



GUJARAT TECHNOLOGICAL UNIVERSITY

(Established by Government of Gujarat under Gujarat Act No. : 20 of 2007)

ગુજરાત ટેકનોલોજીકલ યુનિવર્સિટી

(ગુજરાત સરકારના ગુજરાત અધિનિયમ ક્રમાંક : ૨૦/૨૦૦૭ દ્વારા સ્થાપિત)

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Abstract of the Thesis



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Faculty: Engineering

Discipline/Branch: Civil Engineering

Title of the Thesis: "Fleet Electrification for Public Transit: An Economic Assessment of Intercity Bus Operations In Kutch"

Content of the Abstract Research

Abstract

The extensive use of fossil fuels in transit buses has led to both environmental problems and fuel scarcity. Many countries worldwide have already adopted sustainable development to address these challenges. Similarly, the Indian government has initiated e-vehicle adoption in various sectors through subsidies to reduce dependence on conventional fuels. This research investigates the key areas: fuel consumption dependency and air quality impact assessment for diesel-operated public bus fleet (GSRTC), while exploring fleet electrification possibilities through the replacement of diesel buses with EV-buses. This research employs a three-stage energy modeling methodology: Route Energy Planning (REP), Charging Infrastructure Planning (CIP), and Total Cost of Ownership (TCO) and relevant analysis. The study explores the potential for fleet electrification for Kutch division of GSRTC, aiming to replace existing diesel-powered internal combustion engine (ICE) buses with environmentally friendly EV-buses. Out of 183 buses operating over 82,196 km route length in Kutch, 30% (57 buses) were targeted for replacement in the first stage. Using a 25% minimum SOC (state of charge) threshold, 119 ICE-buses were shortlisted, and after optimizing charging schedules, 66 were finalized as priority buses. An analysis of annual costs for both ICE diesel and EV-buses was conducted, considering bus capitalization, battery capitalization, charging infrastructure, and annual operating costs. The findings revealed that the TCO for an EV-bus is lower than that of a diesel bus (31.00 Rs/km vs. 32.01 Rs/km). This study evaluates the viability of implementing electric mobility for the Gujarat State Road Transport Corporation (GSRTC) in Kutch District, India, to promote sustainable

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Ph.D. Programme

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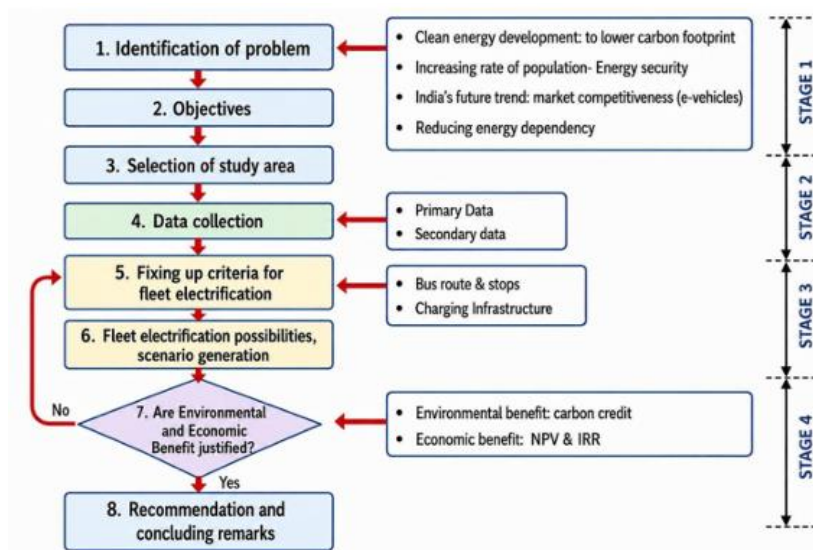
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transportation and reduce emissions. The methodology involved assessing Net Present Value (NPV) and Internal Rate of Return (IRR) using a functional unit of one bus travelling 220 km daily. The bus stations and routes were digitized in GIS format, enabling precise mapping and spatial analysis. The economic assessment indicates that electric bus deployment is financially viable compared with diesel-operated buses. For the 30% fleet replacement scenario, The EV-with-charging scenario achieves The NPV of EVs including charging facilities increases from ₹1,927 lakh at 10% electrification to ₹6,169 lakh at 30% electrification. The corresponding IRRs are 29.52%, 31.13%, and 31.68% for the 10%, 20%, and 30% electrification scenarios, respectively. These values are lower than the 41.87% IRR of diesel buses, but higher than the 31.53% IRR of EVs without charging facilities. The NPV of EVs without charging facilities is ₹2,015 lakh, ₹4,030 lakh, and ₹5,939 lakh, respectively, across the three scenarios.

Problem

1. Clean energy development
2. Increasing rate of passenger transport
3. India's future trend: market competitiveness
4. Reducing energy dependence import by adopting renewable energy

Methodology followed for research Outcome of the research Application





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This PhD Thesis will help in the findings that can support decision-makers in planning EV deployment, optimizing charging infrastructure, and selecting economically and environmentally viable electrification scenarios.

OR

This thesis would be useful for decision-support tool for planning and implementing the gradual transition from conventional diesel buses to electric buses.

- 1) List of Publication(s): 1) Prajapati, M. L., Gundaliya, P. J., & Sheth, A. (2020). Case study: Solar electric vehicles in India. IOP Conference Series: Materials Science and Engineering, 937(1), 012033. IOP Publishing. <https://doi.org/10.1088/1757-899X/937/1/012033>
- 2) Prajapati, M. L., Maheshwari, K., & Tanwar, G. (2022). Fleet electrification planning for Anjar city. Civil Engineering Department, Tolani F. G. Polytechnic, India.
- 3) Prajapati, M. L., & Desai, N. A. (2024). Exploring cost effective fleet electrification possibilities for public transit services in Kutch region. Current World Environment, 19(1), 1–15. Enviro Research Publishers. <https://www.cwejournal.or>