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Decarbonising Spiritual Corridors: EV Integration in South Tamil Nadu’s Carbon-Neutral Hubs – A Case-Based Analysis

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Abstract

Background: Pilgrimage routes create self-reinforcing growth in transport demand and carbon emissions, driven by regular increases and seasonal fluctuations, which are heavily dependent on fossil-fuel-based transport modes and the scarcity of low-carbon infrastructure. There are major spiritual corridors in South Tamil Nadu that are becoming increasingly relevant to state-level decarbonisation and electric mobility agendas. The adoption of electric vehicles (EVs) in pilgrimage-focused transport systems is still informal and not well institutionalised, despite positive policy indicators. **Ok** This paper uses a case-based analysis method to explore recent policy developments, the electrification of public transport, renewable-charging pilot projects, district-based decarbonisation planning, and new private-sector partnerships in Tamil Nadu. **Methodology:** Based on policy documents, government reports, district action plans, and other secondary sources, the research will assess the preparedness of the spiritual corridors to deploy EVs and determine the operational, infrastructural, and governance barriers. **Results:** The discussion shows that, although enabling structures and market interest now exist, decarbonisation at the corridor level can only be achieved through hybrid charging systems, seasonality-capable contract distribution, inter-agency coordination, and all-inclusive transition pathways for informal transport operators. **Conclusion:** The final contribution of the paper is a framework for the context-sensitive implementation of decarbonisation in spiritual corridors through electric mobility.

Keywords: Electric Mobility, Pilgrimage Transport, Spiritual Corridors, Decarbonisation, Case-Based Analysis, Tamil Nadu

Introduction

Transport decarbonisation has emerged as a primary backbone of climate mitigation work, especially in areas where there is an increase in tourism and regional transport movement (Prakhar et al., 2024; Zaino et al., 2024). Pilgrimage corridors are a unique transport environment that has been typified by a surge in episodic travel, involving a large number of passengers and carrying significant socio-cultural importance (Liu et al., 2025). Religious tourism also

constitutes a significant portion of domestic tourism in India, with South Tamil Nadu being an important pilgrimage region linking temples, the coastline, and urban centers. Transport systems operating along such corridors majorly depend on diesel buses and personal vehicles and informal forms of transport (Zaino et al., 2024), which causes congestion, poor quality of the air and increases the carbon emission during peak pilgrimage periods (Say et al., 2023). Although national and state-level electric mobility policies are progressively promoting vehicle electrification, their application has largely been limited to urban commuting and freight transport. The concept of pilgrimage mobility through corridor electrification has not yet become a focus of policy development or scholarly research. This paper fills this gap by reviewing recent and tangible projects in the state of Tamil Nadu that can support EV integration within pilgrimage corridors. Instead of a systematic review approach, the paper adopts a case-based analysis approach to relate policy intent to operational feasibility. The research paper intends to show how the available programs can be modified into cor

Spiritual Corridors as Socio-Technical Transition Spaces

Spiritual corridors are unique mobility systems that interface transport, energy consumption, tourism activities, and the cultural institutions (Geels, 2002; Zaino et al., 2024). These corridors, unlike the transport networks in urban areas, are typified by low frequency and very seasonal demand, reliance on informal and semi-formal transport services, and fragmented governance by transport, tourism, energy and religious authorities (Liu et al., 2025; Say et al., 2023). Conceptually, socio-technical transition, spiritual corridors serve as transition spaces where the existing fossil-based transport regimes coexists with new electric projects in mobility (Geels, 2002). Electric buses, renewable-related charging prototypes and supportive policy incentives can be viewed as niche solutions that interact with existing practices in the environment of changing demand and infrastructural bottlenecks (Prakhar et al., 2024; Sistig et al., 2025). Due to this fact, the concept of spiritual corridors offers a valuable framework of understanding how decarbonisation activities should be scaled to social acceptance, inter-institutional coordination, and changing operating environmplj

Research Questions

In an attempt to cope with the inadequate knowledge of the role of electric mobility transitions in pilgrimage-oriented transport systems, the following questions of the research guide the current study:

1. What is the readiness of spiritual corridors in South Tamil Nadu with regard to the implementation of electric mobility regarding the infrastructure, institutions, and activities?
2. What are institutional and infrastructural and governance restraints in the adoption of electric vehicles in pilgrimage transport corridors?
3. Which strategies can be used to adjust current urban electric mobility prototypes to accommodate urban spiritual corridor context-sensitive decarbonisation?

Methodological Approach

This study adopts a qualitative case-based approach to examine how recent electric mobility initiatives in Tamil Nadu can support decarbonisation in pilgrimage-oriented transport corridors. A case-based design is appropriate because spiritual corridors represent complex transport settings shaped by seasonal demand, mixed formal and informal operations, and multiple institutional actors, which cannot be adequately captured through standard urban mobility models.

Case Selection

The cases were selected through a purposive strategy, emphasising recent initiatives that are both policy-relevant and applicable to corridor-based electric mobility. Selection was guided by three criteria: relevance to electric vehicle policy, operational relevance to public and intercity transport, and relevance to energy and charging infrastructure. The aim was not to provide a comparative performance result, but to record various categories of interventions which combine requirements of decarbonisation at corridor level.

Table 1 Case Selection and Relevance

Case	Policy relevance	Functional Significance	Energy Significance
Tamil Nadu EV Policy (2023)	Provides incentives and regulatory support	Enables public and commercial EV deployment	Supports renewable-linked charging
Electric bus initiatives	Demonstrates feasibility of fleet electrification	Applicable to corridor and intercity routes	Relies on depot-based charging
Renewable charging pilots	Encouraged by state policy	Appropriate to pilgrimage nodes	Incorporate solar energy
District decarbonisation planning	Translates state policy locally	Promotes corridor-based mobility planning	Harmonizes transport and energy planning
Private sector partnerships	Encourages market participation	Catalyzes intercity EV operations	Comprises charging and maintenance

Analytical Approach

The thematic organization of the analysis was made. The review was directed by four key themes, namely infrastructure, governance, contracting, and energy integration. Infrastructure in this case meant the availability of charging systems and the capacity of corridors to feed the electric cars. The infrastructure was evaluated based on the availability of charging and corridor preparedness to electric vehicles. Governance looked at the distribution of responsibilities and co-ordination of the transport, tourism, energy and district level authorities. Contracting looked at operational and financial plans especially those ones that are utilized in the seasonal changes in pilgrimage traveling. Energy integration considered the possibility of using renewable energy and the limitation of the local grid capacity. All of these cases were subject to these themes to make a comparison.

Case Evidence in Tamil Nadu

State Level Electric Vehicle Policy Framework

In the Tamil Nadu state, a big step towards the rapid implementation of EV has been undertaken in the form of the Electric Vehicle Policy (2023) which revolves around fiscal incentives, infrastructure provisioning, and establishment of renewable-based charging incentive solutions. The policy lessens the capital constraint to install the charging stations and provides favourable investment condition to electrify the public transport and commercial EV fleets. Of particular interest is its concentration on renewable energy integration in semi-urban and pilgrimage destinations because these areas might be constrained in terms of grid capacity. The policy in the case of spiritual corridors offers desirable financial and business climate which could facilitate charging stations at temple precincts, highway approach statuses and transport depots. However,

the policy lacks specification of the implementation mechanisms on curve-level, and emphasizing the issue of context-related planning frameworks.

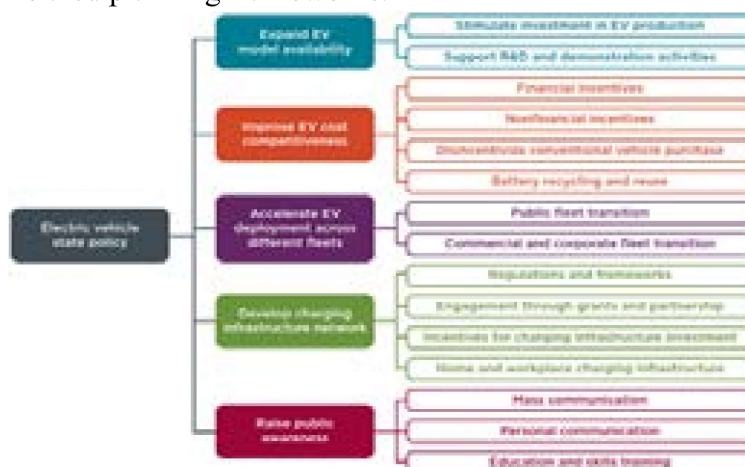


Figure 1: Framework of State-Level Electric Vehicle Policy Instruments and Implementation Pathways

Electrification of Public Transport Projects

Recent experiences with electric buses in metropolitan areas in Tamil Nadu (such as Chennai) and in other government plans of the scheduled expansion of the scheme to other cities (like Madurai) indicate the practicality of massive transformation of public transport. Such projects are typified by in-depot charging, operating contracts of performance type and the allocation of risks in a manner that involves the public authorities and the operators. The usefulness of these efforts with respect to spiritual corridors is found in their transferable modalities of operations. Significant transport routes between pilgrimage towns and other urban hubs can adopt similar contracting and pricing strategies. Notably, service availability payments, and arrangement of leasing systems offers a tool to handle seasonal changes in pilgrim traffic, which frequently discourages the investment of the electri

Table 2 Metropolitan Electric Bus Operations and Corridor-Level Applicability Comparison

Aspect	Metropolitan electric bus operationalisation (Tamil Nadu)	Relevance for spiritual corridors
Operating context	High-demand urban public transport systems	Intercity and corridor pilgrimage transport
Charging approach	Depot-based charging at bus depots	Applicable at corridor terminals and city-edge depots
Contracting model	Performance-oriented operating contracts	Adaptable to corridor services
Payment structure	Service availability payments	Appropriate for managing seasonal pilgrimage demand
Risk allocation	Shared between public authorities and private operators	Minimizes financial risk during off-peak periods
Investment mechanism	Leasing-based fleet procurement	Promotes private investment in corridor EV fleets

Renewable-Linked Charging Demonstration

An example of charging infrastructure based on renewable is a solar-powered EV charging station at the Tamil Nadu Secretariat. The pilot illustrates reduction in dependence on the electricity grid and lifecycle emissions associated with vehicle electrification by integrating solar photovoltaic generation with EV charging. The model is particularly applicable in pilgrimage corridors in South Tamil Nadu, where the high solar potential is matched by the low grid capacity in the semi-urban and rural regions. Renewable-based charging stations at pilgrimage stations can offset the process of last-mile electric mobility while enhancing the environmental credibility of decarbonisation efforts.

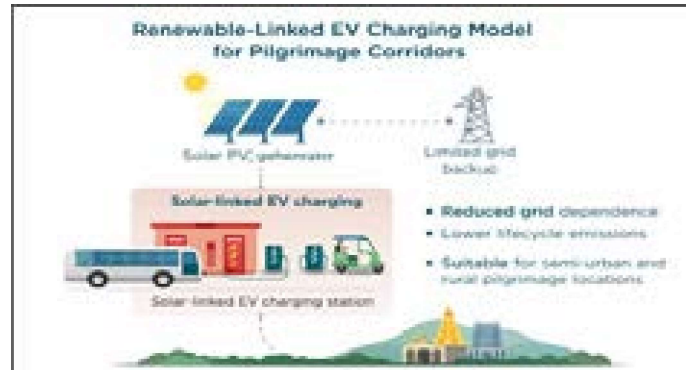


Figure 2: Renewable EV charging for Pilgrimage sites

District-Level Decarbonisation Planning

A successful sub-state planning effort that notably defines transport electrification as part of an area focused on pilgrimage is the Ramanathapuram District Decarbonisation Action Plan. The plan recognizes the need to integrate the EV with tourism management, connectivity of the corridors and electrification of commercial vehicles. The plan offers an effective paradigm to justify state-level EV policy in accordance with local transport and tourism facts because the district hosts the Rameswaram pilgrimage circuit. It demonstrates how the district administrations can pursue the decarbonisation objectives by making interventions at the level of corridors.

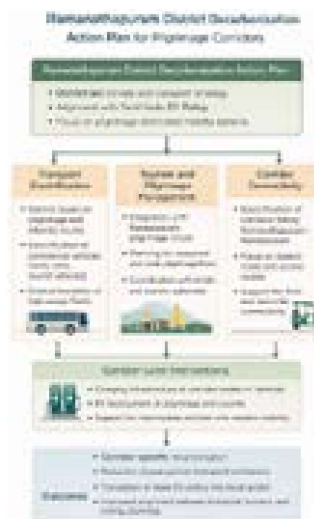


Figure 3: Ramanathapuram District Decarbonisation Action Plan

Private Sector and Manufacturer–Operator Partnerships

The formation of new manufacturer-operator alliance deals in electric intercity coaches, along with other recent actors, indicate an increasing willingness by the private sector to be involved in the process of electrification on corridors. Such deals indicate growing confidence in EV-technology, as long as the proper charging infrastructure and maintenance support and contractual risk mitigation measures are established. In the case of pilgrimage corridors, such partnerships are paramount with intercity coaches being the segment which pilgrims rely on during long track pilgrimage transportation. The use of private operators via organized contracts will help expedite the use of EVs on routes where state agencies do not directly have control over operations.

Cross-Case Insights

Among the cases examined, there are some similar conclusions. Policy incentives and market preparedness is not enough to provide decarbonisation of the corridor level. The integration of EV into the spiritual corridors needs hybrid charging systems that integrate depot-based systems with slow and opportunity charging at the pilgrimage nodes. Seasonal demand variability should be clearly established by financial and contract models in order to make the operators economically viable. The means of renewable energy incorporation can be instrumental in breaking gridlocks and improving the results of carbon reduction. The coordination between the institutional level of transport, tourism, energy and district authorities is vital to prevent a fragmented implementation. Lastly, there is need to have inclusive transition pathways to incorporate informal transport operators who also offer imperative previous beginning and end services critical in pilgrimage settings.

Based on common themes found throughout the cases, the research combines these lessons into a unified model of how spiritual corridors can be decarbonised through electric mobility on a corridor level. The framework brings to the fore the policy, infrastructural, governance and contextual aspects together into a logical structure of analysis linking enabling conditions to operational-outcome.



Figure 4 Framework for Corridor- Level EV Decarbonisation in Spiritual Corridors

Figure 1 illustrates an embedded framework for electric mobility–led decarbonisation in spiritual corridors, developed from a cross-case examination of EV policy instruments, public transport electrification initiatives, renewable charging pilots, district-level planning efforts, and private-sector participation in Tamil Nadu. The framework brings together four interrelated components.

The first consists of enabling conditions, including EV policy incentives, market and technological readiness, and the availability of renewable energy resources, which together establish the baseline feasibility for corridor electrification. At the centre of the framework is the operational transition layer, comprising hybrid charging infrastructure, flexible contracting and financing arrangements capable of responding to pilgrimage seasonality, and coordinated governance across transport, tourism, energy, and district institutions. These aspects are contingent upon the context-specific factors such as transient changes of pilgrimage demand, spatial clustering of activity around religious nodes, grid capacity constraints and the presence of informal transport services. Their mutual interaction underpins the achievement of corridor-level decarbonisation, such as reduced emissions during the peak hours, as well as better air quality, and scalability of the electric mobility adoption, according to the local socio-economic and instituqäs

Implications for Policy and Practice

The findings show that spiritual corridors should be identified as special planning units in a state that is undertaking EV strategies. The inter-agency mechanisms of governance may be implemented in conjunction with more specific mobility plans of corridors that can transform the general policy incentives into the real projects. The pilgrimage routes can be electrified through the assistance of the elastic contracting and phases of implementing the models that had been developed within metropolitan contexts. Semi-urban pilgrimage should also be prioritized in terms of providing infrastructure related to the charging renewable energies to eliminate grid constraint. The policy makers should also develop financial and institutional solutions that can enable the infö

Table 3 Policy and Practice Implications for Electric Mobility in Spiritual Corridors

Policy / Practice domain	Key implication	Relevance for spiritual corridors
Planning scale	Treat spiritual corridors as distinct planning units	Enables corridor-specific electrification strategies rather than city-centric approaches
Governance	Strengthen inter-agency coordination	Aligns transport, tourism, energy, and district authorities for effective implementation
Contracting and rollout	Use flexible and phased deployment models	Adapts metropolitan EV contracting models to seasonal pilgrimage demand
Charging infrastructure	Prioritise renewable-linked charging	Addresses grid constraints in semi-urban and rural pilgrimage areas
Informal transport integration	Design inclusive financial and institutional mechanisms	Enables participation of informal and intermediate transport operators in EV transitions

Limitations and Future Research

This study is analyzed with the help of the examination of the existing documents and secondary sources, which report about the recent developments. This approach is valid in that an early insight into the efforts which are emerging is taken but fails to reflect operational realities on the ground.

Further studies could be improved by the field-based evidence, interviews with major stakeholders, route specific operation information, and measuring the emissions directly at the corridor level. Furthermore, EV-based pilgrimage destinations can have stronger empirical bases of the design and scaling of their corridor-based approaches by taking pilots assessment and cross-regional comparison.

Conclusion

The case-based analysis demonstrates that South Tamil Nadu is well-positioned to pilot the decarbonisation of spiritual corridors through electric mobility. Recent policy reforms, public transport electrification initiatives, renewable charging pilots, district planning efforts, and private sector engagement collectively create a favourable transition environment. However, realising this potential requires moving beyond isolated initiatives towards coordinated, corridor-specific implementation frameworks. By aligning transport electrification with tourism practices, local energy systems, and district-level governance, spiritual destinations can emerge as practical examples of mobility tran

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