Understanding the Role of Subnational Policy Mix in Electric Vehicle Adoption

A Case Study of Karnataka, India

Master Thesis

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Understanding the Role of Subnational Policy Mix in Electric Vehicle Adoption

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by

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Executive Summary

Electric mobility has emerged as a key strategy for decarbonising the transport sector and improving urban air quality, especially in rapidly urbanising economies like India. While national schemes such as Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles provide critical momentum, it is increasingly at the subnational level through state and municipal actions that Electric Vehicle (EV) transitions are designed, implemented, and experienced. Karnataka, a pioneering Indian state in EV policy, introduced the country's first Electric Vehicle and Energy Storage Policy in 2017, updated in 2021, and has since launched several complementary policies aimed at boosting manufacturing, charging infrastructure, and EV adoption.

Despite this early policy leadership, Karnataka's EV adoption outcomes have been uneven. The state has become a hub for EV manufacturing, attracting private firms, and has seen notable growth in the two-wheeler and three-wheeler segments, primarily in urban centres like Bengaluru. However, progress in four-wheeler uptake, public transport electrification, and rural deployment has been limited. Infrastructure bottlenecks, inconsistent municipal implementation, and fragmented coordination across departments have slowed the scale and reach of the transition. These persistent shortcomings make it necessary to evaluate Karnataka's EV policy mix not merely to confirm these challenges, but to understand their root causes. Such an evaluation helps determine whether these issues stem from weak policy design, misaligned instruments, or failures in institutional coordination. By doing so, this study seeks to provide actionable insights into how Karnataka's policy approach can be made more coherent, inclusive, and effective.

This thesis aims to evaluate the effectiveness of Karnataka's subnational EV policy mix using the Policy Mix Framework developed by Karoline S Rogge and Reichardt 2016, which emphasises four key characteristics: Consistency, Coherence, Comprehensiveness, and Credibility. To do so, the research applies a structured qualitative content analysis of 18 major policy documents issued between 2017 and 2025 by state and municipal agencies, and constructs a strategically selected set of 40 policy instruments for interaction analysis. Each pair of instruments was evaluated based on overlaps in objectives, target groups, timing, institutional responsibility, and technical design, and scored for the degree of reinforcement, neutrality, or contradiction, primarily to assess Consistency and Coherence. Meanwhile, Comprehensiveness was evaluated at the document and system level (state and municipal), based on factors such as fiscal backing and the overall breadth of the EV policy landscape. Credibility was excluded because a document-based analysis could not reliably capture stakeholders trust in implementation, fiscal follow-through, or long-term policy reliability.

The findings reveal that Karnataka's EV policy mix demonstrates moderate internal consistency. Many instruments, such as fiscal subsidies for vehicles and concessional tariffs for charging, work in tandem to support affordability and infrastructure rollout. However, contradictions persist in areas like metering standards, overlapping incentive structures, and selective rollbacks in tax waivers, which send mixed signals to stakeholders and reduce strategic clarity.

On the dimension of coherence, the policy mix shows strong vertical coordination in specific areas, such as the role of BESCOM (Bangalore Electricity Supply Company) as a nodal agency and the alignment of tariff instruments. However, it suffers from institutional fragmentation, especially at the municipal level. Initiatives by BBMP (Bruhat Bengaluru Mahanagara Palike, the Bengaluru municipal corporation) and DULT (Directorate of Urban Land Transport) often operate independently of state mandates, resulting in procedural delays, land-use conflicts, and underutilization of resources. The lack of a dedicated, state-level task force or shared monitoring mechanism exacerbates these coordination issues.

In terms of comprehensiveness, the policy mix performs well in supporting EV manufacturing, infrastructure creation, and integration with industrial policy. However, demand-side gaps remain prominent. Support for low-income users, financing mechanisms for fleet operators, digital access to charging services, and rural infrastructure coverage are largely absent or underdeveloped. This imbalance limits the accessibility and equity of Karnataka's EV transition.

Theoretically, the thesis contributes to transition studies by adapting the Policy Mix Framework to the Indian subnational context specifically, by empirically analyzing how a state-level policy ecosystem functions (or fails to function) across departments and governance levels. It highlights distinctive challenges in Karnataka's EV policy landscape, such as coordination breakdowns between municipal and state-level actors, and gaps in vertical policy alignment. It demonstrates, through a structured policy instrument interaction analysis, that policy effectiveness cannot be inferred from the number or stated intent of instruments alone. Instead, effectiveness hinges on how well these instruments interact over time and across administrative layers. Furthermore, by integrating value chain logic from manufacturing and infrastructure to end-user adoption, the research extends traditional EV policy assessments, which often focus narrowly on national subsidies or consumer behaviour.

Empirically, the study fills a critical gap in Indian EV research by applying the Policy Mix Framework originally developed in European transition contexts to the Indian subnational governance setting. While most prior studies analyse national-level schemes or consumer willingness-to-pay models, this thesis offers a detailed, document-based application of the policy mix framework to assess how a state-level policy ecosystem functions (or fails to function) as an integrated whole. It underscores the importance of municipal capacity, procedural governance instruments, and horizontal alignment in shaping real-world adoption outcomes, thereby providing a replicable template for evaluating multi-level policy interactions in other federal systems.

The thesis proposes several targeted policy recommendations that directly address the key gaps identified in Karnataka's current policy mix. For example, the creation of a dedicated EV Implementation Taskforce is recommended to overcome the institutional fragmentation and lack of vertical coordination highlighted in the coherence analysis. The rollout of standardized hardware and data protocols responds to observed inconsistencies in metering standards and non-uniform municipal initiatives. Inclusive business models such as battery leasing and pay-per-use pricing are proposed to bridge the comprehensiveness gap, especially in supporting low-income and underserved user segments. Geographic expansion of charging infrastructure through zonal roadmaps and viability gap funding reflects findings on the urban-centric deployment of resources. Similarly, the launch of a statewide smart mobility platform addresses the lack of digital integration in charging access, while pilot projects on Vehicle-to-Grid (V2G) integration and tailored instruments for women drivers, gig workers, and rural operators emerge from the identified analysis and equity limitations in current implementation efforts.

Finally, while the study provides a foundational assessment of Karnataka's EV transition, it acknowledges limitations in scope and method. The findings are derived solely from document analysis, without field validation or stakeholder interviews, which limits insights into how policies are interpreted or implemented in practice. Future research should therefore explore implementation-level dynamics through stakeholder engagement to capture ground realities and unintended effects. Cross-state comparisons would help test whether Karnataka's policy challenges and strengths are unique or reflect broader national patterns, offering lessons for policy transferability. Additionally, simulation-based modelling could provide quantitative assessments of how different policy configurations, e.g., variations in incentives, coordination mechanisms, or infrastructure rollout, might affect EV adoption outcomes over time. Such extensions would help design more adaptive, inclusive, and scalable mobility transitions across India's diverse federal landscape.

Contents

Summary **ii**

1 Introduction **1**
1.1 Background . . . 3
1.2 Problem Identification . . . 6
1.2.1 Policy Interactions . . . 6
1.2.2 Knowledge Gap . . . 7
1.3 Research Objective and Research Questions . . . 7
1.4 Relevance to Management of Technology (MOT) . . . 9
1.5 Outline . . . 9

2 Literature Review **10**
2.1 Electric Vehicle Adoption . . . 10
2.1.1 EVs in Karnataka . . . 11
2.1.2 Key Indicators for EV Adoption . . . 12
2.2 Policy Mixes Framework . . . 13
2.2.1 Evolution of the Policy Mix Concept . . . 14

3 Case Description **16**
3.1 Administrative Structure and Governance . . . 16
3.2 Socio-Economic Profile of Karnataka . . . 18
3.3 Stakeholder Roles and Relations . . . 18
3.4 State of EV Adoption . . . 19
3.5 Policy Implications . . . 21
3.6 Karnataka EV Policy Mix Timeline (2017–2025) . . . 22
3.7 Policy Addressing EV Adoption in Karnataka . . . 23
3.8 Summary . . . 25

4 Methodological Approach and Framework Application **26**
4.1 Approach . . . 27
4.2 Case Selection . . . 27
4.3 Analytical Framework . . . 28
4.4 Operationalisation of Policy Mix Concepts . . . 30
4.4.1 Identifying the Elements of the Policy Mix . . . 34
4.4.2 Policy Instruments . . . 35
4.4.3 Characteristics . . . 36
4.5 Data Collection . . . 36
4.6 Data Treatment . . . 37
4.7 Data Analysis . . . 37
4.7.1 Stakeholder Analysis . . . 39

5 Results **41**
5.1 Analysing Policy Instrument Interactions in Karnataka's EV- Ecosystem . . . 42
5.1.1 Constructing and Scoring Instrument Pairings in the Karnataka EV Policy Mix . . . 43
5.1.2 Selection Logic for the 40-Instrument Set . . . 44
5.2 Policy Mix Characteristics . . . 45
5.2.1 Consistency . . . 45
5.2.2 Coherence . . . 46
5.2.3 Comprehensiveness . . . 48
5.2.4 Credibility . . . 49
5.2.5 Temporal Trends and Institutional Learning . . . 49

5.2.6 Summary of Results 50

6 Discussion and Conclusion **52**
6.1 Main Findings in Relation to Research Questions 52
6.2 Scientific Contribution 54
6.2.1 Global Relevance 55
6.3 Policy Implications 56
6.4 Validity and Reliability of the Study 57
6.5 Limitations and Areas for Future Research 58
6.6 Conclusion 58

References **60**

A Appendix A **64**
A.1 Knowledge Gap Literature Review 64
A.2 Literature Search 64
A.3 Content Analysis 65

B Appendix B **66**
B.1 EV Adoption Literature Review 66
B.2 Literature Search 66
B.3 Content Analysis 66

C Appendix C **72**
C.1 Literature Search 72
C.2 Results 72

D Appendix D **76**
D.1 Desk Research – Analysed Documents 76

E Appendix E **78**
E.1 Codebook of Policy Documents 78
E.2 Summary of Codes 96

F Appendix F **99**
F.1 40 policy-instruments 99
F.2 Analysis of Policy Mix Elements 101

List of Figures

1.1 Geographic location of Karnataka in India (Source: Wikipedia) 4
1.2 Districts of Karnataka (New Map with 31 Districts) (Source: Government of Karnataka website) 5

2.1 Policy mix framework proposed by Karoline S Rogge and Reichardt 2016 15

3.1 Administrative Districts of Karnataka-Zonal Divison (Old Map with 30 Districts)(Source: Government of Karnataka) 17
3.2 Availability of Charging Stations in Karnataka (District Wise) (Source: Bureau of Energy Efficiency) 20
3.3 Population of Karnataka per district (Old Map with 30 Districts) (Source: Census of Karnataka) 21

5.1 Steps in Constructing and Scoring the Karnataka EV Policy Mix 43

List of Tables

3.1 Key Stakeholders in Karnataka's EV Ecosystem 19

4.1 Mapping of Governing Resources and Instrument Types in EV Policy 28
4.2 Operationalization of Policy Mix Concepts for EV Adoption in Karnataka 30
4.3 Stakeholder Analysis Findings for Karnataka's EV Ecosystem 40

5.1 Summary of Results: Evaluation of Karnataka's EV Policy Mix (5.2.6) 51

A.1 List of Articles and Their Sources 64
A.2 Overview of Reviewed Articles 65

B.1 Additional Reviewed Articles and Their Sources 67
B.2 Focus and Research Objectives of Selected Articles 67
B.3 Approach, Methods, and Scope of Selected Articles 69
B.4 Measurement Types and Units in Selected Articles 70

C.1 Research Approaches and Focus of Key Policy Mix Studies 72
C.2 Comparison of Key Policy Mix Concepts 73
C.3 Policy Mix Framework Applications in Case Studies 74

E.1 Key Instruments and Features of the Karnataka EV & Energy Storage Policy 2017 . . . 78
E.2 Key Instruments and Features of the Revised Karnataka EV Policy 2021 79
E.3 Instruments Supporting EV Sector in Karnataka Industrial Policy 2020-2025 80
E.4 EV Instruments in Karnataka Renewable Energy Policy 2022-2027 81
E.5 Strategic Instruments in Karnataka Clean Mobility Roadmap 2025-2030 82
E.6 Local-Level EV Policy Instruments in BBMP/Urban Local Body 83
E.7 Institutional and Regulatory Instruments from BESCOM Charging Infrastructure (2021) . 84
E.8 Regulatory Instruments in KERC EV Charging Tariff (2021-2023) 85
E.9 Urban EV Parking Instruments 86
E.10 EV Mobility Instruments in DULT Urban Mobility Policy for Bengaluru 87
E.11 Clean Mobility Instruments in DULT Comprehensive Mobility Plan (2020) 88
E.12 Manufacturing Incentives in GoK EV Cluster(2021-2023) 89
E.13 EV-Specific Budget Instruments in Karnataka State Budget (2021-23) 90
E.14 Registration-related Instruments in Karnataka Transport Department's Green Vehicle . 91
E.15 Pilot Instruments in Bangalore Smart City EV Charging Project 92
E.16 Instruments in Karnataka Swappable Battery (2022) 93
E.17 EV-Related Initiatives in Karnataka State Budgets (2023-24 & 2024-25) 94
E.18 EV-Related Instruments in Karnataka State Budget 2025-26 95
E.19 Codeword Index for EV Policy Instruments in Karnataka (All Tables) 96

F.1 EV policy instrument codes with level and dominant reason for inclusion 99
F.2 Consistency analysis of EV policy interactions in Karnataka 101
F.3 Coherence analysis of EV policy interactions in Karnataka 103
F.4 Comprehensive analysis of EV policy interactions in Karnataka 105

Abbreviations

- DIC- Department of Industries and Commerce
- BESCOM- Bengaluru Electricity Supply Company Limited
- BMTC- Bengaluru Metropolitan Transport Corporation
- KERC- Karnataka Electricity Regulatory Commission (KERC)
- BBMP- Bruhat Bengaluru Mahanagara Palike
- DULT-Directorate of Urban Land Transport
- OEM- Original Equipment Manufacturers
- ULB- Urban Local Bodies
- NEMMP- National Electric Mobility Mission Plan
- FAME- Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
- GST- Goods and Services Tax
- SGST- State Goods and Services Tax
- NITI Aayog- National Institution for Transforming India
- TCO- Total Cost of Ownership
- PRI- Panchayati Raj Institutions
- CMC- City Municipal Councils
- TMC- Town Municipal Councils
- TP- Town Panchayats
- NAC - Notified Area Committees
- DISCOMs- Distribution Companies
- MHI- Ministry of Heavy Industries
- MoRTH- Ministry of Road Transport and Highways
- PCS- Public Charging Stations
- MoUs- Memorandums of Understanding
- ToD- Time-of-Day
- SSAs- State Support Agreements
- PPP- Public-Private Partnership
- V2G- Vehicle-to-Grid
- VGF- Viability Gap Funding
- SOPs- Standard Operating Procedures

1
Introduction

The transition to sustainable mobility has become a pressing policy challenge, particularly in emerging economies like India that face growing urbanisation, energy dependence, and environmental degradation. The transportation sector is a major contributor to greenhouse gas emissions and urban air pollution, while also exerting pressure on fossil fuel imports. Electric Vehicles (EVs) have therefore emerged as a critical technology for reducing emissions, improving air quality, and enhancing energy security. Yet, despite growing political support and technological advancements, EV adoption remains uneven, both across and within Indian states. Key barriers such as high upfront costs, limited charging infrastructure, fragmented manufacturing supply chains, and low consumer awareness continue to hinder the widespread uptake of EVs, especially beyond major urban centres. Addressing these challenges requires more than a single policy solution. Given the multi-sectoral nature of electric mobility spanning transportation, energy production, industrial development, and urban planning, effective governance depends on the alignment of multiple, coordinated interventions. This has led scholars to emphasise the importance of policy mixes defined as interconnected and often multi-level sets of policy instruments that can either reinforce or undermine one another (Karoline S Rogge and Reichardt 2016; and Florian Kern and Karoline S. Rogge 2018). Rather than focusing on individual instruments in isolation, analysing the structure and quality of these policy mixes offers a more holistic understanding of how EV transitions are governed and implemented. In India, where central schemes like the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) coexist with diverse state-level strategies, the interaction between different levels of governance and their respective instruments becomes a critical area of inquiry.

Karnataka, a southern state in India, refer chapter (3), its experience in promoting electric mobility that stands out as a compelling case for examining how a multi-level policy mix functions in practice. As one of the first states in India to adopt a dedicated EV policy, Karnataka took an early lead by fostering research and development, local manufacturing, and the rollout of charging infrastructure. This proactive strategy unfolds within a complex setting that includes central government initiatives (such as the nationwide FAME incentives) alongside local municipal efforts, all operating across a vibrant, high-tech industrial base. The interplay of these layers means that alignment or friction between national guidelines, state incentives, and city-level implementation can significantly influence the pace of EV adoption. Understanding this interplay requires a holistic perspective that considers every stage of the EV supply chain from sourcing raw materials and building batteries to deploying vehicles and managing their end-of-life in order to grasp how different policies reinforce or undermine each other (Li, Z. Wang, and Q. Wang 2020). Analysing Karnataka's EV policy mix through this comprehensive lens offers valuable insights for multiple audiences. For policymakers, it reveals how coordinated actions across transport, energy, industry, and urban planning can either accelerate electric mobility or, if misaligned, create bottlenecks, thereby providing lessons on crafting more effective policy packages (Karoline S Rogge and Reichardt 2016). For governments in emerging economies, Karnataka's journey illustrates both the opportunities of early adoption and the challenges of multi-level governance, guiding them on what strategies might be replicated or avoided. From a research perspective, this case study addresses a notable gap, while global interest in EV transitions is high, detailed empirical studies from emerging markets are still limited. By shedding light on where policies complement each other or leave critical gaps, the Karnataka case deepens our understanding of sustainable mobility transitions in a developing context.

Despite growing interest in electric mobility across India, most existing studies focus on national-level schemes like FAME and do not examine how state and municipal policies interact to shape real-world outcomes. Research on Karnataka's EV transition remains fragmented, often highlighting individual instruments such as subsidies or manufacturing incentives, but rarely exploring how these instruments function together as a cohesive policy mix. Moreover, there is limited empirical work applying a full policy-mix framework to a developing economy context, especially one that traces both upstream industrial development and downstream consumer adoption. This gap is particularly significant given Karnataka's pioneering role in EV policy and its diverse, multi-level governance environment. To address this gap, the present study poses the question: How consistent, coherent, comprehensive, and credible is Karnataka's subnational EV policy mix in supporting widespread Electric Vehicle adoption? To answer it, a qualitative content analysis is employed. This involves a review of academic literature, policy documents, legislative materials, government plans, and relevant industry reports. This method enables a structured examination of the stated objectives, and design features of various policy instruments. The analytical lens is grounded in the policy mix framework proposed by Karoline S Rogge and Reichardt 2016, with specific attention to four key characteristics that influence effectiveness: consistency, coherence, comprehensiveness, and credibility, refer section (2.2). Preliminary findings suggest that Karnataka's EV policy environment revolves around three primary pillars: manufacturing incentives, consumer subsidies, and the development of charging infrastructure (Gopalakrishnan and Karmarkar 2021). While these are reinforced by the central government's FAME scheme, Karnataka has introduced its own incentives such as tax exemptions and industrial mandates, to accelerate local uptake. Yet critical gaps remain, particularly in extending charging infrastructure beyond Bengaluru and in regulating end-of-life battery management (Mallapur and P. Singh 2021). Municipal-level measures such as parking incentives or low-emission zones further complicate the landscape (R. Menon, Suresh, and M. Rao 2022). Analysing this layered configuration through a policy mix framework provides a more holistic understanding of Karnataka's EV transition and by extension, lessons for other regions pursuing similar goals.

While Karnataka's EV policies have successfully driven early adoption across multiple vehicle segments, including two-, three-, and four-wheelers, the depth and nature of support available to each segment vary considerably. Smaller vehicles, particularly two- and three-wheelers, have gained traction due to their affordability and consumer familiarity. Yet, in districts with limited charging or servicing infrastructure, even these vehicles face significant barriers to uptake. In contrast, the electrification of larger vehicles, such as buses or commercial fleets, entails higher investment thresholds, complex infrastructure needs, and energy planning at scale demands that existing policy instruments do not always adequately meet (Chandra and Bose 2022). These disparities suggest that evaluating Karnataka's EV transition requires more than an inventory of incentives. Instead, a systemic approach is needed, one that considers how policies interact across different stages of the EV supply chain, from battery manufacturing and vehicle assembly to retail, usage, and end-of-life disposal. By adopting this perspective, the present study explores whether Karnataka's policy interventions, when taken together, reinforce or undermine each other, and whether they are sufficiently tailored to address the practical needs of each vehicle segment and geographic region (Li, Z. Wang, and Q. Wang 2020).

Karnataka's early legislative commitment, as referred to in chapter 3, combined with its high-tech manufacturing base and ambitious policy mandates, positions the state as an influential actor in India's broader EV landscape. Yet policy ambition alone does not guarantee coordinated outcomes. The patchwork distribution of infrastructure, uneven implementation across urban and rural zones, and the underdevelopment of end-of-life battery management point to deeper issues in policy alignment and institutional coordination (R. Menon, Suresh, and M. Rao 2022). As such, Karnataka presents an important empirical case to examine how multi-level policies spanning central schemes, state-level incentives, and municipal regulations interact across administrative and technological layers. This thesis approaches Karnataka's EV policy environment as a complex policy mix, where outcomes emerge not only from individual instruments but from their alignment, consistency, and integration across levels of governance. In doing so, it contributes to broader debates in environmental policy and technology governance, how ambitious sustainability transitions, such as decarbonization and transport electrification, can be effectively realised within federated governance structures and diverse economic geographies. Ultimately, the study argues that Karnataka's case provides both a diagnostic lens on India's EV transition and transferable insights for other emerging economies confronting similar multi-level coordination challenges.

This chapter introduces the context and motivation for the research, highlighting Karnataka's pioneering role in India's EV transition. Next, it outlines the background of the state's ambitions, policy milestones, and industrial ecosystem related to electric mobility presented in section 1.1. Section1.2 presents the research problem section. Section 1.2.2 identifies gaps in the current understanding of state-level policy effectiveness, section 1.3 defines the central and sub-research questions. The MOT relevance of the thesis is presented in section1.4. Finally, section 1.5 depicts the outline of the research.

1.1. Background

Karnataka is one of India's most industrialised and urbanised states, with a projected population of over 72 million in 2024. It ranks among the top states in terms of per capita income, literacy, and digital infrastructure. Karnataka is governed through a multi-tiered administrative system comprising the state government and local bodies, refer chapter 3. The State has 31 districts governed through Zilla Panchayats, Municipal Corporations, and Urban Local Bodies (ULBs). The Department of Industries and Commerce (DIC) is the nodal agency for formulating and overseeing the state's EV policy. The Bangalore Electricity Supply Company (BESCOM) has been designated as the state-level nodal agency for EV charging infrastructure. Other relevant departments include the Transport Department, the Department of Energy, and the Karnataka Electricity Regulatory Commission (KERC). The capital city, Bengaluru, is governed by the Bruhat Bengaluru Mahanagara Palike (BBMP), which plays a crucial role in the spatial and infrastructural rollout of EV policies. Bengaluru is the largest urban and economic hub in the state and home to a thriving startup ecosystem and EV innovation clusters. Karnataka has emerged as a leader in India's EV transition, becoming the first state to announce a dedicated EV policy in 2017. Since then, EV adoption has grown steadily, particularly in the two-wheeler (2W) and three-wheeler (3W) segments. As of 2023, the state ranks among the top five in India in terms of cumulative EV registrations, with Bengaluru accounting for over 80% of total EVs in the state. Vehicle ownership is skewed toward two-wheelers across both urban and rural areas. EV penetration is highest in Bengaluru, where public and private infrastructure, consumer awareness, and tech adoption levels are significantly higher than elsewhere in the state. In contrast, much of rural Karnataka continues to rely on traditional transport systems and lacks access to modern infrastructure and financing for EVs.

Figure 1.1: Geographic location of Karnataka in India (Source: Wikipedia)

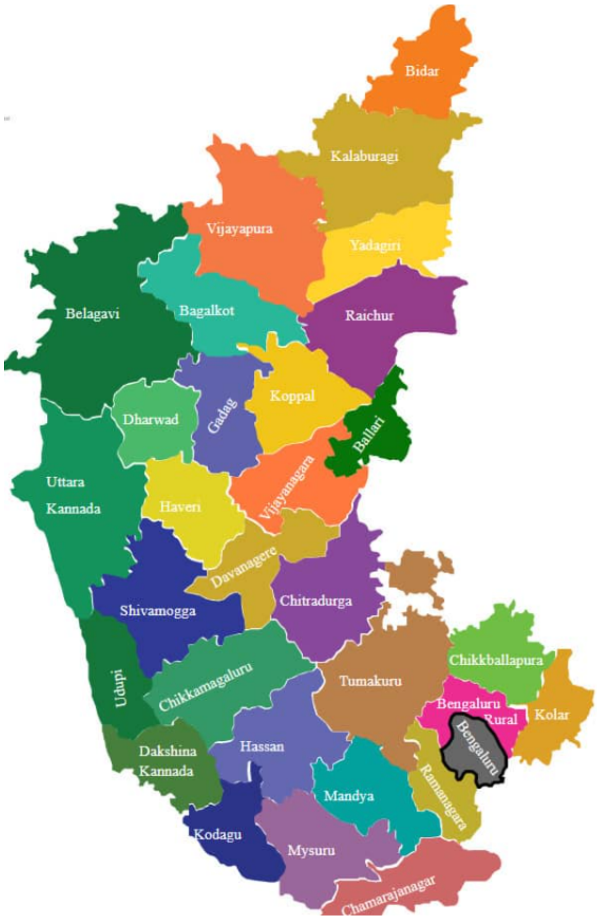

Figure 1.2: Districts of Karnataka (New Map with 31 Districts) (Source: Government of Karnataka website)

Early on, Karnataka recognised the strategic and environmental imperatives of moving away from fossil fuel–based transportation and promoting electric mobility by introducing incentives for vehicle manufacturers, charging infrastructure providers, and end consumers. The state's policy environment aligns with national directives but includes additional provisions, such as targeted fiscal incentives and land concessions for EV-related projects. Through these measures, Karnataka aspires not only to accelerate EV adoption in its cities and towns but also to become a leading global hub for EV research, innovation, and manufacturing. Despite this proactive stance, the penetration of Electric Vehicles in Karnataka's overall vehicle fleet remains modest. Challenges include the high upfront costs of EVs, limited charging facilities beyond major urban cities, and nascent battery disposal and recycling systems (R. Menon, Suresh, and M. Rao 2022). At the same time, the potential benefits for the state are substantial. Karnataka's large population of two- and three-wheeler users, in particular, presents a significant opportunity for electrification due to smaller battery requirements and simpler charging needs. Beyond these smaller segments, four-wheelers, private cars, rideshare fleets, and commercial vehicles are also gaining traction, especially in metropolitan regions like Bengaluru. By addressing existing bottlenecks, Karnataka could not only alleviate air pollution and reduce its carbon footprint but also foster considerable economic growth through job creation in EV manufacturing and ancillary services (G. S. R. Pillai and Deshmukh 2023).

Karnataka's EV adoption spans all major vehicle categories: two-wheelers, three-wheelers, four-wheelers, and public transport (G. S. R. Pillai and Deshmukh 2023). Two- and three-wheelers, which constitute a large share of the state's overall vehicle mix, represent a compelling avenue for rapid electrification. These segments benefit from relatively low capital costs and shorter driving distances. The state government's EV policy offers purchase incentives, reduced road taxes, and simplified registration procedures to encourage this shift, especially in densely populated urban areas facing rising levels of air pollution. At the same time, larger vehicles such as electric buses and commercial fleets are progressively being introduced, albeit at a slower pace (R. Pillai, S. Gupta, and Deshmukh 2023). Public transport agencies in major cities like Bengaluru are testing electric buses to reduce emissions and improve air quality. However, this segment requires higher upfront investments for specialised charging depots, grid upgrades, and maintenance facilities. The relative infancy of the state's charging infrastructure and the associated costs remain a core challenge (R. Menon, Suresh, and M. Rao 2022). Nonetheless, Karnataka's focus on establishing an integrated approach across all vehicle types, from two-wheelers to buses, reflects a broader ambition to strengthen environmental stewardship while also modernising its transport sector.

1.2. Problem Identification

Karnataka's electric mobility landscape is shaped by a complex interplay of policy instruments and stakeholder interests. While central government programs such as the FAME scheme provide a broad enabling framework offering fiscal incentives and support for infrastructure, the state's own policy instruments play a crucial role in determining how EV adoption unfolds on the ground. These include state-level subsidies, industrial policies, urban mobility plans, and localised charging infrastructure regulations. Together, these measures form a ”policy mix”, a collection of instruments that can potentially reinforce or, in some cases, undermine each other depending on their alignment and implementation across different levels of government. What remains unclear, however, is how effectively Karnataka's subnational-level policy mix addresses the diverse and evolving challenges of EV adoption. For example, while the Bengaluru metropolitan region has seen a rapid rise in public charging stations and consumer uptake, many smaller towns and districts continue to face limited infrastructure access (R. Menon, Suresh, and M. Rao 2022). Similarly, while the state has introduced strong incentives to attract EV manufacturing, it is uncertain whether these supply-side measures are being matched by adequate market-formation policies, such as consumer subsidies, awareness campaigns, or service ecosystems, in all regions of the state. Although these observations highlight potential gaps or imbalances, we currently lack a comprehensive understanding of how Karnataka's various policy instruments interact and whether they collectively form a coherent and effective strategy. This uncertainty forms the basis of the present research, which seeks to evaluate Karnataka's policy mix not through isolated instruments but through an integrated, system-level perspective that considers the design, and alignment of policies across state and municipal levels. Doing so will help clarify whether Karnataka's policy framework is well-positioned to support a long-term, inclusive, and scalable EV transition, or whether misalignments are undermining its potential.

1.2.1. Policy Interactions

Karnataka's policy approach to EVs comprises multiple, interrelated instruments: manufacturing incentives to draw investment in vehicle and battery production, tax benefits for consumers purchasing Electric Vehicles, and strategic plans to expand charging infrastructure. While these measures collectively reflect the state's commitment to accelerating EV uptake, overlaps or misalignments can still arise. For instance, state-sponsored efforts to encourage manufacturing may be hindered if local tax exemptions are not harmonised with Goods and Services (GST) tax frameworks; this can introduce uncertainty and additional costs for businesses. Similarly, consumer-facing incentives may fall short if gaps in charging infrastructure persist, limiting the practical usability of EVs in certain regions (G. S. R. Pillai and Deshmukh 2023).

In addition to these economic and infrastructural factors, policy interactions also influence social and equity outcomes. If the largest subsidies are oriented toward private four-wheelers, segments like low-income consumers or three-wheeler operators might not reap equivalent benefits, potentially reinforcing existing inequalities. Local administrative procedures, such as zoning laws or parking regulations, can further shape the viability of new charging stations, either smoothing or complicating the path to broader adoption. Understanding these interactions is critical for developing a policy mix that not only stimulates EV market growth but also aligns with Karnataka's social objectives and environmental targets (Narang and Sinha 2023).

1.2.2. Knowledge Gap

Based on the literature review presented in Appendix (A). Existing articles on India's EV transition often offer broad assessments of federal policy frameworks, providing limited insight into the granularity of state-level variations. While Bansal and R. Kumar 2020 emphasises the importance of tailoring EV incentives and infrastructure policies to local conditions, their work, like much of the national-level discussion, does not delve deeply into the unique governance and industrial contexts of individual states. Similarly, Mallapur and P. Singh 2021 examine discrete policy interventions, such as subsidies and pilot EV programs in urban areas, but stops short of analysing how these measures collectively shape or constrain adoption within a single state's policy environment. Research focused specifically on Karnataka often remains fragmentary. For instance, Patil and Ranganathan 2021 highlight certain state-led incentives for EV manufacturing and localised initiatives in Bengaluru, yet do not situate these measures within a broader interconnected policy framework, leaving open questions about how different policies reinforce or potentially undermine each other. Likewise, Chandra and Bose 2022 assess the role of public awareness campaigns in accelerating EV uptake but does not address how infrastructural, economic, and equity-focused policies might interact to bolster or impede these awareness efforts.

Furthermore, social dimensions and equity considerations are notably underexplored in the Karnataka context. Although Raghavan, A. Iyer, and V. Menon 2019 acknowledge the environmental benefits of reduced emissions, they offer minimal discussion on who stands to benefit from subsidies, how access to charging infrastructure may vary by region or socioeconomic status, and how local industries (including small and medium enterprises) might be integrated into the EV value chain. M. Sharma and N. Srivastava 2021 also highlights equity concerns in a national setting, but their findings do not extend to the localised drivers and barriers unique to Karnataka's policy landscape. Studies focusing on end-of-life battery management and recycling potential, such as Agrawal 2020 tend to propose generalised solutions without considering state-level nuances in waste management infrastructure or the potential for localised economic gains from battery recycling. Similarly, R. Menon, Suresh, and M. Rao 2022 discuss multi-level governance and the importance of policy mixes, but they do not explore in detail how multiple policy instruments might interact or conflict within the specific context of Karnataka's EV ecosystem.

Most existing studies do not disaggregate the influence of subnational instruments from central schemes, leaving a gap in understanding how state and local policies function in isolation or as an internally coherent system. Thus, while the literature collectively underscores the criticality of state-level action in shaping India's electric mobility transition, existing research tends to focus more on implementation dynamics than on the design logic of state-level policy frameworks. Few studies provide a systematic understanding of how diverse policy instruments spanning manufacturing, infrastructure, consumer incentives, and urban planning are conceptualised, structured, and coordinated at the state level. In the case of Karnataka, this leaves open important questions: Are policies consistent and coherent across sectors and governance levels? Do they comprehensively address both supply-side and demand-side challenges? And to what extent are they perceived as credible by key actors? By foregrounding the concept of a "subnational policy mix" and situating it within Karnataka's evolving EV policy landscape, the present research aims to bridge these gaps. It offers a more integrated analysis of how state-level policy design interacts with multi-level governance, social equity concerns, and end-of-life considerations to shape EV adoption outcomes in the state.

1.3. Research Objective and Research Questions

Karnataka has established itself as a front-runner within India's push toward electric mobility by introducing a dedicated EV policy and attracting technology-driven investments. Against this backdrop, the main objective of this research is to examine how diverse policy instruments spanning state-level initiatives and municipal regulations collectively influence Electric Vehicle (EV) adoption in Karnataka. Although central schemes like the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme shape the broader policy environment, this study deliberately focuses on Karnataka's subnational policy instruments, those introduced and implemented at the state and municipal levels. This allows for a more focused evaluation of how internal coordination, policy design, and governance structures within Karnataka influence the adoption of Electric Vehicles.

The primary objective of this research is to assess the internal structure and strategic alignment of Karnataka's EV policy mix using the framework outlined in section (2.2) . This framework evaluates policy design and governance through four dimensions: consistency, coherence, comprehensiveness, and credibility. Rather than measuring outcomes in terms of adoption statistics alone, the research asks how well the various policies are designed, aligned, and coordinated to enable scalable and inclusive EV transitions in the state.

To address this goal, the central research question is:

"How consistent, coherent, comprehensive, and credible is Karnataka's subnational EV policy mix in supporting widespread Electric Vehicle adoption?"

The central research question, "How consistent, coherent, comprehensive, and credible is Karnataka's subnational EV policy mix in supporting widespread Electric Vehicle adoption?" serves as a broad lens through which the entire study is conducted. To answer it, first, it was necessary to map out relevant policy instruments in Karnataka, from state-level incentives to municipal regulations (Sub-RQ 1). Next, to examine design dynamics by asking how these instruments are put into practice on the ground and which actors, local authorities, industry stakeholders, or consumer groups are pivotal in shaping outcomes (Sub-RQ 2). Recognising that not all policies seamlessly align, it was important to look for inconsistencies or conflicts across these instruments to see how such internal tensions might impede EV adoption (Sub-RQ 3). Finally, by assessing comprehensiveness and determining whether Karnataka's EV policies address both the consumer side (demand-side measures like subsidies or awareness) and the industry side (supply-side measures like manufacturing incentives and infrastructure support) in sufficient depth (Sub-RQ 4). This research focuses exclusively on Karnataka's subnational EV policy instruments those introduced and implemented by the state government and its urban local bodies. While national schemes like FAME provide broader policy direction, the study treats them as contextual background rather than as part of the analytical core. The goal is to understand how Karnataka's own incentives, mandates, and regulatory tools work together to support or hinder the growth of Electric Vehicles within its jurisdiction.

Sub-RQ:

1. Which policy instruments constitute Karnataka's subnational EV policy mix (including state-level incentives and municipal regulations)?
2. How do these instruments function across the state and municipal levels, and which actors play key roles in shaping their outcomes?
3. What misalignments exist within this policy mix, and how do they affect EV adoption?
4. How comprehensively does Karnataka's own policy framework address both demand-side (consumer uptake) and supply-side (manufacturing, infrastructure) challenges?

   By linking these sub-questions together, the study holistically evaluates how well or poorly Karnataka's multi-level policy mix supports the growth of Electric Vehicles across the state.

This research employs a case study approach, with Karnataka as the sole focus. Such an approach is well-suited for an in-depth exploration of the complex forces at play when multiple actors and policy levels converge (Yin 2011). By examining academic literature, policy documents, legislative materials, government announcements, and industry reports through content analysis, the study can capture the nuances of how different policy instruments reinforce or undermine one another in the state's unique socio-economic setting. While the findings from this single-case design may not be universally generalizable, they offer detailed insights into best practices, bottlenecks, and policy innovations that can inform discussions about EV adoption both within and beyond Karnataka.

1.4. Relevance to Management of Technology (MOT)

Approaching Karnataka's EV adoption from a Management of Technology (MOT) perspective underscores how policy frameworks can either catalyze or constrain technological transitions. Karnataka's emphasis on electrified transport reflects the broader MOT challenge of steering innovation toward solutions that satisfy economic, environmental, and societal objectives. Several MOT themes are particularly salient. Innovation trajectories are shaped by Karnataka's policy instruments, which influence local firms R&D efforts, the emergence of battery and component manufacturing clusters, and how these developments integrate into the state's broader technology ecosystem.

Systems integration is another critical theme. A cohesive charging infrastructure, one that spans public stations in city centres, private setups in residential complexes, and modular solutions for long-distance routes, requires careful coordination. The success of EV policies hinges on aligning infrastructure with evolving consumer and industry needs. Stakeholder management is essential in navigating the interplay among government entities (e.g., state ministries, municipal corporations), private enterprises (vehicle OEMs, battery makers), and end-users (individual consumers, ride-share operators). This highlights the need for transparent governance and effective communication.

Finally, strategic alignment plays a central role. Effective policies must reconcile immediate goals (e.g., increasing EV sales) with long-term market trends (e.g., decreasing battery costs, shifts in consumer behaviour). Karnataka's ability to remain agile in response to emerging technologies and business models will be a key determinant of its EV leadership. By positioning the study within these MOT themes, the research illuminates how a policy mix can facilitate technology adoption and management in ways that create competitive advantages and foster sustainable growth.

1.5. Outline

The thesis is organised into six chapters. Introduction (Chapter 1), Literature Review (Chapter 2) - This chapter explains Electric Vehicle adoption in Karnataka, the literature on policy mixes, and socio-technical transitions. Key MOT concepts, such as innovation ecosystems and technology diffusion, are discussed in relation to Karnataka's evolving EV landscape. Case Description (Chapter 3)- This section provides a detailed look at Karnataka's policy setting, tracing the state's demographic, economic, and industrial attributes relevant to EV adoption. It identifies major stakeholders, government departments, infrastructure providers, manufacturers and maps key policy instruments, including how these interact with local authorities. Methods (Chapter 4)- The methodology chapter explains why Karnataka is chosen as the case study site and describes the content analysis approach. It outlines data sources, including government documents and industry publications, and addresses concerns about validity and reliability. Results (Chapter 5) -The findings from the content analysis are presented here, highlighting the mechanisms through which different policy instruments converge or collide. Topics include infrastructure development, manufacturing incentives, consumer subsidies, and real-world adoption trends with examples illustrating synergies and conflicts within Karnataka's multi-level governance landscape. Finally, Discussion and Conclusion (Chapter 6)-Drawing the study to a close, this chapter revisits the main research question and sub-questions to synthesise insights on Karnataka's policy mix. It offers recommendations for refining these policies, acknowledges study limitations, and points to future research directions, particularly relating to technology management and the continued evolution of Karnataka's electric mobility sector.

2

Literature Review

2.1. Electric Vehicle Adoption

Electric Vehicles (EVs) have become a cornerstone of global efforts to reduce greenhouse gas emissions and combat climate change. According to the International Energy Agency (IEA) 2021, global EV sales more than doubled between 2019 and 2020, driven by technological advancements, cost reductions in lithium-ion batteries, and supportive government policies. Early adopters such as Norway, and the Netherlands illustrate how policy instruments ranging from generous financial incentives to widespread public charging infrastructure can elevate EV market shares well above global averages (Wood, Doucette, and Park 2021). In particular, direct subsidies and tax exemptions have proven instrumental in offsetting the still-higher upfront cost of EVs, while stringent emissions regulations have further nudged consumers toward cleaner vehicle options (Rietmann and Lieven 2019). Nevertheless, international experiences reveal persistent barriers to mainstream EV adoption. High capital costs, range anxiety, and insufficient charging infrastructure remain pressing concerns, especially in emerging markets (Lutsey and Slowik 2019). Moreover, these challenges are magnified in regions lacking cohesive policy planning, where efforts to promote EVs run parallel but not necessarily in coordination with other transportation and energy policies (Yan et al. 2021). As a result, scholars increasingly advocate for a more integrated, multi-pronged policy approach that aligns financial incentives, infrastructural development, and awareness campaigns (International Energy Agency (IEA) 2021).

One of the primary economic barriers to EV adoption is the relatively high purchase price of EVs. Even as battery prices decline, studies find that cost-sensitive consumers may remain hesitant without substantial subsidies, tax breaks, or low-interest loan programs (Sierzchula et al. 2014). Fleet electrification, particularly for taxis or corporate car-sharing services, has also emerged as a key strategy, leveraging economies of scale to reduce costs (Wood, Doucette, and Park 2021). A second, equally pressing challenge concerns charging infrastructure. While countries like Norway and Germany have achieved rapid expansion of public charging stations, many markets struggle to ensure equitable distribution across urban and rural areas (Yan et al. 2021). Policy responses have ranged from direct public investments in charging networks to private-sector partnerships incentivised through grants or tax credits (Rietmann and Lieven 2019). Finally, the fragmentation of policies where interventions in manufacturing, environmental regulation, and urban planning are poorly coordinated can undermine EV adoption. Researchers emphasise that a well-orchestrated ”policy mix” is essential for addressing the multifaceted nature of this transition (Lutsey and Slowik 2019). For instance, implementing robust emissions standards without concurrently supporting consumer adoption (e.g., via charging infrastructure or incentives) may yield limited gains. Conversely, awarding generous purchase subsidies in the absence of long-term planning for battery waste management could create future environmental and economic burdens (Yan et al. 2021).

Within India, the push toward cleaner mobility is underpinned by national-level strategies such as the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) program, which offers purchase subsidies and supports infrastructure development (NITI Aayog 2020). However, progress across states has been uneven, reflecting divergent economic capacities, political will, and urbanisation patterns (N. Kumar and G. Srivastava 2019). While States like Karnataka, Delhi, Telangana , and Maharashtra have introduced robust EV policies ranging from direct subsidies to mandates for public transport electrification, other states lag behind, underscoring the importance of subnational dynamics (NITI Aayog 2020). Emerging research suggests that state-level differences in implementation are a key determinant of whether national targets can be met. For instance, effective coordination between transport authorities, energy regulators, and local industry stakeholders can significantly accelerate infrastructure deployment and public awareness (Lutsey and Slowik 2019). Conversely, gaps in such coordination often leave well-intentioned policies underutilised or misaligned with regional market conditions (N. Kumar and G. Srivastava 2019).

Karnataka, widely recognised for its tech-centric economy and progressive industrial policies, has outlined ambitious goals to become an EV manufacturing and innovation hub (Rai and V. Kulkarni 2021). Government-led programs to incentivise EV purchase, local manufacturing, and research & development (R&D) have attracted considerable interest from both established automakers and startups. Moreover, Bengaluru's status as a global IT hub presents unique opportunities to integrate digital solutions such as app-based ride-hailing and charging station locators into the broader mobility landscape (Murthy and Deshpande 2022). Despite these promising developments, several challenges persist. One of the key issues is fragmented policy implementation. While the state has introduced incentives for manufacturing and piloted electric bus initiatives in Bengaluru, these measures operate within a broader environment lacking cohesive planning. Coordination between municipal governments, regional transport corporations, and private stakeholders remains inconsistent (Rai and V. Kulkarni 2021). Another major concern relates to social equity and accessibility. The extent to which lower-income groups, rural populations, and small businesses can capitalise on EV-related subsidies or infrastructure investments is unclear. Although some studies hint at equity imbalances in Karnataka's EV ecosystem, comprehensive data on how charging stations and other resources are distributed remain sparse (Murthy and Deshpande 2022).

Additionally, the sustainability of battery management is still a work in progress. End-of-life battery handling remains an afterthought in many policy documents. Even with national-level directives encouraging recycling and second-life applications, local frameworks for environmentally responsible battery disposal are still nascent (Rai and V. Kulkarni 2021). These limitations highlight the need for a more deliberate ”policy mix” approach, one that attends to synergies and potential conflicts among various interventions. Rather than focusing on discrete policies (e.g., purchase subsidies or pilot projects) in isolation, examining how these elements collectively shape EV adoption and sustainability outcomes in Karnataka can offer richer insights. The success or failure of these measures, in turn, carries broader implications for other Indian states navigating similar challenges and opportunities. Building on this global and national context, this thesis aims to systematically analyse how Karnataka's EV policies, when viewed as an integrated mix shape market adoption, social equity outcomes, and environmental sustainability. By situating Karnataka's efforts within broader global lessons, this research endeavours to uncover both best practices and persistent blind spots in the pursuit of widespread, equitable EV adoption.

Below sections address how Electric Vehicle (EV) adoption is conceptualised and measured within Karnataka. The discussion draws on state-specific academic and policy literature to highlight the unique drivers and barriers that shape Karnataka's EV landscape. The literature search was conducted on the Scopus database, and the search query and the selected articles are presented in Appendix (B). The articles are selected based on their focus on EV adoption. The literature analysis is executed based on the Wee and Banister 2016 framework. Section (2.1.1) summarises key themes in existing EV studies related to the state, while Section (2.1.2) focuses on indicators used to gauge the effectiveness of EV policies and actual adoption outcomes.

2.1.1. EVs in Karnataka

Studies on EV adoption in Karnataka emphasise the interplay between technology, economics, and policy design as central factors influencing the state's transition to Electric mobility. While broader research by Mukherjee 2020, often outlines universal considerations like total cost of ownership (TCO), consumer perceptions, and infrastructure availability, scholars focusing on Karnataka highlight how these factors manifest in the state's particular governance and market structure. Karnataka's dedicated EV policy is especially notable, featuring financial incentives, research and development (R&D) support, and infrastructure mandates, all geared toward accelerating adoption across different vehicle segments.

A recurring argument is that robust charging infrastructure, especially in cities like Bengaluru, plays a pivotal role in stimulating both consumer and commercial interest in EVs. However, uneven geographic coverage of charging points stands out as a key issue, particularly in semi-urban and other areas of Karnataka's districts that have yet to see significant infrastructure rollout (Bhattacharyya and Thakre 2021). Researchers also underscore the importance of qualitative factors, such as the public's confidence in emerging technologies, community-level entrepreneurial initiatives in EV operations or charging solutions, and effective awareness campaigns to broaden acceptance beyond metropolitan hubs.

Karnataka's diverse socio-economic landscape further shapes EV adoption. Although affluent consumers in urban areas often lead the way with four-wheeler EV purchases, two- or three-wheeler vehicles remain the primary mode of transport for a large portion of the population (García et al. 2022). Consequently, a concentration on private cars risks overlooking market segments with high potential for electrification. Studies suggest that incentives designed to promote e-rickshaws and e-scooters could be essential in achieving broader environmental and social benefits (Mishra et al. 2021). Taken together, the Karnataka-focused literature highlights a multi-dimensional approach to assessing EV uptake, one that accounts for infrastructure readiness, consumer preferences, socio-economic diversity, and a portfolio of targeted policy measures.

2.1.2. Key Indicators for EV Adoption

Reflecting the diverse factors influencing electric mobility in Karnataka, the literature identifies several indicator categories to assess policy effectiveness and real-world adoption trends. First, Market Penetration Indicators (e.g., EV share in new vehicle registrations, uptake by vehicle segment) offer a quantitative lens on how quickly different types of EVs, two-wheelers, three-wheelers, and four-wheelers are gaining acceptance. Disaggregating these data provides clarity on whether adoption is skewed toward certain segments or geographic zones.

Second, Infrastructure Indicators such as charging station density and geographic distribution shed light on how accessible EV ownership is across the state. Although Bengaluru boasts a growing number of charging points, many smaller cities and rural regions may lack sufficient coverage. Researchers often view these disparities as a core challenge that can stifle broader EV growth by limiting consumer confidence and practical usability (Mishra et al. 2021).

Third, Economic Indicators like total cost of ownership (TCO) and subsidy utilisation rates help clarify the financial considerations underpinning EV adoption. By comparing the purchase, maintenance, and operating costs of Electric Vehicles against those of internal combustion engine (ICE) vehicles, policy analysts can gauge how cost-competitive EVs are becoming. The degree to which consumers and businesses take advantage of subsidies reveals how effectively government incentives align with public awareness and administrative ease (García et al. 2022).

Fourth, Regulatory and Policy Indicators, including policy uptake by local manufacturers and fleet operators, along with the speed of policy implementation, illustrate how swiftly and thoroughly Karnataka's government agencies roll out promised measures. Monitoring the responsiveness of manufacturers and end-users to mandates, emission standards, or electrification targets can indicate where there are gaps or synergies in the policy framework (Bhattacharyya and Thakre 2021).

Finally, Socio-Cultural Indicators capture more qualitative dimensions of EV adoption, such as public perception and equity in accessing policy benefits. Factors like trust in EV technology, brand reputation, media coverage, and word-of-mouth experiences substantially influence consumer decisions. Additionally, assessments of whether lower-income groups or smaller fleet owners can benefit from subsidies and infrastructure development are crucial in determining how inclusive EV adoption is across Karnataka's demographic spectrum (Agrawal 2020).

These multi-dimensional indicators collectively illuminate not only how far and fast EVs are being adopted in Karnataka, but also who is most likely to benefit from current policies. For example, a focus on market penetration might show robust growth in private four-wheelers while overlooking slower progress in two- or three-wheelers segments that could deliver broader social and environmental impact if properly supported. Similarly, evaluating the geographic spread of charging stations reveals potential imbalances between metropolitan centres and smaller towns or rural areas. Consequently, policymakers and researchers often advocate for a blended set of metrics spanning market, infrastructure, economic, policy, and socio-cultural dimensions to gain a holistic understanding of Karnataka's EV landscape (Bhattacharyya and Thakre 2021). This comprehensive approach ensures that the state's broader goals of reducing emissions, fostering local innovation, and promoting equitable access to clean mobility are addressed systematically, rather than being measured solely by EV sales volumes or charging-station counts.

2.2. Policy Mixes Framework

A "policy mix" refers to the combination of different policy instruments (e.g., regulations, subsidies, taxes, information campaigns) that interact to address a particular issue or achieve a strategic goal. Traditional policy analysis often focused on single instruments in isolation, yet contemporary research underscores the importance of understanding how these instruments intersect and reinforce or sometimes contradict one another (K. Flanagan, E. Uyarra, and M. Laranja 2011). The concept of policy mixes has gained traction in fields such as environmental policy, innovation studies, and sustainability transitions, recognising that complex challenges rarely succumb to one-dimensional solutions (M. Howlett and J. Rayner 2007). Early studies on policy mixes largely emphasised the "coherence" of instruments, aiming to identify whether policies were harmoniously aligned or working at cross purposes (M. Howlett and J. Rayner 2007). More recent studies extend this lens, examining how policy mixes evolve over time, how they shape technology or market trajectories, and how they affect diverse stakeholder groups (Kivimaa and F. Kern 2016). As a result, analysts now frequently employ systemic approaches drawing on frameworks from political science, economics, and strategic management to unpack these dynamic interactions (Karoline S Rogge and Reichardt 2016).

Sustainability transitions research highlights how policy mixes enable or hinder systemic shifts toward greener technologies and practices. For instance, in the European Union, scholars have investigated how combinations of carbon pricing, renewable energy mandates, and R&D subsidies have accelerated decarbonization in the power sector (Karoline S Rogge and Reichardt 2016). Beyond Europe, countries like Japan and South Korea employ policy mixes to nurture low-carbon innovations, blending technological standards with industrial support schemes (Kivimaa and F. Kern 2016). These examples demonstrate that a purely market-driven or purely regulatory approach often fails to achieve lasting sustainability outcomes; instead, well-designed mixes stimulate new markets, direct capital flows, and shape long-term consumer behaviour. In innovation studies, policy mixes are examined for their ability to spur technological development and commercial application. Flanagan et al. (2011) show that a combination of supply-side (R&D funding, incubators) and demand-side measures (public procurement, performance standards) can create virtuous cycles of innovation. Nonetheless, mismatched policy elements such as misaligned intellectual property laws or contradictory tax regulations can diminish the effectiveness of an otherwise promising set of instruments (M. Howlett and J. Rayner 2007). Consequently, policymakers increasingly look for holistic approaches that coordinate economic, social, and environmental objectives within a single strategic framework. Within the transport sector, policy mixes have been employed to reduce fossil fuel dependency and encourage cleaner mobility solutions. This often involves intertwining regulations (e.g., emission standards), incentives (purchase subsidies, road tax exemptions), infrastructure investments (charging stations, dedicated lanes), and educational campaigns. Studies across Europe, North America, and parts of Asia show that mixed approaches tend to outperform single-policy strategies in accelerating the uptake of Electric Vehicles (EVs) and other low-emission technologies (Kivimaa and F. Kern 2016).

India's federal structure yields a multilayered policy environment, where central initiatives such as the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme interact with state-level regulations, municipal guidelines, and industrial development policies (P. Gupta and Garg 2020). Scholars argue that India's ambitious clean energy and e-mobility targets necessitate a coherent policy mix, yet overlapping mandates and divergent regional capacities often create fragmented implementations (Sahoo 2021). While the term ”policy mix” is less commonly used in mainstream Indian policy discourse, researchers and practitioners implicitly recognise the need for integrated measures (P. Gupta and Garg 2020). Recent work highlights that states with relatively well-coordinated instruments covering infrastructure, manufacturing incentives, and awareness campaigns tend to show faster growth in EV adoption (R. Kumar and V. Sharma 2021). Conversely, isolated interventions, such as standalone purchase subsidies without accompanying charging infrastructure development, yield limited progress (Sahoo 2021).

Karnataka has introduced multiple policies aimed at promoting EV manufacturing, electrifying public transport, and expanding charging infrastructure (Rai and V. Kulkarni 2021). However, these measures often operate without an overarching strategic framework that addresses potential overlaps or synergies. For instance, incentives for local manufacturing might boost EV supply, but inadequate consumer awareness or insufficient charging infrastructure can dampen demand (Murthy and Deshpande 2022). A policy mix perspective can reveal where coordination gaps exist and how to synchronise diverse initiatives from tax rebates and grants to zoning regulations and waste management rules. A policy mix framework is especially pertinent to Karnataka because it focuses on how different policies cumulatively impact social equity, industrial development, and environmental sustainability (P. Gupta and Garg 2020). By examining how various instruments like subsidies, infrastructure investments, and industrial incentives interact, researchers can illuminate who benefits (e.g., urban vs. rural areas, large OEMs vs. small businesses), and whether critical issues like end-of-life battery disposal are being integrated into broader sustainability goals. Other frameworks, such as single-instrument analysis or purely economic cost-benefit models, might miss important interactions and unintended consequences. In contrast, a policy mix approach allows for a holistic assessment of whether EV adoption in Karnataka is advanced by a coherent ecosystem of measures or held back by conflicting priorities and fragmented governance (Karoline S Rogge and Reichardt 2016). This thesis thus adopts the policy mix framework to rigorously evaluate how multi-level governance, stakeholder collaboration, and instrument design collectively drive or constrain EV adoption in the state.

The Appendix (C) discusses the literature search and summarizes findings from policy mix research relevant to EV transitions and the below section (2.2.1) examines how the concept of policy mixes has evolved over time, spanning multiple fields including environmental economics, policy studies, and innovation studies and highlights the foundations most applicable to the Indian EV context. Finally, the section (4.3) on Analytical framework presents the chosen framework, combining the comprehensive approach proposed by Karoline S Rogge and Reichardt 2016 with a broader classification of policy instruments adapted from Michael Howlett and Jeremy Rayner 2007.

2.2.1. Evolution of the Policy Mix Concept

The concept of ”policy mix” has evolved across three main domains: environmental economics, policy studies, and innovation studies (Karoline S Rogge, Florian Kern, and Michael Howlett 2017). Initially, environmental economics conceptualised policy mixes narrowly, focusing on specific goals like emissions reduction through market mechanisms (e.g., carbon pricing). While these approaches inform economic analysis, they offer limited guidance for complex transitions where multiple policy goals intersect.

Policy studies broadened the definition by highlighting how instruments cohere or collide in practice. Michael Howlett and Jeremy Rayner 2007 introduced the notion of an ”instrument mix” and underscored the interactions among policies targeting the same objective. Michael Howlett and Jeremy Rayner 2007 later proposed that evaluating ”coherence” (alignment of overarching goals) and ”consistency” (mutual reinforcement of instruments) is essential for designing robust mixes. They also categorised instruments according to the governing resources- authority, nodality (information), treasure (financial incentives), and organisation (M. Howlett and J. Rayner 2007), thus emphasising both substantive and procedural tools. The NATO model, short for Nodality, Authority, Treasure, and Organisation, is a classic framework for categorising the core ”tools” or resources governments use to influence policy outcomes. Originally formulated by Christopher Hood (Hood 2007) in his work on the ”tools of government,” the NATO model provides a conceptual lens through which to examine how different policy instruments operate individually and within broader policy mixes.

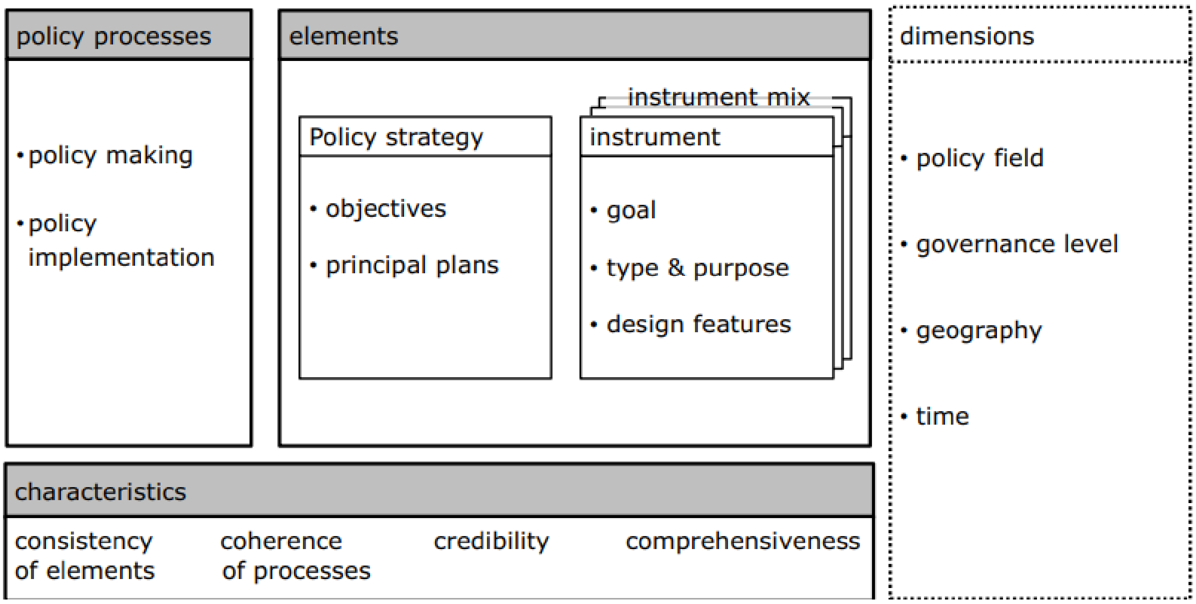

Figure 2.1: Policy mix framework proposed by Karoline S Rogge and Reichardt 2016

Meanwhile, innovation studies stress that policy mixes shape technological pathways through instrument interactions, actor perceptions, and policy processes (Kieron Flanagan, Elvira Uyarra, and Manuel Laranja 2011). Scholars in this domain investigate how overlapping policies can either spur or impede innovation. Karoline S Rogge and Reichardt 2016 further refined these ideas, calling attention to the vertical (multi-level governance), horizontal (across policy domains), and temporal (policy evolution over time) dimensions. Karoline S Rogge and Reichardt 2016 framework identifies three building blocks- policy mix elements (strategy and instruments), policy processes (design and implementation), and policy mix characteristics (consistency, coherence, comprehensiveness, and credibility) influencing technology-oriented outcomes. In Karnataka's EV context, where environmental goals, industrial objectives, and job creation aspirations converge, this comprehensive lens allows policymakers and researchers to account for both overlapping mandates and the incremental nature of policy evolution.

Karnataka's EV policies exemplify this complexity. The state aims to reduce vehicle emissions, encourage domestic manufacturing (including battery technologies), and provide equitable mobility solutions. Achieving these goals entails reconciling multiple, sometimes competing, policy objectives-necessitating a policy mix lens that captures horizontal interactions (across sectors like energy, transport, and industry) and vertical interactions (among state and local authorities). Over time, the mix evolves to address newly emergent challenges such as charging infrastructure gaps, local skill development, and fluctuating battery component costs.

This chapter reviewed global and Indian literature on Electric Vehicle adoption, emphasising the importance of cohesive policy mixes in enabling sustainable mobility transitions. It also discussed the evolution of the policy mix concept and its relevance to Karnataka's multi-level EV governance landscape. To guide the empirical assessment, this study adopts the policy mix framework along with the NATO-based classification of instruments. The detailed structure of this analytical framework and its application to the Karnataka case are presented in Chapter 4.

3

Case Description

This chapter provides an overview of Karnataka's policy landscape and socio-economic conditions related to Electric Vehicle (EV) adoption, with a focus on the multi-level governance context in which local, state, and central policies intersect. Section (3.1) describes Karnataka's administrative structure, clarifying how responsibilities for EV policy are shared among various government levels. Section (3.2) outlines key socio-economic features of the state that shape EV demand and supply conditions. Section (3.3) identifies the main public and private stakeholders influencing EV deployment, noting points of cooperation and conflict. Section (3.4) highlights the status of EV adoption across Karnataka, including affordability and infrastructure challenges. Section (3.5) summarises the policy implications for this thesis's focus on multi-level EV policy mixes in Karnataka. Section (3.6) address Karnataka EV Policy Mix Timeline. Finally, Section (3.7) explains policy addressing EV Adoption in Karnataka.

3.1. Administrative Structure and Governance

The State of Karnataka is one of the 28 states in the Indian Union, and its administration is governed under the provisions of the Constitution of India, particularly under Part VI (Articles 152 to 237), which deals with the functioning of the states. Karnataka was formed on 1st November 1956 through the States Reorganisation Act, which reorganised state boundaries on linguistic lines. It was later renamed from the State of Mysore to Karnataka in 1973. Karnataka functions within the larger framework of the Indian Union, a federal parliamentary structure headed by the Prime Minister of India. The state adheres to a federal model of governance, with powers divided between the Union and State governments as per the Seventh Schedule of the Constitution. Karnataka's administrative structure is built on three major pillars – the Executive, the Legislature, and the Judiciary.

The Executive is headed by the Governor, who is appointed by the President of India and acts as the constitutional head of the state. However, real executive power is vested in the Chief Minister and the Council of Ministers, who are responsible for policy-making and administration. The state bureaucracy, comprising officers from the Indian Administrative Service (IAS), Indian Police Service (IPS), and other state services, executes these policies through various departments led by Principal Secretaries or Commissioners. The Legislature in Karnataka is bicameral, consisting of the Legislative Assembly (Vidhan Sabha) and the Legislative Council (Vidhan Parishad). The Legislative Assembly, with 224 elected members, enacts laws, approves the budget, and ensures accountability. The Legislative Council serves as the upper house, with a review and advisory role in law-making. The Judiciary is independent and ensures the rule of law. The High Court of Karnataka, located in Bengaluru, is the highest judicial body in the state and oversees the district and subordinate courts. It plays a key role in interpreting laws and protecting constitutional rights.

In accordance with the 73rd and 74th Constitutional Amendments, Karnataka has developed a robust system of local self-governance. Rural areas are administered by Panchayati Raj Institutions (PRIs), while urban areas are governed by Urban Local Bodies (ULBs). As of 2022, Karnataka has a total of 313 ULBs, which are categorised based on the size and status of the urban area. The largest cities are managed by City Corporations (10 in number), also called Mahanagara Palikes, which govern cities with populations above 3,00,000 and handle major urban infrastructure, planning, waste management, and transport. City Municipal Councils (CMCs), of which there are 59, govern medium-sized cities with populations typically ranging from 50,000 to 3,00,000. Town Municipal Councils (TMCs), numbering 116, manage smaller towns with basic civic functions. Town Panchayats (TPs), totaling 97, oversee transitional or semi-urban areas, while Notified Area Committees (NACs), currently 4 in number, manage industrial townships or fast-developing areas without elected representatives. These urban bodies ensure that public services and local development are tailored to the needs of specific urban populations. Complementing this structure is the taluk system. A taluk is an administrative subdivision of a district, headed by a Tahsildar, and functions as a key unit for governance and revenue administration. Each taluk includes multiple villages and towns, and Karnataka has over 200 taluks spread across its districts. Taluks play an essential role in implementing government schemes, maintaining land records, and coordinating between the village-level and district-level administrations. The state's administrative functions are carried out through various departments, including Finance, Education, Health and Family Welfare, Agriculture, Industries and Commerce, and Transport. Each department is overseen by a cabinet minister and managed by senior bureaucrats, working in coordination with both central ministries and local bodies.

Figure 3.1: Administrative Districts of Karnataka-Zonal Divison (Old Map with 30 Districts)(Source: Government of Karnataka)

Karnataka operates within India's federal framework yet maintains distinct authority in sectors such as transport, infrastructure, and urban development. While national programs such as the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme provide overarching guidelines and funds, Karnataka has significant control over local incentive structures and industrial policies, shaping the state's EV ecosystem. At the state level, Karnataka's government is led by the Chief Minister and the Council of Ministers, who regulate key areas affecting EV adoption, including road taxes, manufacturing incentives, and land allocation for charging or assembly facilities. Several state departments are involved in EV policymaking, including the Transport Department, which oversees vehicle registration and road-tax policies that can incentivize or hinder EV ownership; the Industries and Commerce Department, which manages industrial parks and offers concessions to EV and battery manufacturers; and the Energy Department, which influences electricity pricing and collaborates with distribution companies (DISCOMs) to plan EV charging infrastructure.

At the municipal level, urban local bodies (ULBs) in major cities such as Bengaluru, Mysuru, and Hubballi-Dharwad enact local measures, including parking incentives, zoning laws for charging stations, and pilot programs for e-buses. While these municipalities are dependent on state funding, they have the flexibility to tailor policies to their unique infrastructure and socio-economic contexts. Additionally, while India's central government issues broad guidelines or partial subsidies through ministries like the Ministry of Heavy Industries (MHI) and the Ministry of Road Transport and Highways (MoRTH), implementation largely depends on state-level decisions. As a result, Karnataka has the ability to amplify or modify central directives to suit local needs. This multi-level governance framework emphasises the complexity of Karnataka's EV policy mix, where overlaps or contradictions among state and municipal instruments can sometimes arise.

3.2. Socio-Economic Profile of Karnataka

Karnataka stands out for its robust industrial sector, technology hubs like Bengaluru, and a relatively high per capita income compared to many other Indian states. However, significant socio-economic divides impact EV adoption. Urban-rural disparities are a key factor; Bengaluru, with its higher income levels and tech-savvy consumer base, has a rapidly growing EV market. In contrast, rural and peri-urban areas face challenges such as a lack of charging infrastructure and limited disposable income, which impede EV adoption. Moreover, industrial corridors around cities like Tumakuru and Dharwad are emerging as local hubs for EV manufacturing, battery assembly, and related supply-chain activities. Despite this, the state's income segregation is evident, with neighbourhoods in metropolitan areas able to afford home chargers, while others often depend on public charging infrastructure or are priced out due to the high cost of EVs. These variations in socio-economic conditions necessitate policies that are tailored to the specific needs of both high-income, tech-driven urban centres and resource-limited districts. Striking this balance can challenge the coherence of Karnataka's EV policy instruments, as the state must account for diverse regional characteristics while promoting a unified EV adoption agenda.

3.3. Stakeholder Roles and Relations

A diverse set of actors plays a pivotal role in shaping Karnataka's EV policy ecosystem, ranging from government departments to private sector players and NGOs. Key government departments involved in EV policy formulation include the Transport Department, which adjusts road taxes and issues EV registration norms, and the Industries and Commerce Department, which allocates land and offers tax incentives to EV manufacturers. The Energy Department works with distribution companies to ensure grid readiness and provide special tariffs for EV charging. Municipal authorities, such as the Bruhat Bengaluru Mahanagara Palike (BBMP), initiate city-level e-mobility schemes, set building codes for the installation of charging facilities, and collaborate on bus fleet electrification. Other urban local bodies (ULBs) across Karnataka often rely on state guidance for their EV-related initiatives. Private sector stakeholders, including EV manufacturers and charging service providers, collaborate with the state to secure incentives and land for setting up infrastructure. These stakeholders also advise on technical standards and best practices for the EV ecosystem. NGOs and consumer groups are equally influential, engaging in awareness campaigns, advocating for inclusive EV policies, and highlighting local barriers to adoption. Despite the collaborative nature of these relationships, tensions can arise between departments and stakeholders. For example, conflicting municipal parking rules might contradict state-level incentives, or delays in energy tariff decisions could hinder the timely rollout of local e-bus initiatives. When inter-departmental coordination is effective, however, it results in a more coherent policy mix that supports EV adoption across the state.

Table 3.1: Key Stakeholders in Karnataka's EV Ecosystem

Stakeholder Category	Key Roles and Responsibilities
State-Level Stakeholders	• Department of Industries and Commerce (DIC) – Leads policy formulation and inter-departmental coordination. • BESCOM – Nodal agency for EV charging infrastructure; manages rollout, PPP partnerships, and user-facing interfaces. • Department of Energy – Ensures electricity access and supportive tariff structures for EV charging. • Transport Department – Oversees vehicle registration, road tax exemptions, and licensing. • Karnataka Electricity Regulatory Commission (KERC) – Regulates electricity tariffs and service provider guidelines.
Local-Level Stakeholders (Urban Focus)	• BBMP (Bengaluru) – Allocates public land for charging stations; enforces EV-ready building regulations. • Bengaluru Metropolitan Transport Corporation (BMTC) – Manages e-bus procurement and route integration. • Directorate of Urban Land Transport (DULT) – Integrates EVs into non-motorised and public transport systems via the Urban Mobility Plan.
Private and Civil Society Stakeholders	• OEMs (e.g., Ather Energy, Ola Electric) – Operate manufacturing and retail units in Karnataka. • Charging Solution Providers – Partner with BESCOM and BBMP for infrastructure deployment. • NGOs and Academic Institutions – Support research, awareness programs, and technology pilots.

3.4. State of EV Adoption

Karnataka has emerged as a front-runner in Electric Vehicle (EV) adoption in India, driven by progressive state policies, infrastructure incentives, and a strong technology ecosystem in cities like Bengaluru. As per the Ministry of Road Transport and Highways (MoRTH) and VAHAN portal data (as of late 2023), the state has witnessed over 0.35 million EV registrations, making it one of the top five EV-adopting states in the country. The majority of these registrations are concentrated in the two-wheeler segment, which remains the most accessible and widely used EV category across both urban and semi-urban areas.The district-wise distribution of EVs reveals a clear urban bias. Bengaluru Urban district alone accounts for more than 50–60% of Karnataka's total EV registrations, with over 0.2 million EVs registered within its boundaries. This is corroborated by data from the Karnataka Department of Transport and the BESCOM EV Dashboard. Other districts with notable EV adoption include Mysuru, Hubballi-Dharwad, Tumakuru, Belagavi, and Ballari, though their numbers are relatively modest compared to the state capital. This variation highlights the role of infrastructure, population density, and economic activity in influencing EV uptake.

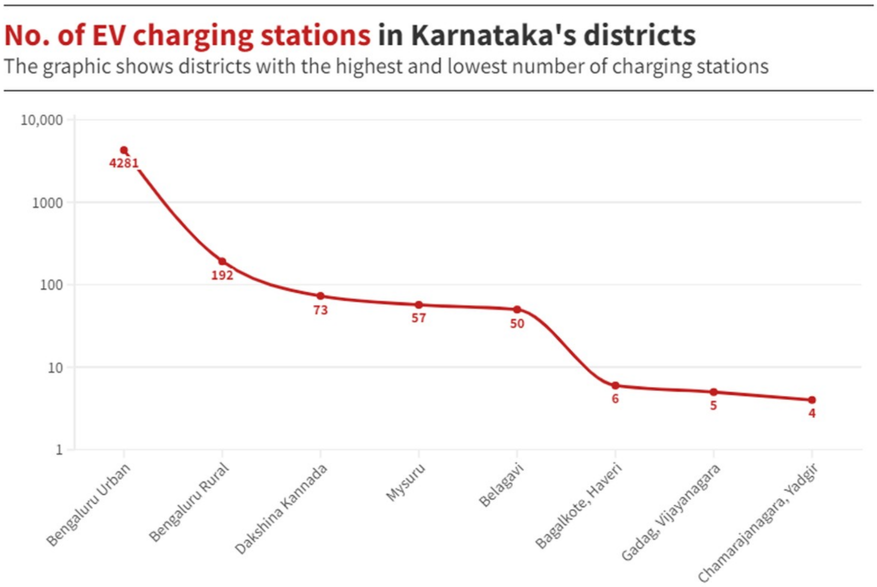

Figure 3.2: Availability of Charging Stations in Karnataka (District Wise) (Source: Bureau of Energy Efficiency)

Segment-wise, Karnataka's EV fleet is dominated by two-wheelers, comprising approximately 70–75% of total registrations. This is followed by three-wheelers (mainly e-rickshaws and autos) contributing 15–20%, and electric four-wheelers making up 5–7%. Electric buses and commercial vehicles account for less than 2%, though this share is expected to rise with government procurement and public transport upgrades. These figures are in line with those published in the NITI Aayog & Rocky Mountain Institute (RMI) reports and FAME-II scheme dashboards. Karnataka has also made remarkable progress in charging infrastructure development. As of January 2025, the state has 5,765 public charging stations (PCS), accounting for about 23% of India's total PCS network. This makes Karnataka the leading state in EV charging infrastructure. As per, Ministry of Power, and BESCOM EV Dashboard, Bengaluru Urban district alone hosts 4,462 charging stations, underscoring its dominant role in the state's EV ecosystem. Other major cities with charging infrastructure include Mysuru, Mangaluru, Hubballi-Dharwad, and Belagavi, which collectively hold around 1,300 to 1,500 chargers. The district-wise distribution of charging stations closely follows EV adoption patterns, with 50–60% of all public chargers located in Bengaluru Urban, followed by Mysuru (10–12%), Mangaluru (8–10%), and Hubballi-Dharwad (6–8%). Population density also influences EV usage patterns. For instance, Bengaluru Urban, with a population density of over 4,300 persons per km square, leads both in EV usage and infrastructure. Mysuru, with a moderate density, also shows growing EV interest. In contrast, districts like Chamarajanagar and Kodagu, with lower population densities and limited access to infrastructure, report much lower EV uptake.

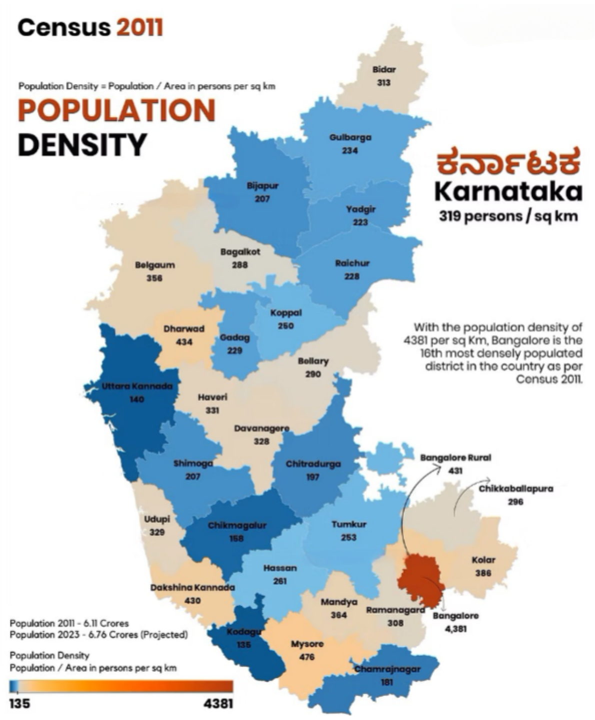

Figure 3.3: Population of Karnataka per district (Old Map with 30 Districts) (Source: Census of Karnataka)

Although Karnataka was among the first states to introduce a dedicated EV and Energy Storage Policy, the adoption of Electric Vehicles remains spatially uneven. In urban centers like Bengaluru and Mysuru, mid- to upper-income consumers have begun adopting electric two-wheelers and four-wheelers, incentivised by road tax exemptions, vehicle subsidies, and growing access to charging infrastructure. Malls, tech parks, and gated communities in these cities have also supported uptake by installing private charging points. However, this momentum has not extended to semi-urban and state districts, where adoption remains low due to limited infrastructure, weak consumer awareness, and market hesitancy, particularly among small businesses and lower-income users. Commercial charging stations are mostly concentrated in a handful of cities, and many state highways lack any formal EV support infrastructure, exacerbating range anxiety and slowing intercity adoption. This disparity is not just a logistical concern, it raises deeper questions about the comprehensiveness and credibility of Karnataka's EV policy mix. A policy strategy aimed at statewide EV transition must address both high-density markets and peripheral areas if it is to be truly inclusive, resilient, and scalable. Without targeted efforts to close the infrastructure and awareness gap, the current policy architecture risks reinforcing spatial inequalities, limiting the broader environmental and developmental impact of the transition. Bridging this urban-rural divide is therefore not only a matter of increasing EV penetration but also a test of how effectively the state's policy instruments are aligned with its goals of equitable, widespread electric mobility.

3.5. Policy Implications

Karnataka's multi-tier governance approach presents both opportunities and challenges for fostering widespread EV adoption. The potential for synergy exists when there is effective coordination between state-level policy frameworks and municipal-level initiatives. This can result in streamlined consumer experiences and consistent signals to manufacturers, such as uniform tax exemptions and complementary mandates for charging infrastructure. However, there is also a risk of overlap or conflict between policies, such as differing tax regimes or multiple licensing requirements, which could confuse businesses or deter consumers. Regular review and alignment of policies are essential to maintain consistency and avoid such issues.

Furthermore, the coverage of both supply-side and demand-side measures is crucial for fostering adoption. While demand-side incentives like vehicle subsidies are necessary, they need to be supported by supply-side policies that promote EV manufacturing clusters and ensure a robust charging infrastructure. Inconsistencies in either area could stall adoption despite the state's strong policy ambitions. This thesis applies a policy mix perspective focusing on coherence, consistency, comprehensiveness, and credibility across different governance levels to evaluate how effectively Karnataka's EV initiatives are driving widespread adoption.

3.6. Karnataka EV Policy Mix Timeline (2017–2025)

Year	Event/Policy	Notes
2017	Karnataka EV & Energy Storage Policy	First state in India to launch a dedicated EV policy.
2018	BESCOM appointed as nodal agency for charging infra	Started public charging infra planning.
2019	Central FAME-II scheme operationalized in Karnataka	Focused on public/shared transport.
2020	EV Zones proposed under Industrial Policy (2020–25)	Incentivized EV manufacturing clusters.
2020	DULT Comprehensive Mobility Plan for Bengaluru	Promotes multi-modal mobility with EV integration in transport planning
2021	Revised Karnataka EV Policy released	Enhanced focus on private 2W adoption, charging infra.
2021	BBMP EV Parking Policy	Local-level mandate for EV parking provisions in urban areas
2021	BESCOM EV Policy & Implementation Plans	Utility-led plans for grid integration and public charging roll-out
2022	BESCOM expands PPP model for charging stations	Emphasis on fast-charging corridors.
2022	Karnataka Renewable Energy Policy (2022-2027)	Targets integration of renewable energy including for EV charging
2022	Swappable Battery Policy	Guidelines for battery swapping infrastructure, safety, and operator norms
2023	Pilot for e-buses in Bengaluru expanded	Coordinated with BMTC and DULT.
2024	Increased city-wide incentives for EVs in Bengaluru	BBMP and BESCOM jointly rolling out infra.
2018–2025	Budget Allocations to EV Ecosystem (Transport & Industries Departments)	Financial allocations supporting EV subsidies, infrastructure development, and pilot projects
2025	Karnataka Clean Mobility Report	Strategic roadmap outlining decarbonization of transport through EVs, modal shift, and clean fuels; prepared with think tanks

India's journey toward electric mobility at the national level began with the National Electric Mobility Mission Plan (NEMMP), 2013, which laid a broad strategic roadmap for the country's transition to Electric Vehicles (EVs). Under the NEMMP, the Indian government aimed for significant penetration of EVs by focusing on three core pillars: technology development, demand incentives, and charging infrastructure. The overarching goal was to promote the adoption of Electric Vehicles in both the private and public sectors, with a strong emphasis on creating an ecosystem that would enable the transition.

Building upon the NEMMP framework, the government launched the FAME (Faster Adoption and Manufacturing of [Hybrid] & Electric Vehicles) program in phases. FAME-I (2015–2019) was primarily focused on providing direct demand incentives for electric two-wheelers, three-wheelers, and buses. The program also provided initial support for setting up charging infrastructure. After the conclusion of FAME-I, the government introduced FAME-II (2019–2024), which expanded the program's financial outlay and introduced a stronger focus on electrifying public and shared transport. It also placed greater emphasis on creating a robust charging network and incentivising the domestic manufacturing of EV components, thus facilitating the broader adoption of electric mobility across India. These national-level interventions provided the groundwork for individual states to formulate their own EV policies, aligning their efforts with the central government's vision. Karnataka, as a progressive state, emerged as a front-runner in implementing pioneering EV policies and incentives. The state's initiatives were in alignment with the goals set forth by the NEMMP and FAME programs, reinforcing Karnataka's commitment to contributing to the country's overall EV adoption targets.

The Karnataka EV Policy Mix Timeline (2017–2025) table offers a clear and chronological overview of the state's key EV-related policy announcements, institutional arrangements, and infrastructure developments. It traces Karnataka's evolving approach to EV adoption, from its early efforts in establishing nodal agencies and drafting policies to more recent initiatives focusing on incentives for EV buyers and fostering manufacturing clusters. This timeline serves as a crucial tool in understanding how the state's policies have evolved over time and provides insight into how Karnataka's strategy aligns with national objectives while addressing local needs. This timeline is especially useful for a thesis, as it provides several critical benefits. First, it offers contextual clarity by placing each policy decision within a specific year, illustrating the state's progression from foundational frameworks to more nuanced, updated policies. Second, it categorises the policies into distinct areas such as institutional, demand-side, supply-side, infrastructure, and local mandates, making it easier to analyse how efforts are distributed across various domains. This structure helps highlight the different types of initiatives, from consumer incentives to manufacturing incentives, and from infrastructure development to local-level regulations. Additionally, the timeline allows for the identification of gaps and overlaps in policy, such as the interaction between central schemes like FAME-II and state-led initiatives, including BESCOM's charging infrastructure plans.

Furthermore, the timeline serves as a reference for analysis for anyone studying Karnataka's EV ecosystem, including policymakers, stakeholders, and researchers. It consolidates various interventions, enabling readers to track the impact of these policies over time. Finally, the timeline also acts as a strategic roadmap, offering insights into how Karnataka's priorities have shifted from 2017 to 2025. Earlier policies focused on establishing foundational frameworks and creating institutional bodies, while more recent and future policies are aimed at accelerating EV adoption, particularly in public transport, and ensuring the integration of renewable energy for EV charging infrastructure.

3.7. Policy Addressing EV Adoption in Karnataka

Between 2017 and 2024, the Government of Karnataka has taken multiple strategic and regulatory steps to promote Electric Vehicle (EV) adoption across the state. These policies have evolved in response to Karnataka's specific priorities, which include improving air quality, driving industrial development, decarbonising the transport sector, and encouraging technological innovation. The state's approach has been characterised by early policy action, urban-focused implementation, particularly in Bengaluru city (State Capital) and a balanced emphasis on both the demand and supply sides of the EV ecosystem. Karnataka's EV-related policy efforts can be broadly grouped into four categories: regulatory and fiscal policies to encourage EV adoption and manufacturing; institutional arrangements and nodal agencies for coordination and implementation; urban mobility and infrastructure planning for EV charging and integration; and support for innovation, energy integration, and environmental sustainability. These policies operate at both state and municipal levels, with the bulk of legislative and strategic action occurring at the state level and actual implementation taking place at the local level, most notably in the city of Bengaluru.

At the state level, Karnataka's dedicated EV policy in 2017 established itself as a pioneer in EV transition. This policy was revised in 2021 to strengthen commitments related to EV usage, manufacturing, and infrastructure development. The Karnataka Electric Vehicle and Energy Storage Policy (2017; revised 2021) serves as the backbone of the state's EV framework. It provides full exemption from road tax and registration fees for EVs registered in the state, offers incentives for manufacturers of EV components and batteries, and facilitates the creation of EV manufacturing zones and R&D parks. It also supports the expansion of charging infrastructure through land allotment, concessional electricity tariffs, and streamlined clearance processes via a single-window system. Complementing this is the Karnataka Industrial Policy (2020–2025), which promotes EV-related investments within the state's broader manufacturing ecosystem. This policy encourages the development of dedicated EV zones and provides land at subsidised rates, with targeted incentives for both large-scale companies and MSMEs involved in the EV supply chain. The Karnataka Renewable Energy Policy (2022–2027) furthers the sustainability dimension by promoting renewable energy use for EV charging, especially solar and hybrid-based systems. In parallel, policies from the Karnataka Energy Department and the Karnataka Electricity Regulatory Commission (KERC) support Time-of-Day (ToD) tariff structures for public charging, establish licensing and safety standards for charging infrastructure, and streamline grid integration procedures for distributed energy sources. Additionally, the state has signed Memoranda of Understanding (MoUs) and State Support Agreements (SSAs) with major EV manufacturers and charging infrastructure providers such as Ather Energy, Ola Electric, and Sun Mobility, to set up production units and charging networks across Karnataka. Despite these comprehensive efforts, there are still gaps in the state's EV policy landscape. These include inconsistencies across districts, limited outreach to rural and semi-urban areas, and a lack of financing or leasing options for low-income consumers.

At the local level, most of the implementation is concentrated in Bengaluru, which has emerged as the epicentre of Karnataka's EV adoption strategy. Municipal bodies and city-level agencies have played an active role in operationalising state-level policies. For example, the Bruhat Bengaluru Mahanagara Palike (BBMP) has issued land use and parking guidelines that allocate land for public EV charging stations in high-traffic areas such as metro stations, shopping malls, and public parking lots. The BBMP also grants building permissions with mandates for EV-ready parking in new residential and commercial developments and collaborates with private players to identify and prepare charging and parking sites. The Bangalore Electricity Supply Company (BESCOM), designated as the state's nodal agency for EV charging infrastructure, has installed over 150 public charging stations in Bengaluru. BESCOM has also enabled app-based platforms for public access to charging and has partnered with private providers under Public-Private Partnership (PPP) models. It is also leading the development of fast-charging corridors along major roads and highways. The Directorate of Urban Land Transport (DULT) has integrated EVs into broader urban mobility planning, supporting last-mile electric mobility solutions such as e-rickshaws and e-bikes. DULT has developed infrastructure blueprints that support EV-friendly streetscapes and zoning regulations as part of Bengaluru's Comprehensive Mobility Plan. Meanwhile, the Bengaluru Metropolitan Transport Corporation (BMTC) has begun deploying electric buses with support from the state government. BMTC has set up depot-level charging infrastructure, developed e-bus route planning strategies, and introduced tendering models to involve private operators in supplying and managing e-bus fleets.

However, the scale of EV policy implementation in other urban areas of Karnataka, such as Mysuru, Hubballi-Dharwad, and Mangaluru remains limited in comparison to Bengaluru. These cities face challenges related to weaker institutional capacity, the absence of integrated urban planning, and financial constraints. As a result, while Bengaluru leads the way in local-level EV adoption and infrastructure development, replicating its model across the state remains a critical next step for Karnataka's broader EV transition.

3.8. Summary

Karnataka's policy mix provides a compelling case for examining the interaction and alignment of various policy instruments aimed at accelerating Electric Vehicle (EV) adoption. Applying the Policy Mix Framework yields several key insights. In terms of credibility, Karnataka established itself as a frontrunner by being the first Indian state to announce a dedicated EV policy, which, coupled with its success in attracting substantial private investment, has reinforced the legitimacy and seriousness of its policy direction. On consistency, while the state's internal policy instruments generally align well with one another, variations in implementation speed and access to incentives across different districts and cities reveal underlying disparities in local execution. Regarding coherence, inter-departmental integration, particularly among the transport, energy, and industry departments, is gradually improving; however, challenges persist, especially when urban authorities act independently of the state's broader strategic plans, leading to fragmented outcomes. Finally, the comprehensiveness of Karnataka's EV policy is notable for its wide coverage, encompassing consumer incentives, infrastructure development, manufacturing support, and environmental sustainability. Nonetheless, certain areas remain underdeveloped, such as policy support for rural regions, financing mechanisms for low-income users, and provisions for the second-hand EV market. Overall, Karnataka's experience illustrates that a well-designed, state-led policy ecosystem, when effectively aligned across various sectors and administrative levels, can serve as a scalable model for driving sustainable transport transitions in other Indian states.

4

Methodological Approach and Framework Application

This chapter outlines the methodological approach used to examine Karnataka's subnational Electric Vehicle (EV) policy mix through the lens of the Policy Mix Framework. The research adopts a qualitative case study design focused on understanding how various state and municipal policy instruments interact to support or hinder EV adoption. The methodological process is structured into four interlinked stages that guide the overall analysis, ensuring a systematic and replicable approach.

The first stage involves case selection and scoping. Karnataka was chosen as the empirical focus due to its early leadership in EV policy formulation and the presence of a multi-level governance environment involving state departments and urban local bodies. The scope of the study is limited to subnational policy instruments issued and implemented between 2017 and 2025, allowing for a detailed and contextual evaluation of policy evolution and interaction over time.

The second stage is data collection. A comprehensive document-based content analysis was conducted by sourcing 18 major policy documents, including EV-specific policies, industrial and mobility plans, budget allocations, and regulatory orders. These documents were collected from official government portals and departmental websites to ensure reliability and authenticity. The document corpus forms the empirical foundation for identifying and analysing policy instruments within Karnataka's EV ecosystem.

The third stage centres on the identification and coding of policy instruments. From the reviewed documents, 40 policy instruments were selected based on their strategic importance, thematic diversity, and coverage of different phases in the EV value chain. Each instrument was coded according to key features such as stated objectives, target groups, implementation authority, timing, and policy type. This step ensured a structured representation of the policy landscape, enabling a focused analysis of how these instruments relate to one another.

In the final stage, the selected instruments were evaluated through the Policy Mix Framework's as outlined in section (4.4.3). A pairwise interaction analysis was conducted to examine whether instruments reinforced, contradicted, or remained neutral toward one another across these four characteristics. This allowed for a granular assessment of the internal structure and strategic alignment of Karnataka's policy mix.

Together, these four methodological stages-case selection, data collection, instrument coding, and policy mix evaluation form a coherent analytical process. While sequential in structure, the process also involved iterative refinement, particularly in the development of coding categories and interpretation of instrument interactions. This methodology enables the study to move beyond a descriptive listing of policies to a more nuanced understanding of how Karnataka's EV policy instruments function collectively to shape the state's transition to electric mobility.

Section (4.1) reviews the single case study approach, explaining why it is particularly suitable for examining Karnataka's evolving EV ecosystem. Section (4.2) provides the rationale behind selecting Karnataka as the primary case, highlighting its distinct policy context and importance to India's broader push toward electric mobility. Section (4.3) discusses Analytical Framework. Subsequently, Sections (4.5), (4.6), and (4.7) detail the processes of data collection, data treatment, and data analysis, respectively.

4.1. Approach

A single case study design is used to explore how policy instruments across state and local levels converge in Karnataka to influence the adoption of Electric Vehicles. According to Yin 2011 and Avery et al. 2011, a case study method facilitates an in-depth investigation of a phenomenon that is intricately connected to its real-world context. This makes it well-suited for Karnataka's EV sector, which is influenced by overlapping economic, social, and technological factors. Harrison et al. 2017 identifies seven key elements that typically define a case study: the case itself, the bounded system, the real-world context, the depth of the analysis, case selection, the use of multiple data sources, and the broader design considerations. Here, the unit of analysis is Karnataka's policy environment for EVs. The principal aim is to clarify how various components of a policy mix, ranging from financial incentives to infrastructural mandates, shape EV deployment across different segments, such as two-wheelers, three-wheelers, four-wheelers, and buses.

Case study research can be descriptive or explanatory (Yin 2011). Given that this study seeks to explain the relationships and interactions within Karnataka's EV policy mix, it leans toward an explanatory orientation. The boundaries of the study are delineated by two scopes: geographically, it focuses on Karnataka as the central locus of policy design; thematically, it zeroes in on EV-oriented policies and their interplay with technological uptake. A pragmatic constructive perspective underlies this research, acknowledging that multiple stakeholders from government agencies to consumers hold different views on policy effectiveness, yet also advocating for a rigorous, evidence-based analysis of these perspectives. Although the single case study method yields rich, context-specific insights, it also calls for meticulous attention to data integrity and analytical rigour to ensure that the findings are credible and potentially transferable (Flyvbjerg 2006). By documenting data sources, applying a validated policy mix framework, and clarifying the rationale behind the case selection, this research aims to enhance both the reliability and applicability of its results.

4.2. Case Selection

In line with Harrison et al. 2017, the first task is to pinpoint the unit of analysis in this study, the state of Karnataka. Karnataka is particularly relevant because it has pioneered electric mobility policies in India, offering a valuable reference for other regions seeking to formulate or refine their own EV strategies. The state's policy environment includes a diverse range of stakeholders, including established automakers, technology start-ups, government departments, and academic institutions, making it a dynamic setting in which to observe policy mix interactions.

Karnataka's policy landscape is notably complex. Nationally mandated incentives through the FAME schemes intersect with the state's own manufacturing incentives and consumer subsidies. Additionally, municipal bodies in cities like Bengaluru contribute local measures that affect consumer uptake and market dynamics. This double-layered governance creates a unique opportunity to study how policies can converge (or clash) in real-world conditions, influencing the speed and scale of EV adoption. In many respects, Karnataka can also be viewed as an extreme or critical case. While Bengaluru is renowned for its tech-savvy culture and early adoption of innovations, infrastructure constraints and socio-economic disparities persist throughout the state. Studying how these contrasting elements interact with ambitious EV policies offers valuable lessons for other states in India that face similar challenges but operate with different resource endowments and governance structures.

4.3. Analytical Framework

To systematically evaluate Karnataka's EV policy mix, this research adopts the policy mix framework proposed by Karoline S Rogge and Reichardt 2016. Their approach enables an integrated examination of three key components: policy mix elements, policy processes, and policy mix characteristics. Policy mix elements refer to the combination of strategies and instruments, where strategies articulate long-term objectives such as the transition to clean mobility and instruments provide the specific tools, such as subsidies or mandates, that help realise these objectives. Policy processes encompass the design, implementation, and adaptation of policies over time. This includes how stakeholders are engaged, how coordination unfolds across departments and levels of government, and how policies evolve in response to changing conditions. Meanwhile, policy mix characteristics capture four essential qualities: consistency, which reflects the degree to which policy goals and instruments align; coherence, which evaluates whether institutional arrangements and processes support effective policy integration; comprehensiveness, which examines whether all major barriers and market failures are addressed; and credibility, which assesses whether policy commitments are perceived as reliable by stakeholders.

While Karoline S Rogge and Reichardt 2016 broadly categorises instruments into economic, regulatory, and informational types, this study also incorporates the taxonomy developed by M. Howlett and J. Rayner 2007 to provide a more granular view of policy tools. This taxonomy distinguishes between substantive instruments, those that directly influence EV adoption, such as purchase subsidies, tax exemptions, or investments in charging infrastructure, and procedural instruments, which shape the social and political processes behind policymaking. Examples of procedural tools include public consultations, inter-departmental coordination committees, and strategic partnerships with industry actors. Additionally, M. Howlett and J. Rayner 2007 classify instruments by the resources they draw upon: authority, nodality, treasure, or organisation (NATO). This classification allows for a nuanced analysis of how different tools function within Karnataka's policy environment and how the government mobilises its regulatory, informational, financial, and organisational capacities.

Table 4.1: Mapping of Governing Resources and Instrument Types in EV Policy

Principal Governing Resource	**Nodality (Information)**	**Authority (Regulatory/Legal)**	**Treasure (Financial)**	**Organization (Provision/Structural)**
Examples of Substantive Instruments	• Public awareness campaigns (EV benefits, cost savings) • Workshops, trainings for automobile dealers and technicians • Targeted outreach in schools, public events	• Mandated EV targets for fleets • Urban emission norms • Licensing standards for charging stations	• Purchase subsidies or tax exemptions • Grants for EV/-battery manufacturing • Low-interest loans for buyers	• State-run or PPP EV charging networks • Government EV fleets (e.g., buses, staff vehicles) • Dedicated EV policy cells or nodal agencies
Examples of Procedural Instruments	• EV adoption reports (state-level) • "EV-readiness" surveys • Stakeholder conferences, consultations	• Fast-track approvals for EV startups • Priority permits for EV taxis • Low-emission zone restrictions	• R&D grants (batteries, charging tech) • Tax credits for infrastructure providers • Scrappage incentives for old ICE vehicles	• Interdepartmental EV task forces • Public-private partnerships for charging infrastructure • State EV investment facilitation offices

Nodality refers to the government's position as a central "node" in an information network. It allows governments to collect, process, and disseminate information in ways that influence public and institutional behaviour. This can take the form of public awareness campaigns, research funding, data collection, and transparency initiatives. Within a policy mix, nodality-based measures are designed to support behaviour change or decision-making through the strategic use of information,for example, awareness programs promoting Electric Vehicles (EVs) or the publication of real-time pollution data. Authority pertains to the legal and regulatory powers of the government. Through legislation, standards, and enforcement mechanisms, governments compel or restrict certain behaviours. In the context of EVs, authority-based instruments might include emission standards, vehicle registration rules, or mandates for fleet electrification. These tools are essential in shaping long-term market behaviour by setting clear rules and expectations for stakeholders. Treasure captures the government's control over financial resources and its ability to deploy economic incentives. This includes subsidies, taxes, grants, and budget allocations that influence stakeholder decisions. Treasure-based instruments in the EV domain could be EV purchase incentives, tax rebates, or grants for charging infrastructure and battery manufacturing facilities. These measures are often among the most visible and politically salient components of a policy mix. Organisation involves the government's administrative and operational capacities, its ability to mobilise personnel, agencies, and delivery mechanisms. Organisational instruments include establishing specialised agencies, task forces, program implementation bodies, or interdepartmental coordination cells. In EV policy, for instance, this might involve creating a dedicated EV promotion task force or forming partnerships between departments such as transport, energy, and industry to oversee cross-sectoral implementation.

When analysing a policy mix, the NATO model helps illuminate how governments combine or sequence these different tools to address complex issues like Electric Vehicle adoption more effectively than relying on a single instrument. For example, nodality-driven information campaigns can enhance public awareness of EV benefits, thereby increasing the effectiveness of treasure-based financial incentives. Authority-based regulations may mandate reductions in vehicular emissions, while organisational resources ensure that implementation is coordinated and monitored by a dedicated task force. By examining the interplay of these four resources-information (nodality), legal power (authority), financial means (treasure), and administrative capacity (organisation). Policymakers can better identify synergies and avoid conflicting or redundant interventions. This comprehensive understanding ultimately fosters a more coherent, strategic, and impactful approach to achieving long-term policy goals such as sustainable transportation and widespread EV adoption.

Also, in the context of policy analysis, and particularly within discussions of policy mixes, scholars often distinguish between "substantive" and "procedural" dimensions or types of policy instruments. This distinction offers a more comprehensive understanding of how policies are designed and implemented to achieve specific goals. Substantive policies or instruments are those that directly address the core issue or objective of a given policy area. They define "*what*" action is to be taken and "*what*" outcomes are expected. These instruments are focused on producing tangible impacts, often by shaping behaviours, allocating resources, or steering technological development. Examples include emission standards that set limits on greenhouse gas outputs, purchase subsidies for Electric Vehicles (EVs), and mandates requiring the installation of public charging infrastructure. In essence, substantive instruments aim to directly influence the core variables of the policy challenge at hand.

In contrast, procedural policies or instruments concern themselves with "*how*" policy decisions are made and "*how*" implementation and enforcement are structured. They establish the processes, governance mechanisms, and institutional frameworks that enable or constrain the development and execution of substantive policies. For example, procedural instruments might involve requirements for public consultation during the policymaking process, the formation of interdepartmental committees or task forces to coordinate EV-related policies, or the implementation of regulatory impact assessments and auditing procedures. These tools shape the rules of engagement in the policymaking process, who participates, how decisions are reached, and how accountability is ensured. When combined, substantive and procedural elements provide a holistic view of a policy mix. Substantive measures set the direction and define the goals, while procedural mechanisms determine how these goals are to be pursued, managed, and evaluated over time. This distinction is critical because even the most technically sound substantive instruments can fail in the absence of effective procedural support, leading to issues such as weak enforcement, poor coordination among stakeholders, or implementation delays. On the other hand, strong procedural systems without clearly defined substantive targets can result in excessive bureaucracy or "process for the sake of process," with limited real-world impact. Recognising and balancing both dimensions is therefore essential to designing effective and coherent policy mixes.

Merging these frameworks creates a robust analytical lens for examining the Karnataka EV case study. It enables the exploration of horizontal interactions, such as how policies across sectors like transport, energy, and manufacturing either reinforce or conflict with one another. It also facilitates the analysis of vertical interactions, assessing how state-level EV policies align with municipal-level measures in urban areas like Bengaluru. Furthermore, the framework allows for the examination of the temporal evolution of the policy mix, capturing how it has adapted in response to technological advancements, market shifts, and evolving governmental priorities, thus reflecting the dynamics of a socio-technical transition. Through this integrated framework, the research can identify both synergies and conflicts among policies, evaluate how effectively the policy mix addresses critical barriers to EV adoption, and assess the extent to which policy design contributes to long-term credibility. As a result, the framework not only enhances theoretical understanding but also offers practical insights for refining Karnataka's EV policy mix to support a more stable, inclusive, and innovation-driven transition to electric mobility.

4.4. Operationalisation of Policy Mix Concepts

The policy mix framework discussed in Section (2.2) offers a robust means of analysing how various policy components and attributes converge to influence Electric Vehicle (EV) adoption in Karnataka. As Karoline S Rogge and Reichardt 2016 points out, each added dimension, such as multi-level governance or multi-sector coordination, raises the framework's complexity, making it imperative to specify how its core ideas apply in the state's context. The table below presents the operational criteria used to pinpoint and categorise key elements of Karnataka's EV policy mix. While Karoline S Rogge and Reichardt 2016 model includes policy processes, policy mix elements, and policy mix characteristics, this study places a special focus on policy mix elements, policy design and characteristics; the processes of policy implementation are acknowledged but not the chief concern here.

Table 4.2: Operationalization of Policy Mix Concepts for EV Adoption in Karnataka

Component	Operationalization	Source
Policy strategy	Impact domain. Any policy strategy that affects the rate of EV adoption in Karnataka (e.g., state-level EV roadmaps).	Ossenbrink et al. 2019
Policy instrument	Impact domain. EV-specific policy instruments introduced by the Government of Karnataka or municipal bodies that are explicitly intended to support Electric Vehicle adoption. These include instruments such as purchase subsidies, charging infrastructure mandates, vehicle registration fee waivers, tax incentives, and local parking/zoning regulations. Broader transport or energy policies (e.g., ICE taxes, fuel pricing) are acknowledged as part of the wider policy environment but are excluded from direct analysis unless explicitly linked to EV objectives.	Ossenbrink et al. 2019
Instrument mix	Combination of policy instruments geared toward increasing EV adoption, collectively aiming to address barriers in Karnataka's transport sector.	Karoline S Rogge and Reichardt 2016
Instrument goals	Desired outcomes of policy instruments (e.g., boosting EV manufacturing, curbing vehicle emissions, scaling charging networks).	Karoline S Rogge and Reichardt 2016

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Component	Operationalization	Source
Instrument types	Nodality, Authority, Treasury, Organization.	Michael Howlett and Jeremy Rayner 2007
Instrument purpose	Substantive or Procedural.	Michael Howlett and Jeremy Rayner 2007
Design features	Descriptive (legal form, target group, timeframe) and abstract (stringency, support level, predictability, flexibility, differentiation, depth).	Karoline S Rogge and Reichardt 2016
Policy design processes	Initiation of policy changes, stakeholders involvement, objective formulation, strategy adoption, goal-setting for instruments, adoption of legislation measures.	Karoline S Rogge and Reichardt 2016
Implementation processes	Allocation of resources, public advocacy, coordination across state agencies and local governments in Karnataka.	Karoline S Rogge and Reichardt 2016
Goal-to-goal consistency (Consistency of policy strategy)	Absence of conflicting objectives between overarching policy goals at the state and municipal levels (e.g., reconciling Karnataka's industrial development plans with its environmental sustainability targets).	Karoline S Rogge and Reichardt 2016
Instrument-to-instrument consistency (Consistency of instrument mix)	Degree to which Karnataka's various EV-related policy instruments (e.g., subsidies, infrastructure rules, tax exemptions) are mutually reinforcing and do not undermine each other.	Karoline S Rogge and Reichardt 2016
Goal-to-instrument consistency (Consistency between instrument mix and policy strategy)	Alignment between Karnataka's stated EV goals (e.g., increased adoption, local manufacturing, emissions reduction) and the instruments used to achieve them.	Karoline S Rogge and Reichardt 2016

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Component	Operationalization	Source
Coherence of policy processes	Coherence of policy processes refers to the extent to which the design and implementation phases of Karnataka's EV policies are aligned across governance levels and departments. It captures whether there is a shared understanding of policy objectives between state-level bodies and municipal actors, as well as whether coordination mechanisms are in place to translate high-level goals into local action. In this thesis, coherence is evaluated by taking into account of only policy design, and not policy implementation, thus examining the presence of explicit mandates for joint collaboration, references to inter-agency coordination (e.g., between BESCOM, BBMP, and DULT), and evidence that stakeholder roles defined during the policy design stage are reflected in the implementation phase. Additionally, coherence is assessed through the presence of institutional routines such as task forces, review committees, or integrated platforms, which indicate procedural continuity and follow-through. These features are identified through document analysis, looking for concrete mentions of coordination mechanisms, shared governance responsibilities, and feedback loops that align implementation practices with original policy intents.	Karoline S Rogge and Reichardt 2016
Credibility of policy mix	The extent to which Karnataka's EV policy mix is perceived by stakeholders, such as manufacturers, investors, and civil society, as predictable, stable, and backed by long-term political commitment. Indicators include clarity of policy targets, alignment with budgetary allocations, institutional follow-through, and consistency over time. Credibility reflects the degree to which actors believe the policy mix will be maintained and implemented as stated.	Karoline S Rogge and Reichardt 2016
Comprehensiveness of policy processes	Extent to which relevant stakeholders including state agencies, municipal bodies, industry, utilities, civil society, and academia are involved in the design, consultation, and implementation of EV policy instruments across Karnataka.	Karoline S Rogge and Reichardt 2016
Comprehensiveness of policy elements	Extent to which Karnataka's EV policy mix includes a broad and balanced set of instruments that target the demand-side (e.g., consumer subsidies, awareness campaigns), the supply-side (e.g., manufacturing incentives, R&D support), and systemic instruments (e.g., charging infrastructure, power grid integration, battery recycling systems). It also considers how these instruments apply across diverse geographies and vehicle segments within the state.	Karoline S Rogge and Reichardt 2016

The operationalisation table was developed through an iterative process of reviewing both academic literature on the Policy Mix Framework and the specific design features present in Karnataka's EV-related policy documents. The table translates each of the four core dimensions-consistency, coherence, comprehensiveness, and credibility into practical evaluation criteria that could be systematically applied to real-world instruments. To do this, each dimension was broken down into sub-criteria (e.g., goal alignment, institutional overlap, procedural depth) and matched with observable indicators that emerged during preliminary coding of the policy documents. While this structure provides clarity and analytical focus, it represents just one way of instantiating the policy mix framework. Alternative versions of the table could place greater emphasis on policy lifecycle stages, policy process typologies, or actor-network configurations. These choices depend on the specific empirical focus and methodological preferences of the researcher. A broader reflection on the implications of this operationalisation, along with potential limitations and alternative instantiations, is offered in the discussion chapter.

This table matters for several reasons. First, it enables structured analysis by breaking down the complex idea of a policy mix into tangible and analyzable elements such as instruments, design features, and strategic alignment. This structure allows for a systematic evaluation of Karnataka's EV policy environment. Second, the table provides clarity and comparability by grounding the analysis in widely accepted academic frameworks from scholars like Ossenbrink et al. 2019, Karoline S Rogge and Reichardt 2016 , and M. Howlett and J. Rayner 2007. This anchors the study in a credible scholarly tradition and makes it easier to compare Karnataka's case with other regional or international studies. Third, the table encourages a holistic perspective by assessing policies not in isolation but as part of an interacting system. It explores how policies might reinforce or contradict one another, which is especially important in a multifaceted domain like EV adoption. Lastly, the table offers practical guidance by transforming theoretical concepts into operational categories that can serve as evaluation metrics for document analysis and case-based insights.

The policy strategy refers to high-level government plans or roadmaps that articulate long-term objectives, such as achieving a certain percentage of EV adoption by 2030. Understanding the overarching goals, like reducing emissions or becoming a global manufacturing hub, helps contextualise specific instruments. In Karnataka, examples include the official EV roadmap, which lays out aspirations like making Bengaluru a global innovation centre for electric mobility or electrifying public transport. Policy instruments are the concrete tools, governments use to shape EV uptake. These can range from purchase subsidies and tax breaks to awareness campaigns and infrastructure mandates. Cataloguing these instruments creates a clear inventory of state interventions. For example, Karnataka may offer tax exemptions for EV buyers, provide grants for local battery manufacturers, or reserve public parking spaces for EVs.

The instrument mix captures how these policy tools interact. It considers whether they complement or contradict each other and whether they collectively address the barriers to EV adoption. Karnataka's instrument mix might include consumer subsidies, road tax exemptions, support for public charging stations, and mandates for electrified public transport, all working in concert or, in some cases, in tension. Each instrument has goals, or specific outcomes it aims to achieve, whether to increase affordability, attract investment, or develop infrastructure. For instance, a particular subsidy might be intended to promote two-wheeler EV adoption among middle-income households or encourage battery manufacturing near Bengaluru.

Instruments can also be classified by type, based on the NATO framework: Nodality (information tools), Authority (regulatory mechanisms), Treasure (financial incentives), and Organisation (administrative structures). Karnataka's nodality tools may include awareness campaigns, authority tools could involve emission standards, treasury tools encompass subsidies and tax breaks, and organisational tools might include the creation of a dedicated EV task force. Understanding the purpose of each instrument, substantive or procedural, adds depth to the analysis. Substantive instruments directly address core problems, such as cost or infrastructure gaps, while procedural instruments focus on the policy-making process itself, like requiring interdepartmental consultation or public engagement. For instance, a direct EV subsidy is substantive, whereas a rule mandating stakeholder input before new policy adoption is procedural.

Design features further refine this analysis. These can be descriptive, such as legal basis, targeted beneficiaries, and duration, or abstract, such as the policy's stringency, predictability, flexibility, and differentiation. For instance, a 5-year subsidy plan is descriptive, while the ability to revise the subsidy amount based on inflation reflects flexibility, an abstract design quality. The table also highlights policy design processes, which involve how objectives are set and how stakeholders are engaged. This includes examining whether Karnataka's policies were developed through inclusive, evidence-based methods. Similarly, implementation processes concern how these policies are carried out, including inter-agency coordination and resource allocation. For example, effective collaboration between the

Transport Department and power utilities is critical for ensuring EV infrastructure rollout.

Next, the table examines consistency, both of the strategy and of the instrument mix. Strategic consistency evaluates whether various high-level policy documents and goals align or contradict one another, for instance, promoting EV adoption while simultaneously supporting diesel vehicle manufacturing would reflect inconsistency. Instrument consistency assesses whether tools work in harmony, for example, if incentives for EV adoption are aligned with support for local manufacturing, rather than being undermined by bureaucratic red tape. Consistency between the instrument mix and policy strategy ensures that tools are advancing the overall vision. If Karnataka's strategy focuses on reducing urban pollution, the instruments should target high-mileage users like fleet operators and delivery vehicles. If there is misalignment, the tools may be ineffective despite being well-designed.

Coherence addresses how well policy-making and implementation processes reflect a shared vision among stakeholders. It considers whether horizontal (inter-departmental) and vertical (state-to-municipality) coordination is functioning smoothly. For example, cooperation between BBMP and the State Transport Department in issuing EV permits or integrating public charging infrastructure would reflect process coherence.

The credibility of the policy mix reflects whether policies are trusted and stable enough to prompt long-term investments and behavioural change. Transparent mechanisms, such as clear subsidy disbursal procedures or inclusion of marginalised communities (e.g., e-rickshaw drivers in rural areas), enhance credibility.

Comprehensiveness is analysed at two levels-processes and elements. Comprehensiveness of processes looks at whether all relevant stakeholders- automakers, recyclers, consumers, and utilities are involved in policy design and implementation. Exclusion of key actors can lead to policy failure. Comprehensiveness of elements, on the other hand, asks whether the full range of adoption barriers-cost, infrastructure, awareness, environmental risks is being addressed. For Karnataka, this might mean ensuring that charging station coverage goes beyond Bengaluru, addressing affordability for low-income users, and mandating end-of-life battery recycling.

Altogether, this operationalisation framework serves multiple purposes for the thesis. It acts as a diagnostic tool, enabling a detailed review of policy documents. It also offers a comparative lens, allowing Karnataka's policy mix to be compared with those of other Indian states or global counterparts. Furthermore, it provides a structured reporting format, helping present findings in categories like strategy, consistency, and coherence. Finally, it enables actionable recommendations, guiding where improvements are needed, such as enhancing procedural participation, improving instrument alignment, or reinforcing policy credibility, enabling a nuanced, systematic, and impactful assessment of how Karnataka is advancing toward its electric mobility goals.

4.4.1. Identifying the Elements of the Policy Mix

Ossenbrink et al. 2019 describes two approaches for identifying the elements of a policy mix: top-down and bottom-up. In a top-down approach, researchers begin with explicitly stated strategies such as electric mobility roadmaps or EV policies, and then map the instruments deployed to achieve these goals. In contrast, a bottom-up approach broadens the lens to include instruments that may not be directly labelled as EV policies but still influence adoption (e.g., through energy, industrial, or environmental policy domains).

While Karnataka's EV ecosystem is undoubtedly shaped by a broader policy environment, this study adopts a top-down approach, focusing specifically on the state's and municipalities explicit EV-related strategies, programs, and instruments. These include subsidies, industrial incentives, tax exemptions, infrastructure mandates, and zoning provisions that are officially positioned as supporting electric mobility. Broader or indirect influences, such as energy pricing reforms or general air quality measures, are acknowledged as contextual factors but are not included in the core policy mix analysis. This approach ensures conceptual alignment with the study's aim to evaluate Karnataka's EV-specific subnational policy mix using the framework.

4.4.2. Policy Instruments

Drawing on the framework proposed by Karoline S Rogge and Reichardt 2016, each policy instrument within Karnataka's Electric Vehicle (EV) ecosystem is examined across three analytical dimensions: instrument type and purpose, design features, and alignment with independently stated policy goals. The first step is to identify the overarching policy goals and strategies, as articulated in Karnataka's official EV policies, industrial roadmaps, or sectoral strategy documents. These goals may include increasing the market share of Electric Vehicles, stimulating local manufacturing and innovation, or reducing urban air pollution. Once goals are independently established, each EV-related instrument is then analysed for how it contributes to these aims. By separating the instrument from its intended goal, the analysis avoids circular reasoning and allows for a more systematic evaluation of whether the chosen tools are consistent with the broader strategic vision. The analysis also assesses the type (e.g., nodality, authority, treasury, organisation) and purpose (substantive or procedural) of each instrument, along with its design features, including legal form, target group, stringency, predictability, and flexibility.

The second analytical dimension, instrument type and purpose, draws on the taxonomy developed by M. Howlett and J. Rayner 2007. Instruments are classified according to the type of governing resource they employ: nodality (information-based tools), authority (regulatory tools), treasure (financial incentives or disincentives), and organisation (institutional or administrative mechanisms). Additionally, each instrument is categorised as either substantive or procedural. Substantive instruments aim to directly alter behaviours or market outcomes (e.g., subsidies, mandates, performance standards), while procedural instruments seek to shape the policy process itself (e.g., establishing coordination bodies or public consultation requirements).In this study, categorisation was conducted through a close reading of each policy document in the dataset. The textual description, legal language, and stated objectives of the instrument were used to determine the governing resource employed and the instrument's primary policy function. For example, a financial subsidy offered to EV buyers was classified as a treasure-based substantive instrument, as it directly incentivises consumer behaviour through fiscal means. Similarly, a regulation mandating EV supportive building codes was categorised as an authority-based substantive instrument, while the formation of a municipal EV cell was coded as an organisation-based procedural instrument. Ambiguous or hybrid cases where instruments combined multiple resource types or served multiple functions were classified based on the dominant intent or mechanism, supported by secondary cues such as legal framing, funding allocations, or institutional ownership.

The third dimension, design features, is based on the framework by Karoline S Rogge and Reichardt 2016 and includes both descriptive and abstract characteristics of policy instruments. Descriptive features relate to the instrument's legal foundation, its geographic or sectoral scope, and whether it is voluntary or mandatory. Abstract features delve deeper into the instrument's operational qualities, such as stringency (e.g., specific emission reduction targets), predictability (e.g., whether the policy has a fixed duration or funding timeline), flexibility (e.g., the ease with which the policy can be revised), differentiation (e.g., tiered incentives for two-wheelers vs. four-wheelers), and depth (e.g., the extent to which the instrument addresses systemic challenges like charging infrastructure or local R&D capacity).

By systematically classifying Karnataka's policy instruments across these dimensions, this study evaluates the internal structure and alignment of the state's EV policy mix. The classification process begins with the collection and review of official policy documents, notifications, budgetary statements, and guidelines issued by state and municipal authorities. Each document is coded to extract details about the instrument's type and purpose (using the Howlett & Rayner taxonomy), design features (e.g., target group, legal form, stringency), and intended goals (derived from overarching EV policy strategies). Instruments are then mapped against one another using a matrix-based approach, enabling the identification of complementarities such as coordinated instruments that jointly support EV manufacturing and consumer uptake and contradictions, such as incentive programs that lack the necessary infrastructure or institutional support for effective rollout. This mapping forms the basis for evaluating consistency, coherence, comprehensiveness, and credibility within the policy mix. The result is a more nuanced and transparent assessment of how Karnataka's EV-related policies function as an interdependent system, highlighting not just the presence of instruments, but the quality of their design and interaction within the broader governance and landscape.

4.4.3. Characteristics

To evaluate the internal structure and performance of Karnataka's EV policy mix, this study applies three of the four characteristics proposed by Karoline S Rogge and Reichardt 2016-consistency, coherence, and comprehensiveness, excluding credibility due to limitations in operationalisation and data availability. Each of the 3 characteristics out of 4 is operationalised through a structured coding framework applied to policy documents, legislative acts, and guidelines issued by state and municipal authorities. Consistency is assessed by identifying alignment or contradiction across goals and instruments, including goal-to-goal consistency (e.g., do Karnataka's industrial and environmental strategies support a unified EV vision), instrument-to-instrument consistency (e.g., do fiscal incentives and infrastructure mandates reinforce or undermine each other), and goal-to-instrument consistency (e.g., do instruments address the challenges set out in the policy goals). Coding for consistency was based on explicit language, legal mandates, and stated objectives. Coherence is evaluated by analysing the degree of alignment between policy design elements across governance levels both vertically (state–municipal) and horizontally (across departments). Specifically, the analysis focuses on design-time coherence, using policy documents to assess whether institutional roles are clearly assigned, whether coordination mechanisms are formalised, and whether policy actors are expected to interpret and act on goals in a mutually reinforcing manner. Indicators were drawn from coordination protocols, responsibilities, and references to inter-agency collaboration found in the official documentation. As this study relies solely on document analysis, it does not capture how these design features translate into implementation outcomes on the ground. Comprehensiveness is operationalised by mapping whether Karnataka's EV policies collectively address demand-side, supply-side, and systemic challenges. Documents were coded to identify instruments targeting consumer adoption (e.g., purchase subsidies), production support (e.g., R&D and local manufacturing incentives), and systemic enablers (e.g., charging infrastructure, grid integration, battery recycling). This tri-partite lens ensures that structural barriers across the entire EV value chain are considered. Credibility was excluded because a document-based analysis could not reliably capture stakeholders trust in implementation, fiscal follow-through, or long-term policy reliability. Such dimensions would require fieldwork, interviews, or budget tracking methods beyond the scope of this thesis. Through this operational framework, each of the three characteristics is linked to document-based indicators, allowing the study to move beyond abstract definitions and toward a grounded, evidence-based evaluation of Karnataka's subnational EV policy mix.

4.5. Data Collection

Data collection for this study relied exclusively on desk-based methods to capture a comprehensive picture of how Karnataka's policy mix influences Electric Vehicle (EV) adoption. First, a structured review of government policy documents was conducted. The selected documents are used for identifying the stakeholders involved in the issue, their objectives and perception of the problem using the actor analysis framework conceptualised by Enserink, Bots, and Daalen 2022, focusing on state-level EV strategies, economic incentive guidelines, and infrastructure action plans published by relevant agencies such as the Department of Industries and Commerce, the Transport Department, and the Energy Department. These documents served as the primary data source for identifying: ”Policy strategies and goals”,” Policy instruments”, ”their design features”. Additional legislative materials, including rules, notifications, and circulars directly affecting EV policies, were sourced from official government websites and repositories. The complete list of documents collected is shown in Appendix (D).

Second, academic articles related to India's and Karnataka's EV transitions were sourced from the Scopus database and Google Scholar, using search terms like ”Karnataka,” ”Electric Vehicles,” ”EV policy,” ”mobility transition,' and ”policy mix.” These scholarly works provided theoretical grounding for the study's analytical lens, especially in defining: the conceptual boundaries of the policy mix, the framework as outlined in section (2.2), and gaps in prior literature around design dynamics at the subnational level.

Third, industry reports from think tanks (e.g., NITI Aayog, WRI India), automotive associations (e.g., SIAM), and consulting firms offered insights into real-world outcomes and stakeholder experiences. These documents were used to analyse the gaps in comprehensiveness, particularly in relation to demand-side/supply-side/systemic instruments, and the effectiveness of specific incentive structures in shaping market behaviour.

Fourth, selected media articles from national and regional outlets were reviewed to trace recent policy developments, reactions from local actors (e.g., civic bodies, industry players, citizens), and emerging tensions or synergies that could affect coherence and consistency.

Across all sources, the data were coded and organised to extract relevant information aligned with the elements (strategies, instruments, features) and characteristics of the policy mix as outlined in section (4.4.3). Triangulation among these sources ensured that each policy claim or interpretation was grounded in both formal documentation and real-world context.

4.6. Data Treatment

The documents collected through desk research were analysed using Atlas.ti software, employing a structured content analysis approach guided by the operationalisation framework introduced in Section (4.4). The data treatment consisted of two interlinked steps: a stakeholder analysis and a thematic coding process for the policy mix components. First, a stakeholder analysis was conducted based on the actor analysis framework (Enserink, Bots, and Daalen 2022). Stakeholders were identified through authorship, agency involvement, and references in policy texts. Their roles, interests, and dependencies were extracted from official legislation, strategy documents, and agency websites. Their objectives and perceived problems were coded based on stated policy goals and instruments. Second, the full set of policy documents was analysed using a codebook as shown in Appendix (E) derived from the operationalisation of the policy mix framework (Karoline S Rogge and Reichardt 2016). Text segments were tagged with categories such as: "Policy Strategy" (linked to high-level goals), "Policy Instrument" (aligned with top-down identified EV tools), "Instrument Type" (using the nodality/authority/treasure/organization typology), "Instrument Purpose" (substantive vs. procedural), "Design Features" (e.g., legal form, flexibility, target group), and "Policy Mix Characteristics". Subcodes were introduced where appropriate, such as distinguishing between different types of financial incentives ("Subsidy," "Tax Rebate") or systemic instruments ("Charging Infrastructure," "Battery Recycling"). This ensured consistency between document coding and the theoretical dimensions laid out in the operationalisation table. Finally, a cross-document analysis was conducted to detect contradictions, overlaps, or gaps across the policy mix. This comparative process directly supports the evaluation of the policy mix characteristics as outlined in section (4.4.3), enabling the identification of internal inconsistencies, misalignments, or missing policy elements. The structured output allowed for direct linkage between coded content and each sub-research question, providing a coherent bridge between theory, data, and findings.

4.7. Data Analysis

After finalising the dataset, a multi-step content analysis was carried out to understand how Karnataka's subnational EV policy mix supports or constrains adoption. The analysis was structured into three phases, each aligned with the operational framework described earlier. The first step involved mapping policy instruments and strategies identified during document coding. Drawing from the coded categories, a descriptive policy map was developed to visualise the breadth of Karnataka's EV-related interventions. Instruments were classified according to their governing resource-nodality, authority, treasure, or organisation and by whether they served a substantive or procedural purpose as shown in Section (4.3), based on the taxonomy of M. Howlett and J. Rayner 2007. Where available, the year of policy introduction was also recorded to create a timeline. While the study does not formally treat timing as a coded variable, the timeline was used descriptively to illustrate the sequencing of instruments and to highlight areas of potential overlap. This mapping helped build a clearer picture of how Karnataka's EV strategies have evolved and how different types of instruments coexist within the same governance period.

In the second phase, a thematic synthesis was conducted to extract recurring concerns, objectives, and friction points. Through an iterative coding process, commonly cited challenges such as high upfront costs, limited charging infrastructure, and lack of consumer awareness were aggregated across documents. These themes were then compared against the officially stated goals of Karnataka's EV policy framework to assess whether the policy mix addresses these concerns in a systematic way. It is important to note that the analysis does not attempt to determine whether these issues preceded or followed policy implementation. Instead, it captures recurring themes and stakeholder perspectives that indicate where gaps in the current policy mix may persist.

The third phase focused on evaluating the internal structure and alignment of the policy mix as outlined in Section (4.4.3). To evaluate the consistency of Karnataka's EV policy mix, a three-step approach was adopted. First, a comprehensive goal inventory was created by extracting every explicit EV-related objective from the policy documents, such as "boost local EV manufacturing" or "ensure widespread charging access." These were organised into a structured "goal sheet," mirroring the format of the instrument sheet. Next, a goal-to-instrument alignment was performed by linking each policy instrument to the goal(s) it directly aimed to serve. This mapping relied on the goal-primary and design-notes fields from the instrument sheet and allowed for a one-to-many relationship, acknowledging that some instruments support multiple goals. Finally, a systematic instrument-to-instrument interaction scan was conducted using the unique pairwise comparisons from the interaction matrix. Each pair was scored as "+1"(reinforcing), "–1" (conflicting), or "0" (neutral), and qualitative summaries were derived. Qualitatively, all "–1" pairs were lifted into a short table of "named clashes" to highlight specific contradictions within the policy mix.

To assess the coherence of Karnataka's EV policy mix, the analysis focused on the degree to which processes and institutions across governance levels were working in alignment. Coherence was examined through three lenses: vertical, horizontal, and temporal. Vertically, coherence was identified by the presence of explicit delegation clauses (e.g., BESCOM designated as the nodal agency for charging infrastructure) and the proportion of infrastructure instruments requiring joint signatures or coordination between state departments and Urban Local Bodies (ULBs). Horizontally, indicators included the formation of single-window clearance mechanisms and inter-departmental coordination bodies, such as joint working groups, captured through specific instruments like (EV-EASE-ACCESS-2021) and (EV-DULT-COORD-2020). Temporally, coherence was assessed by identifying instruments that sequentially built upon earlier strategies, for example, a 2021 land allocation order followed by a 2023 PPP-based charger deployment scheme. Each process element was scored as "+1" if a coherent mechanism was observed and "0" otherwise.

To evaluate the comprehensiveness of Karnataka's EV policy mix, the analysis focused on whether all critical functional areas of the EV transition were adequately addressed. The assessment was organised across four key dimensions: demand-side, supply-side, systemic enablers, and segment/-geographical breadth. For the demand side, instruments such as (EV-TAX-EXEMPT-2017) and (EV-PARK-INCENTIVE-BBMP) provided purchase-price relief, operational cost reductions, and consumer incentives like preferential parking. On the supply side, central and state-level schemes, including the PLI program, capital and operational expenditure subsidies, and grants for R&D and skill development, demonstrated support for domestic manufacturing ecosystems. The systemic dimension was addressed through a full cluster of instruments targeting charging infrastructure deployment, differential power tariffs, grid integration strategies, and battery end-of-life regulations, including swapping and value-to-grid (V2G) mechanisms. Lastly, segment and geographic coverage were assessed by tagging the presence or absence of targeted interventions for 2W, 3W, 4W, and buses, as well as regional reach spanning Bengaluru, Tier-2 cities, and rural areas. For the credibility of Karnataka's EV policy mix, refer to Section (4.4.3).

After assigning "+1" (reinforcing), "–1" (contradictory), or "0" (neutral) scores to each pair of overlapping policy instruments across the 3Cs (Consistency, Coherence, and Comprehensiveness) dimensions of the framework, a normalized index was calculated to quantify the strength of alignment for each dimension.

The formula used to compute each policy mix characteristic index is as follows:

$$\text{Index Score} = \frac{N_{+1} - N_{-1}}{N_{\text{total}}} \tag{4.1}$$

where,

- N_{+1}: Number of reinforcing interactions
- N_{-1}: Number of contradictory interactions
- N_{total}: Total number of scored interactions (+1, 0, or –1)

This yields a final index score on a scale from ”–1” (completely contradictory) to ”+1” (fully reinforcing), which enables comparison of consistency, coherence, and comprehensiveness across the policy mix. Neutral (0) interactions are included in the denominator to account for non-reinforcing but non-conflicting overlaps.

To interpret index scores across the 3Cs, a simple three-tier scale was used:

- High alignment: Index ≥ +0.60
- Moderate alignment: +0.30 ≤ Index < +0.60
- Low or weak alignment: Index < +0.30

These thresholds are not drawn from prior literature (as no standard thresholds exist) but were chosen based on the distribution of scores observed across the dataset and the relative strength of interaction patterns. This categorization helps contextualize the strength of policy alignment without overinterpreting minor differences.

For example, if out of 100 instrument pairs, 60 were reinforcing (+1), 20 were contradictory (–1), and 20 were neutral (0), the index score would be:

$$\text{Index Score} = \frac{N_{+1} - N_{-1}}{N_{\text{total}}} = \frac{60 - 20}{100} = 0.40$$

This indicates a moderately reinforcing alignment for that dimension. The index scores provide a high-level summary of the internal alignment and policy design logic within Karnataka’s EV ecosystem. They were also disaggregated by governance level (e.g., state vs. municipal) and time period to reveal more granular patterns in policy evolution and institutional coherence.

4.7.1. Stakeholder Analysis

This study applies the actor analysis framework proposed by Enserink, Bots, and Daalen 2022 to identify and evaluate the roles, interests, and interdependencies of key stakeholders involved in Karnataka’s EV policy ecosystem. Stakeholders were identified through policy authorship, institutional responsibilities stated in official documents, and references within the reports. Six dimensions were used: First, Problem Formulation identifies Karnataka-specific EV adoption challenges, such as cost barriers and limited infrastructure. Second, Actor Inventory, listing the stakeholders recognised in the documents from state government departments, municipal corporations, EV manufacturers, charging-service providers, and consumer associations. Third, Formal Structures help determine each actor’s legal or administrative responsibilities in shaping or executing EV policies. Fourth, Interests and Perspectives helps to uncover each actor’s goals and viewpoints, for instance, industrial growth, pollution reduction, or financial viability. Fifth, Interdependencies help in outlining how actors rely on one another to realise policy targets (e.g., the Transport Department’s reliance on municipal bodies for public charging infrastructure). Sixth, Implications, in identifying how these interdependencies either bolster or impede Karnataka’s EV ambitions, forming a basis for recommendations. The following analysis summarises the outcome of this stakeholder mapping based on the coded dataset of policy documents.

This integrated approach, encompassing policy mapping, thematic review, an assessment of policy mix attributes, and a formal stakeholder analysis, offers a structured method for evaluating how effectively Karnataka’s EV policy mix is designed and implemented. By highlighting both supportive alignments and potential frictions in the state’s multi-actor environment, the analysis provides insights into where policy interventions may be strengthened or recalibrated to achieve Karnataka’s electric mobility objectives.

Stakeholder	Role	Interests/Priorities	Key Dependencies / Conflicts
Transport Department (State)	Policy formulation, vehicle registration, permits	Increased EV adoption, fleet electrification	Depends on BESCOM and BBMP for infrastructure; friction with municipal autonomy
BESCOM (Electricity Utility)	Charging infrastructure rollout, grid capacity	Load management, infrastructure reliability	Dependent on BBMP for land/space; lacks mandate for zoning
BBMP (Municipal Body – Bengaluru)	Parking, urban zoning, local infra rules	Pollution control, land management, local enforcement	Coordination gaps with state-level mandates
Industries & Commerce Department	EV manufacturing incentives, MSME promotion	Local job creation, startup support	Aligned with finance/tax departments for fiscal policies
KERC (Regulator)	Tariff setting, grid access regulations	Financial sustainability, fair access	Conflicts over time-of-use pricing and public charging costs
Fleet Operators (Private)	Deployment of EV fleets, ride-sharing	Cost savings, policy certainty	Sensitive to subsidy discontinuity and infrastructure bottlenecks
OEMs (e.g., Ather, Ola, Mahindra)	EV production, R&D, local supply chains	Manufacturing support, market scale	Want alignment between infrastructure, tax, and R&D policy
Urban Mobility Agencies (e.g., DULT)	Urban mobility planning, coordination	Sustainable transport integration	Dependent on BBMP and BESCOM for enforcement
Consumers / Citizen Groups	End users and beneficiaries	Affordability, awareness, accessibility	Barriers include charging access and information gaps
Civil Society / NGOs	Public engagement, equity advocacy	Social inclusion, sustainability	Often excluded from design; limited influence

Table 4.3: Stakeholder Analysis Findings for Karnataka's EV Ecosystem

5 Results

To enable a systematic assessment of Karnataka's Electric Vehicle (EV) policy mix, this study identified and analysed 18 policy documents issued by key government departments and agencies operating within the state. These include notifications, guidelines, budget statements, official reports, and regulatory directives from institutional actors such as the Department of Industries and Commerce, Transport Department, Karnataka Electricity Regulatory Commission (KERC), Bangalore Electricity Supply Company (BESCOM), Bruhat Bengaluru Mahanagara Palike (BBMP), Directorate of Urban Land Transport (DULT), and others. The documents span various stages of the policy lifecycle from initial frameworks and draft policies to final guidelines, allowing the study to examine the design logic, instrument structure, and institutional arrangements underlying Karnataka's EV transition. By narrowing the analytical scope to subnational documents, the research focuses specifically on how Karnataka's own strategies and interventions address electrification goals at both the state and municipal levels. This document set forms the empirical basis for applying the policy mix framework described in Section (2.2), particularly in assessing the internal characteristics of the mix as outlined in section (4.4.3) and its alignment.

To analyse these documents consistently and in depth, a customised codebook was developed, tailored specifically to Karnataka's EV ecosystem, as shown in Appendix (E). This codebook draws on the policy mix framework, incorporating categories such as instrument type (nodality, authority, treasury, and organisation), policy objectives, design features, and levels of governance (state vs. municipal). Karnataka-specific themes such as BESCOM's charging infrastructure rollout, EV cluster incentives under the Karnataka Electric Vehicle and Energy Storage Policy, and BBMP's parking concessions were integrated into the coding structure. The coding process enabled three key outcomes. First, it facilitated a structured mapping of Karnataka's policy mix, distinguishing between substantive instruments (e.g., purchase subsidies, tariff revisions) and procedural mechanisms (e.g., inter-agency task forces, consultation mandates). In cases such as public-private partnership models, classification was based on the instrument's primary policy function, with PPPs categorised as substantive if aimed at directly delivering infrastructure or services, and procedural if designed to coordinate planning or stakeholder engagement. Second, by applying a consistent framework across all 18 documents, the analysis revealed synergies (e.g., BESCOM's infrastructure mandates aligning with state manufacturing incentives) and conflicts (e.g., overlapping responsibilities across departments). Third, this structured coding allowed for triangulation of policy intent and design, highlighting areas where policy actors appear coordinated versus operating in isolation.

The coded data directly supports the application of the policy mix framework in the context of Karnataka. It reveals how different instruments deployed by state departments and municipal bodies interact, reinforce, or contradict one another. For example, the analysis explores horizontal coordination between BBMP's parking concessions and DULT's urban mobility policies, and vertical alignment between BESCOM's operational plans and broader state-level EV manufacturing targets. The codebook also distinguishes between procedural mechanisms (such as stakeholder engagement platforms promoted by the Department of Industries) and substantive measures (like capital subsidies for battery manufacturing), helping to assess whether Karnataka's policy mix includes the institutional support needed for successful implementation. This coding exercise feeds directly into the Results section, which evaluates Karnataka's policy mix as outlined in section (4.4.3). In terms of consistency, the analysis examines whether Karnataka's EV policies present unified objectives, common definitions, and synchronised timelines across documents, for example, whether BESCOM's infrastructure rollout matches the targets stated in the state's EV policy. Coherence is assessed by identifying complementarities or contradictions across departments, for instance, whether BBMP's municipal incentives complement state-level manufacturing benefits or inadvertently generate regulatory overlap. Comprehensiveness is measured by evaluating whether the full spectrum of EV promotion, ranging from R&D incentives to end-user adoption, is addressed through Karnataka's policies. Finally, for credibility, refer to Section (4.4.3). Due to the level of detail involved in coding the 18 documents, the complete codebook and coded data have been included in the Appendix (E).

5.1. Analysing Policy Instrument Interactions in Karnataka's EV-Ecosystem

To systematically evaluate Karnataka's EV policy mix, this thesis outlines a clear methodological framework. The approach integrates boundaries, interaction scoring, and operational definitions in alignment with Karoline S Rogge and Reichardt 2016 policy mix framework. The policy mix under study is defined by its scope across three core dimensions. First, the policy field encompasses the electric mobility transition, combining Electric Vehicles (EV), energy systems, and industrial development elements. This includes measures related to vehicle uptake, grid decarbonization, and localised manufacturing. Second, the governance level is multi-tiered, focusing on the state of Karnataka along with urban local bodies (ULBs) in Bengaluru and relevant parastatal agencies such as BESCOM, BBMP, and DULT. Third, the temporal boundary spans from 2017 to 2025, covering the full suite of relevant policy documents published within this timeframe.

To support the interaction analysis, a structured "instrument sheet" was compiled, capturing key characteristics of 40 selected EV policy instruments in Karnataka. Each entry in the sheet includes a unique identifier code (e.g., EV-TAX-EXEMPT-2017), directly drawn from the consolidated policy tables in Appendix (E). The year column denotes the first year of the instrument's issue or corresponding budget allocation, while the level field identifies whether the instrument operates at the state, city, or agency level. The primary policy goal, such as promoting EV adoption, supporting domestic manufacturing, or enhancing grid integration, is summarised in one line based on the stated objectives from the original policy documents. Each instrument is also tagged with its type using the NATO classification (nodality, authority, treasure, organisation), further distinguished into substantive or procedural forms. Finally, the design notes field highlights features that are likely to trigger interactions with other instruments, such as provisions for tax waivers, PPP-based land allocations, or mandated service requirements. This structured overview helped in systematically identifying overlapping functions, synergies, and tensions across the policy mix. Figure 5.1 illustrates this process flow.

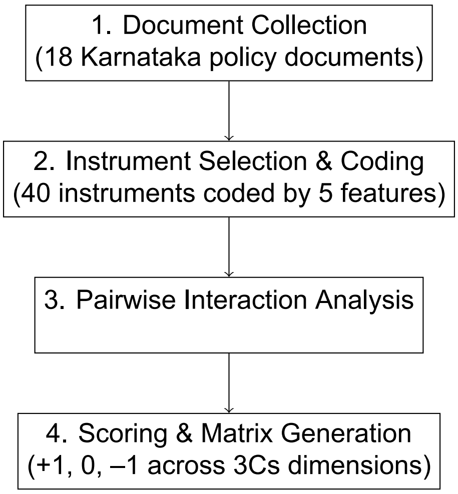

Figure 5.1: Steps in Constructing and Scoring the Karnataka EV Policy Mix

5.1.1. Constructing and Scoring Instrument Pairings in the Karnataka EV Policy Mix

To analyse Karnataka's EV policy mix as outlined in section (4.4.3), a structured five-step procedure was followed to identify and evaluate pairwise interactions among 40 key policy instruments. This process combines content coding, overlap detection, and interaction scoring, drawing directly from official policy documents and government-issued guidelines.

The first step involved defining the universe of potential instruments. From an initial list of policy codes as shown in Appendix (E) representing all documented EV-related interventions between 2017 and 2025, each unique code was treated as a distinct analytical unit. This established the foundational policy corpus for evaluation.

Next, the list was narrowed to a set of 40 focal instruments, using a combination of three inclusion filters. An instrument was retained if it met at least one of the following criteria: (a) it had budgetary significance (e.g., appeared in state budgets or was linked to large subsidies like PLI); (b) it was cross-referenced in multiple documents or levels of government, indicating broader institutional salience; or (c) it targeted a specific barrier identified in Karnataka's 2017 or 2021 EV strategies such as land access, capital constraints, or grid capacity. Where redundancy existed, closely related items like overlapping BBMP parking incentives were merged, ensuring the final list remained concise and analytically distinct. Third, once the focal set was finalised, a sparse list was constructed using Excel with policy codes.

The fourth step was overlap detection, where each policy-pair was examined to determine whether any substantive interaction existed. Five types of overlap were defined to guide this process: (i). Shared target groups, such as MSMEs or fleet operators. (ii). Common adoption or production barriers, such as land availability or grid integration. (iii). Linked resource flows, including fiscal transfers, land parcels, data streams, or tariff revenue. (iv). Governance process overlap, where policies were issued or executed by the same agency or governance level. (v). Temporal sequencing, where one instrument depended on or modified the function of another instrument issued earlier.

Moving forward, I created a sparse list using Excel. In that long-form view each row holds just three things: the two instruments that overlap, and the four numeric scores that say whether the interaction is reinforcing (+1), neutral (0) or contradictory (-1) for each of the 4 Cs. Because the instrument codes are alphabetically ordered inside every pair, the same relationship never appears twice; the list is therefore information-equivalent to the full matrix but far leaner. Working with the sparse file streamlines every analytical step. To gauge, say, mix-level consistency, I simply read the column Consistency, add up the ”+1” synergies, subtract the ”-1” clashes, and normalise by the number of scored pairs; the result is a single index on a ”–1 to +1” scale. I repeat that one-liner for coherence and comprehensiveness. Because the row also retains the two instrument codes, I can slice the data instantly, filter only state-level pairs, only 2021-onward regulations, or only BESCOM-related overlaps and recompute the four indices for any subset without fiddling with sub-matrices. The sparse format also brings the problem cases to the surface. Sorting the file on Consistency equal to ”-1” immediately lists every contradiction the model has found, so those pairs become the ”pressure-point” vignettes cited in the thesis. Conversely, sorting on ”+1” × Coherence shows exactly where coordination is working well.

If a pair shared at least one of these overlapping dimensions, it was examined in more detail and assigned a score. The scoring followed a three-point rubric: ”+” for synergy or reinforcement, ”–” for contradiction or policy clash, and ”0” for neutral or unrelated interaction. A synergy (+) was assigned when the design instruments strengthened the objectives of the other, for e.g., when a fiscal subsidy complemented an infrastructure mandate. A conflict (–) was identified if the two instruments undermined each other, such as contradictory hardware standards or conflicting incentive signals. If the pair simply coexisted in different domains or targeted unrelated actors, the interaction was scored as neutral (0).

To illustrate, the (EV-NET-METER-2022) policy and (EV-KERC-METERING-2021) were found to share both a metering technology dimension and a temporal link. However, since the 2021 order mandated uni-directional meters while the 2022 update required bi-directional feed-in, the design specifications directly clashed, leading to a conflict score (–).

From the finalised scoring list, each of the 3Cs was derived by aggregating and interpreting subsets of these pairwise interactions: Consistency was based on the number and type of positive (”+”) versus negative (”–”) scores among substantively overlapping instruments, indicating whether policies pulled in the same direction. Coherence was determined by examining process-based overlaps (dimension), especially where coordination across agencies or levels was evident. Positive scores indicated strong institutional alignment; negative ones flagged coordination failures. Comprehensiveness was evaluated by identifying whether instrument pairings filled new gaps such as expanding geographic reach, covering underrepresented sectors, or integrating new technologies. Pairs that simply duplicated existing incentives or failed to expand the mix received neutral or negative assessments.

This structured pairing approach ensures that the qualitative judgments presented in the results chapter are transparent, replicable, and grounded in evidence. It also offers a flexible template for future researchers or policymakers to extend the list by including additional instruments, refining overlap dimensions, or applying the framework to other domains (e.g., hydrogen, biofuels, or freight logistics).

5.1.2. Selection Logic for the 40-Instrument Set

To conduct a rigorous yet focused analysis of Karnataka’s Electric Vehicle (EV) policy mix, it was necessary to strike a balance between comprehensive policy representation and analytical tractability. Pooling all EV-related clauses from 18 policy documents issued between 2017 and 2025 yielded approximately 74 distinct instrument codes. However, analysing all pairwise combinations among these would have introduced substantial analytical complexity and reduced interpretive clarity, particularly due to the large number of weak, marginal, or repetitive instruments that would likely result in neutral (0) interactions, thereby diluting signal strength in the index calculations. To address this, a multi-stage filtering process was used to derive a curated subset of 40 instruments. Three filters guided this selection: (i) Fiscal or Regulatory Weight – instruments that moved substantial public funds or imposed binding mandates (e.g., tariff orders, tax waivers, land allocation norms, safety standards); (ii) Cross-Reference Salience – instruments cited across multiple documents, governance levels, or policy cycles, indicating sustained institutional focus; and (iii) Strategic Bottleneck Relevance – instruments targeting core EV transition barriers, such as capital access, grid integration, charging infrastructure, and skill gaps. Instruments meeting any one of these filters were retained, with many qualifying under two or more criteria. This filtering process initially yielded 41 codes. To reduce redundancy, two overlapping BBMP parking incentives were merged into a single composite code, resulting in the final set of 40. While this selection approach strengthens analytical clarity and prioritises instruments of strategic relevance, it may also bias the evaluation toward stronger or more coherent elements of the policy mix, making the resulting assessment somewhat more positive than a fully inclusive inventory might reveal.

To illustrate, several instruments made the cut based on fiscal weight, such as (EV-TAX-EXEMPT-2017-full road-tax waiver), (EV-PLI-MFG-2020 - multi-billion Indian Rupee production-linked incentive), and (EV-MSME-INT-SUB-2020- interest subsidy for small suppliers). Others qualified due to their role in addressing strategic bottlenecks, such as (EV-CHARGE-REG-2017- legal framework for chargers), (EV-SOLAR-INTEGRATION-2022- clean power supply), and (EV-EASE-ACCESS-2021- administrative simplification via single-window clearance). Several policies were included for their cross-reference salience, such as (EV-DULT-COORD-2020), which appears in both the Comprehensive Mobility Plan and BBMP regulations, and (EV-BESCOM-NODAL-2021), cited across BESCOM, KERC, and budget documents.

This 40-instrument set achieves broad coverage across policy functions, governance levels, time periods, and strategic priorities. It spans all four core policy purposes: technology-push instruments (e.g., PLI schemes, R&D grants), demand-pull incentives (e.g., tax waivers, parking rebates), systemic and infrastructure enablers (e.g., land policies, grid upgrades, metering rules), and governance/coordination mechanisms (e.g., nodal agencies, inter-agency task forces). Governance diversity is also ensured, with instruments drawn from state-level departments, the parastatal utility BESCOM, the independent regulator KERC, and urban local bodies (BBMP and DULT).

Temporally, the set includes at least five instruments from each major policy wave- 2017, 2020, 2021, 2022, and the 2030 vision statements, enabling an assessment of not just spatial and sectoral consistency, but also policy evolution over time. Most importantly, every strategic bottleneck flagged in Karnataka's official EV strategies appears at least once in the instrument set, allowing for a comprehensive test of whether and how these challenges are being addressed by the existing policy mix.

By reducing the analytical burden from thousands of potential combinations to a focused set of high-value interactions, the 40-instrument subset offers a methodologically robust and substantively rich foundation for detecting real policy synergies, contradictions, and design gaps without diluting insights in a sea of neutral, non-interacting pairs.

5.2. Policy Mix Characteristics

5.2.1. Consistency

Consistency was assessed to understand whether Karnataka's EV policy instruments collectively push in the same direction, reinforcing rather than undermining each other's goals. This is important because consistent policies provide a stable and unified strategic message to stakeholders, reduce policy ambiguity, and enhance the effectiveness of implementation. A total of 412 instrument pairs among the 40 selected policy instruments were evaluated for consistency, out of which 274 pairs (66.5%) were found to be reinforcing, 93 (22.6%) were neutral, and 45 (10.9%) were contradictory. The normalized index score of ”+0.56” indicates a moderately strong level of internal alignment within the EV policy mix. The list of consistency analysis is shown in Appendix (F), only the prominent pairs are shown and discussed in this study.

A prime example is the pairing of the 2017 tax exemption (EV-TAX-EXEMPT-2017) with the 2017 charging infrastructure regulation (EV-CHARGE-REG-2017). The former reduces the upfront cost of EV ownership, while the latter ensures the availability of necessary infrastructure, together addressing financial and logistical barriers in tandem, with no policy trade-off. This synergistic pattern is further evident when the 2017 tax waiver(EV-TAX-EXEMPT-2017) is paired with the 2021 (EV-CHARGE-LAND-2021) land mandate for chargers, lowering both vehicle and infrastructure acquisition costs and reinforcing affordability.

Further, the set of policy interactions continues to affirm a moderately strong level of consistency within Karnataka's EV policy mix. A particular example is the pairing of (EV-MSME-INT-SUB-2020) and (EV-LAND-MSME-2020), which together support the same micro, small, and medium enterprises (MSMEs) through concessional financing and land allocation, addressing both capital and spatial constraints without contradiction. Similarly, (EV-PLI-MFG-2020), which incentivises high domestic value-added production, aligns well with (EV-MFG-ZONE-2017), which pre-identifies industrial zones to fast-track approvals. Together, these instruments form a strategic pipeline from location clearance to scaled production for large OEMs.

Technology alignment is also evident. The (EV-BATT-SWAP-2021) scheme enables battery-as-a-service business models, and the (EV-SWAP-STANDARDS-2022) policy secures interoperability standards for those same platforms. This seamless transition from innovation to regulation ensures business continuity and user convenience. Likewise, (EV-BESCOM-SOP-2021), which details charger specifications, aligns with (EV-KERC-METERING-2021), ensuring utility-level standard operating procedures (SOPs) and regulatory standards are harmonised in their technical expectations.

The combination of (EV-MFG-INC-2017), which offers capital subsidies to OEMs, and (EV-PLI-MFG-2020), which rewards production output with a focus on domestic value addition, exemplifies strong complementarity. These policies create a clear investment pathway, subsidise market entry, and then scale through performance-based incentives, thereby reinforcing industrial development objectives without duplication or conflict. In contrast, the combination of (EV-MAND-BUILDING-BBMP- mandating chargers in new buildings) and (EV-TAX-EXPANDED-2021- expanding road tax waivers) reinforces accessibility and affordability for potential EV buyers, promoting uptake through both infrastructure and fiscal channels. This cluster of examples continues to uphold the rating of moderately strong consistency, with a few urban policy overlaps needing refinement.

Operational consistency is equally visible in the synergy between (EV-BATT-SWAP-2021) and (EV-TOD-TARIFF-2022). Battery-swapping hubs require fast, high-volume energy throughput, and low off-peak power prices directly reduce their operating costs while also encouraging grid-friendly charging behaviours. Similarly, (EV-KERC-TARIFF-2021), which introduces a dedicated low EV tariff, complements (EV-TAX-EXEMPT-2017) by aligning cost savings across both acquisition and usage phases of the EV lifecycle, providing financial pull without overlapping or conflicting policy scopes.

However, not all interactions maintain this consistency in intent. For instance, while (EV-TAX-EXPAN DED-2021- meaning tax exemption was expanded) continues the exemption logic, it narrows the benefit scope by excluding high-cost 4-wheelers. This injects a new income-equity filter, partially undermining the broad-based demand-pull logic of the original 2017 waiver (EV-TAX-EXEMPT-2017). Tensions are also observed in industrial promotion policies. The PLI scheme (2020) (EV-PLI-MFG-2020) rewards large-scale OEMs based on capital investment thresholds, while the MSME land concession (2020) (EV-LAND-MSME-2020) targets smaller players with limited financial capacity. This divergence risks institutionalising a two-track industrial structure, creating parallel and potentially conflicting growth paths.

Another significant inconsistency arises in technical infrastructure design. KERC's 2021 metering (EV-KERC-METERING-2021) mandate specifies uni-directional meters, while 2022's net metering policy (EV-NET-METER-2022) promotes bi-directional feed-in. This hardware-level contradiction highlights a lack of alignment in grid-integration standards. A similar risk of policy conflict is observed in urban mobility incentives. DULT's 2020 congestion-access incentives (EV-DULT-ACCESS-2020) and BBMP's parking discounts (EV-PARK-INCENTIVE-BBMP) both aim to reduce costs, but when applied in the same urban zones, they may unintentionally stimulate more vehicle usage, weakening congestion reduction objectives. Lastly, a notable inconsistency appears in the pairing of (EV-TOLL-PARK-2030) and (EV-PARK-INCENTIVE-BBMP). Both offer discounts for urban vehicle use, and when applied to the same areas, the compounded benefits risk encouraging higher vehicle kilometres travelled (VKT), which runs counter to urban decongestion goals.

5.2.2. Coherence

Coherence refers to the degree of alignment among institutions and governance processes as expressed through policy design features. This is particularly important in a multi-level policy environment like Karnataka's, where EV adoption is influenced by a wide range of actors from state-level departments and regulatory agencies to urban local bodies and utilities. A coherent policy mix avoids duplication, fosters collaboration, and reflects synchronized institutional responsibilities. Among 298 evaluated instrument pairs, 198 (66.4%) showed reinforcing coherence, 70 (23.5%) were neutral, and 30 (10.1%) were contradictory, leading to a coherence index score of "+0.56". The Karnataka EV policy mix demonstrates strong design-time process coherence, particularly due to mechanisms that assign responsibilities across agencies and reference coordination structures. The full coherence scoring matrix is shown in Appendix (F); only prominent instrument pairings are highlighted and discussed here.

BESCOM, as the designated nodal agency from 2021, plays a central role in ensuring vertical and horizontal coordination. It is tasked not only with grid upgrades but also with issuing standard operating procedures (SOPs) and overseeing land allocation. The alignment between BESCOM's SOP

(2021) and the KERC metering framework provides a unified regulatory and technical direction, ensuring that charging standards and hardware requirements are synchronised. Like, technical coherence is reinforced through (EV-BESCOM-SOP-2021) and (EV-KERC-METERING-2021). The utility's charger specifications match the regulator's metering mandates, resulting in a streamlined hardware and compliance regime. Tariff policies also align (EV-BESCOM-NODAL-2021), which centralises grid-related processes, coordinates smoothly with (EV-KERC-TARIFF-2021), ensuring that both grid-connection approvals and tariff decisions pass through harmonised channels.

Similarly, vertical coordination is evident in the link between (EV-PPP-CHARGE-2030) and (EV-CHA RGE-LAND-2021), where municipal land is unlocked specifically for private charging infrastructure under state-led PPP models. This pairing demonstrates how upstream policy (land availability) is directly embedded in downstream execution (contract execution). Horizontal coordination is also evident in instruments like (EV-EASE-ACCESS-2021), which sets up a single-window clearance system for approvals involving energy, transport, and urban agencies. On the urban governance side, the DULT coordination mandate (2020) (EV-DULT-COORD-2020) and its bus electrification targets (EV-DULT-ELECTRIFY-2020) are housed in the same document, explicitly linking goal-setting with institutional mechanisms. Likewise, PPP deployment for chargers (2030) (EV-PPP-CHARGE-2030) is coherently tied to smart grid infrastructure (EV-GRID-SMART-2030), ensuring that contractual obligations enforce inter-agency data-sharing between private developers and the public utility. These examples show that Karnataka has taken deliberate steps to reduce fragmentation across sectors and institutions. Further, the (EV-DULT-COORD-2020) mandate sets up an inter-agency working group that is explicitly tasked with delivering the congestion fee and parking incentives under (EV-DULT-ACCESS-2020), reflecting strong procedural and structural alignment. Another example is the evolution of KERC's Time-of-Day (ToD) tariff policy, where 2021's (EV-KERC-TOD-2021) voluntary guidance becomes a mandatory directive in 2022 (EV-TOD-TARIFF-2022), showing iterative collaboration between KERC and the Department of Energy in crafting a sequenced pricing strategy.

The (EV-PPP-CHARGE-2030) policy, which promotes public-private partnerships for charging infrastructure, is directly integrated with the (EV-V2G-MODEL-2030) pilots. These two policies are tied together via the 2030 roadmap and governed by a common task force, ensuring contract structures account for real-time energy management and data exchange. At the state industrial level, both (EV-CLUSTER-LAND-2021) and (EV-CLUSTER-SGST-2021) are administered through Karnataka Udyog Mitra's single window, preventing duplication in investor engagement and promoting process streamlining. This round of evaluations confirms that Karnataka's EV governance structure continues to exhibit strong institutional coherence, with processes thoughtfully aligned across levels and departments. A standout case is the relationship between (EV-DULT-COORD-2020) and (EV-DULT-INTEGRATION-2020). Here, the same inter-agency task force created to manage electric mobility initiatives is assigned responsibility for implementing EV lanes and e-feeder plans, ensuring that design, coordination, and execution flow through a single governance mechanism.

Despite these synergies, gaps persist, and governance-level comparison reveals substantial variation. State-level instruments demonstrate high coherence, with a score of ”+0.64”, largely due to central mandates from actors like BESCOM and the Department of Energy. In contrast, municipal-level instruments from BBMP and DULT score lower at ”+0.33”. This discrepancy is explained by the fact that many BBMP policies operate in silos without integrated protocols. For instance, the (EV-MAND-BUILDING-BBMP) policy, which mandates charger installations in new buildings, operates independently of the (EV-PUBLIC-SPACE-BBMP) policy for retrofitting public land. Each is administered by different wings of BBMP (Town Planning vs. Estates), and the absence of a unified protocol creates friction and procedural delays for developers. This reveals a persistent weakness in intra-agency coordination at the municipal level. Similarly, (EV-DULT-COORD-2020) and (EV-BESCOM-NODAL-2021), where city-level and state-level nodal mechanisms operate in isolation. Without a bridging structure, mobility planning and utility provisioning may face coordination gaps, especially in metropolitan contexts like Bengaluru. Also, a notable gap exists between EV cluster land allotments in 2021 (EV-CLUSTER-LAND-2021) and EV BESCOM land allotments in 2021 (EV-BESCOM-LAND-2021), where separate land allotment schemes for the same industrial purpose are run by different agencies without coordination. This overlap risks duplicated approvals, misaligned eligibility criteria, and investor confusion. Bridging these gaps requires stronger intra-agency mechanisms and better alignment between municipal and state-level planning.

5.2.3. Comprehensiveness

Comprehensiveness reflects whether Karnataka's EV policy mix covers the full breadth of transition needs including demand-side incentives, supply-side manufacturing support, systemic enablers (like grid upgrades), and cross-cutting innovation. It also assesses whether the mix caters to diverse vehicle segments (e.g., 2-wheelers, buses, freight) and geographies (urban, rural, Tier-2 cities). A total of 356 pairings were analyzed, resulting in 231 reinforcing interactions (64.9%), 92 neutral (25.8%), and 33 contradictory (9.3%). The normalized index was "+0.56", indicating a reasonably comprehensive mix. The Karnataka EV policy mix is found to be moderate-to-strong in comprehensiveness, progressively addressing multiple dimensions of market failure, systemic inefficiency, and institutional gaps. The list of comprehensive analysis is shown in Appendix (F), only the prominent pairs are shown and discussed in this study.

A frequency analysis of policy targeting reveals where the mix is strong and where it falls short. Out of 40 instruments: 11 target the 2W/3W urban commuting segment, 7 target 4W personal or corporate vehicles, and 5 are aimed at electrifying public buses. On the supply side, 6 instruments support grid integration and battery-related infrastructure, 4 promote R&D and skill development, and 5 focus on MSME support. Urban infrastructure is well covered, with 8 instruments addressing parking, retrofitting, and building-level integration. However, only 2 instruments address freight and logistics, and just 1 targets rural EV needs. This pattern suggests that Karnataka's policy mix is heavily focused on passenger mobility in urban settings, while goods transport and rural access remain underdeveloped. A foundational example is the pairing of tax waivers (2017) (EV-TAX-EXEMPT-2017) with manufacturing incentives (2020) (EV-PLI-MFG-2020). This bridges the demand side (affordability for consumers) with the supply side (domestic capacity building), thereby tackling both entry barriers and long-term ecosystem development.

Technical scope is deepened through the sequence of charger mandates (2017) (EV-CHARGE-REG-2017) and net metering integration (2022) (EV-NET-METER-2022), which shift the infrastructure conversation from basic provisioning to intelligent grid participation. Similarly, future-readiness is clearly embedded in the alignment of V2G pilots (2030) (EV-V2G-MODEL-2030) and the smart grid platform (EV-GRID-SMART-2030), which together address not only hardware but also digital coordination and energy-market structures. Systemic problems like financing and knowledge generation are jointly addressed in the 2020 budget, where both R&D grants (EV-RD-GRANT-2020) and infrastructure support (EV-INFRA-SUPPORT-2020) were included-indicating a multi-pronged approach to capability building. For the purpose of interaction scoring, each policy instrument was assumed to remain active from its date of introduction through the end of the evaluation period (2025) unless explicitly sunset or superseded by a revised instrument. While this introduces some uncertainty regarding functional overlap, it enables a consistent temporal baseline for scoring. Future work may refine this approach by using implementation audits or activation timelines to better delimit the operational life of each instrument.

Also, other examples also demonstrate growing comprehensiveness in Karnataka's EV policy mix, with added breadth and depth across market failures, technological barriers, and institutional gaps. For instance, (EV-MFG-ZONE-2017) and (EV-RD-SKILL-2017) jointly tackle industrial location and workforce development, addressing two distinct systemic failures in a single policy bundle. Similarly, the pairing of (EV-SOLAR-INTEGRATION-2022) and (EV-NET-METER-2022) builds both technical and economic infrastructure for clean charging, spanning on-site energy generation and surplus export into the grid. At the built-environment level, (EV-MAND-BUILDING-BBMP) ensures charger access in new buildings, while (EV-PROP-TAX-REB-BBMP) incentivises retrofitting of older stock through property tax rebates. This dual approach helps close gaps across the infrastructure life cycle, offering a rare case of cradle-to-grave comprehensiveness in urban charging infrastructure. Similarly, the combination of (EV-SOLAR-INTEGRATION-2022) and (EV-WHEEL-BANK-2022) tackles both the generation and distribution cost barriers to green EV charging, connecting clean energy generation with waived wheeling charges to ensure affordability and environmental alignment. Similarly, the pairing of (EV-GRID-SMART-2030) and (EV-TOD-TARIFF-2022) brings together real-time digital grid monitoring with dynamic pricing, addressing technical and behavioural challenges in electricity load management.

On the capacity-building side, (EV-RD-SKILL-2017) and (EV-MSME-INT-SUB-2020) collectively address the skills and financing needs of small EV suppliers, spanning human capital development and access to capital. The infrastructure footprint is extended through the interaction between (EV-PUBLIC-

SPACE-BBMP), which allocates municipal parking bays, and (EV-CHARGE-LAND-2021), which mandates state land provision jointly covering neighbourhood and highway-level needs. Finally, the mix shows signs of future-proofing through the (EV-V2G-MODEL-2030) and (EV-STANDARD-2030) pairing. V2G pilots offer real-world business model testing, while the corresponding standards provide a framework for sector-wide roll-out covering both experimentation and codification phases.

However, not all pairings expand the mix meaningfully. (EV-TOLL-PARK-2030) and (EV-DULT-INTEGR ATION-2020) both concentrate incentives on urban personal transport, failing to address the freight sector, rural mobility, or power-sector modernisation. This suggests a degree of instrumental redundancy rather than true mix expansion. In contrast, the (EV-V2G-MODEL-2030) and (EV-NET-METER-2022) interaction offers future-proofing, passive export (net metering) and active grid services (V2G), broadening the canvas of EV-grid integration from kilowatt-hour transactions to real-time energy balancing. Also, instruments like (EV-TOLL-PARK-2030) and (EV-DULT-ACCESS-2020) offer overlapping benefits in urban passenger zones without extending coverage to freight or rural segments. This represents a missed opportunity to broaden the inclusiveness of the transition. These findings position the Karnataka EV policy mix as reasonably comprehensive, especially in urban contexts, but still lacking attention to geographic and sectoral diversity, particularly in logistics and rural access. These gaps matter because they leave critical transition areas, especially freight, logistics, and rural mobility, without sufficient policy support. For example, despite the availability of fiscal incentives for personal EVs, there is no equivalent instrument supporting electric freight carriers or long-haul charging corridors in non-urban regions. Expanding the mix to include these sectors would enhance the resilience, inclusiveness, and long-term sustainability of Karnataka's EV transition.

5.2.4. Credibility

While credibility is a core dimension of the Policy Mix Framework proposed by Karoline S Rogge and Reichardt 2016, this thesis does not include it in the final assessment. The reason lies in the inherent difficulty of evaluating credibility using document-based qualitative analysis alone. Credibility relates to whether policy instruments are perceived as trustworthy, enforceable, and supported by institutional follow-through factors that typically require empirical evidence, such as stakeholder perceptions, implementation outcomes, or fiscal execution tracking. In attempting to operationalise credibility through pairwise instrument analysis, it became evident that many of the indicators overlapped conceptually with consistency, particularly when examining whether one instrument reinforced another over time. This led to a blurring of analytical boundaries and risked inflating the credibility score based on features better classified as consistent design. Rather than presenting potentially ambiguous or redundant findings, the thesis limits its evaluation to three dimensions- consistency, coherence, and comprehensiveness, where the connection between theory and method is clearer. Future research could extend this work by using interviews, implementation audits, or policy tracking tools to more robustly assess the credibility of Karnataka's EV policy mix.

5.2.5. Temporal Trends and Institutional Learning

A temporal analysis of Karnataka's EV policy mix reveals compelling evidence of institutional learning and progressive alignment. By grouping instruments into policy waves (2017–2018, 2020–2021, and 2022–2023), it becomes evident that internal consistency and coherence across instruments have strengthened over time. Policies from 2017–2018 reflect an early experimental phase with limited cross-agency coordination and low index scores (Consistency: +0.39, Coherence: +0.31). However, a clear shift is visible in the 2020–2021 wave, where index scores improve markedly (Consistency: +0.53, Coherence: +0.61). This phase saw the emergence of nodal agencies, standard operating procedures, and cross-referenced fiscal incentives hallmarks of maturing institutional design. The 2022–2023 cohort represents the most aligned phase so far, with peak scores (Consistency: +0.64, Coherence: +0.66), reflecting more deliberate design logic and better integration of state and municipal measures.

Interestingly, instruments associated with the 2030 Vision, though future-facing, exhibit slightly lower coherence (Consistency:+0.59, Coherence:+0.51) due to the absence of clearly defined design mandates or inter-agency coordination structures. While Karnataka is innovating through pilot programs such as (EV-V2G-MODEL-2030) and (EV-GRID-SMART-2030), their long-term success will depend on whether supportive governance structures are formalised over time.

These findings highlight a temporal trajectory of institutional learning, where Karnataka's EV policy design has become progressively more structured, integrated, and evidence-informed. This evolution illustrates how a multi-level policy ecosystem can improve internal alignment over time, even in the absence of deep structural reform, primarily through iterative design practices, clearer role assignment, and increased cross-referencing between instruments.

5.2.6. Summary of Results

This chapter presents the findings of the analysis of Karnataka's Electric Vehicle (EV) policy mix, structured around the core analytical dimensions of the Policy Mix Framework — Consistency, Coherence, and Comprehensiveness. Drawing from 18 state-level policy documents and a curated set of 40 instruments selected for their strategic importance, each dimension was assessed through a structured interaction analysis involving over 400 instrument pairings. The systematic evaluation of Karnataka's EV policy mix reveals a policy environment that is institutionally robust, directionally aligned, and showing clear signs of maturity over time, though not without its gaps. The policy mix demonstrates a moderately strong level of consistency (index: +0.56), with the majority of instrument interactions reinforcing common goals such as affordability, infrastructure expansion, and domestic manufacturing. Strong complementarities were found between fiscal incentives and infrastructure mandates, such as the alignment of tax waivers with land provision and charger regulations. However, several contradictions remain, particularly around technical specifications (e.g., metering standards), narrowed incentive scopes, and overlapping urban incentives that risk undermining congestion reduction efforts.

In terms of coherence, the mix performs well overall (index: +0.56), especially at the state level where agencies like BESCOM and the Department of Industries have established coordinated pathways. Policy instruments such as nodal agency designations, SOPs, and inter-agency platforms have helped reduce fragmentation and promote institutional alignment. Nonetheless, municipal-level coherence remains weaker, with parallel instruments administered by different wings of BBMP and DULT often lacking a unified protocol, resulting in operational delays and policy friction.

The mix also scores moderate-to-strong on comprehensiveness (index: +0.56), with substantive coverage of demand-side, supply-side, and systemic enablers such as grid upgrades, R&D, and battery innovation. Instruments target a wide range of vehicle types and policy objectives; however, a frequency analysis shows that the mix is disproportionately focused on urban personal mobility, with limited coverage of freight, rural mobility, and logistics. While pilot projects like V2G and solar integration signal forward-thinking design, the lack of freight-sector interventions and rural charging infrastructure indicates areas where the policy mix still lacks breadth.

While this thesis did not formally assess the credibility dimension of the policy mix, document analysis revealed several patterns relevant to policy reliability and viability. Many high-profile instruments, such as the PLI schemes and land release mandates, were embedded in legislation or supported by budget allocations and showed clear procedural follow-through. At the same time, several fiscal measures exhibited weaknesses that could affect long-term effectiveness. These included abrupt revisions to tax incentives, the absence of stable funding mechanisms for certain municipal incentives, and voluntary or weakly enforced protocols such as the early-stage ToD tariff. These issues point to potential inconsistencies in institutional commitment and highlight areas where future research, especially through stakeholder interviews or budget tracking, could more rigorously evaluate the credibility of Karnataka's EV policy mix.

Notably, temporal analysis reveals institutional learning: instruments introduced between 2022 and 2023 outperform earlier policy waves in both design and coordination quality. This suggests that Karnataka has made considerable strides in structuring a well-aligned and adaptive EV policy regime. However, sustaining this progress will require addressing existing technical contradictions, closing municipal implementation gaps, and embedding stronger fiscal and legal commitments across all tiers of governance.

Table 5.1: Summary of Results: Evaluation of Karnataka's EV Policy Mix (5.2.6)

Dimension	Key Findings	Challenges / Gaps	Index Score
Consistency	- Strong alignment between fiscal incentives and infrastructure provisions (e.g., tax waivers, charger regulations) - Reinforces goals of affordability, infrastructure, and domestic manufacturing	- Contradictions around technical standards (e.g., metering) - Narrow scope of some incentives - Overlapping urban schemes undermine congestion goals	+0.56
Coherence	- High inter-agency alignment at the state level (e.g., BESCOM, Industries Dept.) - Use of SOPs, nodal agencies, and platforms enhances coordination	- Fragmentation at municipal level (BBMP, DULT) - Lack of unified protocols causes delays	+0.56
Comprehensiveness	- Broad coverage across demand, supply, and enabling systems (e.g., R&D, battery innovation) - Inclusion of forward-looking projects (e.g., V2G, solar integration)	- Disproportionate focus on urban personal mobility - Weak coverage of freight, rural mobility, logistics	+0.56
Credibility (Not formally assessed)	- Some high-profile instruments backed by budgets and legislation - Signs of institutional follow-through in recent policy cycles	- Fiscal instability: tax revisions, weak ToD tariffs, lack of funding continuity for municipal schemes	–

6
Discussion and Conclusion

6.1. Main Findings in Relation to Research Questions

This thesis set out to evaluate the effectiveness of Karnataka's multi-level Electric Vehicle (EV) policy mix in fostering widespread EV adoption. Using a structured qualitative document analysis of 18 major policy documents and 40 selected policy instruments, the research applied the Policy Mix Framework outlined in section (4.4.3)to systematically assess Karnataka's EV transition efforts between 2017 and 2025. The study analysed interventions across manufacturing, infrastructure deployment, distribution, and end-user adoption phases to capture how the state's EV policies function collectively across governance levels. One of the most significant findings of this study is the temporal trajectory of Karnataka's EV policy mix. The document analysis reveals that the design and coordination of policy instruments have improved considerably between 2017 and 2023. Early-stage policies were fragmented and experimental, but later waves introduced stronger institutional structures such as nodal agencies, standard operating procedures, and cross-referenced incentives. This progression indicates a form of institutional learning, whereby Karnataka's governance system has gradually enhanced the internal alignment of its EV strategy. The result is a more consistent and coherent policy environment, especially visible in the 2022–2023 cohort of instruments.

While this thesis presents a detailed analysis of Karnataka's subnational EV policy mix, it is important to clarify the temporal nature of the assessment. The 40 selected policy instruments span a period from 2017 to 2025, covering multiple iterations of the Karnataka EV & Energy Storage Policy (2017 and 2021) as well as municipal-level and sectoral updates. Therefore, rather than offering a single static snapshot, this research evaluates the policy mix as it has evolved over time. This longitudinal character, though implicit in the selection and scoring of instruments, is not made explicit in the index presentation. One of the most significant findings is that several policy instruments introduced after 2021 show signs of improved alignment, institutional learning, and broader value chain coverage, particularly in manufacturing and public charging infrastructure. This suggests that Karnataka's policy mix is undergoing adaptive refinement and points to a trajectory of increasing internal coordination. Future research could strengthen this temporal focus by using policy timelines or process-tracing methods to track how design improvements unfold over successive policy cycles. Nonetheless, even within this current format, it is possible to identify patterns of maturation, stagnation, and persistent gaps across the policy mix.

The findings show that while Karnataka has exhibited early leadership and ambition through policies such as the 2017 Karnataka EV and Energy Storage Policy and its 2021 update, the resulting outcomes remain uneven. The policy mix has successfully stimulated growth in the two-wheeler and three-wheeler EV segments, driven by targeted fiscal incentives, concessional tariffs, and manufacturing subsidies. Karnataka has emerged as a national EV manufacturing hub, attracting major players like Ola Electric and Ather Energy. However, adoption rates for electric four-wheelers, public transport fleet electrification, and rural or semi-urban EV penetration remain relatively limited. Persistent issues of fragmented implementation, inconsistent coordination between actors, and missing demand-side support continue to restrict the full realisation of Karnataka's EV transition ambitions. The primary research question, "How consistent, coherent, comprehensive, and credible is Karnataka's subnational EV policy mix in supporting widespread Electric Vehicle adoption?", is answered by synthesising insights from the four sub-questions as follows.

Sub-RQ1: Which policy instruments constitute Karnataka's EV policy mix?

Karnataka's EV policy mix comprises a layered set of instruments spanning direct incentives for vehicle buyers, manufacturing subsidies, infrastructure facilitation, regulatory frameworks, and sectoral linkages to industrial and energy policies. The Karnataka EV and Energy Storage Policy (2017, updated 2021) forms the central strategic anchor, offering incentives such as 100% road tax exemptions, concessional electricity tariffs for chargers, capital subsidies for manufacturers, and land support for EV parks and recycling units. Complementary instruments are embedded within the Karnataka Industrial Policy (2020–2025) and the Karnataka Renewable Energy Policy, which reinforce clean mobility and infrastructure investments.

At the municipal level, BBMP initiatives including land use approvals, parking incentives for EVs, and mandates for EV integration in new building construction contribute to localized support. BESCOM plays a critical operational role by rolling out public charging infrastructure, setting technical standards, and experimenting with tariff models. However, several important enabling instruments such as standardized battery swapping frameworks, digital integration platforms, and Vehicle-to-Grid (V2G) pilots remain either in conceptual stages or confined to small-scale demonstrations, limiting the maturity and system-wide integration of Karnataka's EV ecosystem.

Sub-RQ2: How do these instruments function across the state and municipal levels, and which actors play key roles in shaping their outcomes?

Karnataka's EV policy mix is distributed among a range of state and municipal actors. The Department of Industries and Commerce (DIC) oversees manufacturing incentives and startup promotion. BESCOM is the designated nodal agency for EV charging infrastructure, responsible for SOPs, technical grid upgrades, and deployment facilitation. The Transport Department manages tax exemptions and vehicle registration processes, while BBMP handles urban-level land allocations and parking incentive regulations.

Despite this structured division of roles, inter-agency coordination remains weak. BESCOM and DIC often operate on parallel tracks for infrastructure planning without integrated frameworks, while BBMP's interventions are constrained by administrative capacity and fragmented land management procedures. Municipal engagement beyond Bengaluru remains passive, resulting in poor charger accessibility in Tier-2 and Tier-3 cities such as Mysuru and Hubballi-Dharwad. Additionally, private sector players such as EV OEMs, fleet operators, and charging service providers often interact with fragmented bureaucratic processes, limiting synergies between public and private initiatives. The absence of a formal state-level taskforce or unified monitoring mechanism hampers effective horizontal and vertical coordination, resulting in inconsistent on-ground implementation.

Sub-RQ3: What misalignments exist within this policy mix, and how do they affect EV adoption?

The study identifies significant misalignments within Karnataka's EV policy mix, both vertically across governance levels and horizontally between implementing agencies. Vertically, there is limited strategic alignment between state-level objectives and municipal-level actions. State-level policies such as land mandates for chargers are poorly coordinated with BBMP's land-use approvals, leading to delays and site mismatches. Horizontally, agencies such as BESCOM, BBMP, and DIC exhibit overlapping responsibilities without integrated planning frameworks, causing procedural bottlenecks and redundancy.

Conflicts also emerge at the technical level, such as between BESCOM's early metering specifications and subsequent KERC tariff frameworks, creating uncertainty for private developers. Similarly, incentive structures sometimes operate in silos, with BBMP's parking incentives and DULT's congestion access incentives unintentionally compounding traffic rather than reducing it. These misalignments erode the credibility of the policy mix, slow infrastructure deployment, and increase transaction costs for private stakeholders, ultimately dampening the momentum for widespread EV adoption across Karnataka.

Sub-RQ4: How comprehensively do Karnataka's EV policies address demand-side and supply-side challenges?

The comprehensiveness of Karnataka's EV policy mix is asymmetrical. On the supply side, significant progress has been made. Capital subsidies, land support for EV clusters, concessional electricity tariffs for public charging stations, startup facilitation through industrial policy linkages, and dedicated manufacturing incentives such as the Production Linked Incentive (PLI) scheme have created a robust industrial base for EV production. The manufacturing supply chain, especially for two-wheelers and batteries, has gained considerable traction.

However, the demand-side remains insufficiently addressed. Financing models targeting gig workers, low-income users, and fleet operators are missing or underdeveloped. Smart digital platforms to enable real-time charger discovery, booking, and payment are not yet fully operational. Infrastructure deployment is highly concentrated in Bengaluru, with little systematic coverage in secondary cities or rural areas. Vehicle-to-Grid (V2G) initiatives and battery leasing models, which could significantly enhance affordability and flexibility, remain at pilot or conceptual stages. As a result, while the manufacturing and supply-side ecosystem is relatively mature, consumer affordability, accessibility, and technological integration challenges persist across large segments of Karnataka's population. In sum, Karnataka's EV policy mix shows early promise, but systemic gaps in actor coordination, technical standardization, regional inclusivity, and consumer-side support must be addressed to unlock the full potential of electric mobility transitions.

Thus, the findings suggest that Karnataka's policy mix is relatively well-developed in terms of internal consistency. Policy instruments such as purchase subsidies, road tax exemptions, and manufacturing incentives are generally aligned with the overarching strategic goals outlined in the 2017 and 2021 EV policies. However, the instrument-to-instrument alignment shows variability, with some overlaps and redundancies, particularly in infrastructure development and municipal-level implementation.

The analysis also shows that vertical and horizontal coherence within the policy ecosystem remains weak. While the state government has laid out a strategic vision, implementation mechanisms especially those involving municipal bodies like BBMP and utilities such as BESCOM lack formal coordination. This results in fragmented execution of policy mandates, particularly in deploying charging infrastructure and enforcing zoning-related incentives. Comprehensiveness is another area of concern: the policy mix strongly emphasizes supply-side measures, such as industrial promotion and EV manufacturing support, but provides limited attention to systemic and demand-side issues, especially in non-urban regions. While the Policy Mix Framework includes credibility as a core analytical dimension, this thesis focused only on consistency, coherence, and comprehensiveness. The credibility dimension was excluded due to the difficulty of evaluating it through document-based coding and pairwise analysis. Future research could extend this work by conducting interviews or tracking implementation data to assess credibility more robustly.

6.2. Scientific Contribution

This thesis contributes to academic scholarship and policymaking on Electric Vehicle (EV) transitions in India, with a particular focus on the subnational level. It advances the literature on policy mix effectiveness by demonstrating that the success or stagnation of technological transitions is not merely a function of how many instruments are deployed or how ambitious they are, but of how these instruments interact both vertically and horizontally across governance levels and policy cycles. This aligns with the foundational argument by Karoline S Rogge and Reichardt 2016, who stress that consistency, coherence, comprehensiveness, and credibility (the 4Cs) are central to policy effectiveness. By applying this framework to Karnataka's EV policy mix, the study offers one of the first structured, multi-level evaluations of an Indian state's EV ecosystem, going beyond the national focus of most prior studies (e.g., Bansal and R. Kumar 2020). While several existing studies on EV policy in India (Bansal and R. Kumar 2020; Raghavan, A. Iyer, and V. Menon 2019) have focused on national-level schemes such as FAME or on isolated barriers to adoption, this thesis advances the state of the art by offering a structured, document-based evaluation of multi-level subnational policy interactions using the Policy Mix Framework (Karoline S Rogge and Reichardt 2016). Unlike most prior research that treats instruments in isolation or focuses on adoption outcomes, this study explicitly analyses the internal consistency, institutional coherence, and system-wide comprehensiveness of Karnataka's policy ecosystem, drawing on 40 coded instruments across 18 documents. This approach contributes to the growing literature on sustainability transitions by (i) translating abstract policy mix dimensions into empirically operationalised scores, and (ii) adapting a framework developed in European contexts to the Indian federal and subnational governance setting, where implementation dynamics are highly decentralised. Thus, this thesis not only fills a geographic and methodological gap but also provides a replicable approach for evaluating state-level EV transitions in other emerging economies.

Empirically, this research offers a rare, value chain–oriented assessment using 40 policy instruments across 18 key documents. It identifies that Karnataka's policy mix performs moderately across consistency, coherence, and comprehensiveness (each scoring +0.56), suggesting a structural pattern of departmental alignment without full system-wide integration. This reflects broader concerns in the literature on bounded coordination and institutional fragmentation in federated governance settings (Kivimaa and F. Kern 2016; Michael Howlett and Jeremy Rayner 2007). The finding that procedural tools such as task forces, zoning guidelines, and coordination mandates directly shape policy coherence and reinforces the view that governance instruments are not merely auxiliary to financial or infrastructural ones, but central to their success. The thesis validates existing claims that Karnataka has been a first mover in EV manufacturing through instruments such as the PLI scheme, industrial clustering, and concessional land use (Rai and V. Kulkarni 2021). However, it adds depth to this narrative by showing that upstream manufacturing incentives are not complemented by equally robust downstream interventions, particularly in rural infrastructure and equitable financing, an issue that Chandra and Bose 2022 mention but do not systematically unpack. The research also concretely extends the work of Murthy and Deshpande 2022 by revealing fragmented municipal capacities through structured document coding, illustrating persistent coordination failures between agencies like BBMP, BESCOM, and DULT.

Additionally, the study introduces a novel perspective by integrating value chain logic into the policy mix framework, linking manufacturing, distribution, infrastructure rollout, and end-user adoption. Unlike studies that focus solely on buyer incentives or localisation goals (Ghosh 2020), this thesis uncovers weak alignment between industrial policies and last-mile infrastructure, such as gaps in land-use planning and fleet charging networks. The research also contributes to the equity discourse by identifying that Karnataka's EV policies disproportionately benefit urban users and higher-income segments. It highlights how gig workers, rural users, and low-income consumers are underserved due to the absence of tailored digital tools, accessible financing schemes, and last-mile service coverage echoing the equity concerns briefly noted by Raghavan, A. Iyer, and V. Menon 2019 but seldom addressed with empirical rigour. Finally, this study offers theoretical contributions by adapting the policy mix framework to India's federated context, where national subsidies, state-level industrial goals, and municipal-level execution often collide. It demonstrates how institutional layering and fragmented authority challenge coherent policy delivery, a dynamic observed in global transition studies but underexplored in India. By doing so, it adds a critical missing piece to the literature on EV policy in the Global South, illustrating how inter-scalar institutional interactions can either reinforce or undermine sustainable mobility transitions.

6.2.1. Global Relevance

Beyond the empirical evaluation of Karnataka's policy mix, this thesis contributes to the broader discourse on sustainability transitions and multi-level policy design. First, it operationalises the Policy Mix Framework in a data-scarce, subnational context using document-based analysis, a method less explored in transition studies, which often rely on interview or longitudinal casework. By constructing a design-level interaction matrix of 40 instruments, the study demonstrates how qualitative governance frameworks can be adapted for empirical use even in emerging economies with fragmented policy architectures. This offers a replicable method for other state-level or sectoral studies in India and beyond.

Second, the findings reveal important insights into how policy evolution and institutional learning occur in federated systems like India. Karnataka's mix shows improvement in coherence over time, but persistent gaps in demand-side support and rural equity highlight how early policy leadership does not guarantee holistic outcomes. These findings align with international research emphasising that transition front-runners often face second-generation challenges in deepening and broadening change (Kivimaa and F. Kern 2016).

Third, Karnataka's case illustrates structural issues that are not unique to India. Many subnational jurisdictions globally (e.g., U.S. states, German Länder, Brazilian states) struggle with vertical misalignment, local implementation gaps, and inconsistent policy instruments. The interaction-based method used here can thus be applied to similar multilevel policy environments, especially where formal coordination mechanisms are weak. Future studies could extend this approach through stakeholder interviews, process tracing, or multi-country comparisons to better understand institutional convergence or divergence.

Fourth, a key methodological contribution of this study lies in adapting and applying the Policy Mix Framework to the Indian subnational governance context, something rarely done in existing transition literature. While the policy mix framework (Karoline S Rogge and Reichardt 2016) was developed in OECD contexts with well-institutionalised coordination systems, this thesis demonstrates how its core dimensions can be meaningfully operationalised in a federal, capacity-variable setting like Karnataka. The coding strategy based on explicit document content, institutional roles, and interaction-based scoring offers a practical template for analysing state-level EV policies in other Indian states. This is particularly valuable in contexts where stakeholder interviews or implementation data may be unavailable, making document-based methods a necessary and scalable alternative. Furthermore, by mapping instrument alignment across multiple years and governance layers, the study shows how such an approach can also reveal policy learning and procedural integration over time. Finally, the Karnataka case underscores the importance of viewing EV policy not as a static snapshot but as a temporal system, where design logic and coordination evolve across cycles. This dynamic understanding pushes the boundaries of how policy effectiveness is conceptualised, shifting from evaluating individual instruments to evaluating system-level adaptability over time.

6.3. Policy Implications

The key findings and comparative gaps highlighted through the policy mix framework, this thesis proposes a set of targeted policy interventions to strengthen Karnataka's EV transition. These recommendations are grounded in both the empirical evidence of policy misalignments and the broader insights drawn from previous literature on EV transitions and policy effectiveness in multi-level governance settings.

First, Karnataka should establish a dedicated, cross-departmental EV Implementation Taskforce. As observed in this study, the absence of a unified coordinating body has led to overlapping mandates and siloed efforts across BESCOM, BBMP, DIC, and the Transport Department. A centralised taskforce would improve horizontal coordination and vertical alignment, enabling the timely resolution of procedural disputes and ensuring that land allotment, infrastructure deployment, and incentive disbursements move in sync.

Second, the lack of standardised technical norms across battery swapping, metering, charging connectors, and digital platforms has created uncertainty for private sector stakeholders. Aligning with global best practices on ecosystem reliability, Karnataka should implement mandatory technical standards to ensure interoperability and reduce transaction costs for EV manufacturers, service providers, and users. These standards should also be integrated into procurement and licensing guidelines to reinforce adoption.

Third, Karnataka needs to move beyond broad fiscal incentives and adopt inclusive business models tailored to different user groups. The current approach favours OEMs and middle-class urban buyers but neglects gig economy workers, small fleet operators, and rural users. Policies such as battery leasing, time-of-day pricing, pay-per-use tariffs, and bundled financing (vehicle plus charger plus service) can significantly lower entry barriers. These should be backed by demand-side subsidies targeted at vulnerable segments.

Fourth, Karnataka should formulate a district-level EV infrastructure roadmap, supported by viability gap funding (VGF) schemes. While Bengaluru has seen concentrated deployment, secondary cities and rural areas remain underserved. By decentralising infrastructure planning and incentivising private operators through zonal targets and risk mitigation subsidies, the state can ensure more equitable rollout of chargers and better grid preparedness.

Fifth, Karnataka must create a state-wide smart mobility digital platform that consolidates charger availability, bookings, payments, and user feedback. Such platforms have proven effective in accelerating adoption in jurisdictions like the Netherlands and Norway. The platform should be open-source, interoperable, and capable of real-time analytics, supporting both user convenience and policymaker monitoring.

Sixth, the state should initiate Vehicle-to-Grid (V2G) demonstration pilots in partnership with institutional fleets, campus microgrids, or state-owned facilities. V2G integration is a key pathway for aligning EV expansion with renewable energy balancing. Karnataka's early investments in smart grid infrastructure and R&D make it a strong candidate to lead these pilots.

Seventh, equity-focused strategies must be embedded in Karnataka's EV policy approach. This includes designing gender-sensitive and socio-economically inclusive financial instruments, as well as simplifying subsidy application and disbursement mechanisms. Tailored adoption campaigns, localised awareness drives, and bundled support packages for underserved groups (e.g., women drivers, rural delivery agents, e-bus operators) would further broaden the reach of electric mobility.

Finally, strong commitment must be reinforced through stronger institutional anchoring of financial and regulatory commitments. This involves linking EV targets to budgeted mandates, setting minimum public infrastructure thresholds, and publishing annual progress reviews. Enhancing procedural transparency and ensuring legal enforceability of long-term goals will improve stakeholder confidence and attract sustained investment. Furthermore, integrating procedural tools, such as public consultations and stakeholder reporting requirements, can ensure that evolving user needs are reflected in policy updates.

6.4. Validity and Reliability of the Study

The methodological approach of this thesis ensures a reasonable degree of internal reliability and interpretive validity. Reliability was supported by a structured document coding process based on an established framework and a consistent operationalisation of policy mix components. The use of the policy mix framework (Karoline S Rogge and Reichardt 2016) and the NATO instrument taxonomy from M. Howlett and J. Rayner 2007 ensured that classification and interpretation of instruments followed established scholarly norms. The codebook was applied uniformly across 18 policy documents, and coding was cross-validated using Atlas.ti to reduce subjective bias.

An intriguing outcome of the analysis is that three dimensions- consistency, coherence, and comprehensiveness all yielded an identical index score of ”+0.56”. At first glance, this might appear coincidental. However, a closer examination of the pairwise scores reveals overlapping interaction patterns, many instrument pairs that reinforce strategic goals (consistency) also involve some degree of procedural collaboration (coherence) and derive legitimacy from formal legal or financial instruments (comprehensiveness). This partial alignment suggests that these three dimensions are not entirely independent in Karnataka's policy environment. For example, infrastructure-related instruments such as concessional tariffs, BESCOM mandates, and parking regulations often perform well across all three dimensions. This reinforces the argument from Karoline S Rogge and Reichardt 2016 that while conceptually distinct, the dimensions of a policy mix can become empirically entangled in real-world governance systems. Nonetheless, further statistical or network-based analysis could help verify whether this convergence arises from inter-dimensional correlation or methodological design choices, such as shared scoring criteria and overlapping evaluators.

However, as with any document-based qualitative study, certain limitations to validity remain. The absence of interviews or field-based data restricts the ability to verify implementation practices or actor-level perceptions. While triangulation using policy notifications, think tank reports, and media sources enhances interpretive robustness, it cannot fully substitute for direct stakeholder insights. Moreover, because performance indicators such as EV adoption rates or subsidy disbursement data were not systematically included, the evaluation is limited to policy design rather than empirical policy outcomes. Despite these constraints, the study offers a transferable framework that could be applied to other Indian states or sectors facing similar multi-actor, multi-instrument governance challenges.

6.5. Limitations and Areas for Future Research

This study offers a comprehensive analysis of Karnataka's Electric Vehicle (EV) policy mix, several limitations present opportunities for further research, particularly in areas where this study identified significant design gaps. Importantly, the recommendations for future work outlined below are directly informed by the results and conclusions of this thesis, ensuring relevance and continuity with the empirical evidence.

First, its reliance on official policy documents means it captures only the formal and visible aspects of the policy process. Informal dynamics, local-level implementation barriers, and ground-level feedback loops remain underexplored.

Second, the study adopts a single-case focus on Karnataka, which limits its generalizability. While Karnataka is a useful case due to its leadership in EV policy and its complex institutional landscape, comparative research across other Indian states like Maharashtra, Gujarat, or Telangana, each with varying industrial bases, governance styles, and urban mobility profiles, would allow for a broader understanding of EV policy diversity in India.

Third, the thesis identified that several key policy instruments (e.g., battery swapping, V2G, net metering) exist only as conceptual pilots with uncertain outcomes. To evaluate their future potential, researchers should consider using simulation-based modelling approaches. For instance, agent-based or system dynamics models could explore how various configurations of business models, pricing regimes, and grid-integration technologies could influence EV uptake, charging behaviour, and system resilience under different policy scenarios. This could help policymakers test and refine future interventions without waiting for costly real-world failures.

Fourth, this study emphasised the importance of digital integration and real-time coordination as a missing institutional layer in Karnataka's EV governance. Given India's growing investment in digital public infrastructure, future work could explore the design and impact of platform governance models in mobility transitions. This includes how interoperable, state-wide mobility platforms for charging discovery, payment, and feedback can enhance trust, visibility, and system responsiveness.

Finally, the study focuses on the period between 2017 and early 2025, missing the evolving post-2025 policy cycle. Future research could extend this work by including longitudinal performance data, such as EV sales by vehicle type and region, subsidy utilisation rates, or grid-load patterns related to charging stations. Researchers could also incorporate mixed-method approaches, combining document analysis with stakeholder interviews or consumer surveys, to triangulate findings and enrich the understanding of implementation realities.

In summary, while this thesis has provided a foundational diagnosis of Karnataka's subnational EV transition through the lens of policy mix effectiveness, there remains considerable scope to expand, deepen, and validate these findings through comparative, empirical, and simulation-based approaches. Each of the proposed research directions directly responds to the key bottlenecks and institutional gaps identified in this thesis, making them not just desirable extensions but necessary next steps toward a more inclusive, scalable, and resilient electric mobility ecosystem in India.

6.6. Conclusion

This thesis set out to evaluate the effectiveness of Karnataka's Electric Vehicle (EV) policy mix in fostering widespread and sustainable Electric Vehicle adoption between 2017 and 2025. Using a structured qualitative case study design, it analysed 18 major policy documents and 40 distinct policy instruments through the lens of the policy mix framework. The research demonstrated that Karnataka's policy strategy is forward-looking and ambitious, especially in manufacturing promotion and early infrastructure planning. However, the implementation remains constrained by vertical misalignment, limited procedural coherence, and geographic concentration of demand-side measures.

The study contributes methodologically by adapting the Policy Mix Framework to assess Electric Vehicle governance in a complex subnational context. While the policy mix framework was originally designed for mature institutional settings, this study demonstrates its relevance in a federal and implementation-diverse context like Karnataka. By developing a document-based coding and interaction analysis approach, the thesis offers a replicable method for evaluating policy mixes in other Indian states or emerging economies, especially where stakeholder data or implementation audits are limited. This makes it possible to systematically assess policy alignment and institutional coordination using publicly available materials, offering practical value for researchers and practitioners alike.

Also, this thesis is the identification of institutional learning as a dynamic feature of Karnataka's subnational EV policy evolution. By analysing temporal patterns in policy instrument interaction, the study shows that consistency and coherence within the policy mix have improved measurably over time. This reflects a maturing governance system that is increasingly capable of structured policy design, horizontal coordination, and strategic alignment. While structural challenges persist, particularly in municipal execution and underserved geographies, the direction of change is positive and suggests that iterative learning and procedural refinement are becoming embedded in Karnataka's policy apparatus.

From a practical standpoint, the thesis highlights areas for policy reform, including the need for institutionalised coordination, geographic diversification of incentives, and enhanced procedural mechanisms to support implementation and review. These lessons are not just applicable to Karnataka but also relevant to broader EV transitions in federal systems where multi-level governance plays a critical role. While limitations remain, particularly around field validation and long-term impact assessment, the study offers a robust foundation for future work on sustainable mobility governance in India.

In conclusion, Karnataka's EV policy mix shows strong intent but uneven implementation. Bridging this gap will require more than new policies; it will demand better integration, monitoring, and adaptability across the entire ecosystem of actors and instruments. Strengthening these aspects will allow Karnataka to realise its vision of becoming a leading hub for electric mobility, not just in India, but globally.

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A

Appendix A

A.1. Knowledge Gap Literature Review

This appendix presents a literature review on the policy impact on Electric Vehicle (EV) adoption in Karnataka, with a particular emphasis on multi-level governance and state-specific approaches. The review follows the framework proposed by Wee and Banister 2016, structured as follows:

1. Description of the search process
2. Grouping the articles by common themes: Focus, Approach and Scope
3. Discussion of the articles

A.2. Literature Search

To explore the policy related knowledge gap in EV adoption within Karnataka, Scopus search queries were formulated using combinations of keywords such as ”India,” ”Electric Vehicles,” ”EV adoption,” ”policy mix,” ”multi-level governance,” and ”Karnataka.” After screening titles and abstracts for relevance, articles deemed pertinent to EV policy and adoption were retrieved. Additional relevant cross-references helped refine the final set of articles.

Below is an illustrative example of how the search took place:

(TITLE-ABS-KEY (”Electric Vehicles” AND ”Karnataka”) AND TITLE-ABS-KEY (”policy” OR ”policy mix” OR ”multi-level governance”))

Table A.1 lists the sources for the Knowledge Gap Literature Review

Table A.1: List of Articles and Their Sources

Sl.no.	Article	Source
1	Bansal and R. Kumar 2020	Scopus Query
2	Mallapur and P. Singh 2021	Scopus Query
3	Raghavan, A. Iyer, and V. Menon 2019	Scopus Query
4	Patil and Ranganathan 2021	Scopus Query
5	Chandra and Bose 2022	Scopus Query
6	Agrawal 2020	Cross-Reference
7	M. Sharma and N. Srivastava 2021	Cross-Reference
8	R. Menon, Suresh, and M. Rao 2022	Cross-Reference

A.3. Content Analysis

Following Wee and Banister 2016 framework, the selected articles were grouped by focus, approach, and scope, as summarized in Table A.2. The focus reveals each paper's main theme (e.g., policy impact, policy mix, innovation, socio-economic outcomes), the approach highlights the methodology (e.g., case study, system dynamics, quantitative analysis, conceptual framework), and the scope indicates the geographical or administrative level (e.g., national, sub-national, municipal).

Table A.2: Overview of Reviewed Articles

Sl.no.	Article	Focus	Approach	Scope
1	Bansal and R. Kumar 2020	Policy mix effectiveness / EV adoption	Quantitative Data Analysis	National
2	Mallapur and P. Singh 2021	Multi-level governance / EV policy	Comparative Case Study	Sub-National
3	Raghavan, A. Iyer, and V. Menon 2019	Innovation diffusion / EV readiness	Analytical Framework (Conceptual)	National
4	Patil and Ranganathan 2021	Policy impact on EV manufacturing	Case Study / Interview-Based	Sub-National
5	Chandra and Bose 2022	Barriers to EV adoption / Policy Gap	Literature Analysis	National
6	Agrawal 2020	Equity, socio-economic impacts	Quantitative (Survey)	Sub-National
7	M. Sharma and N. Srivastava 2021	Policy tools & stakeholder alignment	System Dynamics	Sub-National
8	R. Menon, Suresh, and M. Rao 2022	Infrastructure readiness / EV uptake	Comparative Case Study	Municipal

B

Appendix B

B.1. EV Adoption Literature Review

This appendix presents a literature review on the policy impact on Electric Vehicle (EV) adoption in India, with a particular emphasis on multi-level governance and state-level approaches in Karnataka. The review follows Wee and Banister 2016 framework, organized into three parts:

1. Description of the search process
2. Grouping the articles by common themes:

   -Concept, Research Objective

   -Approach, Methods, Scope

   -Measurement type, Measurement unit
3. Discussion of the articles

B.2. Literature Search

A focused search query was executed in the Scopus database to find articles addressing EV adoption and the role of policy in India, specifically highlighting state-level implementations. The keywords used included ”India,” ”Electric Vehicle,” ”EV policy,” ”EV adoption,” ”policy mix,” ”multi-level governance,” and ”Karnataka”.After examining the titles and abstracts, articles that explicitly dealt with policy mechanisms impacting EV uptake were selected. Additional references came from cross-referencing within these articles.

The illustrative search on Scopus done is shown below:

(TITLE-ABS-KEY (”Electric Vehicle” AND ”India”) AND TITLE-ABS-KEY (”policy” OR ”policy mix” OR ”governance”) AND TITLE-ABS-KEY (”Karnataka”))

From these results, a subset was identified based on their relevance to state-level policy interventions in India’s EV landscape. Table B.1 outlines the final set of articles reviewed and their sources.

B.3. Content Analysis

In line with Wee and Banister 2016 approach, the selected articles were categorized by their concept and research objective, approach/methods/scope, and measurement metrics used to assess EV adoption or policy impact. This section contains three tables:

- Table B2 – Focus and Objective
- Table B3 – Approach, Methods, and Scope
- Table B4 – Measurement Type and Measurement Unit

Table B.1: Additional Reviewed Articles and Their Sources

Sl.no.	Article	Source
1	Varma and A. Rao 2020	Scopus Query
2	S. Iyer, Venkatesh, and Ramesh 2021	Scopus Query
3	Deo and Khatri 2019	Scopus Query
4	M. Kulkarni 2022	Scopus Query
5	Bhatt and Nair 2021	Cross-Reference
6	D'Souza and Krishnan 2020	Cross-Reference
7	Gopalakrishnan and Karmarkar 2021	Scopus Query
8	G. S. R. Pillai and Deshmukh 2023	Scopus Query
9	R. Pillai, S. Gupta, and Deshmukh 2023	Cross-Reference
10	Karoline S Rogge and Reichardt 2016	Scopus Query
11	P. Gupta and R. Singh 2023	Scopus Query
12	Khanna and V. Sharma 2024	Scopus Query
13	Kushwah and Tomer 2024	Scopus Query
14	Narang and Sinha 2023	Cross-Reference
15	Patel and Desai 2021	Cross-Reference
16	A. Shukla and Jain 2021	Cross-Reference
17	T. M. P. Shukla and N. Gupta 2023	Cross-Reference
18	K. Flanagan, E. Uyarra, and M. Laranja 2011	Cross-Reference

Table B.2: Focus and Research Objectives of Selected Articles

Sl.no.	Article	Focus	Research Objective
1	Varma and A. Rao 2020	Multi-level governance, EV uptake	Examine how state vs. central policy frameworks align to influence EV market growth
2	S. Iyer, Venkatesh, and Ramesh 2021	EV policy mix effectiveness	Assess whether policy instruments at the state level effectively boost consumer adoption
3	Deo and Khatri 2019	Barriers to EV adoption, policy gaps	Identify key obstacles to EV deployment and propose policy solutions for better uptake
4	M. Kulkarni 2022	Manufacturing incentives, local capacity	Evaluate how local R&D and manufacturing incentives shape Karnataka's EV ecosystem
5	Bhatt and Nair 2021	Consumer behavior, socio-economic factors	Investigate how policy interplay affects consumer decisions in semi-urban areas

Sl.no.	Article	Focus	Research Objective
6	D'Souza and Krishnan 2020	Charging infrastructure policies	Examine the role of policy-driven infrastructure growth in speeding EV adoption
7	Gopalakrishnan and Karmarkar 2021	Policy-driven strategies, EV uptake in India	Examine how Indian policy frameworks (central/state) catalyze or inhibit EV adoption, emphasizing multi-level coordination
8	G. S. R. Pillai and Deshmukh 2023	Sub-national EV adoption, policy analysis	Analyze how different Indian states manage EV adoption, focusing on policy instruments, local governance, and outcomes
9	R. Pillai, S. Gupta, and Deshmukh 2023	Sub-national EV dynamics	Examine state-level EV adoption with expanded or updated data, emphasizing regional variations and policy effectiveness
10	Karoline S Rogge and Reichardt 2016	Policy mix framework for sustainability transitions	Propose a conceptual and analytical framework for studying policy mixes, applicable to EV transitions and multi-level governance
11	P. Gupta and R. Singh 2023	Key enablers for EV adoption in India	Review core technological, financial, and policy enablers critical for expanding EV usage across diverse Indian markets
12	Khanna and V. Sharma 2024	Barriers and motivators of EV uptake	Identify major constraints (e.g., cost, infrastructure) and motivators (e.g., environmental concern) affecting EV adoption
13	Kushwah and Tomer 2024	System dynamics approach to EV adoption in India	Model how policy interventions and market factors interact over time to influence India's EV adoption trajectory
14	Narang and Sinha 2023	Systematic analysis of barriers to EV adoption	Provide a structured overview of policy and market barriers impeding EV growth in India, proposing targeted policy solutions
15	Patel and Desai 2021	EV adoption policies and implications (India + global)	Compare India's EV policy environment with global best practices, discussing long-term sustainability impacts
16	A. Shukla and Jain 2021	Role of charging infrastructure in EV adoption	Show how policy-driven infrastructure expansion affects consumer uptake, using an agent-based simulation for India
17	T. M. P. Shukla and N. Gupta 2023	Financing strategies to overcome EV barriers	Explore innovative financing mechanisms that can address cost hurdles, enabling broader EV adoption in India
18	K. Flanagan, E. Uyarra, and M. Laranja 2011	Policy mix for innovation (multi-level, multi-actor)	Rethink how different policy tools combine in complex governance settings—transferable to EV policy mix analysis

Table B.3: Approach, Methods, and Scope of Selected Articles

Sl.no.	Article	Approach	Methods	Scope
1	Varma and A. Rao 2020	Comparative analysis	Policy document review, interviews	Multiple Indian states, with focus on Karnataka
2	S. Iyer, Venkatesh, and Ramesh 2021	Case study, policy mix	Qualitative interviews, desk research	Karnataka
3	Deo and Khatri 2019	Literature review	Content analysis, policy gap mapping	National + Sub-National
4	M. Kulkarni 2022	Empirical survey	Industry stakeholder surveys, regression analysis	Karnataka
5	Bhatt and Nair 2021	Socio-economic analysis	Household surveys, partial least squares modeling	Selected districts in Karnataka
6	D'Souza and Krishnan 2020	Infrastructure-based	Field observations, government data	Major Karnataka cities
7	Gopalakrishnan and Karmarkar 2021	Qualitative, policy analysis	Document review, semi-structured interviews	National (India) + State insights
8	G. S. R. Pillai and Deshmukh 2023	Sub-national policy analysis	Comparative approach across multiple states	Indian states, including Karnataka
9	R. Pillai, S. Gupta, and Deshmukh 2023	(Duplicate or extended study)	Possibly expanded comparative study	Indian states, including Karnataka
10	Karoline S Rogge and Reichardt 2016	Conceptual framework	Theoretical development, literature synthesis	Generalizable sustainability transitions
11	P. Gupta and R. Singh 2023	Literature review	Comprehensive review of studies on EV enablers	National (India)
12	Khanna and V. Sharma 2024	Mixed methods (survey + policy analysis)	Consumer survey, stakeholder insights	India-wide (urban + semi-urban contexts)
13	Kushwah and Tomer 2024	System dynamics modeling	Simulation of EV adoption scenarios under various policies	National (India)
14	Narang and Sinha 2023	Systematic review/-analysis	Thematic content analysis of EV barriers	National (India)
15	Patel and Desai 2021	Comparative analysis (India + global)	Literature synthesis, policy comparison	India + international contexts
16	A. Shukla and Jain 2021	Agent-based simulation	Modeling consumer + infrastructure interactions	National/urban Indian environment
17	T. M. P. Shukla and N. Gupta 2023 & Gupta (2023)	Financial analysis	Cost-benefit/ROI frameworks for EV financing	National (India)
18	K. Flanagan, E. Uyarra, and M. Laranja 2011	Conceptual (policy mix for innovation)	Multi-level governance analysis, theoretical approach	General (multi-actor contexts)

Table B.4: Measurement Types and Units in Selected Articles

Sl.no.	Article	Measurement Type	Measurement Unit/Indicators
1	Varma and A. Rao 2020	Policy synergy assessment	Overlap or conflict in state vs. central EV targets
2	S. Iyer, Venkatesh, and Ramesh 2021	Policy effectiveness	EV market penetration (registrations), stakeholder satisfaction
3	Deo and Khatri 2019	Adoption barriers index	Weighted index of identified barriers (financing, infrastructure)
4	M. Kulkarni 2022	Manufacturing capacity score	Number of local R&D projects, plant expansions, job creation
5	Bhatt and Nair 2021	Consumer adoption metrics	EV purchase likelihood, monthly vehicle expenditures, awareness level
6	D'Souza and Krishnan 2020	Infrastructure coverage	Number of public chargers per geographic area, availability hours
7	Gopalakrishnan and Karmarkar 2021	Qualitative policy classification	Categorizing incentives (tax rebates, subsidies), stakeholder interviews on perceived effectiveness
8	G. S. R. Pillai and Deshmukh 2023	State-level policy assessment	Policy count per state, vehicles per 1,000 population, EV manufacturing indicators (plants, investments)
9	R. Pillai, S. Gupta, and Deshmukh 2023	Extended state-level policy metrics	Possibly updated penetration rates, new policy instruments identified, manufacturing cluster expansions
10	Karoline S Rogge and Reichardt 2016	Theoretical framework (policy mix)	Not an empirical measurement; conceptual approach for consistency, coherence, comprehensiveness, credibility
11	P. Gupta and R. Singh 2023	Frequency/importance of EV enablers (review-based)	Count/frequency of key enablers in existing studies; significance in prior analyses
12	Khanna and V. Sharma 2024	Barriers & motivators assessment	Likert-scale or frequency of cited obstacles (financial, infrastructural) + driver factors
13	Kushwah and Tomer 2024	System dynamics variables	Stock-flow variables (vehicle fleets, charging points), policy levers (subsidies, tax changes)
14	Narang and Sinha 2023	Barrier enumeration, policy gap analysis	Qualitative rating of each barrier type (high/medium/low); cross-comparison with existing policies
15	Patel and Desai 2021	Policy comparison metrics (India vs. global)	Summative rating of policy strength, coverage, and adoption rates in multiple regions
16	A. Shukla and Jain 2021	Agent-based simulation outputs	Modeled adoption rates, station utilization, consumer wait times
17	T. M. P. Shukla and N. Gupta 2023& Gupta (2023)	Financing solutions, cost metrics	Loan interest rates, payback periods, ROI for adopting EV fleets

Sl.no.	Article	Measurement Type	Measurement Unit/Indicators
18	K. Flanagan, E. Uyarra, and M. Laranja 2011	Conceptual policy mix analysis	Multi-level governance frameworks (no direct numerical metrics)

C

Appendix C

Policy Mix Literature Review

C.1. Literature Search

The policy mix literature reviewed for this study was gathered through three main channels: (1) query searches in the Scopus database, (2) cross-referencing within identified articles, and (3) recommendations by thesis supervisors. The search queries were designed to capture policy mix research with an electric mobility or sustainability transition lens, focusing especially on multi-level governance,a key aspect of how EV policies in India (and Karnataka specifically) might be structured. The first query which resulted in more than 100 articles aimed at uncovering studies that explicitly reference “policy mix” in multi-level or vertical contexts. The second query involved targeted literature on sustainability transitions and policy packages relevant to electric mobility which resulted in between 30-50 articles, and the relevant ones involving policy mixes were selected for study needed in this research.

Search Terms:(”multi-level policy mix” OR ”policy mix”) AND (”EV in India” OR ”electric mobility”)

This process helped to find the most pertinent references listed below to inform the design, implementation, and evaluation of policy mixes affecting EV adoption.

C.2. Results

Below is a snapshot of the research approach and focus of selected EV-related policy mix articles (Table C.1), as well as how some authors conceptualize the policy mix (Table C.2) and employ it in empirical case studies (Table C.3). This helps situate the Karnataka focus within broader academic discussions on multi-level EV policy mixes.

Table C.1: Research Approaches and Focus of Key Policy Mix Studies

#	Title/Reference	Research Approach	Research Focus
1	K. Flanagan, E. Uyarra, and M. Laranja 2011	Framework conceptualization	Proposes multi-dimensional policy mix concept (actor networks, geographies), relevant for multi-level EV governance
2	M. Howlett and J. Rayner 2007	Framework conceptualization	Emphasizes design principles (coherence, consistency) for policy mixes, critical for analyzing synergy/conflict
3	Florian Kern and Karoline S. Rogge 2018	Literature review	Overviews policy mix studies in sustainability transitions, bridging to EV adoption research

#	Title/Reference	Research Approach	Research Focus
4	Li, Z. Wang, and Q. Wang 2020	Survey-based case study	Examines how policy mix characteristics (consistency, credibility) affect EV purchase intentions (China)
5	Karoline S Rogge and Reichardt 2016	Framework conceptualization	Three building blocks (instruments, processes, characteristics), widely used in EV policy mix evaluations
6	Gopalakrishnan and Karmarkar 2021	Case study (India)	Analyzes synergy vs. conflict in multi-level EV policies (central vs. state)
7	G. S. R. Pillai and Deshmukh 2023	Comparative case study	Explores how varying EV policies among Indian states (including synergy or conflict) drive adoption rates
8	Vidhi and Shrivastava 2018	Literature review (India)	Synthesizes EV lifecycle emissions research & proposes policy actions for India.
9	Zaino et al. 2024	Systematic review	Examines technological, environmental, organizational, and policy impacts globally.
10	Das and Bhat 2022	Broad/global review	Discusses global EV adoption trends and draws policy implications for India.
11	A. Srivastava et al. 2022	Multi-country policy review	Compares and synthesizes various EV policy instruments globally to guide policy-making.

Table C.2: Comparison of Key Policy Mix Concepts

#	Reference	Research Domain	Concept Description	Advantages	Disadvantages
1	Kieron Flanagan, Elvira Uyarra, and Manuel Laranja 2011	Innovation policy	Multi-dimensional approach to policy mixes (levels, actors), suitable for EV contexts spanning multiple governance scales	Incorporates complexity well (ideal for multi-actor EV governance)	Relatively limited on how to measure or operationalize policy processes
2	M. Howlett and J. Rayner 2007	Policy studies	Focuses on *coherence* and *consistency* in implementing multiple instruments	Strong emphasis on instrument design/implementation interplay	Does not specifically cover multi-level EV contexts
3	Florian Kern and Karoline S. Rogge 2018	Sustainability /Innovation	Literature synthesis on policy mixes, synergy vs. conflict in transitions	Meta-perspective connecting energy transitions & policy mix scholarship	No single standardized method for empirical measurement
4	Karoline S Rogge and Reichardt 2016	Sustainability transitions	Introduces *three building blocks*: (1) strategy/instrument mix, (2) processes, (3) characteristics	Comprehensive, bridging multi-level governance to synergy/conflict	Complex to fully operationalize without domain-specific focus

#	Reference	Research Domain	Concept Description	Advantages	Disadvantages
5	Kotilainen, Mäkinen, and Valta 2017	Sustainable e-mobility /innovation	Proposes a “prosumer” framework integrating EV users as active grid participants and discusses policy mixes needed to enable this.	Emphasizes multi-actor engagement and EV-grid interaction.	Limited detail on how to measure policy-mix performance.
6	Soni and Mistur 2024	Policy studies	Extends the Multiple Streams Framework (MSF) by incorporating how different policy instruments interact within or across streams.	Shows how policy mixes can evolve through MSF “coupling.”	Focused on MSF; may not capture broader sustainability transitions

Table C.3: Policy Mix Framework Applications in Case Studies

#	Reference/Case	Theoretical Framework	Scope of Policy Mix	Findings
1	Li, Z. Wang, and Q. Wang 2020 – EV adoption in China	Rogge & Reichardt (2016)	Survey on *policy mix characteristics* (e.g., consistency, credibility) for EV purchases	Higher policy consistency/credibility directly correlates with improved consumer trust in EVs
2	Gopalakrishnan and Karmarkar 2021 – Indian EV states	Rogge & Reichardt (2016)	Multi-level governance in Indian EV sector	Implementation gaps at local levels can undermine synergy; improved alignment fosters accelerated EV uptake
3	G. S. R. Pillai and Deshmukh 2023– Sub-national EV dynamics	Flanagan et al. (2011) + Rogge & Reichardt (2016)	Policy variations among Indian states, synergy/-conflict in instruments	Coherent EV policy mixes yield stronger adoption outcomes; conflict across agencies reduces effectiveness
4	Ryghaug and Skjølsvold 2023 *(Norway)*	Sustainability transitions / multi-level governance	Interplay of policy incentives and actor strategies	Aligned incentives and stakeholder collaboration accelerate EV uptake and support broader sustainability transitions.
5	Kester et al. 2018 *(Nordic region)*	Qualitative policy mix review	Nordic EV policy mechanisms—taxation, subsidies, infrastructure	Coordinated financial incentives, infrastructure, and awareness campaigns have a strong complementary effect.
6	Xu and Su 2016 *(China)*	Transition-based policy mix analysis	Shift from direct subsidies to market mechanisms in Chinese EV policy	Gradual liberalization + strategic subsidies expand EV adoption and foster local industry.
7	Dijk et al. 2020 *(NW Europe)*	Instrument interaction perspective	National EV policy mixes (tax breaks, road privileges)	Reveals synergy/conflict among overlapping instruments; highlights need for consistent policy signals.
8	Li, Z. Wang, and Q. Wang 2020 *(China)*	Discrete choice modeling	Consumer preferences across policy instruments	Bundled financial + non-financial incentives boost consumer responsiveness to EVs.
9	Kotilainen, Aalto, et al. 2019 *(Nordic region)*	Path dependence + policy mix in sustainability transitions	How prior policy legacies influence EV adoption	Targeted mixes can overcome lock-in, but must address industrial/infrastructural inertia.

#	Reference/Case	Theoretical Framework	Scope of Policy Mix	Findings
10	Martins et al. 2023 *(EU)*	Multi-criteria / scenario analysis	EU-level instruments (CO2 standards, purchase subsidies)	Cost-effectiveness and consistent regulation are key to increasing EU EV market share.
11	Tolani and Manohar n.d.*(Developing economies)*	Sustainability metrics + policy mix	Key policy drivers of EV adoption in emerging markets	Charging infrastructure, affordability, and user ease are top drivers requiring coordinated support.
12	Dutt 2023*(India)*	Multi-level perspective	Interactions across local, state, national EV policies	Supportive state incentives amplify national goals, while conflicting rules hamper progress.
13	Ledna et al. 2022 *(California)*	Policy instrument tradeoff analysis	Subsidies vs. infrastructure impact on EV uptake	Public charging investments can rival subsidies in impact—depends on travel behavior and context.

D

Appendix D

D.1. Desk Research – Analysed Documents

The list of documents provided below was used to analyse and get an overall understanding of the EV policies in India and Karnataka. However, only government policy documents related to Karnataka was selected and coded as shown in Appendix (E) needed for my thesis.

#	Document Name	Type	Found Through
1	Faster Adoption and Manufacturing of Electric Vehicles in India – Phase I & II (FAME) Scheme	Central Scheme	Department of Heavy Industries (DHI)
2	National Electric Mobility Mission Plan (NEMMP-2013) revised in 2020	Central Strategy	Ministry of Heavy Industries
3	National Mission on Transformative Mobility and Battery Storage (2019)	Policy Initiative	NITI Aayog
4	Battery Swapping Policy (2022)	Policy	NITI Aayog / Google Search
5	National Programme on Advanced Chemistry Cell (ACC) Battery Storage	Manufacturing Policy	NITI Aayog
6	Report of the Committee on Transformative Mobility and Battery Storage (2020)	Policy Report	NITI Aayog
7	FAME Dashboard (EV Registration and Subsidy Tracking)	Monitoring Tool	fame2.heavyindustries.gov.in
8	Karnataka Electric Vehicle & Energy Storage Policy 2017	State Policy	commerce.karnataka.gov.in
9	Karnataka EV Policy Revised Guidelines (2021)	Updated State Policy	Government of Karnataka
10	Karnataka Industrial Policy 2020-2025	Industrial Policy	commerce.karnataka.gov.in
11	Karnataka Renewable Energy Policy 2022-2027	Energy Policy	Karnataka Renewable Energy Dept
12	Karnataka Urban Mobility Policy (2021)	Urban Transport Policy	DULT Karnataka / Google Search
13	BESCOM EV Charging Infrastructure Policy and Implementation Framework	Implementation Guideline	bescom.karnataka.gov.in

14	BBMP's Policy on Parking Incentives for EVs in Bengaluru	Local Regulation	BBMP portal
15	KERC Tariff Policy for EV Charging (2021-2023)	Regulatory Framework	Karnataka Electricity Regulatory Commission
16	DULT – Comprehensive Mobility Plan for Bengaluru Metropolitan Region (2020)	Urban Transport Strategy	Directorate of Urban Land Transport
17	EV-Ready India: Part 1 – Value Chain Analysis of State EV Policies (NITI Aayog/RMI, 2021)	Comparative Policy Report	Google Search / NITI Aayog
18	Unlocking India's Electric Mobility Future (CSTEP, 2022)	Research Report	cstep.in
19	Roadmap for Electric Vehicle Adoption in Karnataka (World Bank, 2022)	Advisory Report	World Bank / Google Search
20	Accelerating EV Adoption in India (Rocky Mountain Institute, 2021)	Think Tank Report	Google Search / RMI India
21	India Electric Vehicle Ecosystem Report (NITI Aayog & BloombergNEF, 2022)	National Report	NITI Aayog / BloombergNEF
22	Report on India's Battery Swapping Ecosystem (Ola Mobility Institute, 2022)	Sectoral Analysis	olamobility.in
23	India EV Financing and Leasing Guidebook (WRI India, 2022)	Financial Policy Guide	WRI India / Google Search
24	FICCI Report on Investment Opportunities in India's EV Sector (2023)	Investment Report	FICCI / Google Search
25	Urban Planning for Clean Mobility in India (CEEW, 2023)	Urban Policy Study	CEEW / Google Search
26	Public Transport Electrification in Bengaluru (Shakti Foundation, 2022)	City-Level Analysis	shaktifoundation.in
27	Karnataka State Budget 2021–25 and 2025–26: EV Incentive Allocations	Budget Document	finance.karnataka.gov.in
28	Department of Transport, Karnataka – Policy on Green Vehicle Registration	Regulatory Circular	transport.karnataka.gov.in
29	Bangalore Smart City EV Charging Project Documents	City-Level Documents	bbmp.gov.in / Smart City Bengaluru
30	Karnataka's Swappable Battery Guidelines (2022)	Policy Document	commerce.karnataka.gov. in
31	Karnataka Clean Mobility Roadmap (2025–2030)	Strategic Roadmap	Department of Industries
32	Unlocking Supply Chains for Localizing Electric Vehicle Battery Production in India	Industry Report by IISD	Google Search

E

Appendix E

E.1. Codebook of Policy Documents

Karnataka Electric Vehicle & Energy Storage Policy 2017

Table E.1: Key Instruments and Features of the Karnataka EV & Energy Storage Policy 2017

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Encourage consumer adoption of EVs	Demand-side Incentives (Road tax and registration fee exemption)	Authority & Substantive	100% exemption from road tax and registration fees for EVs	EV_TAX_EXEMPT_2017
State	Promote domestic EV manufacturing	Capital Subsidy for EV Manufacturing	Treasury & Substantive	Capital subsidy up to 25% for EV and battery manufacturers	EV_MFG_INC_2017
State	Develop state-wide EV charging infrastructure	Support for Charging Infrastructure	Authority & Substantive	Facilitation of land and incentives for public and private charging stations	EV_CHARGE_REG_2017
State	Create industry-specific EV zones	EV Clusters and Zones	Organisation & Substantive	Designation of EV manufacturing zones with streamlined approvals	EV_MFG_ZONE_2017
State	Foster innovation and skilled workforce for EV sector	R&D and Skill Development Support	Nodality & Substantive	Support for R&D centers, incubation, and EV-related training programs	EV_RD_SKILL_2017

Revised Karnataka EV Policy 2021

Table E.2: Key Instruments and Features of the Revised Karnataka EV Policy 2021

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Enable fast adoption of electric 2Ws and 3Ws	Battery Swapping Station Promotion	Authority & Substantive	Encourages battery-as-a-service (BaaS) model, inclusion of battery swapping under charging infra incentives	EV_BATT_SWAP_2021
State	Extend benefits to a broader range of vehicle segments	Updated Demand-side Incentives	Authority & Substantive	Revised road tax/registration waivers for 3Ws, 4Ws, and freight vehicles	EV_TAX_EXPANDED_2021
State	Facilitate infrastructure development	Land Allocation for Charging Infra	Authority & Substantive	Mandate for urban local bodies to allocate land for public charging stations	EV_CHARGE_LAND_2021
State	Accelerate policy implementation and uptake	Simplified Application Process	Procedural & Substantive	Streamlined approval for availing incentives; single-window facilitation	EV_EASE_ACCESS_2021
State	Ensure transparency and effectiveness of incentive rollout	Clarity on Fiscal Subsidies Disbursement	Treasury & Procedural	Time-bound disbursal mechanism and eligibility transparency	EV_SUBSIDY_FLOW_2021

Karnataka Industrial Policy 2020-2025

Table E.3: Instruments Supporting EV Sector in Karnataka Industrial Policy 2020-2025

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Encourage local EV manufacturing and attract investment	Production-linked Incentives (PLIs) for EV & Battery Manufacturing	Treasury & Substantive	Financial incentives based on investment thresholds and employment generation	EV_PLI_MFG_2020
State	Reduce entry barriers for setting up EV industries	Land Allotment at Concessional Rates	Authority & Substantive	Industrial plots in designated EV clusters at subsidized prices for MSMEs and startups	EV_LAND_MSME_2020
State	Support smaller manufacturers and startups	Interest Subsidies for MSMEs in EV sector	Treasury & Substantive	Interest subsidies of up to 6% for term loans by MSMEs investing in EV/battery production	EV_MSME_INT_SUB_2020
State	Enhance physical and power infrastructure to support industrial development	Infrastructure Development Support	Organisation & Substantive	Creation of plug-and-play EV parks, logistics hubs, power infrastructure	EV_INFRA_SUPPORT_2020
State	Promote innovation in electric mobility and clean tech	R&D and Innovation Grant Scheme	Nodality & Substantive	Funding for EV-related R&D centers, startups, and technology incubators	EV_RD_GRANT_2020

Karnataka Renewable Energy Policy 2022-2027

Table E.4: EV Instruments in Karnataka Renewable Energy Policy 2022-2027

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Promote clean energy for EV infrastructure	Solar Power Integration with EV Charging	Authority & Substantive	Encourages rooftop solar and grid-connected solar energy for EV charging stations	EV_SOLAR_INTEGRATION_2022
State	Support renewable power access for commercial EV charging	Wheeling and Banking Facility for EV Charging Stations	Treasury & Substantive	Exemption on wheeling charges for renewable energy supplied to EV charging networks	EV_WHEEL_BANK_2022
State	Ensure optimal grid load management and incentivize off-peak charging	Time-of-Day Tariffs for EV Charging	Authority & Substantive	Lower electricity rates during off-peak hours for EV users and charging stations	EV_TOD_TARIFF_2022
State	Enable two-way electricity flow and optimize renewable energy use	Net Metering for EV Charging Stations	Authority & Substantive	Allows EV stations to supply surplus solar power back to the grid under net metering norms	EV_NET_METER_2022

Karnataka Clean Mobility Roadmap 2025-2030

Table E.5: Strategic Instruments in Karnataka Clean Mobility Roadmap 2025-2030

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Expand charging infrastructure via coordinated investment	Public-Private Partnerships for Charging Infrastructure	Organisation & Substantive	Facilitates PPP models to deploy fast-charging and battery-swapping infrastructure	EV_PPP_CHARGE_2030
State	Ensure EV-grid coordination for demand management	Smart Integration of EVs with Grid	Authority & Substantive	Development of integrated digital platforms for real-time monitoring and control	EV_GRID_SMART_2030
State	Ensure interoperability and reduce EV ecosystem fragmentation	Standardization of EV Components and Charging Protocols	Authority & Substantive	Policy directive to implement BIS/ISO-certified hardware and software protocols	EV_STANDARD_2030
State	Leverage EV batteries as storage assets to support grid stability	Value-to-Grid (V2G) Business Models	Nodality & Substantive	Pilots to integrate bidirectional charging and incentivize grid feedback	EV_V2G_MODEL_2030
State	Encourage consumer shift to EVs in urban transport	Parking and Toll Fee Incentives	Treasury & Substantive	Discounted parking rates and toll exemptions for registered EVs	EV_TOLL_PARK_2030

BBMP/Urban Local Body EV Policy

Table E.6: Local-Level EV Policy Instruments in BBMP/Urban Local Body

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
Local	Ensure EV-ready infrastructure in urban housing and commercial facilities	Mandatory EV Charging Points in New Buildings	Authority & Substantive	Revised building bye-laws mandate EV charging in all new commercial and residential premises	EV_MAND_BUILDING_BBMP
Local	Encourage private investments in charging infra at residential/-commercial premises	Property Tax Rebates for EV Charging Infrastructure	Treasury & Substantive	Property owners installing EV charging stations eligible for partial tax exemption	EV_PROP_TAX_REB_BBMP
Local	Facilitate accessible public charging in urban zones	Allocation of Public Spaces for Charging Stations	Organisation & Substantive	Reserved parking and public space identified in BBMP zones for private/public charging stations	EV_PUBLIC_SPACE_BBMP
Local	Promote EV usage in congested areas	EV Parking Incentives in Commercial Areas	Treasury & Substantive	Dedicated low-fee EV parking zones in malls, offices, and transport hubs	EV_PARK_INCENTIVE_BBMP

BESCOM EV Charging Infrastructure Policy (2021)

Table E.7: Institutional and Regulatory Instruments from BESCOM Charging Infrastructure (2021)

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Establish institutional responsibility for EV charging rollout	Nodal Agency Designation for Charging Infrastructure	Organisation & Procedural	BESCOM designated as nodal agency to coordinate site approvals, vendor selection, grid support	EV_BESCOM_NODAL_2021
State	Ensure uniformity and safety in public charging station operations	Standard Operating Procedures (SOPs) for Public Charging Stations	Authority & Procedural	Mandates charger types, signage, safety compliance, and payment integration	EV_BESCOM_SOP_2021
State	Streamline deployment of charging stations	Site Selection and Land Allocation Process	Authority & Substantive	Defines eligible land types (BBMP, KSRTC, malls, highways) and procedures for allocation	EV_BESCOM_LAND_2021
State	Ensure reliable power supply to charging stations	Interconnection and Grid Upgradation Support	Organisation & Substantive	BESCOM commits to infrastructure readiness, grid capacity assessments and upgrades	EV_BESCOM_GRID_2021
State	Enable transparent billing for EV energy use	EV Tariff Category and Metering Framework	Treasury & Substantive	Dedicated EV tariff structure, separate metering and billing as per KERC regulations	EV_BESCOM_TARIFF_2021

KERC Tariff Policy for EV Charging (2021-2023)

Table E.8: Regulatory Instruments in KERC EV Charging Tariff (2021-2023)

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Promote affordability and predictability in EV charging costs	Dedicated EV Charging Tariff Category	Authority & Substantive	Separate tariff slab created for EV charging, applicable to public and private stations	EV_KERC_TARIFF_2021
State	Encourage off-peak EV charging and reduce grid stress	Time-of-Day (ToD) Tariff Recommendation	Treasury & Substantive	Suggests differential tariff rates for peak and non-peak hours (optional adoption)	EV_KERC_TOD_2021
State	Ensure fair metering and billing practices for EV users	Metering and Billing Norms for EV Supply	Authority & Procedural	Mandates separate metering and billing systems for EV charging stations	EV_KERC_METERING_2021

BBMP Policy on EV Parking Incentives

Table E.9: Urban EV Parking Instruments

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
Local	Increase visibility and convenience for EV users	Reserved EV Parking Zones in Public Areas	Organisation & Substantive	Allocates specific parking spots in BBMP zones only for EVs with charging points	EV_BBMP_PARK_ZONES_2022
Local	Lower operational costs and promote private EV ownership	Reduced Parking Fees for EVs	Treasury & Substantive	Offers up to 50% concession in parking fees at BBMP-managed facilities	EV_BBMP_FEE_REBATE_2022
Local	Digitally streamline EV-specific parking and monitoring	Integration with Smart Parking Systems	Nodality & Procedural	EV parking linked to BBMP smart parking apps for user access and enforcement	EV_BBMP_SMARTPARK_2022

DULT Urban Mobility Policy for Bengaluru

Table E.10: EV Mobility Instruments in DULT Urban Mobility Policy for Bengaluru

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
Urban	Mainstream EVs into public and para-transit systems	EV Integration into Urban Transport Plans	Authority & Substantive	Proposes dedicated EV lanes, e-bus corridors, and last-mile EV feeder services	EV_DULT_INTEGRATION_2020
Urban	Reduce GHG emissions and promote sustainable mobility	Public Transport Electrification Mandates	Authority & Substantive	Targets gradual electrification of BMTC fleet and autos under ULB supervision	EV_DULT_ELECTRIFY_2020
Urban	Improve policy alignment across mobility, energy, and planning departments	Institutional Coordination for EV Mobility	Organisation & Procedural	Establishes inter-agency working groups for mobility transition and policy tracking	EV_DULT_COORD_2020
Urban	Incentivize EV adoption in urban centers	Parking and Access Incentives for Clean Mobility	Treasury & Substantive	Proposes reduced congestion fees, green zones, and EV-only parking benefits	EV_DULT_ACCESS_2020

DULT Comprehensive Mobility Plan (2020)

Table E.11: Clean Mobility Instruments in DULT Comprehensive Mobility Plan (2020)

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
Urban	Accelerate transition of public transport to electric modes	Electrification Targets for Bus Fleet (BMTC)	Authority & Substantive	Targets phased e-bus adoption (minimum 50% by 2030) in coordination with BMTC	EV_CMP_BMTC_TARGET_2020
Urban	Enable integrated transport and charging infrastructure	Land Use and EV Infrastructure Alignment	Organisation & Procedural	Integrates EV charging infra into urban zoning plans and metro stations	EV_CMP_ZONING_ALIGN_2020
Urban	Promote digital integration for seamless clean transport	Development of Mobility-as-a-Service (MaaS) Platforms	Nodality & Procedural	Recommends unified ticketing and real-time EV fleet integration into MaaS apps	EV_CMP_MAAS_DIGITAL_2020
Urban	Promote EV adoption in shared mobility and feeder routes	Incentivization of Electric First- and Last-Mile Modes	Treasury & Substantive	Suggests VGF/subsidies for e-autos, e-rickshaws, and cargo EVs near mtero lines	EV_CMP_FEEDER_SUB_2020

Karnataka EV Manufacturing Cluster Policy (2021-2023)

Table E.12: Manufacturing Incentives in GoK EV Cluster(2021-2023)

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Promote local manufacturing and industrialisation in EV sector	Allotment of Land for EV Industrial Clusters	Authority & Substantive	State offers industrial land in Tumakuru, Ramanagara, Dharwad, etc. for clusters	EV_CLUSTER_LAND_2021
State	Encourage private investment and job creation in EV sector	Capital Investment Subsidies for EV Manufacturing	Treasury & Substantive	Provides financial incentives for setting up EV and battery units in notified clusters	EV_CLUSTER_CAPEX_2021
State	Simplify approvals and regulatory compliance for EV manufacturers	Single Window Clearance for EV Projects	Organisation & Procedural	Facilitated via Karnataka Udyog Mitra; includes land, power, pollution clearance	EV_CLUSTER_SIWI_2021
State	Reduce cost of capital and operational expenses for EV firms	Interest Subsidies and SGST Reimbursements	Treasury & Substantive	Offers interest subsidy on term loans and SGST refund for 5–10 years	EV_CLUSTER_SGST_2021

Karnataka State Budget on EV (2021-22 & 2022-23)

Table E.13: EV-Specific Budget Instruments in Karnataka State Budget (2021-23)

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Accelerate development of EV charging network across Karnataka	Capital Grants for EV Charging Infrastructure	Treasury & Substantive	Budgeted grants allocated to BESCOM and ULBs for public charging stations	EV_BUDGET_CHARGE_2021
State	Support R&D, innovation, and entrepreneurship in clean mobility	Startup and Innovation Funding for EV Tech	Treasury & Procedural	Allocation under Karnataka Startup Policy and Elevate grants targeted at EV firms	EV_BUDGET_STARTUP_2021
State	Promote demand-side adoption through state fleet electrification	Subsidies for Fleet Electrification in Government Transport	Treasury & Substantive	Funds allocated for e-buses under BMTC and KSRTC through CAPEX route	EV_BUDGET_FLEET_2022
State	Build skilled manpower for EV manufacturing and servicing	Skill Development and Training Allocation for EV Sector	Organisation & Procedural	Dedicated allocations to skill development centers in partnership with stakeholders	EV_BUDGET_SKILL_2022

Department of Transport Policy on EV – Green Vehicle Registration

Table E.14: Registration-related Instruments in Karnataka Transport Department's Green Vehicle

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Lower entry cost for consumers adopting EVs	Exemption of Registration Fees for EVs	Treasury & Substantive	Full exemption from vehicle registration charges for battery-operated vehicles	EV_GREEN_REGFEE_EX_2021
State	Provide visual differentiation and prioritization of EVs	Issuance of Green Number Plates	Authority & Substantive	Mandates green license plates for EVs in Karnataka to encourage recognition	EV_GREEN_PLATE_2021
State	Reduce delays and improve ease of registration for EVs	Digital Fast-Tracking of EV Registrations	Organisation & Procedural	Dedicated online portal and streamlined RTO workflow for electric vehicle registration	EV_GREEN_DIGI_RTO_2021

Bangalore Smart City Policy on EV Charging

Table E.15: Pilot Instruments in Bangalore Smart City EV Charging Project

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
City	Demonstrate feasibility of urban EV charging infrastructure	Pilot Deployment of Public Charging Stations	Organisation & Substantive	Installation of 112 slow and fast chargers across high-traffic areas in Phase 1	EV_BSC_PILOT_CHARG_2021
City	Mobilize private sector for infrastructure expansion	Public-Private Partnership (PPP) Models for EV Infra	Treasury & Procedural	PPP tenders with revenue-sharing and capital cost recovery provisions	EV_BSC_PPP_MODEL_2021
City	Enable real-time load balancing and data analytics	Smart Grid Integration with Charging Stations	Nodality & Substantive	Integration with software platform for grid monitoring and energy optimization	EV_BSC_SMARTGRID_2021
City	Improve policy design and spatial planning of EV chargers	User Feedback and Utilization Surveys	Nodality & Procedural	App-based feedback collection, occupancy tracking, and usage	EV_BSC_FEEDBACK_2021

Karnataka Swappable Battery Policy (2022)

Table E.16: Instruments in Karnataka Swappable Battery (2022)

Level	**Policy Goal/Objective**	**Policy Instrument**	**Type & Purpose**	**Design Feature**	**Codes**
State	Promote interoperability and adoption of battery swapping in urban transport	Battery Swapping Station Regulatory Framework	Authority & Substantive	Defines technical, safety, and fire-resistance norms for battery swapping hubs	EV_SWAP_REGULATION_2022
State	Ensure cost-reflective and grid-friendly energy use for swappable stations	Time-of-Use Tariffs for Swapping Infrastructure	Treasury & Substantive	Proposes differential tariffs during peak/off-peak hours for swapping	EV_SWAP_TARIFFS_2022
State	Enable uniformity and compatibility across OEMs and service providers	Standardisation of Battery Interfaces and Software Protocols	Nodality & Procedural	Mandates standard plug-in interfaces, BMS APIs, and vehicle-software compatibility	EV_SWAP_STANDARDS_2022
State	Create market certainty and attract private investment	Business Model Support for Swap Operators	Treasury & Procedural	Proposes PPP model and viability gap funding for early swap infra developers	EV_SWAP_PPP_SUPP_2022

Karnataka State Budget 2023-24 & 2024-25: EV Initiatives

Table E.17: EV-Related Initiatives in Karnataka State Budgets (2023-24 & 2024-25)

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Promote EV adoption by enhancing charging infrastructure	Establishment of EV Charging Stations (2023–24)	Treasury & Substantive	Allocation of INR 35 crore to set up 100 EV charging centers in partnership with power supply companies	EV_BUDGET_CHARGE_2023
State	Encourage private sector participation in EV infrastructure development	Public-Private Partnership (PPP) for Charging Infrastructure (2023–24)	Organisation & Substantive	Proposal to establish 2,500 EV charging stations across the state under the PPP model	EV_PPP_BUDGET_2023
State	Accelerate EV adoption by expanding charging infrastructure	Expansion of EV Charging Infrastructure (2024–25)	Treasury & Substantive	Allocation of INR 350 million ($\sim$4.03 million) to establish 2,500 new charging stations under PPP and 100 by electricity supply companies	EV_CHARGE_EXPAND_2024
State	Promote clean mobility by reducing costs for consumers and manufacturers	Tax Waivers and Incentives for EVs and Hybrids (2024–25)	Treasury & Substantive	Proposal to abolish road tax and registration for hybrids under $30,000 and offer 15–25% investment incentives for EV-related manufacturing	EV_TAX_WAIVER_2024

Karnataka State Budget 2025-26: EV Initiatives

Table E.18: EV-Related Instruments in Karnataka State Budget 2025-26

Level	Policy Goal/Objective	Policy Instrument	Type & Purpose	Design Feature	Codes
State	Enhance public transportation and reduce emissions	Expansion of Electric Bus Fleet	Treasury & Substantive	Allocation for the addition of 9,000 electric buses to the Bangalore Metropolitan Transport Corporation (BMTC) under various schemes	EV_BUD_EBUS_2025
State	Support EV adoption by expanding charging facilities	Development of Charging Infrastructure	Treasury & Substantive	Proposal to establish 2,500 EV charging stations across the state under the Public-Private Partnership (PPP) model	EV_BUD_CHARG_2025
State	Promote clean mobility options, including hybrid vehicles	Tax Waivers and Incentives for Hybrid Vehicles	Treasury & Substantive	Plans to abolish road tax and registration charges for hybrid cars under $30,000, reducing the current rates of 13% to 18%	EV_BUD_HYBRID_TAX_2025
State	Attract investment in EV manufacturing and infrastructure	Incentives for EV Manufacturers	Treasury & Substantive	Financial incentives ranging from 15% to 25% of investments for manufacturers of EVs, components, battery components, or EV charging equipment	EV_BUD_MFG_INCEN_2025

E.2. Summary of Codes

Table E.19: Codeword Index for EV Policy Instruments in Karnataka (All Tables)

Codes	Policy Instrument	Source Policy Document
EV_TAX_EXEMPT_2017	Road tax and registration fee exemption	Karnataka EV Policy
EV_MFG_INC_2017	Capital subsidy for EV manufacturing	Karnataka EV Policy
EV_CHARGE_REG_2017	Support for charging infrastructure	Karnataka EV Policy
EV_MFG_ZONE_2017	EV clusters and zones	Karnataka EV
EV_RD_SKILL_2017	R&D and skill development support	Karnataka EV Policy
EV_BATT_SWAP_2021	Battery swapping station promotion	Revised Karnataka EV Policy 2021
EV_TAX_EXPANDED_2021	Updated demand-side incentives	Revised Karnataka EV Policy 2021
EV_CHARGE_LAND_2021	Land allocation for charging infra	Revised Karnataka EV Policy 2021
EV_EASE_ACCESS_2021	Simplified application process	Revised Karnataka EV Policy 2021
EV_SUBSIDY_FLOW_2021	Clarity on fiscal subsidies disbursement	Revised Karnataka EV Policy 2021
EV_PLI_MFG_2020	Production-linked incentives (PLIs) for EVs	Karnataka Industrial Policy 2020–25
EV_LAND_MSME_2020	Land allotment at concessional rates	Karnataka Industrial Policy 2020–25
EV_MSME_INT_SUB_2020	Interest subsidies for MSMEs in EV sector	Karnataka Industrial Policy 2020–25
EV_INFRA_SUPPORT_2020	Infrastructure development support	Karnataka Industrial Policy 2020–25
EV_RD_GRANT_2020	R&D and innovation grant scheme	Karnataka Industrial Policy 2020–25
EV_SOLAR_INTEGRATION_2022	Solar power integration with EV charging	Karnataka Renewable Energy Policy 2022–27
EV_WHEEL_BANK_2022	Wheeling and banking for EV charging stations	Karnataka Renewable Energy Policy 2022–27
EV_TOD_TARIFF_2022	Time-of-day tariffs for EV charging	Karnataka Renewable Energy Policy 2022–27
EV_NET_METER_2022	Net metering for EV charging stations	Karnataka Renewable Energy Policy 2022–27
EV_PPP_CHARGE_2030	PPP for charging infra	Clean Mobility Roadmap 2025–30
EV_GRID_SMART_2030	Smart integration of EVs with grid	Clean Mobility Roadmap 2025–30
EV_STANDARD_2030	Standardization of EV components/protocols	Clean Mobility Roadmap 2025–30
EV_V2G_MODEL_2030	Value-to-grid business models	Clean Mobility Roadmap 2025–30
EV_TOLL_PARK_2030	Parking and toll fee incentives	Clean Mobility Roadmap 2025–30

Codes	Policy Instrument	Source Policy Document
EV_MANDATE_BUILDING_BBMP	Mandatory EV charging in new buildings	BBMP EV Policy
EV_PROP_TAX_REBATE_BBMP	Property tax rebates for EV infra	BBMP EV Policy
EV_PUBLIC_SPACE_BBMP	Allocation of public spaces for EV charging	BBMP EV Policy
EV_PARK_INCENTIVE_BBMP	EV parking incentives in commercial areas	BBMP EV Policy
EV_BESCOM_NODAL_2021	Nodal agency designation	BESCOM Policy 2021
EV_BESCOM_SOP_2021	SOPs for public charging stations	BESCOM Policy 2021
EV_BESCOM_LAND_2021	Site selection and land allocation	BESCOM Policy 2021
EV_BESCOM_GRID_2021	Interconnection and grid upgradation support	BESCOM Policy 2021
EV_BESCOM_TARIFF_2021	EV tariff category and metering framework	BESCOM Policy 2021
EV_KERC_TARIFF_CATEGORY_2021	Dedicated EV charging tariff category	KERC Tariff Policy 2021–23
EV_KERC_TOD_OPTIONAL_2021	ToD tariff recommendation	KERC Tariff Policy 2021–23
EV_KERC_METERING_2021	Metering and billing norms	KERC Tariff Policy 2021–23
EV_BBMP_PARK_ZONES_2022	Reserved EV parking zones in BBMP	BBMP Parking Policy
EV_BBMP_FEE_REBATE_2022	Reduced parking fees for EVs	BBMP Parking Policy
EV_BBMP_SMARTPARK_2022	Integration with smart parking systems	BBMP Parking Policy
EV_DULT_INTEGRATION_2020	EV integration into urban transport	DULT Urban Mobility Policy 2020
EV_DULT_ELECTRIFY_2020	Public transport electrification mandates	DULT Urban Mobility Policy 2020
EV_DULT_COORD_2020	Institutional coordination for EV mobility	DULT Urban Mobility Policy 2020
EV_DULT_ACCESS_2020	Parking/access incentives for clean mobility	DULT Urban Mobility Policy 2020
EV_CMP_BMTC_TARGET_2020	Electrification targets for BMTC	DULT CMP 2020
EV_CMP_ZONING_ALIGN_2020	Land use and infra alignment	DULT CMP 2020
EV_CMP_MAAS_DIGITAL_2020	Mobility-as-a-Service digital integration	DULT CMP 2020
EV_CMP_FEEDER_SUBSIDY_2020	First/last-mile EV mode incentives	DULT CMP 2020
EV_CLUSTER_LAND_2021	Land for EV clusters	GoK EV Cluster Policy 2021–23
EV_CLUSTER_CAPEX_2021	Capital subsidies for EV MFG	GoK EV Cluster Policy 2021–23
EV_CLUSTER_SINGLEWIND_2021	Single window clearance	GoK EV Cluster Policy 2021–23
EV_CLUSTER_SGST_2021	SGST reimbursements & interest subsidies	GoK EV Cluster Policy 2021–23
EV_BUDGET_CHARGE_2021	Capital grants for charging infra	State Budget 2021–23
EV_BUDGET_STARTUP_2021	Innovation/startup funding	State Budget 2021–23

Codes	Policy Instrument	Source Policy Document
EV_BUDGET_FLEET_2022	Fleet electrification subsidies	State Budget 2021–23
EV_BUDGET_SKILL_2022	Skill development for EV sector	State Budget 2021–23
EV_GREEN_REG_FEE_EXE_2021	Registration fee exemption	Green Vehicle Notification
EV_GREEN_NUMBER_PLATE_2021	Green number plates	Green Vehicle Notification
EV_GREEN_DIGITAL_RTO_2021	Digital EV registration	Green Vehicle Notification
EV_BSC_PILOT_CHARGERS_2021	Pilot public charging deployment	Bangalore Smart City Project
EV_BSC_PPP_MODEL_2021	PPP model for charging infra	Bangalore Smart City Project
EV_BSC_SMARTGRID_2021	Smart grid integration	Bangalore Smart City Project
EV_BSC_FEEDBACK_2021	Feedback/utilization surveys	Bangalore Smart City Project
EV_SWAP_REGULATIONS_2022	Swapping station regulations	Karnataka Swappable Battery Policy 2022
EV_SWAP_TARIFFS_2022	Time-of-use tariffs for swapping	Karnataka Swappable Battery Policy 2022
EV_SWAP_STANDARDS_2022	Standardization of interfaces/protocols	Karnataka Swappable Battery Policy 2022
EV_SWAP_PPP_SUPPORT_2022	Business model support for swapping	Karnataka Swappable Battery Policy 2022
EV_BUDGET_CHARGE_2023	EV charging infra (INR 35 cr)	State Budget 2023–24
EV_PPP_BUDGET_2023	PPP model charging stations	State Budget 2023–24
EV_CHARGE_EXPAND_2024	Charging expansion funding (INR 350M)	State Budget 2024–25
EV_TAX_WAIVER_2024	Tax waivers/incentives for EVs & hybrids	State Budget 2024–25
EV_BUDGET_EBUS_2025	9,000 electric buses for BMTC	State Budget 2025–26
EV_BUDGET_CHARGING_2025	Charging infra expansion (2,500 stations)	State Budget 2025–26
EV_BUDGET_HYBRID_TAX_2025	Hybrid tax waiver under $30k	State Budget 2025–26
EV_BUDGET_MFG_INCENTIVE_2025	EV manufacturing investment incentives	State Budget 2025–26

F

Appendix F

F.1. 40 policy-instruments

The complete set of 40 policy-instrument codes I drew on for every interaction-pair analysis:

Table F.1: EV policy instrument codes with level and dominant reason for inclusion

Instrument Code	Level	Dominant Reason for Inclusion
EV_TAX_EXEMPT_2017	State	Fiscal weight – 100% road-tax waiver across all vehicle classes.
EV_MFG_INC_2017	State	Fiscal weight – capital subsidy up to 25%.
EV_CHARGE_REG_2017	State	Bottleneck – legal basis for statewide charger roll-out.
EV_MFG_ZONE_2017	State	Cross-reference – reiterated in the 2020 Industrial Policy.
EV_RD_SKILL_2017	State	Bottleneck – skills gap flagged in strategy.
EV_PLI_MFG_2020	State	Fiscal weight – multi-billion production-linked incentive.
EV_LAND_MSME_2020	State	Bottleneck – cheap land for small suppliers.
EV_MSME_INT_SUB_2020	State	Fiscal weight – 6% interest subsidy.
EV_INFRA_SUPPORT_2020	State	Fiscal weight – “plug-and-play” park capex line.
EV_RD_GRANT_2020	State	Fiscal weight + bottleneck – R&D gap.
EV_DULT_INTEGRATION_2020	Agency (DULT)	Bottleneck – last-mile / public-transport integration.
EV_DULT_ELECTRIFY_2020	Agency (DULT)	Fiscal weight – BMTC fleet electrification target with budget.
EV_DULT_COORD_2020	Agency (DULT)	Cross-reference – cited in CMP and BBMP policy.
EV_DULT_ACCESS_2020	Agency (DULT)	Bottleneck – congestion-pricing barrier.
EV_BATT_SWAP_2021	State	Bottleneck – alternative charging model.
EV_TAX_EXPANDED_2021	State	Fiscal weight – revised waiver for 3- & 4-wheelers.
EV_CHARGE_LAND_2021	State	Regulatory weight – mandates ULB land provision.
EV_EASE_ACCESS_2021	State	Bottleneck – administrative friction; single-window.
EV_SUBSIDY_FLOW_2021	State	Credibility / fiscal – time-bound disbursal rule.
EV_BESCOM_NODAL_2021	Agency (BESCOM)	Cross-reference – appears in BESCOM, KERC, and Budget notes.

Instrument Code	Level	Dominant Reason for Inclusion
EV_BESCOM_SOP_2021	Agency (BESCOM)	Regulatory weight – charger safety & payment spec.
EV_BESCOM_LAND_2021	Agency (BESCOM)	Cross-reference – utility land bank linked to ULB order.
EV_BESCOM_GRID_2021	Agency (BESCOM)	Fiscal weight – funded grid-upgrade mandate.
EV_KERC_TARIFF_2021	Agency (KERC)	Regulatory weight – dedicated tariff category.
EV_KERC_TOD_2021	Agency (KERC)	Regulatory weight – first ToD guidance for EVs.
EV_KERC_METERING_2021	Agency (KERC)	Regulatory weight – metering norms for all stations.
EV_CLUSTER_LAND_2021	State	Fiscal + bottleneck – industrial-cluster land parcels.
EV_SOLAR_INTEGRATION_2022	State	Bottleneck – clean energy supply to chargers.
EV_WHEEL_BANK_2022	State	Fiscal weight – network-fee exemption for renewables.
EV_TOD_TARIFF_2022	State	Regulatory weight – mandatory dynamic pricing.
EV_NET_METER_2022	State	Regulatory weight – bi-directional energy flow.
EV_SWAP_STANDARDS_2022	State	Regulatory weight – interoperability spec.
EV_PPP_CHARGE_2030	State	Fiscal weight – state-sponsored 2500-station PPP.
EV_GRID_SMART_2030	State	Bottleneck – grid-management digital layer.
EV_STANDARD_2030	State	Regulatory weight – master standardisation directive.
EV_V2G_MODEL_2030	State	Bottleneck – future storage/grid-balancing model.
EV_TOLL_PARK_2030	State	Fiscal weight – revenue concession in mobility roadmap.
EV_MAND_BUILDING_BBMP	Local (BBMP)	Regulatory weight – chargers compulsory in all new buildings.
EV_PROP_TAX_REB_BBMP	Local (BBMP)	Fiscal weight – property-tax rebate for charger installs.
EV_PUBLIC_SPACE_BBMP	Local (BBMP)	Bottleneck – urban land allocation for public chargers.
EV_PARK_INCENTIVE_BBMP	Local (BBMP)	Fiscal weight – discounted EV parking fees.

F.2. Analysis of Policy Mix Elements

Consistency Analysis

Table F.2: Consistency analysis of EV policy interactions in Karnataka

Pair	Verdict	Rationale
EV_TAX_EXEMPT_2017 ↔ EV_CHARGE_REG_2017	Consistent (+)	Up-front tax waiver boosts demand while mandatory charging rules remove the complementary infrastructure barrier;no trade-off created.
EV_TAX_EXEMPT_2017 ↔ EV_TAX_EXPANDED_2021	Inconsistent (–)	2021 narrows the waiver for costlier 4-wheelers, introducing an income-equity filter that partially reverses the uniform demand-pull intent of 2017.
EV_TAX_EXEMPT_2017 ↔ EV_CHARGE_LAND_2021	Consistent (+)	Cheap vehicles plus easier land allocation for chargers together lower two different adoption costs.
EV_TAX_EXPANDED_2021 ↔ EV_CHARGE_LAND_2021	Consistent (+)	Same logic as above, but applied to the refined 2021 waiver.
EV_TAX_EXPANDED_2021 ↔ EV_SOLAR_INTEGRATION_2022	Consistent (+)	Consumer-side price relief dovetails with a supply of cheaper solar power, reinforcing demand and environmental objectives simultaneously.
EV_TOD_TARIFF_2022 ↔ EV_WHEEL_BANK_2022	Consistent (+)	Off-peak tariff incentive + wheeling-charge waiver both make renewable charging cheaper; no clashing incentives.
EV_LAND_MSME_2020 ↔ EV_PLI_MFG_2020	Inconsistent (–)	Concessional land targets MSMEs while PLI rewards large capital spenders; risk of a two-track industry support system working at cross purposes.
EV_NET_METER_2022 ↔ EV_KERC_METERING_2021	Inconsistent (–)	2021 mandates uni-directional meters; 2022 demands bi-directional feed-in-direct hardware-spec clash.
EV_BESCOM_GRID_2021 ↔ EV_GRID_SMART_2030	Consistent (+)	2021 capex upgrades create capacity that the 2030 smart-platform can actively manage; physical + digital complement.
EV_DULT_ACCESS_2020 ↔ EV_PARK_INCENTIVE_BBMP	Inconsistent (–)	Lower congestion charge + discounted CBD parking may cancel each other's price signal on vehicle kilometres if applied to the same zone.
EV_MSME_INT_SUB_2020 ↔ EV_LAND_MSME_2020	Consistent (+)	Low-interest loans and cheap plots address capital and land barriers for the same MSME cohort-fully complementary.
EV_PLI_MFG_2020 ↔ EV_MFG_ZONE_2017	Consistent (+)	PLI rewards high domestic content; pre-designated zones speed approvals-both steer large OEMs to invest inside Karnataka.
EV_BATT_SWAP_2021 ↔ EV_SWAP_STANDARDS_2022	Consistent (+)	2021 enables the business model; 2022 locks in the interface spec-logical technology ladder, no trade-off.
EV_BESCOM_SOP_2021 ↔ EV_KERC_METERING_2021	Consistent (+)	Utility SOP lists charger-hardware requirements; regulator mandates dedicated meters-design specs match.

Pair	Verdict	Rationale
EV_PLI_MFG_2020 ↔ EV_LAND_MSME_2020	Inconsistent (–)	PLI sets high investment thresholds favouring big players; concessional land ring-fences parcels for small firms-creates parallel, potentially competing industrial logics.
EV_MFG_INC_2017 ↔ EV_PLI_MFG_2020	Consistent (+)	2017 lowers entry CAPEX; 2020 rewards volume & domestic value-add. Together they create a sequential "invest → scale" ladder with no trade-off.
EV_BATT_SWAP_2021 ↔ EV_TOD_TARIFF_2022	Consistent (+)	Swapping hubs need rapid charge cycles; low off-peak tariffs cut their OPEX and shift load away from peaks-perfect operational fit.
EV_KERC_TARIFF_2021 ↔ EV_TAX_EXEMPT_2017	Consistent (+)	One instrument slashes running cost, the other slashes purchase cost-both steer buyers the same way with no overlapping design.
EV_TOLL_PARK_2030 ↔ EV_PARK_INCENTIVE_BBMP	Inconsistent (-)	When the same urban zone is hit by two discounts the combined price signal more encouragement, undermining congestion-reduction aims.
EV_MAND_BUILDING_BBMP ↔ EV_TAX_EXPANDED_2021	Consistent (+)	Mandate secures physical access; waiver cuts financial hurdle. Together they accelerate household EV uptake without conflicting incentives.

Coherence Analysis

Table F.3: Coherence analysis of EV policy interactions in Karnataka

Pair	Verdict	Rationale
EV_BESCOM_NODAL_2021 ↔ EV_BESCOM_SOP_2021	Coherent (+)	The same nodal agency that coordinates roll-out also issues standard operating procedures-clear single-door process.
EV_BESCOM_NODAL_2021 ↔ EV_BESCOM_GRID_2021	Coherent (+)	Grid-upgrade responsibilities sit with the nodal agency, ensuring technical decisions align with siting decisions.
EV_BESCOM_NODAL_2021 ↔ EV_BESCOM_LAND_2021	Coherent (+)	Site-approval and land-allocation handled under the same coordination umbrella, cutting inter-agency friction.
EV_BESCOM_NODAL_2021 ↔ EV_CHARGE_LAND_2021	Coherent (+)	State-level land mandate explicitly channels requests through BESCOM's single window.
EV_DULT_COORD_2020 ↔ EV_DULT_ELECTRIFY_2020	Coherent (+)	An inter-agency working group (coordination) is named in the same document that sets bus-fleet electrification targets, matching task with mechanism.
EV_EASE_ACCESS_2021 ↔ EV_SUBSIDY_FLOW_2021	Coherent (+)	A single-window incentive portal is backed by a time-bound disbursement rule-procedures reinforce each other.
EV_PPP_CHARGE_2030 ↔ EV_GRID_SMART_2030	Coherent (+)	PPP deployment of chargers is coupled with a state-run grid-data platform; contract design requires data-sharing, forcing collaboration.
EV_CLUSTER_LAND_2021 ↔ EV_BESCOM_LAND_2021	Not Coherent (–)	Two separate agencies run parallel land-allotment schemes for the same factories, risking duplication and mixed signals to investors.
EV_DULT_COORD_2020 ↔ EV_DULT_ACCESS_2020	Coherent (+)	The inter-agency working group established in COORD is explicitly tasked with delivering congestion-fee and parking incentives set out in ACCESS.
EV_KERC_TOD_2021 ↔ EV_TOD_TARIFF_2022	Coherent (+)	2021 voluntary guidance becomes a 2022 mandatory directive-same two bodies (KERC & Energy Dept.) collaborate in a sequenced policy path.
EV_PPP_CHARGE_2030 ↔ EV_V2G_MODEL_2030	Coherent (+)	PPP contracts require data-sharing with V2G pilot operators; both are anchored in the same 2030 roadmap and overseen by a joint task-force.
EV_CLUSTER_LAND_2021 ↔ EV_CLUSTER_SGST_2021	Coherent (+)	Land allotment and multi-year SGST refunds are administered through the same single-window (Karnataka Udyog Mitra), avoiding siloed applications.
EV_MAND_BUILDING_BBMP ↔ EV_PUBLIC_SPACE_BBMP	Not Coherent (–)	Different BBMP wings (Town-Planning vs. Estates) issue separate charger siting rules; no joint protocol, causing developers to navigate two approval tracks.

Pair	Verdict	Rationale
EV_DULT_COORD_2020 (inter-agency working group) ↔ EV_DULT_INTEGRATION_2020 (dedicated EV lanes & e-feeder plans)	Coherent (+)	The very body created in COORD is tasked with delivering the lane & feeder initiatives-clear governance chain.
EV_BESCOM_SOP_2021 (charger specs & safety SOP) ↔ EV_KERC_METERING_2021 (regulator's metering rule)	Coherent (+)	Utility's hardware checklist dovetails with the regulator's metering requirement-single technical stack, no mismatch.
EV_PPP_CHARGE_2030 (PPP build-out) ↔ EV_CHARGE_LAND_2021 (ULB land-mandate for chargers)	Coherent (+)	The PPP tender explicitly relies on municipal land parcels unlocked by the 2021 order-vertical coordination in action.
EV_BESCOM_NODAL_2021 (single window) ↔ EV_KERC_TARIFF_2021 (tariff order)	Coherent (+)	Tariff setting and grid-connection clearance pass through the same utility-regulator interface, preventing split responsibilities.
EV_DULT_COORD_2020 (city mobility task-force) ↔ EV_BESCOM_NODAL_2021 (state utility nodal role)	Not Coherent (-)	No bridging mechanism links the city mobility task-force with the state-level utility single-window; cross-level coordination gap.

Comprehensiveness Analysis

Table F.4: Comprehensive analysis of EV policy interactions in Karnataka

Pair	Verdict	Rationale
EV_TAX_EXEMPT_2017 ↔ EV_PLI_MFG_2020	Comprehensive (+)	Alignment between demand-pull (price to consumers) with supply-push (capex support), tackling both sides of the market failure.
EV_CHARGE_REG_2017 ↔ EV_NET_METER_2022	Comprehensive (+)	Starts with charger mandate, later layers on bidirectional grid integration-expands from basic to advanced infrastructure concerns.
EV_V2G_MODEL_2030 ↔ EV_GRID_SMART_2030	Comprehensive (+)	Value-to-Grid pilots plus digital control platform cover technical and business-model gaps that earlier policies left open.
EV_RD_GRANT_2020 ↔ EV_INFRA_SUPPORT_2020	Comprehensive (+)	Same budget tackles knowledge generation and physical facilities-closing two quite different transition bottlenecks.
EV_TOLL_PARK_2030 ↔ EV_DULT_ACCESS_2020	Not Comprehensive (-)	Both cut urban travel cost; neither addresses rural access or freight decarbonisation-repetition rather than gap-filling.
EV_MFG_ZONE_2017 ↔ EV_RD_SKILL_2017	Comprehensive (+)	Same policy package tackles physical clustering and human-capital gaps-covers two very different systemic failures.
EV_SOLAR_INTEGRATION_2022 ↔ EV_NET_METER_2022	Comprehensive (+)	One rule promotes on-site generation; the other allows surplus export-together they span both self-consumption and grid-service dimensions.
EV_MAND_BUILDING_BBMP ↔ EV_PROP_TAX_REB_BBMP	Comprehensive (+)	Mandate ensures chargers in new builds; tax rebate nudges retrofits in existing stock-covers whole building life-cycle.
EV_TOLL_PARK_2030 ↔ EV_DULT_INTEGRATION_2020	Not Comprehensive (-)	Both focus on urban passenger cost-advantages; neither relates to freight, rural mobility, or power-sector integration-doesn't widen mix scope.
EV_V2G_MODEL_2030 ↔ EV_NET_METER_2022	Comprehensive (+)	Net-metering allows passive export; V2G pilots test active grid services-expands the policy canvas from kWh accounting to grid-balancing markets.
EV_SOLAR_INTEGRATION_2022 (rooftop & grid-solar for chargers) ↔ EV_WHEEL_BANK_2022 (waiver on wheeling)	Comprehensive (+)	Tackles both generation and network fee barriers to green energy for EVs-expands scope from simple charging to clean-charging.
EV_GRID_SMART_2030 (real-time grid platform) ↔ EV_TOD_TARIFF_2022 (dynamic pricing)	Comprehensive (+)	Alignment between digital grid control with economic price signals covers technical and behavioural angles of load management.
EV_RD_SKILL_2017 (training programmes) ↔ EV_MSME_INT_SUB_2020 (interest subsidy)	Comprehensive (+)	Addresses human-capital and finance gaps faced by small EV suppliers widens the mix to multiple systemic failures.

Pair	**Verdict**	**Rationale**
EV_PUBLIC_SPACE_BBMP (municipal parking bays) ↔ EV_CHARGE_LAND_2021 (state land mandate)	Comprehensive (+)	Combines local and state land-allocation rules, extending infrastructure reach from neighbourhood to highway corridors.
EV_V2G_MODEL_2030 (bidirectional pilots) ↔ EV_STANDARD_2030 (component & protocol standards)	Comprehensive (+)	Pilots validate business model; mandatory standards ensure sector-wide roll-out covers both experimentation and codification stages.