

PATHWAYS TO ELECTRIC MOBILITY

“Comprehensive Approach for ZEV Mandates and EV Transition in India” & “Assessment of PLI Scheme in EV Manufacturing in India.”

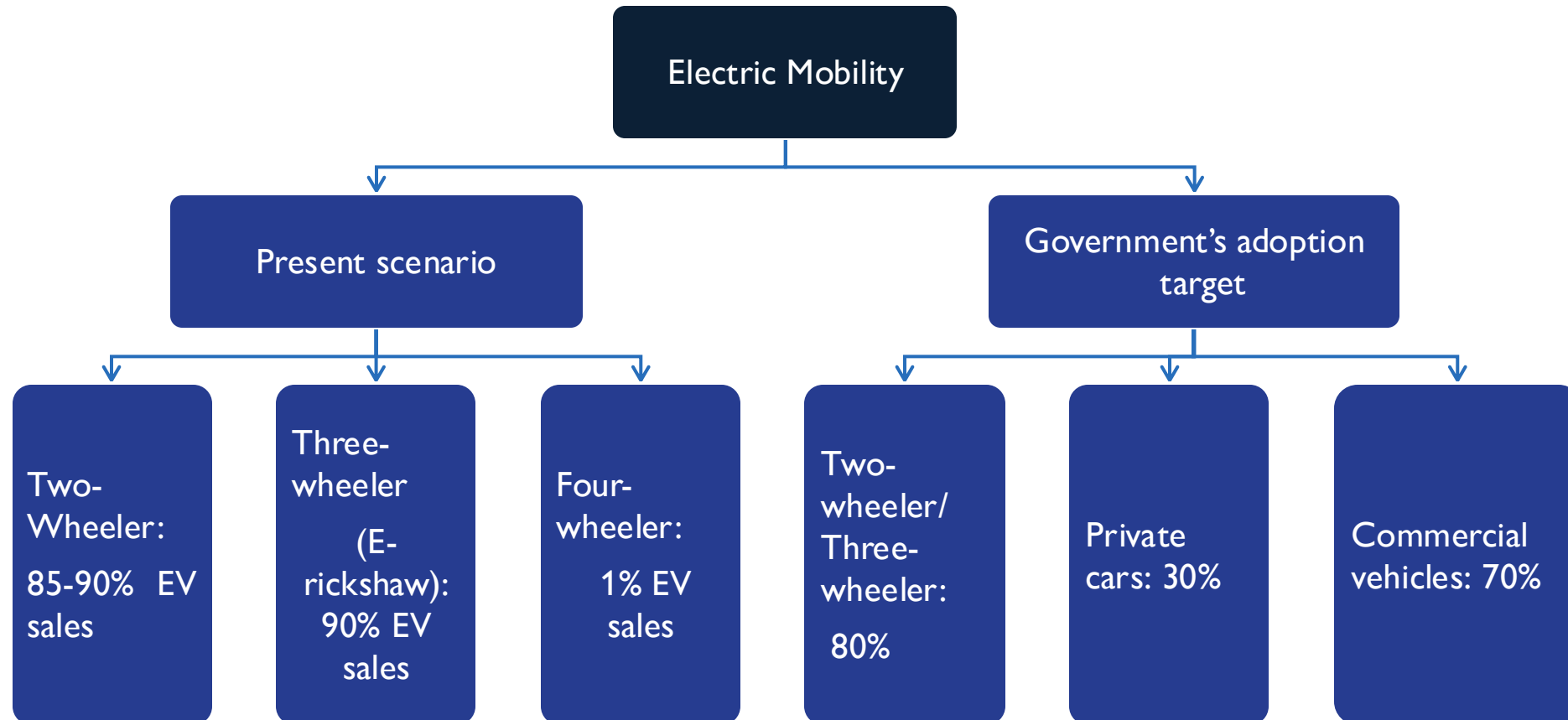
EV penetration trends in India

Key Pillars of India's push toward electric mobility

Transformation of transportation sector

Attainment of Sustainable Development Goals

Reduction in carbon emissions



Global Surge in EV Sales, India on a Steady Ascent

In the year 2024, The global electric vehicle market size is expected to be generate revenue of \$ 786.2.billion in and is projected to grow at 6.63% annually in the period 2024-29 2024 to reach \$1,084 billion by 2029.

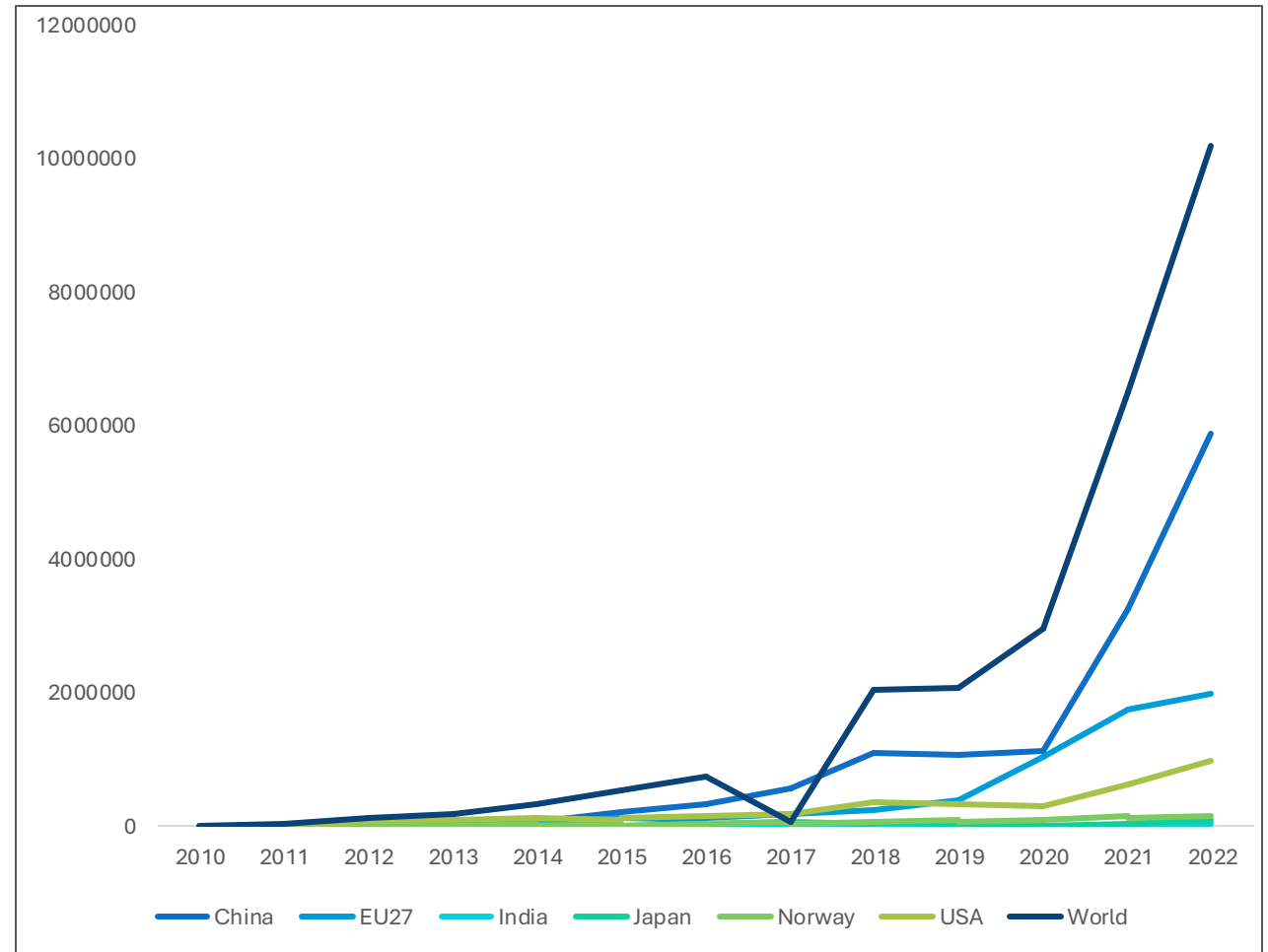
Nearly 14 Million electric cars were sold in the world with 95% being sold in China, Europe and USA alone.

In China, the number of new electric car registrations reached 8.1 million in 2023, increasing by 35% relative to 2022.

In terms of EV penetration, Norway leads the countries with an 80% EV penetration in the market followed by Iceland (41%), Sweden (32%).

Source- IEA Global EV Outlook, Statista

EV Sales among Passenger Vehicles



Source- Jaeger, 2023; IES, 2023; Climate Action Tracker, 2020.

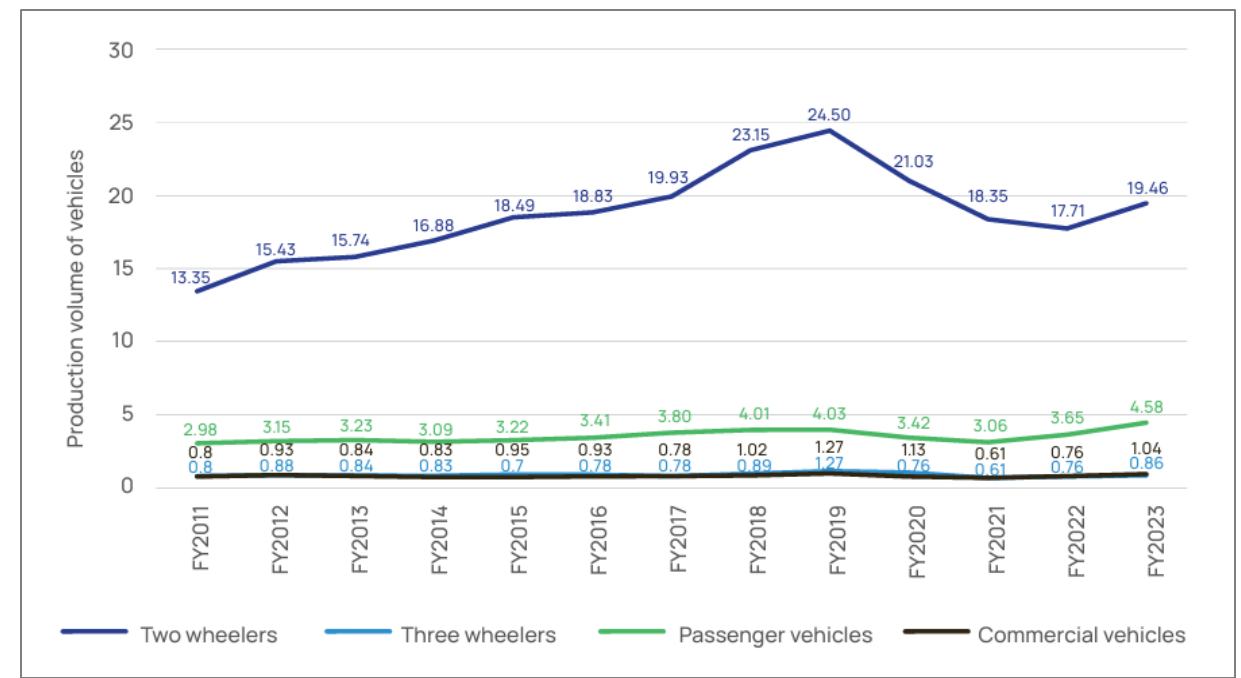
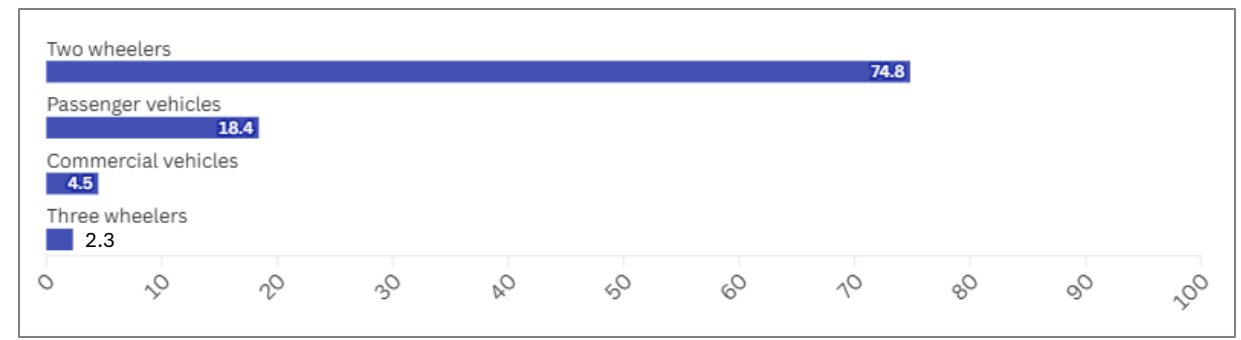
Overview of India's Automobile Industry

In 2021, value of India's Automotive USD 100 Billion and it accounted for 49% of the manufacturing GDP and produced a total of 3.7 crore direct and indirect jobs.

It is projected to reach USD 160 Billion by 2027 at 8.1% CAGR.

In the fiscal year 2022-23, the industry manufactured a total of 2,59,31,867 vehicles, compared to the previous year's output of 2,30,40,066 units. Within this period, two-wheelers dominated the market with a substantial 74.8% share, while passenger cars constituted 18.4%, Commercial 4.5% and Three Wheelers 2.30%.

In the Electric Vehicles Segment, two-wheeler (2W) EVs form the majority of EV sales today, accounting for 85%–90% of all EV units sold in India followed by four-wheeler (4W) EVs (7%–9% of sales) and three-wheeler (3W) EVs (5%–7% of sales).

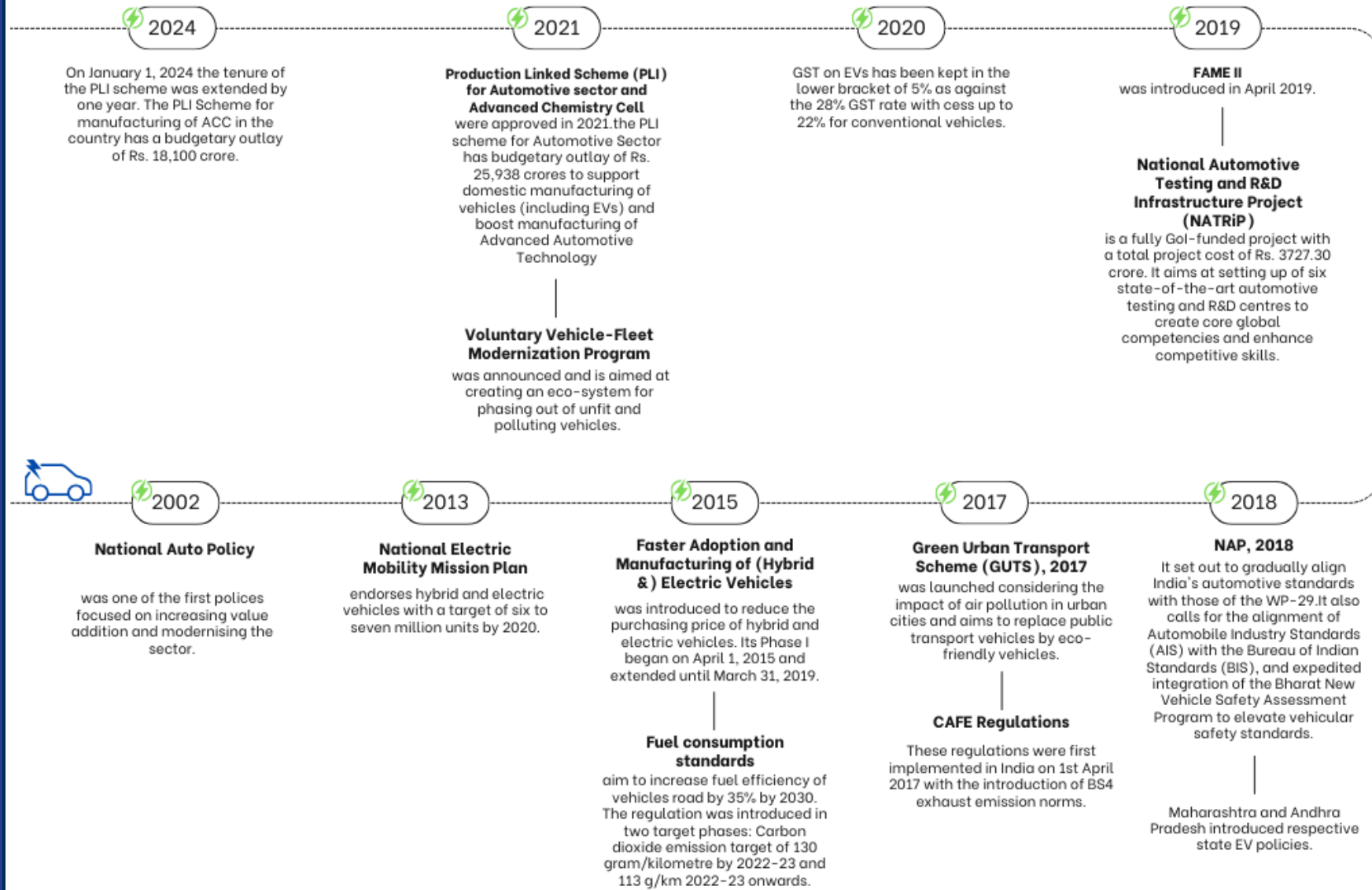


Source- SIAM

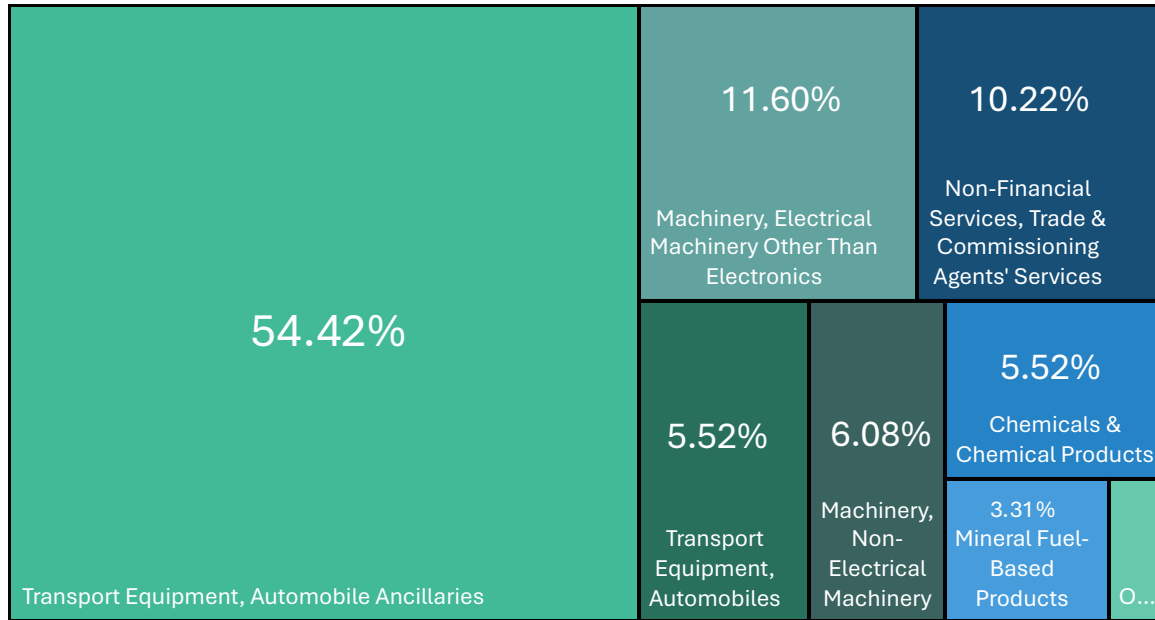
Source- Mordor Intelligence, Ministry of Finance, SIAM.

Indian Government's Initiatives and Schemes for Electric Mobility

The Indian government has implemented measures to boost EV penetration, focusing on stimulating consumer demand. These policies rely on subsidies and monetary incentives, which are unsustainable for the government and do not address critical aspects like manufacturing costs, technology, or innovation.



India's EV Transition: Current Standing and Future Needs



Automobile Production Process affected due to EV transition

Component manufacturing of engine parts, motor assembly, petroleum-based products, Physical and Human resources for ICE assembly, repair and maintenance

New segments in Production Process due to EV

Raw material mining, Battery cell procurement and manufacturing, Battery pack operations, Power electronics, EVSE manufacturing, Battery and second life, Physical and Human resources battery assembly, swapping, repair, charging infrastructure and maintenance

- The current stakeholder's distribution shows **11.60% are involved in Electrical Machinery**. More than 50% are involved in manufacturing of transport equipment. Within this segment, only **4.06% are involved in Electrical Automobile Parts**.
- Over 75% of India's component industry consists of tier 2 and tier 3 players**. This limits the country's ability to build a robust, well-integrated supply base.

Major Impediments to EV Transition India

High Total Cost of Ownership

- EV components constitute approximately 60% of the overall EV cost at present and are expected to remain above 50% in 2025.
- Despite Exemption in GST and Subsidies, 4W remain out of reach of the purchasing power of the average India consumer with the lowest range car at 8 lakhs.

Dependency on demand side initiatives

- Demand side initiatives have created a market for EVs but have no direct influence in manufacturing cost, technology of innovation.
- An overview of best practices globally and current pace of India's adoption necessitates incorporation of supply side initiatives

Lack of singular target and mismatch between state targets

- At present, 33 states and UTs have policies focusing on EVs, which significantly contributes to the promotion of EV adoption and encouragement of innovation
- Long term integrated goals have streamline electric mobility process in China, US, Norway and EU.

Battery and Charging Infrastructure

- Heavy Reliance on China for import of lithium- ion batteries and raw material for battery production.
- Lack of integrated efforts between private and government players to establish capabilities for battery manufacturing.
- Lack of adequate Charging Infrastructure

Incentives for EV adoption in different economies

Initial policies around the world focused on consumer incentives to spur demand, followed by supply-side measures to drive production and achieve economies of scale in EV production. Successful implementation of ZEV mandate in China propelled its Electric Vehicle market to the Giant it stands today.

China

Various EV centric projects started under the National Key Technologies R&D program.

Thousands of Vehicle, Tens of Cities program to deploy at least 1000 EVs in selected cities between 2009-12. The program focused upon providing financial subsidies to spur EV procurement

Exemption of EVs from peak hour traffic control and financial aid for setting up charging facilities

NEV Mandate in 2018

United States of America

Introduction of ZEV mandate by CARB in 1990 in California. The mandate stipulated 2% of the vehicles to be electric

Introduction of Advanced Clean Cars Program in 2012, setting targets to exceed Electric vehicle sales to exceed 10%.

Formulation of Advanced Clean Cars II standards for post 2025 aiming for full transition to EVs by 2035.

Various Rebate Projects to provide incentives of up to 9,500 dollars to adopt EVs and replace ICE Vehicles

European Union

21 countries in the EU offer Tax breaks from purchase of Electric vehicles.

Green deal Industrial Plan led to Critical Raw Materials Act to secure supply chains and recycling of materials used in battery production

Net Zero Industry Act in 2023 with an objective of producing 40% of EU's critical net-zero technologies somatically by 2030.

European Battery Alliance- Attaining Manufacturing capacity of 550 GWh

Norway

Focus on consumer incentives to cultivate a demand-driven market

Exemption of Import tax, VAT, road tax, toll charges etc. for electric vehicles.

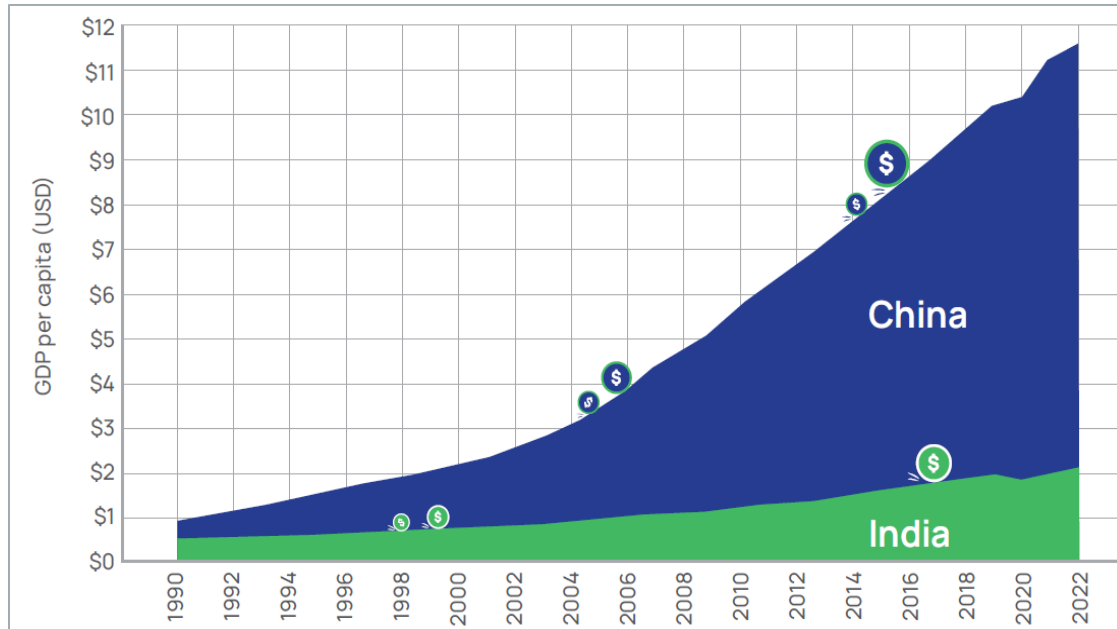
Incentives such as complimentary Municipal parking and Access to Bus Lanes.

Heavy investment in Charging Infrastructure in the country.

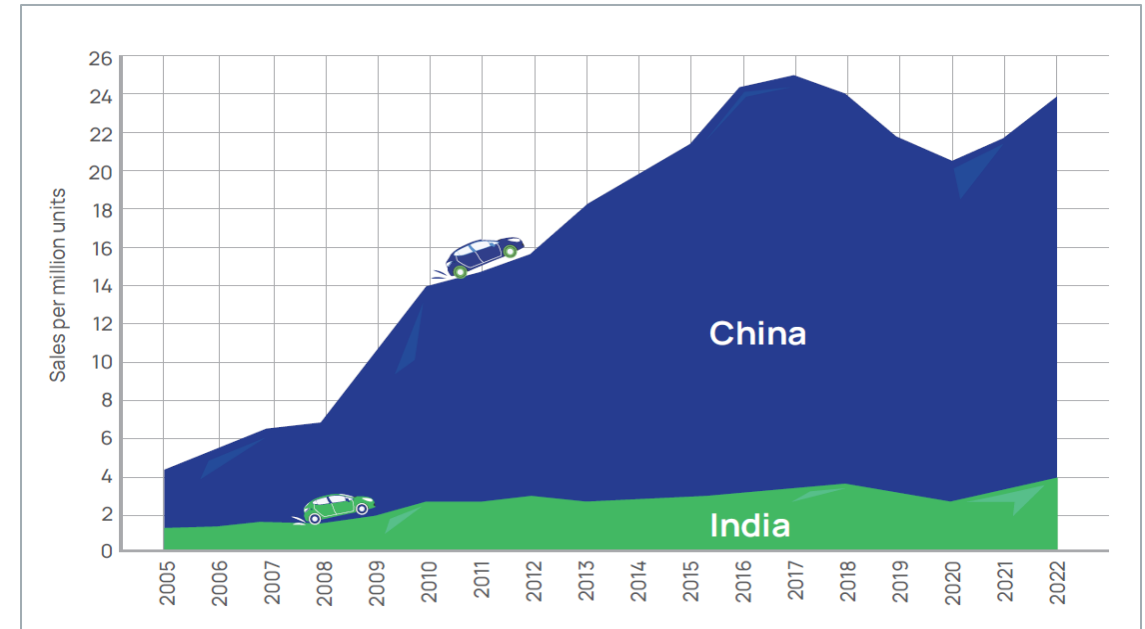
Is India Ready For a ZEV Mandate? Comparison against China and points of diversion.

Achieving ZEV success can be in two ways – increasing per capita income or improving manufacturing infrastructure to reduce production costs.

GDP Per capita – India Vs China



Automobile Sales per Million – India Vs China



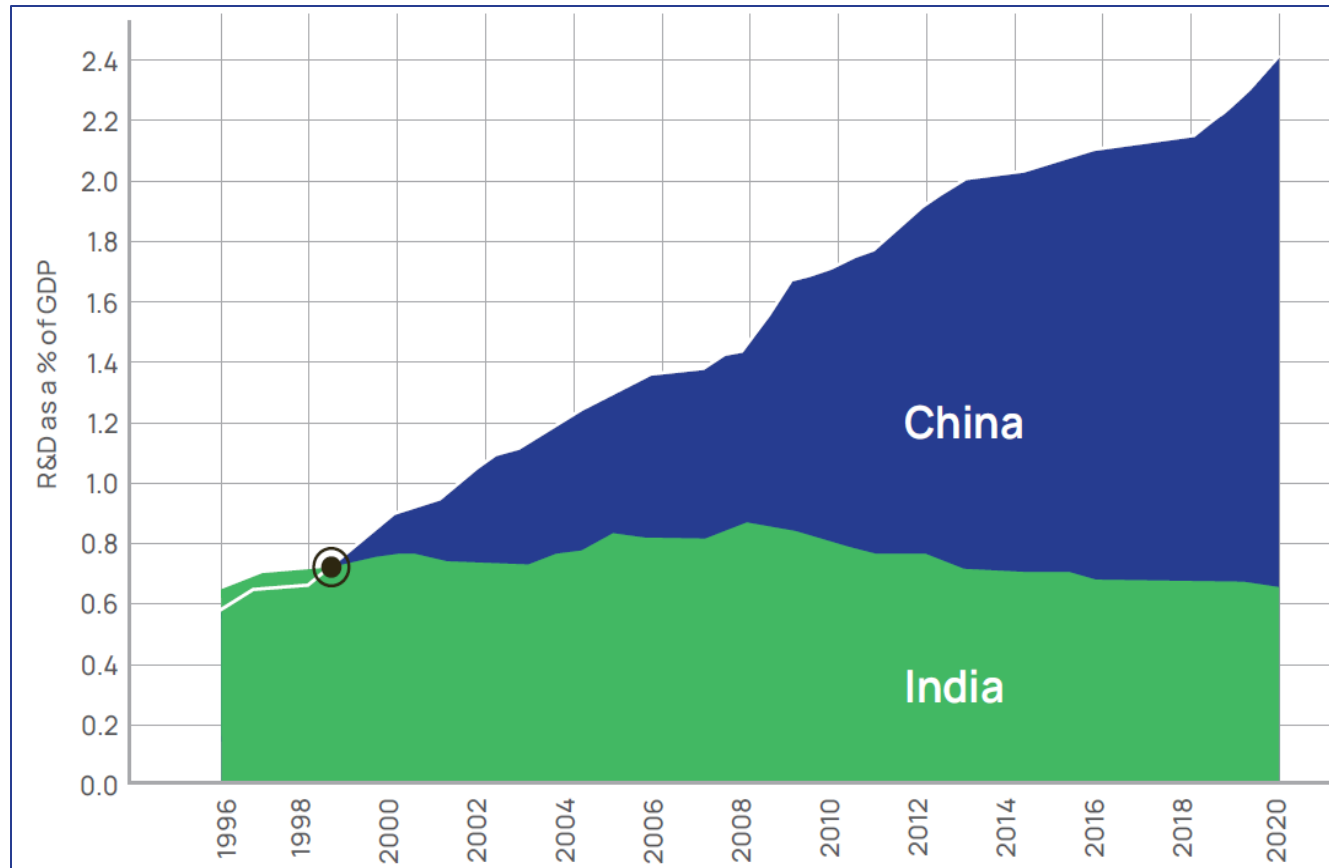
The inception of ZEV research in China in 1991 occurred at a time when its per capita GDP was approximately twice that of India's, standing at USD 905.03 and USD 534.48, this gap has now widened to 5.53 as of 2023.

China implemented the ZEV mandate in 2017, when passenger vehicle sales had surged to 24.72 million. India sold 2.55 million passenger vehicles, a market size four times smaller than China's.

In the Chinese Automobile sector, there are more than 150 automobile brands, with almost 60% being domestic. India currently has only 17 major Passenger Car manufacturers.

Need for Impetus on Research Development and Technological Advancement for ZEV mandate Success.

R&D as a percentage of GDP– India Vs China



In 1996, India had a higher share of R&D expenditure as a percentage of GDP than China, but China's consistent and escalating R&D investments, reaching 2.43% of GDP in 2021, have surpassed India's, which peaked at 0.86% in 2008 before declining 0.6 in 2021. The impact of this divergence is evident in the global automotive market. China's cost-effective and technologically advanced cars have propelled its dominance in vehicle exports, surpassing Japan as the largest exporter of passenger automobiles in 2023.

ZEV Success in India- Proposed Evaluation by mathematical model

First attempt to understand the model's applicability to India as a nation. Operates under the assumption that **30% of total production** must meet ZEV standards for each manufacturer.

Methodology:

Utilizes a **non-linear optimization approach** to simulate policy impacts on automakers' production decisions.

Focuses on the **Indian automotive industry's response** to a Zero Emission Vehicle (ZEV) mandate.

Objective:

Maximize total profit for each participating firm in the industry.

Constraints:

Includes **linear constraints** to accurately represent the mandate's impact.

The model integrates a **tradeable credit mechanism**. (Target ZEV Credits = $2 \times 0.3 \times$ (Total production of vehicles by the firm))

Central Role of Battery in the EV Ecosystem- Investment Priorities and Approaches

Battery is the most essential component of the Electric vehicle. Constituting to 30-40% of the EVs price, investments in battery is key to technological and cost effectiveness of the vehicle.

Investment by China

Private Investment **\$222** Billion

Government Investment **\$27.7** Billion

Investment by India

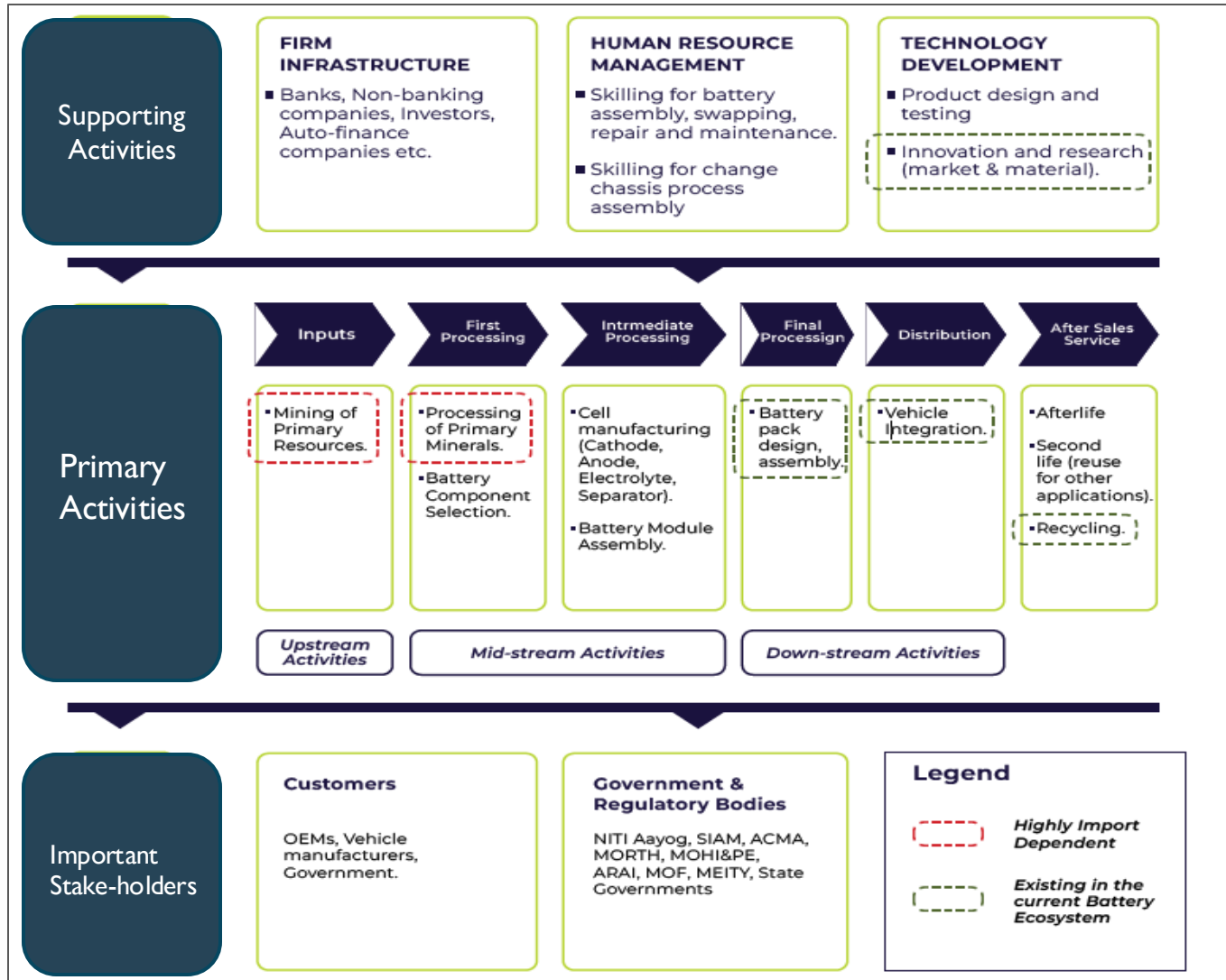
Private Investment **\$3.5** Billion

Government Investment **\$8.0** Billion

China has further committed \$75.81 billion dollars to support the manufacturers and customers of EV during the period 2024-27.

India is at a nascent stage in its EV development, the current investment levels constitute **less than 2 per cent of China's total expenditure.**

Current EV Battery Value Chain in India



- ✓ Six essential manufacturing segments are involved in the creation of EV lithium-ion batteries: **cell assembly, pack assembly, cell cathode, cell anode, cell electrolyte, and cell separator.**
- ✓ India's involvement in this supply chain is mainly restricted to the assembly of batteries, with a significant dependence on imports principally from China, Taiwan, and other European nations.
- ✓ India imported almost 450 million units of lithium-ion batteries in the fiscal year 2020, with an investment of nearly USD 865 million

Fig. Battery Value Chain in India

Results of the Input Output Model

Sectors	Increase in Output (million \$)
Battery	10,157.06
Mining and Quarrying	1,536.12
Basic Metals and Fabricated Metal	1334.46
Chemicals and Chemical products	1039.56
Rubber & Plastics	964.91

Indirect Effect	Increase in Output (million \$)
Construction	326.76
Financial Intermediation	273.67
Retail Trade	201.41
Education	81.11
Wealth	21.19

- The Input Output model estimates a **\$19,389 Million** increase in economic output in the country through the PLI ACC scheme.
- After the battery production sector, Mining and Quarrying showed an estimated **\$1536.17 Million** increase in output.
- Manufacturing related industries such as chemicals and chemical products are forecasted to increase by **\$ 1,039.56 million**, while basic metals and fabricated metals are anticipated to grow by **\$ 1334.6 million**.

Direct & Indirect Effect on Employment

Direct Effect	
Sectors	Increase in Employment
Mining and Quarrying	34,728
Basic Metals and Fabricated Metal	31,022
Chemicals and Chemical Products	14,664
Rubber and Plastics	76,627
Sale Maintenance and repair of motor vehicles	6,072
Electrical and optical equipment	8,047
Indirect Effect	
Manufacturing	3,296
Wholesale Trade and Commission trade	29,330
Other Community, social and personal services	3,98,197

- The scheme is estimated to add **1.03 million** jobs in the Indian Economy.
- The largest increase is expected in the sector for battery production with estimated **179,546** jobs in the sector.
- Except for battery manufacturing, Mining and Quarrying Sector is expected to add **34,728** jobs with an addition of **76,627** jobs in the Rubber and Plastics sector.
- The PLI scheme is expected to indirectly lead to an addition of **3.98 lakh jobs** in Other Community, Social and Personal Services Sector.

Key Takeaways and Recommendations

1

Balance of Demand and Supply Side Policies

- ✓ A balanced approach, integrating demand and supply-side policies, is crucial for sustainable growth and development in the industry. Customized supply-side strategies for each segment of the automotive value chain, from raw material extraction to after-sales services, play a pivotal role.
- ✓ Introducing a ZEV mandate can act as a supply-side policy, compelling automakers and stakeholders to ramp up production capabilities, streamline forward and backward linkages, and reduction in reliance on imports.

2

Reduction in Total Cost of Ownership to Increase EV Penetration

- ✓ The initial upfront cost of electric vehicles (EVs) is higher than ICE vehicles, this remains a significant barrier for consumers.
- ✓ To overcome this, a ZEV mandate is implemented, forcing manufacturers to scale up production, leading to economies of scale and reduced costs.
- ✓ This results in affordable and efficient EV models, promoting market penetration and contributing to the nation's economic and environmental sustainability goals.

3

Policy Recommendations

- ✓ **Need for Integrated Efforts within the EV Ecosystem-**
A cohesive policy framework is required to encompass both upstream and downstream activities within the value chain, addressing gaps currently present in India's policy landscape.
- ✓ **Targeted Policy for Lithium Refining**
To reduce reliance on foreign lithium imports and lower costs, a domestic lithium procurement policy is needed.

4

Key Learnings for Industry Players

- ✓ **Collaboration Between Private Entities and Public Players for Accelerating Growth-**

Learning from the Chinese Experience, Private Entities should focus on collaborating with the Government to establish strong and resilient supply chains in the Indian Market.
- ✓ **Necessity of Investment and innovation by Private Players for Driving Growth**

To enhance domestic manufacturing capabilities, increased private sector-led investment in Research and Development within the sector is essential.

5

Synergizing Stakeholder Efforts for Efficient EV Development.

- ✓ The Indian automotive sector is poised to experience significant supply chain disruptions with the implementation of the ZEV mandate. To effectively transition to EVs, collaboration among all stakeholders is essential. This includes proactive automakers, well-designed government policies, strategic incentives, and the removal of barriers to supply and demand.
- ✓ The government should promote EV manufacturing and foster a supportive ecosystem, while private companies need to invest in research and technology. Aligning public-private strategies will enable cost-competitive and technologically advanced automobiles

6

Reduction of Infrastructural and Financial Barriers to Adopt EVs.

- ✓ Transition strategies for EVs in India involve long-term strategic planning, financial incentives, infrastructure development, and EV-per-charger ratio.
- ✓ India's EV-per-charger ratio is crucial for assessing charging network adequacy, as compared to countries like China, Korea, and the Netherlands.
- ✓ India has 135 EVs (PVs and 2Ws) and 86 EVs per charging station for 3Ws, highlighting the need for funding and legislative support to expand EV charging networks and shape India's EV landscape.

7

Strengthening CAFE Regulations and Credit Systems.

- ✓ India's automotive industry, under Corporate Average Fuel Efficiency (CAFE) norms, can incentivize automakers to produce electric vehicles (EVs) by 2030.
- ✓ However, the current norms lack clear guidelines for their utilization, rollover mechanisms, trading possibilities, and penalties.
- ✓ The current norms allow manufacturers to fulfill minimum credit requirements without manufacturing EVs, despite higher credit weights for BEV, PHEV, and HEV. Stricter CAFE norms and credit regulations would compel manufacturers to prioritize EV manufacturing.