Note: This is a sample of the report. Key figures and text may be removed. The original report has total 76 pages with up to date figures and text.

India Charging Ahead

Market Report on Electric Vehicle Charging

2019 Q1

pManifold Business Solutions

RESEARCH | CONSULTING | ENGAGEMENT | GLOBAL KPO

Coverage of the Report

- Global Scenario
  - EV & BEV Trends
  - BEV vs. PHEV Trends
  - Chargers Deployment - Public Charging
  - Key Policy Levers that influenced EVSE infra development
  - Key Demand Incentives that influenced EV adoption
  - Charging Incentives – Home, Work
  - EV OEMs, EV Components & Service Players
- India Scenario
  - India EV Market Size
  - India EV & Charging Trends
  - Risks for EV Adoption
  - Bharat EV Charging Standards
  - India EV Innovations - Battery Swapping
  - Policies – Centre, State, Electricity Tariffs,
  - Key Players – e-2W, e-3W, e-4W, e-bus
  - Major EV Component Manufacturers
  - EV Fleet and Public Charging Station Operators
- EV related Tender Opportunities
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  - DHI's e-Bus Tender Analysis
- EV Charging Technology Overview
  - EV Charging Architecture & Types
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- Techno Commercial Assessment of EV Charging Opportunities
  - EV Adoption & Maturity across Vehicle Segments
  - Mix of EV Charging Options and Infra at City Level
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  - EV Public Charging Opportunity & Risks
  - Bulk Battery Charging, Home Charging and Swapping Opportunity & Risks
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Executive Summary – 1/3

Global Landscape for EV Charging

- Combined BEV and PHEV stock crossed 2 millions in 2xxx, of which BEV crossed y million. China and USA are the two dominant leaders in BEV space with total market share of ~xx%.
- New registrations of **BEV cars** hit a new record in 20yx with over 4x0 thousand sales worldwide. Still BEVs account for less than 0.xx% of total global car stock.
- BEVs and PHEVs are fighting for market share. Few Nordic markets are seeing higher CAGR for PHEV over BEVs.
- On an average, there is **xx public charger for every xx EVs** on road and **xx fast charger for every xx slow chargers. Public chargers form xx% of total chargers.**
- Coordinated Govt. support (Central, State, and City) in form of grant and subsidies played a major role in setting up public charging infra in most countries
- Different taxes exemption/reduction/credit for EV across its lifecycle from acquisition, registration and on-road running acted as good boost for EV take-up. Penalties on ICE also helped with EV additions.
- Countries are recognising more and more that right home charging solutions and aligned incentives can actually help to reduce high public charging infrastructure
- Govt. support in form of capital subsidy to promote Businesses to setup EV Charging Infrastructure for their employees has positive impact on EV adoption
- Globally, Vehicle OEMs have made commitments and laid down road maps for transition to increasing EVs supply. More model range and choices of EVs help shape increase adoption.

India Landscape for EV Charging

- **By 2xxx**, it is estimated there will be ~xxx million total vehicle stock on road. With aligned EV policy and aggressive Govt. support, if **optimistic** xx% new sales shall become EV by 2030 across vehicle segments, then it is estimated there will be approx. **xxx million total EV stock on road, taking xx% share**.
- if **xx% new sales by** 2030 then it is estimated there will be approx. **xx million total EV stock on road, taking xx% share**.
- 2W to form major share of EVs. Swapping Batteries has potential to capture >xx% market share. Home charging will form major load share. Peak load and electricity consumption from EVs shall be sizeable and shall need good grid management solutions.
- India has defined custom Bharat EV Charging Standards **AC-001 & DC-001 for low and medium voltage vehicle** architecture (2W, 3W & 4W). Higher voltages standards are yet to be defined.
- Indian Academia & Industry has jointly evolved and developed **battery swapping ecosystem & standards**. It is seen as one strong contender to make EV affordable and take it to masses. More pilots and operations results shall help build maturity.

Executive Summary – 2/3

- **FAME II Program** Budget is estimated to be 7X of the FAME I Budget (Rs. xxx crore). Key policy focus on Buses and setting charging infrastructure for all categories of EV
- Capital subsidy (to OEMs, end-customers), separate EV Tariff category, land lease are some key interventions that States shall be supporting to drive supply-demand
- Discoms are taking lead in setting up Public Charging Stations in Metro Cities
- Tier-2 and Tier-3 cities apart from metro cities are also taking step forward to run EV pilots and setup necessary charging infrastructure

Broader EV Value Chain & Players in India

- The EV design strategy of automobile players (conversion or purpose design) shall have significant impact on the value chain.
- There are xxx charging stations in India with most deployment are in Delhi and Bangalore
- The start-up community is more active in 2W segment market than established players. The Ather Energy is referred as Tesla of Scooters in India.
- Mahindra Electric is the only company in India to offer EV cars for purchase to user. Maruti Suzuki the leader in 4W segment to launch its first EV by 2xxx.
- Goldstone-BYD and Tata Powers are leading EV automobile players in the bus segment in India with order book of xx e-Buses from EESL

EV Related Tender Opportunities in India

- State Govt. and Municipal Corporations under Smart City are actively looking for EV adoption and charging infrastructure
- Exicom and SBD Green Energy to supply AC chargers to EESL and Exicom, BHEL and Delta to supply Fast DC chargers
- Goldstone-BYD won 3 out of x tenders in Gross Cost Contract Conditions while Tata Motors won all x Outright Purchase tenders

EV Charging Topology

- **EV-EVSE, EVSE-CMS and CMS-Mobile/Consumer** are key interactions to be designed well for building good EV Charging eco-system
- **AC slow charging** for low voltage application and small battery size vehicles. **DC fast charging** for high voltage application and big battery size vehicles.
- Deployment of EV Chargers (AC and DC) will vary across **charging locations** and **vehicle segments**
- Usage of any type of EV charging is limited by EV internal design. **Battery size** and **Chemistry** are important influencers.
- **Power Train Voltage, On-Board Charger rating, EV-EVSE Communication protocol, and Charging Connector types** are other vehicle parameters that influences charger selection

Executive Summary – 3/3

- Modes used for EV charging. Mode y is low acceptable because of safety hazards. Mode 2 is fair acceptable and Mode 3 and 4 have high control and safely features.
- Countries took lead in developing different Charging standards and there are 3 major ones – **CCS from US & Europe; xx from Japan and xx from China**. India is in phase of building custom **Bharat Charging Standards**.

EV Charging Business Opportunities

- **Mass vehicle segments** (3W, 4W fleet and Buses) support good EV economics, driven by certainty and longer distances travels per day. **Individual vehicle segments** (2W and 4W) will take longer time for adoption, primarily driven by low costs and more choices.
- There will be new class of EV charging services providers who will start supporting EV charging from setup to operations and value added services. They shall be linked forward with end-customers and backward with Discoms, and other Charging and Battery OEMs.
- TCO of comparable EVs comes lower than equivalent ICE vehicles for all segments. Swapping Battery has further potential to optimise the TCO better.
- The Solar EV Integrated Charging Stations could improve the business margins by xx% depending upon the charging location i.e. tariff category
- Local Storage Batteries at Charging Stations can help to reduce high demand charges when charger utilization rate is low.

Grid & Tariff Impact, Risks, Policy Enablers

- Some states have announced special tariff for charging electric vehicles. More states likely to follow the trend
- Impact on Grid: EVs to account xx% of total power consumption if all new sales are xx% EV by 2030

GLOBAL OVERVIEW

Global BEV vs. PHEV Trends

BEVs and PHEVs are fighting for market share. Few Nordic markets are seeing higher CAGR for PHEV over BEVs.

Country	Sales (2012-16)
C	
U	
N	
J	
F	
G	
U	
C	
N	
K	
S	
I	
Others	

YEAR → xx xx xx xx xx

	Highest Sale
	Between Highest & Lowest Sale
	Lowest Sale

% BEV of Total EV Stock

Less than 20%	20%to 40%	40%to 60%	60%to 80%	More than 80%

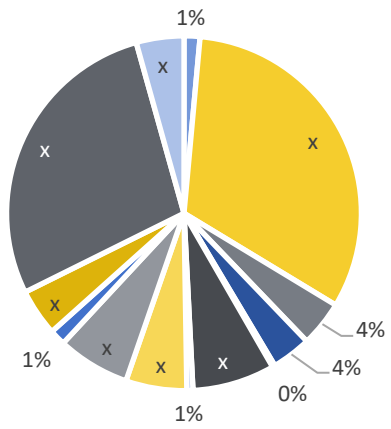
Some Key Facts

- BEV sales in most of the leading countries is growing consistently over x years
- Global stock of EV (BEV and PHEV combined) surpassed two millions stock in 2xxx. BEV and PHEV sales accounts xx% and xx% resp.
- BEV sales in India were inconsistent till 2xxx. This highlights the need of strong EV policy compared to other countries.
- **BEV Sales-** xx, Norway, xx, Korea and India are driving dominant BEV sales
- **Both BEV and PHEV Sales-** xx, Japan, xx and Canada are driving mix BEV and PHEV sales
- **PHEV Sales-** xx, Netherlands and xx are driving dominant PHEV sales

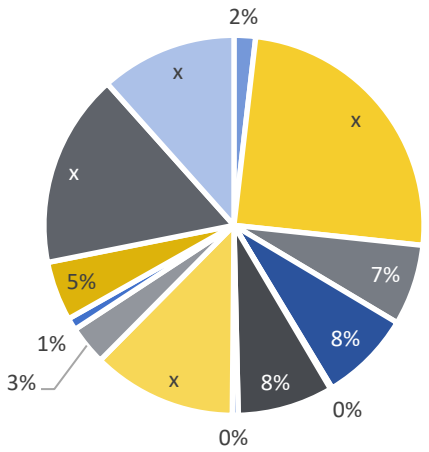
Global Chargers Deployment - Public Charging

*On an average, there is **xx public charger for every xx EVs** on road and **xx fast charger for every xx slow chargers. Public chargers form xx% of total chargers.***

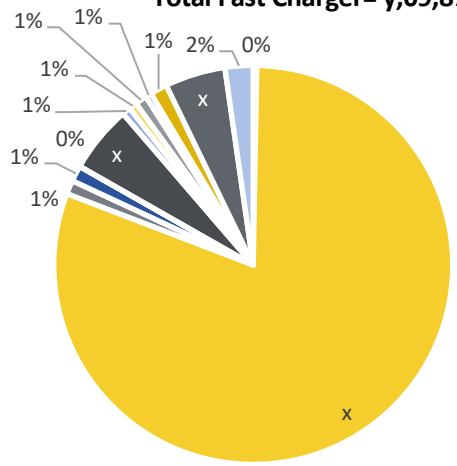
In 20yx, Total EV (BEV+PHEV) Sales= 20,y4,240



Total Slow Charger= 2,y2,394



Total Fast Charger= y,09,87y



Country	EV/EVSE
C	6.9
C	4.6
F	5.3
G	4.1
Ir	13.6
Ja	6.5
K	6.1
N	4.2
N	16.3
Sv	10.7
U	7.0
U	13.9
O	3.2
Total	6.3

EV Sales to public EVSE Charger Ratio

Some Key Facts

- In 20yx, the Global EV chargers (public and private) surpassed 2 millions. Public chargers form ~xx% of total chargers. Public chargers CAGR was xx% against EV stock CAGR of xx%.
- 8y% of the fast chargers are deployed by China. This is possibly because of the significant growth of electric buses than any other country in the world.
- There is a large variation in EV/EVSE ratio for public chargers. This ratio is normally between 4 to 7 for most of the countries.
- On an average, the chargers are deployed in a below pattern,
  - One Public Charger for every six EVs on road
  - One Slow Chargers for ever ten EVs on road
  - One Fast Charger for every x EVs on road
  - Two Slow Charger for every one Fast Charger
- At present, most EV owners rely on private home charging point. As per the IEA reports, most of the EV owners in Norwegian charger their EVs most frequently at home or at work.

INDIA SCENARIO

Scenario y

India EV Market Size

***By 2xxx**, it is estimated there will be **~xxx million total vehicle stock** on road. With aligned EV policy and aggressive Govt. support, if **optimistic xxx% new sales** shall become EV by 2xxx across vehicle segments, then it is estimated there will be approx. **xxx million total EV stock on road, taking xx% share**.*

Key Assumptions:

- x00% new sales to be EVs in public mass transport (Buses, 3W, and 4W fleet) by 2xxx. For individual 2W & 4W, x00% new sales to be EVs by 2xxx.
- Of projected xxx million total vehicle stock by 2xxx, approx. xx% to be 2W, xx% to be 3W, xx% 4W and xx% to be Buses and bigger vehicles

	2xxx	2xxx	2xxx	2xxx
Two Wheeler	< 0.x Million	~ x.xx Million	~ xx.xx Million	x% ~xxx million EVs
Three Wheeler (PV+CV)	< y,000	~ 0.xx million	~ x.xx million	x3% ~ x.xy million EVs
Four Wheeler (PV+CV)	< yx,000	~ 0.xx million	~ y0.xx million	x% ~ xx,0y million EVs
Buses	< xx	~ xx,000	~ 0.x Million	x% ~ 0.x Million EVs

How to Read?

Chart subtitles: EV Stock as % of Total Vehicle Stock in a given vehicle segment
Example: 2x% of total 2W on road will be a electric 2W

By 20xx, EV market shall gain momentum and see noticeable impact on road and environment

By 2xxx, there will be ~xxx million EVs on road that accounts approx. xx% of total vehicles.

Source: pManifold Analysis

State EV Policy

Capital subsidy (to OEMs, end-customers), separate EV Tariff category, land lease are some key interventions that States shall be supporting to drive supply-demand

GUJARAT

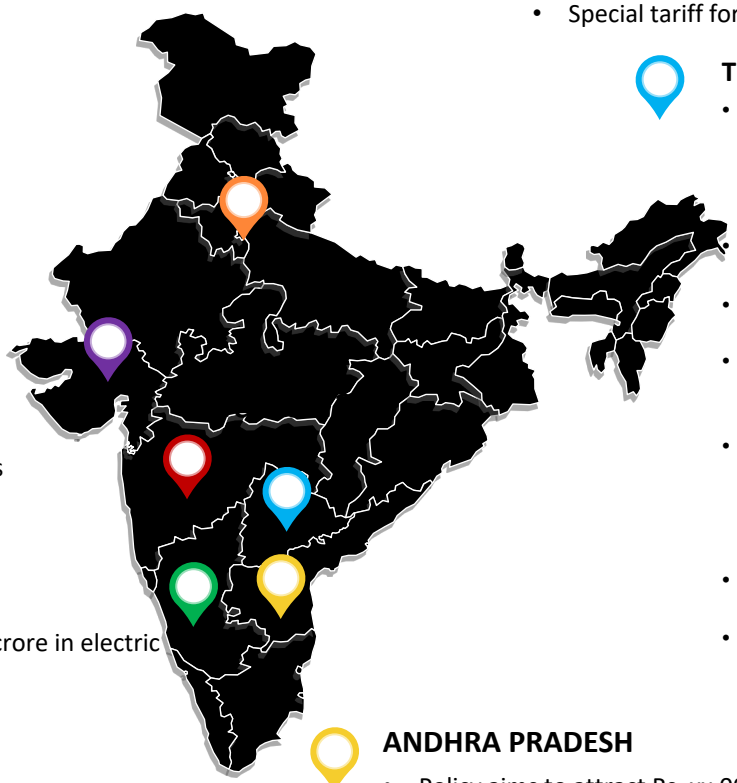
- To provide state capital subsidy on EV purchase
- **Charging Station Subsidy:** Plans to provide capital subsidy to first xxx Fast charging station to the tune of xx% of capital cost (max. Rs. y0 lakhs)
- Priority to setup charging infra every 7xkm on highways
- Govt. land on lease for setting up charging infra and charging points shall be provided at Govt. office parking lots

MAHARASHTRA

- Aims at creating an enabling environment for the manufacture of x,00,000 EV's till 2023
- **Incentives** provided for vehicles
  - 2W – INR x,000/unit
  - 3W – INR y,000/unit
  - 4W – INR y00,000/unit
  - Buses- INR x0,00,000/unit
- **EV Subsidy:** xx% subsidy to first x00,000 EV registered
- **Charging Station Subsidy:** xx% capital subsidy on equipment/machinery or max. subsidy of INR y million per charging station to the first 2x0 stations setup in Maharashtra
- Road tax and registration fees on EV purchase are exempted

KARNATAKA

- Policy aims to attract investments worth Rs xy,000 crore in electric vehicle manufacturing and charging infrastructure
- **Incentives** for Electric Vehicle
  - **2W –** INR x,x00 – xx,000/unit
  - **4W –** INR xx,000 – x,x0,000/unit
  - **Buses –** INR x,x00,000 – x0,000,000/unit
- **Battery Swapping Station Subsidy:** xx% on equipment and machinery
  - **2W/3W-** First y00 stations (max. Rs. x lakhs)
  - **4W-** First x stations (max. Rs. x lakhs)
  - **Buses-** First x stations (max. Rs. x Lakhs)
- **Fast charging station for all vehicle types:** First xx stations (max. Rs. xxlakhs)



DELHI

- Launched a subsidy scheme of Rs. xx,000 for the E-Rickshaws
- Delhi government is considering waiving road tax on all EVs
- xx% subsidy for purchase of electric scooters and cars
- Special tariff for charging station (Fixed- Rs. x.x/kWh)

TELANGANA

- **Policy Target:** Attract investments worth $x Billion and generate employment for x0,000 persons by 2022 through EV manufacturing and charging infrastructure development in Telangana State
- The EV policy is targeted to achieve y00% migration of EV by 2030 in Telangana
- **Incentive:** For personal mobility, registration charges to be exempted till 20xx
- **Power Tariff:** Separate category of tariff for EV charging will be created for both public and private
- Corporate Offices with annual turnover of INR y00 Cr+ operating within GHMC limits to compulsorily migrate 2x% of their employee commuting fleet to EV by 202xx and xx% by 2030
- Charging points will be setup at Govt. office parking lots.
- Govt. to setup first y00 fast charging stations in GHMC and other cities in a phased manner

ANDHRA PRADESH

- Policy aims to attract Rs. xx,000 Cr investment
- **Policy Target:** xx,00,000 EV on road by 20xx; city buses electrification of 4 cities by 20xx and in the state by 20xx
- **Incentive:** Complete reimbursement of road tax and registration fees on sale of EV till 20xx
- **Subsidy:** y0% capital subsidy for the first 2 car manufacturing firms, stamp duty reimbursement for purchase or lease of land and state GST reimbursements

EV CHARGING TECHNOLOGY OVERVIEW

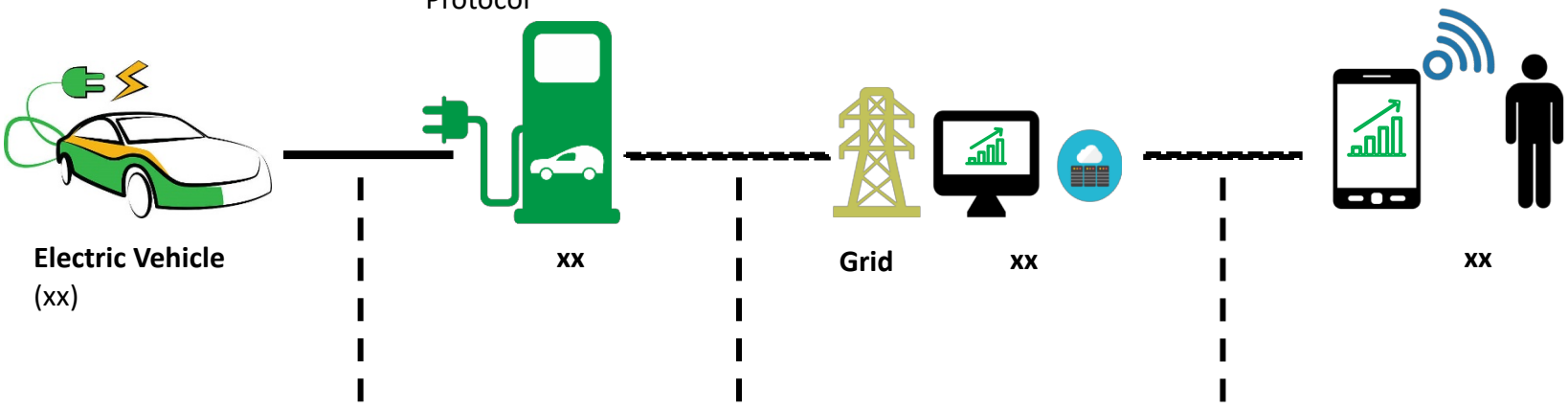
EV Charging Architecture

EV-EVSE, EVSE-CMS and CMS-Mobile/Consumer *are key interactions to be designed well for building good EV Charging eco-system*

Charger Type:
AC/DC Chargers
Power Level:
Slow/Fast Chargers

Charging Standard Parameters:
Level, Mode, Connector Type, Communication Protocol

Infrastructure



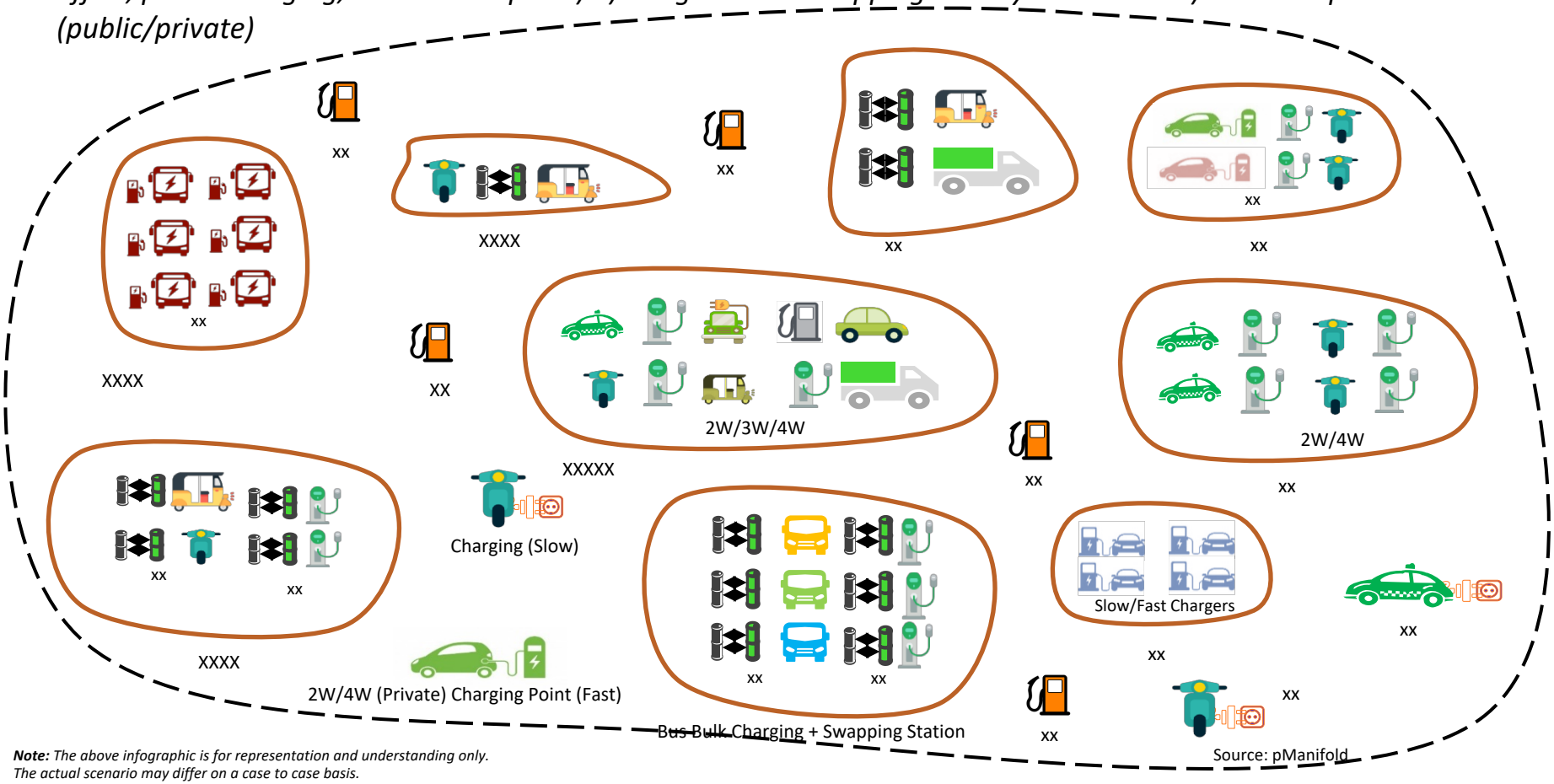
Communication Protocol

xx	xx	xx
• Ensure Safe and Reliable Power Supply for Battery Charging • CAN and PLCC are physical communication channels used • CCS, GB/T and XX are different standards used	• Demand & Supply Management • Metering, Billing & Payment system • User Authorization • Report Generation & Analytics • Uses OCPP protocol	• Locating Charging Stations • Advance Booking for Charging slot • Billing & Payment • Report Generation & Analytics

TECHNO COMMERCIAL ASSESSMENT OF EV CHARGING OPPORTUNITIES

Mix of EV Charging Options and Infra at City Level

Different charging options and infra requirements depending upon y) Vehicle segment 2) Charging Location (home, office, public charging, commercial place) 3) Integrated or Swapping battery model and 4) Ownership (public/private)



Note: *The above infographic is for representation and understanding only. The actual scenario may differ on a case to case basis.*

Some top criterion from GOI for prioritising investments in Public Charging Infra:

- *Town Population- More than x million (then extended to y+ million)*
- *Distance between two charging stations (within city)- x kms*
- *Distance between two charging stations (highways)- x kms*
- *A typical PCS can have Two Fast & One Slow Charger*
- *Top x metros (>x million population) are Delhi, Bengaluru, Mumbai, Kolkata, Ahmedabad, Hyderabad, Chennai, Pune, Surat, and Jaipur. Estimated xx and xx DC fast chargers and AC slow chargers respectively at investment of INR xx crores.*
- *The PCS can be operated either by Govt. or Private party or PPP*

Summary of TCO for EVs

TCO of comparable EVs comes lower than equivalent ICE vehicles for all segments. Swapping Battery has further potential to optimise the TCO better.

Total Cost of Ownership (TCO) for EVs

	TCO (Rs./km)		
Vehicle Segment	**ICE**	**EV (Integrated Battery)**	**EV (Swap Battery)**
2W	Rs. x.x/km	Rs. x.x/km (Range- xkm)	Rs. x.x/km (Range- x km)
3W (e-Rickshaw)	NA	Lead- Rs. x.y/km (Range- x km) LIB- Rs. x.x/km (Range- x km)	Rs. x.x/km (Range- x km)
4W	Rs. xx.x/km (Petrol) Rs. xx.0/km (Diesel)	Rs. xx.xx km (Range- y km)	Rs. xx.x/km (Range- xx km)
Buses	Rs. xx.x/km	Rs. xx.x/km (Range- xkm)	Rs. xx.x/km (Range- xx km)

Total Cost of Charging (TCC)*

	TCC (Rs./FC)				
Vehicle Segment	**Home (Individual)**	**Housing Society**	**Work/ Private**	**Commercial**	**Public Charging**
2W (Range-xkm)	Rs. x/FC	Rs. x/FC	Rs. xx/FC	Rs. x/FC	Rs. xx/FC
4W (Range- xkm)	Rs. x/FC	Rs. x/FC	Rs. xx/FC	Rs. x/FC	Rs. xx/FC

**Total Cost of Charging includes Charging Infrastructure Capital Cost, Electricity Cost, Manpower Cost, AMC*

Source: pManifold Analysis, EV Elephant Series Blog

REPORT PURCHASE DETAILS

Companies Covered

Segment	Companies Covered
EV 2-W	Bajaj, TVS, Hero Electric, Ather Energy, Okinawa Autotech, Lohiya Auto
EV 3-W	Hero Electric, Mahindra Electric, Lohiya Auto, Kinetic Green
EV 4-W	Honda, Maruti Suzuki, Mahindra Electric, Nissan, Hyundai, Tata Motors
E-Bus	Goldstone, Tata Motors, Ashok Leyland, Eicher Motors
Charger and Motor Manufacturers	BHEL, ABB, Borg Warner, Hitachi, Exicom

Let's deploy our **insights** and **actions** for your business to **improve** and **grow!**

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