sunlight and convert it into electricity. The number and capacity of these panels would depend on the station's energy demand and the available sunlight in the location.

Battery Storage: To ensure a consistent power supply, energy storage systems, like batteries, can be integrated into the charging station. These batteries store excess energy produced during daylight hours and provide electricity for charging EVs during periods without sunlight.

Charging Infrastructure: The charging station would feature electric vehicle chargers compatible with the targeted electric vehicles' charging standards. Depending on the required charging capacity, Power Level 2 chargers or even DC fast chargers might be installed.

Power Management and Load Balancing: Efficient power flow is crucial to optimize solar generation and charge EVs effectively. Load balancing and smart charging algorithms can be implemented to distribute power among multiple EVs, ensuring efficient energy utilization.

Remote Monitoring and Maintenance: Remote monitoring systems can be set up to track solar power generation, energy storage levels, and the charging status of EVs. This allows for efficient maintenance planning and ensures reliable operation of the charging station in remote locations.

Off-Grid Capability: Given the unreliable access to the electrical grid in remote areas, the solar powered EV charging station must be designed to operate off-grid independently. The focus would be on self-sufficiency, utilizing solar power as the primary energy source.

Scalability and Expandability: The solar EV charging station can be designed to accommodate future growth and increased demand by easily adding more solar panels, energy storage capacity, and charging infrastructure as needed.

The Solar EV charging stations play a valuable role in promoting clean and sustainable transportation options while overcoming infrastructure limitations. By combining solar power and EV charging, these stations reduce dependence on fossil fuels and offer a renewable energy solution for electric vehicles in areas where conventional power sources may be challenging to access, in addition to providing cost effective EV charging solution.

9.3 Future EV battery technologies

Numerous emerging EV battery technologies are currently under research and development, aimed at enhancing the performance, range, charging speed, and overall efficiency of electric vehicles. Some significant advancements in EV battery technology are mentioned below:

1. **Solid-State Batteries**: These batteries employ solid electrolytes instead of liquid ones found in conventional lithium-ion batteries. They have the potential to offer higher energy density, faster charging times, increased safety, and longer lifespan.

2. **Lithium-Sulphur Batteries:** Lithium-sulphur batteries have a higher theoretical energy density compared to lithium-ion batteries. They use sulphur as the cathode material, which is more abundant and less expensive than the cobalt used in many lithium-ion batteries. Lithium-sulphur batteries also have the potential for improved energy storage capacity.

3. **Lithium-Air Batteries:** Lithium-air batteries have the potential for even higher energy density compared to lithium-ion batteries. They use oxygen from the air as the cathode material, reducing the overall battery weight. However, challenges like high reactivity and limited cycle life still need to be overcome for practical use.

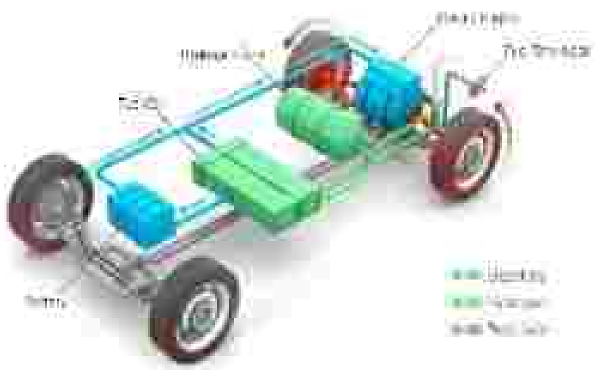
4. **Graphene-Based Batteries:** Researchers are exploring the use of graphene, a single layer of carbon atoms, in batteries to improve their performance. This includes higher energy density, faster charging, and improved lifespan.

5. **Sodium-Ion Batteries:** Sodium-ion batteries offer an alternative to lithium-ion batteries by using sodium ions for energy storage. Sodium is more abundant and less expensive than lithium, making sodium-ion batteries potentially more cost-effective. However, addressing the challenges of lower energy density and limited cycle life is an ongoing research focus.

6. **Advanced Lithium-Ion Batteries:** Continuous efforts are made to enhance existing lithium-ion battery technology. This involves optimizing electrode materials like utilising silicon anodes to increase energy density, and exploring new electrolyte formulations to boost battery performance, safety, and longevity.

7. **Hybridization and Integration:** Future EV battery technologies may involve hybrid systems that combine various battery chemistries or integrate batteries with other energy storage technologies like capacitors or ultra-capacitors. Such hybridization and integration can further improve energy storage capacity and power delivery.

8. **Fuel cell batteries**: Also known as fuel cells, are electrochemical devices that convert the chemical energy of a fuel, often hydrogen gas, into electrical energy through a chemical reaction. Unlike traditional batteries which stores electrical energy, fuel cells continuously generate electricity as long as fuel and oxidizer (typically oxygen from the air) are supplied, they consist of an anode (negative electrode), a cathode (positive electrode), and an electrolyte. Hydrogen enters the anode, where it is splits into protons and electrons. The protons travel through the electrolyte to the cathode, while the electrons create electrical circuit. At the cathode, the protons, electrons, and oxidizer combine to form water or other by-products.



It's important to note that while the development and research of these future EV battery technologies are promising, challenges such as cost, scalability, safety, and mass production still needs to be addressed. However, ongoing investments and advancements in battery research and development indicate a promising future for electric vehicle batteries, offering improved performance and capabilities.

10 Summary

In the recent years, electric mobility has gained significant popularity in India due to progressive government policies and regulations enacted by both the Central and the State Governments. The increased public awareness about the benefits of transitioning to Electric Vehicles (EVs) has made EVs a preferred choice across the country. According to the Economic Survey 2023, India's domestic EV market is predicted to grow at a CAGR of 49% between FY 2022 and FY 2030, with annual sales estimated to reach around 10 million by 2030. Additionally, the EV industry is expected to create approximately 50 million direct and indirect jobs by year 2030[61].

Leading Indian automobile manufacturers have begun manufacturing EVs in the country. Further, taking advantage of the favourable EV demand and supportive policy paradigm ecosystem, several international automakers have also initiated setting up EV manufacturing facilities in India. In the fiscal year 2022 – 23, EV sales tripled compared to the previous year with majority of sales coming from e-2W and e-3W segments. The share of EVs in total vehicle sales increased to around 5.30% in FY 2022-23 from approximately 2.50% in the previous fiscal year, indicating the growing acceptance of EVs among vehicle users in India. The transition to EVs from ICE vehicles is estimated to reduce carbon emissions by more than 30% by FY 2030. [62]

With the increasing demand for electric vehicles, the network public EV charging infrastructure is also expanding due to investments from both Government and the private sectors. The fiscal year 2022 – 23 witnessed a significant growth in public EV charging infrastructure over the previous years.

Under the current policy & regulatory framework to encourage EV proliferation, the Government of India through its various nodal ministries is offering fiscal and non-fiscal incentives for development of the EV ecosystem. The Ministry of Power is supporting 7 states covering 9 mega cities (having 4 million plus population) in establishing EV Accelerator cells to facilitate the accelerated deployment of public EV charging infrastructure. These cells are being developed to serve as a single window entity for the implementation of all e-mobility programs in the state including public EV charging infrastructure an undertake coordination with all state departments. At the state level, 26 states have notified EV policies that provide plethora of benefits to develop the demand and supply side of the EV ecosystem in India.

Bureau of Energy Efficiency (BEE), in collaboration with the Indian Institute of Technology, Delhi (IIT-D) is conducting a feasibility study for a Catenary based EV charging of HDVs. Additionally, BEE is developing performance benchmarks for EVs and EVs, batteries and EV chargers ensuring sale of quality & energy efficient product in the Indian market.

To create awareness on the benefits provided by the Central and State government, BEE has developed the 'EV Yatra' web portal and mobile application, serving as a one-stop destination for accessing all e-mobility related programs across the country.

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[61] Invest India
[62] BEE analysis

Together all these initiatives are fostering a positive environment for large scale EV adoption and promote Indian e-mobility market to develop & sustain in future years.

The state level e-mobility preparedness index offers insights into the progress of implementation of state level e-mobility initiatives. States experiencing slow EV adoption can learn from peers by emulating best practices policies, programs and technologies propelling them to centre stage on Indian e-mobility canvass.

Annexure A: Scoring methodology for state e-mobility index

Number of Parameters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Parameters for evaluation	Concession Land for PCS deployment in EV Policy	Demand Charge waiver for EV supply tariff (Rs./kW or kVA)	EV Charging tariff	Higher LT load threshold	Ratio of operational PCS in urban area (9 sq. km)	Ratio of operational PCS on highway at every 25 km	EV / EVSE ratio (slow PCS)	EV / EVSE ratio (fast PCS)	Workshop of GO ELECTRIC activities	Capital Subsidy for deployment of slow PCS	Capital Subsidy for deployment of fast PCS	No. of PCS sanctioned in FAME II	Share of E-buses in total fleet	Nominate SNA for EVCI	% EV sales (FY21-2023)
% Weight of each Parameter	5.00	6.00	8.00	3.00	8.00	5.00	2.00	20.00	7.00	2.00	5.00	6.00	8.00	8.00	7.00
Criteria	Yes (5 marks)	Yes (5 marks)	Below ACoS (5 marks)	Above 150 kW (5 marks)	Above 2 (5 marks)	more than 50% PCS deployed as per MoP guidelines, 5	1-50 (5 marks)	1-50 (5 marks)	Above 10% share in total GDC activity (5 marks)	Above Rs. 10 lakhs (5 marks)	Above Rs. 10 lakhs (5 marks)	Above 500 PCS (5 marks)	>2% (5 marks)	Yes (5 marks)	Above 5% (5 marks)
	No (0 marks)	No (0 marks)	Equal ACoS (3 marks)	75 - 150 kW (3 marks)	1-2 (4 marks)	30-50% PCS deployed as per MoP guidelines, 4	50-150 (4 marks)	50-150 (4 marks)	5-10% share in total GDC activity (4 marks)			300-500 PCS (4 marks)	1-2% (4 marks)	No (0 marks)	3-5% (4 marks)
			Above ACoS (0 marks)	up to 75 kW (2 marks)	0.5 - 1 (3 marks)	10-30% PCS deployed as per MoP guidelines, 3	150-500 (3 marks)	150-500 (3 marks)	2-5% share in total GDC activity (3 marks)	Rs. 50,000 - Rs. 10 lakhs (3 marks)	Rs. 50,000 - Rs. 10 lakhs (3 marks)	100-300 PCS (3 marks)	0.5-1% (3 marks)		1-3% (3 marks)
					0.1 - 0.5 (2 marks)	5-10% PCS deployed as per MoP guidelines, 2	500-1000 (2 marks)	500-1000 (2 marks)	1-2% share in total GDC activity (2 marks)	Up to Rs. 50,000 (1 mark)	Up to Rs. 50,000 (1 mark)	50 - 100 PCS (2 marks)	0.1-0.5 (2 marks)		0.5-1% (2 marks)

					0-0.1 (1 marks)	up to 5% PCS deployed, as per MoP guidelines (1 marks)	Above 1000 (1 marks)	Above 1000 (1 marks)	0-1% of the total GHG activity (1 marks)			0 - 30 PCS (1 marks)	0 - 0.1 (1 marks)		0-0.5% (1 marks)

Annexure B: Criteria not considered for e-mobility index

S. No.	State Name	EV Policy Status	Registration and Road tax exemption	Subsidised interest loans for procure EVs	Subsidised Interest loans for manufacturing units	Property tax rebates for charging infra	Parking fee waiver	Reserved parking	Toll free waiver	Public procurement of EVs	Single window clearance	ZEV credits to manufacturers	Preferential treatment on roads	Exemption from odd even rule
1	Andaman & Nicobar	Draft	✓	-	-	✓	✓	-	-	-	-	-	-	-
2	Andhra Pradesh	Notified	✓	-	-	-	-	✓	-	✓	-	-	✓	-
3	Arunachal Pradesh	Draft	-	-	-	-	-	-	-	-	-	-	-	-
4	Assam	Notified	✓	-	✓	-	✓	-	-	✓	-	-	-	-
5	Bihar	Draft	✓	-	-	-	-	-	-		-	-	-	-
6	Chandigarh	Notified	✓	-	-	-	-	✓	-	✓	✓	-	-	-
7	Chhattisgarh	Notified	✓	-	-	-	✓	✓	-	-	✓	-	-	-
8	Delhi	Notified	✓	✓	-	-	✓	✓	-	✓	✓	-	-	-
9	Goa	Notified	✓	✓	-	-	✓	✓	-	✓	✓	-	-	-
10	Gujarat	Notified	-	-	-	-	-	-	-	-	-	-	-	-
11	Haryana	Notified	✓	-	-	✓	-	✓	-	✓	-	-	✓	-
12	Himachal Pradesh	Notified	✓	-	-	-	-	✓	✓		✓	-	-	-
13	Jharkhand	Notified	✓	✓	✓	-	✓	✓	-	-	✓	-	-	-
14	Karnataka	Notified	-	-	✓	-	-	-	-	-	-	-	-	-
15	Kerala	Notified	✓	-	-	-	✓	✓	✓	-	-	-	✓	-
16	Ladakh	Notified	✓	-	-	-	✓	✓	-	✓	-	-	✓	-
17	Madhya Pradesh	Notified	✓	-	-	-	✓	-	-	✓	-	-	✓	-
18	Maharashtra	Notified	✓	-	-	-	✓	✓	-	-	-	✓	✓	-
19	Manipur	Notified	✓	-	-	-	✓	✓	-		-	-	✓	✓
20	Meghalaya	Notified	✓	-	-	-	-	✓	-	-	-	-	✓	✓

21	Odisha	Notified	✓	-	-	-	✓	✓	-	✓	-	-	✓	-
22	Punjab	Notified	✓	-	-	-	-	✓	✓	-	✓	-	✓	-
23	Rajasthan	Notified	✓	-	-	✓	-	-	-	-	-	-	-	-
24	Tamil Nadu	Notified	✓	-	✓	-	-	-	-	✓	✓	-	-	-
25	Telangana	Notified	✓	-	-	-	-	✓	-	✓	✓	-	✓	-
26	Uttar Pradesh	Notified	✓	-	-	-	-	-	-	-	-	-		-
27	Uttarakhand	Notified	✓	-	-	-	-	✓	-	-	✓	-	-	-
38	West Bengal	Notified	-	-	-	-	-	-	-	-	-	-	-	-
29	Tripura	Notified	✓	-	-	-	-	✓	-	-	-	-	-	-
	Total		**25**	**3**	**4**	**3**	**12**	**19**	**3**	**11**	**10**	**1**	**11**	**2**

Annexure C: State government initiatives for accelerated adoption of e-mobility

S. No.	States / UTs	E-mobility related announcements
1.	Andhra Pradesh	• NREDCAP (State SNA) has entered an agreement with Andhra Pradesh State Road Transport Corporation (APSRTC) for development of PCS at APSRTC bus depots across the state • To make Vijayawada as a model e-mobility city, state government has identified 105 locations for installation of 105 slow and fast public EV chargers • NREDCAP is planning to develop solar powered public EV charging station at 12 locations across the state • State government has developed web portal for providing e-2W to state government employees on soft term loan basis with zero down payment
2.	Assam	• Assam Electronics Development Corporation Limited (Amtron) has planned to setup EV charger manufacturing unit at Tech City in Bongora, Guwahati
3.	Chandigarh	• CREST (UT SNA) is planning to install 67 nos. of public EV charging stations across the UT of Chandigarh
4.	Goa	• RfP for deployment of PCS at 40 locations across the state is in process • State of Goa has developed a roadmap for deployment of adequate number of public EV charging stations by year 2030
5.	Haryana	• State of Haryana has a target to set up of 725 number of public EV Charging Stations in the state by year 2025
6.	Himachal Pradesh	• State government has identified six green energy corridors for setting up of PCS
7.	Karnataka	• Single Window system for setting up of public EV charging station • RfP for deployment of 1000 PCS (on PPP model) across the state, has been published
8.	Kerala	• KSEB (State SNA) is planning to develop solar powered rapid charging hub in Kaloor, Kochi with 10 numbers of 120 kW CCS-II chargers

S. No.	States / UTs	E-mobility related announcements
9.	Madhya Pradesh	• State government is planning transition of bus fleets in the cities of Bhopal, Indore, Jabalpur, Dewas, Sagar and Ujjain. This initiative aims to determine the appropriate quantity and capacity of Electric charging stations that will be gradually installed at the public places, bus depots, ensuring efficient charging for the electric buses • City of Indore is currently working to install 47 solar integrated public EV charging stations for e-2W & e-4W • Installation of 217 nos. public EV charging stations is proposed across the state, Bhopal (63 nos.), Indore (123 nos.) and Jabalpur (31 nos.)
10.	Maharashtra	• MSEDCL (State SNA) has a single window system for availing state incentives for EV charging stations • Developed a Mobile App 'PowerUp' for locating nearest EV charger • Single window system at DISCOM for providing electricity connection to PCS
11.	Tamil Nadu	• The state government is planning to establish PCS in the feasible locations along three national highways, Chennai to Chengelpet, Chennai to Kanchipuram, Chennai to Hosur
12.	Telangana	• TSREDCO (State SNA) is installing 150 nos. of DC fast chargers in Hyderabad and planning to install 240 kW Fast EV Chargers along National and State Highways • Additionally, TSREDCO is planning to install 200 PCS across the State under PPP model
13.	Uttar Pradesh	• Land packages has been identified in 10 out of 17 municipal corporations for setting up PCS • Uttar Pradesh Metro Rail Corporation has identified locations at 9 metro stations in Kanpur and 15 metro station in Lucknow for setting up public EV charging infrastructure • Location has been identified for establishment of 169 nos. of public EV charging station location in Noida • 334 locations have been identified in 17 cities for setting up PCS • 114 routes have been identified in 14 cities for deployment of electric buses • State government recently published RfP for establishment of 36 PCS along five state expressways
14.	Uttarakhand	• State Transport Department has prepared a Detailed Project Report for creation of Public EV Charging Infrastructure along Char Dham Marg
15.	West Bengal	• WBSEDCL released an RfP for establishment of 100 nos. of PCS while WBSEDCL is planning to establish 207 PCS. These PCS will have a combination of slow and fast EV chargers

Annexure D: Details on State wise tariff

S. No.	State Name	DESCOMs	Average Cost of Supply (ACoS)	Fixed charge	Electricity Supply tariff (EV) to PCS
			Rs./unit	(Rs / kW / month)	Rs./unit
1	Andaman & Nicobar	Electricity Dept. – A&N	41.34	0	10.0
2	Andhra Pradesh	APCPDCL, APEPDCL, APSPDCL	7.26	0	6.7
3	Arunachal Pradesh	Dept. of Power - AP	12.11	Not defined	Not defined
4	Assam	APDCL	8.02	LT: 150, HT:180	LT: 5.90, HT: 7.40
5	Bihar	NBPDCL, SBPDCL	8.30	0	LT: 8.87, HT: 8.00
6	Chandigarh	Electricity Department-Chandigarh	5.32	0	LT: 3.80; HT: 3.60
7	Chhattisgarh	CSPDCL	6.22	0	5.00
8	Delhi	BRPL, BYPL, TPDDL, NDMC	7.02	0	LT: 4.50, HT: 4.00
9	Goa	Electricity Department-GOA	5.87	0	LT: 4.70, HT 4.50
10	Gujarat	DGVCL, MGVCL, PGVCL, UGVCL,	6.64	LT:25 / installation/ month, HT: 25 / kVA / month	LT: 4.10; HT: 4.00
11	Haryana	DHBVNL, UHBVNL	6.62	0	LT: 6.62, HT 6.22
12	Himachal Pradesh	HPSEBL	6.05	0	5.82
13	Jammu & Kashmir	JPDCL, JKPDD	7.05	LT:100/KW, 11KV: 175/KW and 33KV: 150/KW	LT: 5.1, 11KV: 5 and 33KV 4.9
14	Jharkhand	JBVNL	NA	Rural: 50/KW, Urban - 100/KW	Rural: 5.80, Urban - 6.15
15	Karnataka	BESCOM, CESCOM, GESCOM, HESCOM, MESCOM	8.7	LT: 70/KW (≤50 KW), LT: 170/KW (above 50 KW) and HT: 200/KVA	5
16	Kerala	KSEBL	6.1	LT: 90/KW HT: 270/KVA	LT: 5.30, HT: 6.00
17	Ladakh	LPDD	8.3	LT:100/KW, 11KV: 175/KW and 33KV: 150/KW	LT: 5.1, 11KV: 5 and 33KV 4.9
18	Lakshadweep	Electricity Dept.-Lakshadweep	48.11	0	7.8
19	Madhya Pradesh	MPMKVVCL, MPPKVVCL, MPWKVVCL	6.79	0	LT: 6.79, HT: 6.96
20	Maharashtra	AEML, BEST, MSEDCL,	8.09	LT 75/KW HT 75/KVA	LT: 6.08, HT: 6.9

		Tata Power,			
21	Manipur	MSPDCL	11.76	Not defined	Not defined
22	Meghalaya	MePDCL	7.61	LT - 120/KVA HT - 230/KVA	LT: 9.70, HT: 9.90
23	Mizoram	Power Dept.-Mizoram	10	LT:75/kW/month HT: 75/kVA/month	LT:8.20/kWh HT: 8.65/kVAh
24	Nagaland	Dept. of Power-Nagaland	9.94	Not defined	Not defined
25	Odisha	TPCODL, TPNODL, TPWODL	5.87	0	5.5
26	Puducherry	ED-Puducherry	5.92	0	HT 5.33, LT 5.53
27	Punjab	PSPCL	6.48	0	6.28/kVAh
28	Rajasthan	JVVNL, JDVVNL, AVVNL	7.89	LT: 40/kVA HT: 135/kVA	6
29	Sikkim	Sikkim Power Dept.	7.03	500/month below 45 kW 150/KVA above 45 kW	5.5
30	Tamil Nadu	TANGEDCO	8.22	LT - 25 – 138/kVA HT - 138/kVA	LT - 6 to 9 (ToD) HT - 6 to 9 (ToD)
31	Telangana	TSNPDCL, TSSPDCL	7.09	LT : 50/kW HT: 100/KVA	LT: 6.00, HT: 5.00 - 7.00
32	Tripura	TSECL	6.73	Rs. 50/KW	6.9
33	UT OF D&NH AND D&D	ED-D&NH	3.67	0	LT: 5.10, HT: 4.90
34	Uttar Pradesh	DVVNL, KESCO, MVVNL, PAVVNL, PUVVNL	7.46	0	LT: 6.2, HT: 5.9 EV CS LT: 7.7 EV CS HT: 7.3
35	Uttarakhand	UKPCL	6.66	0	6.25
36	West Bengal	WBSEDCL	6.99	0	6

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