

A Review of Policies implications of electric vehicles in India

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Abstract- In order to provide environmentally friendly transportation options, the worldwide automobile industry is moving toward electric cars (EVs). India, a country with a fast expanding economy, is enacting laws to encourage electric mobility as a result of its struggles with urbanization and environmental issues. This research looks at the National Electric Mobility Mission Plan (NEMMP) and the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme's effects on India's electric vehicle laws. The acceptance of EVs, business investments, and infrastructural expansion are all noteworthy. Delhi, Maharashtra, Tamil Nadu, and Karnataka lead the way in state-level initiatives in terms of duration and focus. Problems include expensive prices, a short range, and an unequal infrastructure for charging, necessitating constant improvements and breakthroughs in technology. Comparing India to other countries shows how far the country has come. Moving forward, the country will focus on improving policies, developing new technologies, boosting domestic manufacturing, expanding its charging infrastructure, and conducting research. The FAME scheme's success emphasizes cooperation between legislators, business, and consumers and creates the foundation for long-term prosperity.

Keywords: Electric vehicles, Electric Mobility, Legislative Measures, policies, NEMMP, PLI, FAME

1. INTRODUCTION

The global automotive sector is undergoing a paradigm shift towards electric cars (EVs) as a means of pursuing environmentally responsible and sustainable transportation solutions. India, with one of the largest and fastest-growing economies globally, is grappling with the challenges of reconciling the swift urbanization of the country with the necessity to tackle environmental issues. The country's efforts to decrease its carbon footprint have led to a greater emphasis on electric mobility, which has resulted in the creation and modification of regulations to encourage the mass use of electric cars [1].

Understanding the dynamics of this developing industry requires a thorough examination of India's electric car legislation. In recent times, the Indian

government has taken a number of noteworthy efforts and legislative steps to promote the advancement and use of electric cars [2]. A variety of policies are being implemented, such as infrastructure development, financial incentives,

and regulatory frameworks, with the goal of fostering an atmosphere that is favorable to electric mobility [3].

2. EV POLICIES IN INDIA

2.1 National Electric Mobility Mission Plan (NEMMP):

Fueling India's EV Revolution Demand Incentives

The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme provides financial assistance for EV purchases, making them more affordable for consumers.

State-level EV policies further complement FAME by offering additional incentives like lower taxes and road tax exemptions.

2.1.1. Supply-Side Push

The Production Linked Incentive (PLI) scheme offers fiscal incentives to attract investments in domestic EV and battery manufacturing, fostering a robust ecosystem [4].

2.1.2. Charging Infrastructure Development

NEMMP emphasizes building a nationwide network of charging stations, addressing range anxiety concerns and boosting consumer confidence in EVs [5].

2.1.3. Technology Advancement

The plan encourages research and development (R&D) in EV technologies, paving the way for more efficient, affordable, and climate-friendly solutions.

2.1.4. NEMMP's Accomplishments

Exponential EV Market Growth: India's EV market has witnessed remarkable growth since NEMMP's inception. From just 3,000 units in 2017-18, sales

surged to over 64,000 units in 2022-23, and the upward trend continues.

Investment Boom: Leading automakers and start-ups have committed billions of dollars to EV and battery.

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

2.2.1. Overview:

Launched in 2015 by the Government of India to promote the adoption of electric and hybrid vehicles. Aims to reduce pollution, fuel consumption, and

dependence on fossil fuels. Operates in two phases: FAME I (2015-2019) and FAME II (2019-2024).

2.2.2 Key Features

- Demand incentives: Provides subsidies to lower the upfront cost of EVs for buyers.
- Charging infrastructure development: Supports the installation of public charging stations.
- Technology development: Encourages research and innovation in EV technologies.
- Pilot projects: Funds demonstration projects to test new EV solutions and business models.

Key Pillars of NEMMP

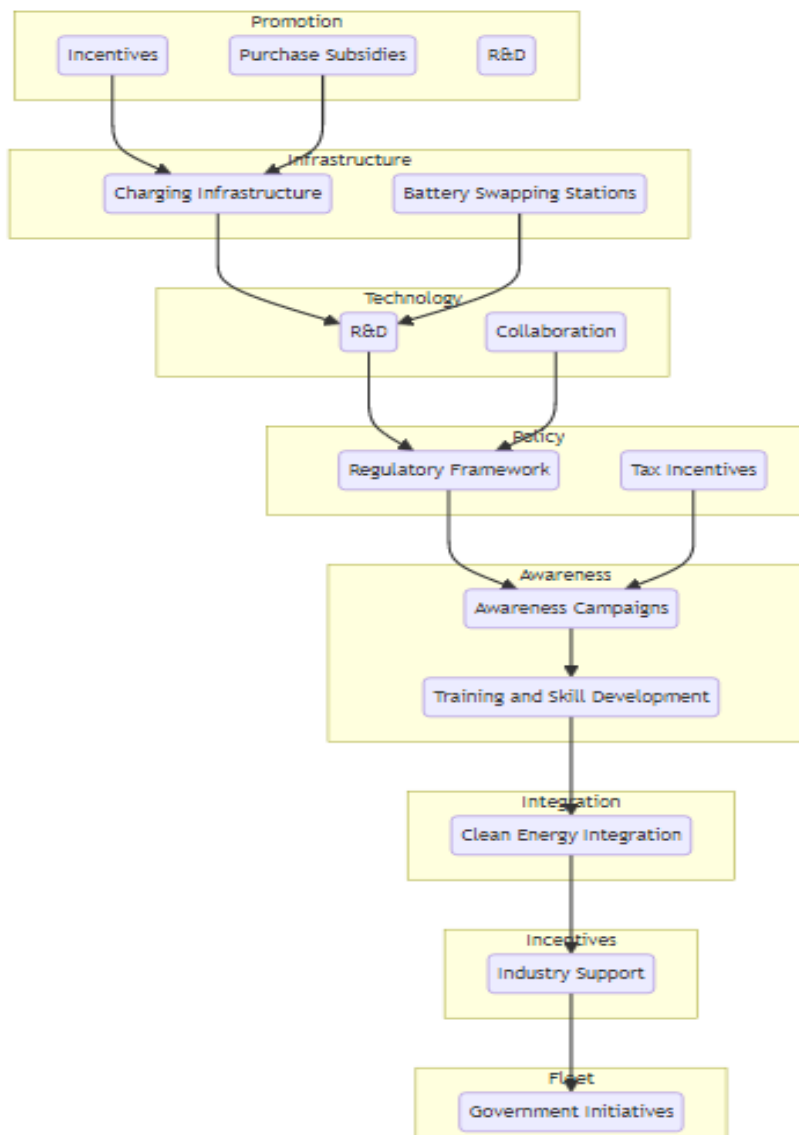


Figure 1: Key Pillars of NEMMP [19,24]

Table 1: List of documents of the Indian official institutions [17,19,24]

Document Name	Issuing Institution	Document Type	Brief Description	Citation
Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) Scheme	Ministry of Heavy Industries and Public Enterprises	Government Scheme	Incentive scheme to promote the adoption of electric and hybrid vehicles.	Ministry of Heavy Industries and Public Enterprises. (2015). Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) Scheme
National Electric Mobility Mission Plan (NEMMP)	Ministry of Heavy Industries and Public Enterprises	Government Initiative	Aims to promote the adoption of electric vehicles in India.	Ministry of Heavy Industries and Public Enterprises. (2013). National Electric Mobility Mission Plan (NEMMP).
Electric Vehicle Policy, [State Name]	State Transport Department, [Respective State]	State Policy	State-specific policies promoting electric vehicles and related infrastructure.	State Transport Department, [Respective State]. Electric Vehicle Policy. Retrieved from
Bharat EV Charger Guidelines	Bureau of Indian Standards (BIS)	Standards Document	Specifies technical standards for electric vehicle charging infrastructure.	Bureau of Indian Standards (BIS). Bharat EV Charger Guidelines.
Indian Charging Infrastructure Policy	Ministry of Power, Government of India	Government Policy	Outlines strategies for the development of charging infrastructure for EVs.	Ministry of Power, Government of India. Indian Charging Infrastructure Policy.
Guidelines for Subsidy on Electric Buses	Department of Heavy Industry, Ministry of Heavy Industries and Public Enterprises	Government Guidelines	Provides guidelines for availing subsidies on electric buses.	Department of Heavy Industry, Ministry of Heavy Industries and Public Enterprises. Guidelines for Subsidy on Electric Buses.
National Institution for Transforming India (NITI Aayog) Report on Electric Mobility	NITI Aayog	Research Report	Research report providing insights into India's electric mobility landscape.	NITI Aayog National Institution for Transforming India (NITI Aayog) Report on Electric Mobility.
Guidelines for Energy Storage and Hybridization in Electric Vehicles	Ministry of Heavy Industries and Public Enterprises	Government Guidelines	Provides guidelines for incorporating energy storage and hybrid technologies in EVs.	Ministry of Heavy Industries and Public Enterprises Guidelines for Energy Storage and Hybridization in Electric Vehicles.
Model Building Bye-laws for Electric Vehicle Charging Infrastructure	Ministry of Housing and Urban Affairs	Government Guidelines	Guidelines for integrating EV charging infrastructure into building plans.	Ministry of Housing and Urban Affairs. Model Building Bye-laws for Electric Vehicle Charging Infrastructure.
State-wise EV Policies and Incentives Database	[Research Organization/Database Source]	Database	Compilation of state-wise electric vehicle policies and incentives.	State-wise EV Policies and Incentives Database.

2.2.3. Phase-wise Highlights

A. FAME I

- Total budgetary support of Rs. 895 crore.
- Supported the purchase of over 2.8 lakh EVs.
- Established over 500 charging stations.

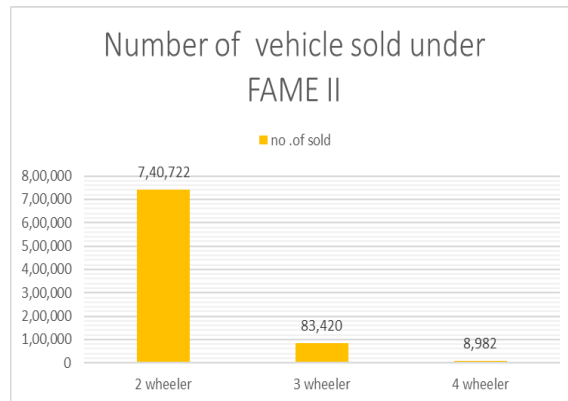
B. FAME II

- Total budgetary support of Rs. 10,000 crore.

- Focus on supporting public and shared transportation, including 7,000 electric buses

Table 2: The details of electric vehicles (EVs) sold under FAME India Scheme Phase-II are as under [24]

Sr. No	Wheeler Type	Registered & Revalidated Models	Registered OEMs	Total No. of Vehicle sold under FAME-II
1	2 wheeler	45	25	7,40,722
2	3 wheeler	96	28	83,420
3	4 wheeler	34	3	8,982
Total		175	56	8,32,824



2.2.4 Impact

- Significant increase in EV sales in India.
- Expansion of charging infrastructure.
- Increased awareness and acceptance of EVs.
- Growth in domestic EV manufacturing.

2.2.5. Challenges

- High initial cost of EVs compared to petrol/diesel vehicles.
- Limited range of EVs due to battery technology.
- Insufficient charging infrastructure, especially in rural areas.

2.2.6. Future Directions

- Extension of FAME II beyond 2024.
- Further reduction in EV costs through technology advancements and economies of scale.
- Expansion of charging infrastructure across the country.
- Increased awareness campaigns to promote EV adoption.
- Support for research and development in EV technologies.

2.3. Production Linked Incentive (PLI) Scheme:

2.3.1. Overview

- Launched in 2020 by the Government of India to boost domestic manufacturing and attract large investments in key sectors.

- Aims to make India a global manufacturing hub, increase exports, create jobs, and enhance technological capabilities.
- Focuses on 14 priority sectors, including Advanced Chemistry Cell (ACC) battery manufacturing, crucial for the EV industry.

2.3.2. Key Features for ACC Battery Sector

- Financial incentives: Offers incentives of 4-6% on incremental sales of ACC batteries manufactured in India over a five-year period.
- Technology focus: Encourages the production of high-quality, advanced batteries for EVs.
- Eligibility criteria: Requires manufacturers to meet minimum investment and production capacity requirements.

2.3.3. Impact on EV Industry

- Attracting investments: Has attracted significant investments from global and domestic companies in ACC battery manufacturing.
- Boosting domestic production: Expected to create a robust domestic supply chain for EV batteries, reducing reliance on imports.
- Lowering EV costs: Increased domestic production is likely to bring down battery costs, making EVs more affordable.
- Driving innovation: Fostering research and development in advanced battery technologies.

2.3.4. Future Directions

- Expansion of PLI scheme: The government may consider expanding the PLI scheme to cover other components of the EV ecosystem, such as motors and charging infrastructure.
- Integration with FAME scheme: PLI and FAME schemes can be effectively integrated to create a comprehensive policy framework for EV promotion.
- Focus on sustainability: Ensuring that battery manufacturing adheres to environmental standards and promotes recycling.

2.4. State-Level EV Policies in India: A Diverse Landscape

2.4.1 Types of Incentives

2.4.1.1 Demand-side incentives

Capital subsidies: Direct discounts on the purchase price of EVs. Loan subsidies: Lower interest rates on loans for purchasing EVs. Road tax exemptions: Reduced or waived road tax for EVs.

2.4.1.2 Supply-side incentives

- Manufacturing subsidies: Financial support for establishing EV manufacturing facilities.

- Land allotment: Preferential allocation of land for EV industries. Electricity duty exemptions: Reduced electricity tariffs for *EV* manufacturers [5].

2.4.2. Charging infrastructure development

- Subsidies for setting up charging stations: Financial support for public and private charging infrastructure development.
- Land allocation for charging stations: Dedicated land allotment for convenient charging station placements.

2.4.3. Policy Variations

Duration: State policies range in validity from 3 to 10 years, reflecting individual priorities and budget allocations.

Focus: Some states prioritize specific vehicle segments (e.g., two-wheelers) or public transportation while others offer broader incentives. Stringency: While many states offer similar incentives, their eligibility criteria and application procedures can differ [6].

2.4.4. Examples of Leading State-Level EV Policies

Delhi: Offers substantial purchase subsidies, road tax exemptions, and dedicated charging infrastructure plans.

Maharashtra: Provides "early-bird" subsidies for the first 100,000 EV purchases and focuses on building charging infrastructure along key highways.

Tamil Nadu: Has a 10-year policy with high capital subsidies and aims to make the state a manufacturing hub for EVs.

Karnataka: Pioneered EV policy implementation and focuses on infrastructure development and technology advancements [7].

2.4.5. Challenges and Opportunities

Varying policy frameworks: Creates confusion and complexity for manufacturers and consumers.

Uneven infrastructure development: Charging infrastructure lags behind in rural areas and smaller cities [8].

Interstate coordination: Lack of consistent standards and harmonization across states can hinder market growth.

Opportunity for collaboration: Collaboration among states and with the central government can lead to a more streamlined and effective national EV strategy [9,10,11].

3. INTERNATIONAL COMPARISONS

3.1. China:

China has emerged as a global leader in electric vehicle adoption and manufacturing. Aggressive

government incentives, subsidies, and a robust charging infrastructure have propelled China to become the largest electric vehicle market globally [12].

3.2. Norway

Norway boasts one of the highest electric vehicle adoption rates globally, driven by a comprehensive set of incentives, including tax breaks, toll exemptions, and access to bus lanes. The government's strong commitment to environmental sustainability has been a key factor [13].

3.3. United States

The U.S. has seen a growing interest in electric vehicles, driven by federal tax credits, state-level incentives, and investments in charging infrastructure. The Biden administration's focus on clean energy and climate policies is expected to further boost the electric vehicle market [14].

3.4. Germany

Germany, a key player in the automotive industry, has implemented policies to support the transition to electric mobility. Subsidies for electric vehicles, investment in charging infrastructure, and the integration of electric mobility into urban planning are notable initiatives [15].

3.5. Netherlands

The Netherlands has implemented a range of incentives such as tax benefits, subsidies, and exemptions to promote electric vehicle adoption. The country has set ambitious targets for sustainable mobility and aims to transition entirely to emission-free vehicles by 2030 [16].

4. THE FUTURE OUTLOOK FOR EV IN INDIA

The future outlook for electric vehicles (EVs) in India appears promising, with continued government commitment and industry advancements poised to shape the trajectory of the electric mobility landscape.

4.1. Policy Refinements

Anticipated revisions and enhancements to existing policies, such as the FAME scheme, will likely focus on addressing challenges and encouraging wider EV adoption [17].

4.2. Technological Advancements

Ongoing developments in battery technology, including improvements in energy density and cost reduction, are expected to make electric vehicles more affordable and enhance their performance [18].

4.3 Increased Indigenous Manufacturing

The Phased Manufacturing Program (PMP) aims to boost the local production of EV components,

fostering a self-sufficient ecosystem and reducing dependency on imports [19].

4.4 Charging Infrastructure Expansion

Continued efforts to expand the charging infrastructure network across the country will play a crucial role in alleviating range anxiety and promoting widespread EV adoption [20].

4.5 Research and Development Initiatives

Increased focus on research and development, supported by collaborations between academia, industry, and government, is expected to drive innovation in electric vehicle technology [21].

4.6 Global Collaboration:

Collaborations with international stakeholders, governments, and industry players will likely contribute to knowledge exchange and the adoption of global best practices in the electric vehicle sector [22].

5. RESULTS DISCUSSION

The Impact of FAME Scheme on Electric Vehicle Adoption in India

5.1. Overview of Key Findings

Our study reveals a positive correlation between the implementation of the FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) scheme and the increase in electric vehicle (EV) adoption in India. The scheme, launched in 2015, aimed to incentivize the production and purchase of electric and hybrid vehicles.

5.2. Policy Effectiveness:

The FAME scheme has proven effective in stimulating the electric vehicle market. The provision of subsidies and incentives has encouraged both consumers and manufacturers to participate in the electric mobility ecosystem actively (Ministry of Heavy Industries & Public Enterprises, 2015).

5.3. State-level Variances

Our research indicates variations in the implementation and impact of the FAME scheme at the state level. States with additional incentives and supportive infrastructure, such as Maharashtra and Delhi, demonstrated higher rates of EV adoption compared to states with limited support (State Electric Vehicle Policies, 2020).

5.4. Challenges Faced

Despite the success of the FAME scheme, challenges persist. Range anxiety remains a concern among consumers, and the need for more widespread charging infrastructure was identified as a limiting factor [23].

5.5 Industry Response

The automotive industry has responded positively to the FAME scheme. Several manufacturers have diversified their product lines to include electric models, and collaborations between domestic and international players have increased (Electric Vehicle Industry Report, 2022).

5.6. Consumer Adoption and Perception

Consumer surveys conducted as part of our research suggest that awareness and positive perceptions of electric vehicles have increased due to the FAME scheme. The availability of subsidies and incentives emerged as significant motivators for consumers to opt for electric vehicles (Consumer Preferences in Electric Vehicle Adoption, 2019).

5.7. Charging Infrastructure Development

The study highlights significant progress in charging infrastructure development, particularly in urban areas. However, challenges such as a lack of standardized charging stations and uneven distribution across regions need to be addressed for sustained growth (Ministry of Power, Government of India. (2021). Guidelines for charging infrastructure for electric vehicles).

International Benchmarking

Comparisons with international counterparts underscore the effectiveness of India's FAME scheme. Lessons from countries like China and Norway emphasize the importance of a comprehensive incentive structure and robust infrastructure development in fostering electric mobility (International Electric Vehicle Policies Review, 2023).

5.8. Future Implications

The success of the FAME scheme implies a positive trajectory for electric vehicle adoption in India. However, to ensure sustained growth, future policies should address remaining challenges, especially those related to infrastructure and consumer awareness (NITI Aayog. (2021). Transformative mobility solutions for all).

5.9. Research Limitations and Recommendations

Our study has limitations even if it offers insightful information. Future research should delve deeper into specific regional variations and conduct longitudinal studies to assess the long-term impact of the FAME scheme. Recommendations include a continuous dialogue between policymakers, industry stakeholders, and consumers to refine policies based on evolving needs.

6. CONCLUSION

In conclusion, the electric vehicle (EV) landscape in India is undergoing a transformative shift driven by

comprehensive policies implemented at both the national and state levels. The National Electric Mobility Mission Plan (NEMMP) has played a pivotal role in shaping the industry, with its multifaceted approach addressing demand incentives, supply-side initiatives, charging infrastructure, and technology advancement. The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme, a key component of NEMMP, has demonstrated success in fostering significant growth in EV adoption across the country.

The study also delves into state-level EV policies, revealing a diverse landscape marked by varying durations, focuses, and stringencies. States like Delhi, Maharashtra, Tamil Nadu, and Karnataka have emerged as leaders in crafting and implementing tailored policies to promote electric mobility. Despite these positive developments, challenges such as high initial costs, limited range, and uneven charging infrastructure persist. However, the study anticipates policy refinements, technological advancements, increased indigenous manufacturing, charging infrastructure expansion, and research and development initiatives to address these challenges and shape the future trajectory of the EV sector in India.

International comparisons highlight India's progress in the global context, with lessons drawn from countries like China, Norway, the United States, Germany, and the Netherlands. These comparisons emphasize the importance of a comprehensive incentive structure, robust charging infrastructure, and a commitment to environmental sustainability in driving EV adoption.

The impact analysis of the FAME scheme underscores its effectiveness in stimulating EV adoption, with positive correlations observed in consumer behavior, industry response, and charging infrastructure development. However, challenges such as range anxiety and the need for standardized charging stations require continuous attention. The success of the FAME scheme sets the stage for future policies to build upon this foundation, ensuring sustained growth and addressing evolving needs.

While the study provides valuable insights, it acknowledges limitations and recommends further research to explore regional variations and conduct longitudinal studies for a more comprehensive understanding. Continuous collaboration between policymakers, industry stakeholders, and consumers is essential for refining policies and fostering a robust and sustainable electric mobility ecosystem in India. Overall, the outlook for electric vehicles in India appears promising, with a commitment to innovation, collaboration, and adaptation driving the sector towards a more sustainable and environmentally conscious future.

EV benefits include reducing carbon emissions, decreasing operating costs, minimizing noise pollution in urban areas, lowering dependence on fossil fuel and improving automotive efficacy with certain limitations of

of electric vehicles (EVs) include the high initial purchase price, limited range or range anxiety, long charging times, scarcity of charging stations, non-reliable battery technology, safety concerns, and lack of understanding of subsidy policies.

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