



Maharashtra State Road Transport Corporation's
**Electrifying
Transformation**
E-Bus Project and Beyond





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- ASRTU is an apex coordinating body of all State Road Transport Undertakings (SRTUS).
- The Secretary, (RT&H) Ministry of Road Transport & Highways, (MoRT&H) Govt of India is the ex-officio President of ASRTU.
- ASRTU has expertise of more than 50 years for promoting public transport in the country. At present 90 SRTUS/SPVs are the backbone of mobility for the urban rural and hilly region population across the country and collectively operate about 150000 buses and provide gainful employment to 1.0 million people.
- ASRTU motto is to promote public transport at par with the international standard.

VISION

Thriving on challenges, moving on the wheels of innovations and facilitating seamless integration of India's State Road Transport Undertakings, to ensure a world-class passenger road transport system reaching all corners of India, thus making a mark in the global map of public road transport.

MISSION

Committed to

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- Formulation of policies and facilitating their implementation, advocacy with Ministry and Government agencies, addressing issues of common interest in various interactive forums for the benefit of member undertakings.
- Enhancing the competency of Transport managers of STUs by participation in National and International Conferences and Seminars, workshops and training.
- Providing a common procurement service of quality automobile components at reasonable prices meeting the standard specifications to its member.



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MSRTC's Electrifying Transformation: E-Bus Project and Beyond

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Key Message from Mr. Shekhar Channe (IAS),



Vice Chairman and Managing Director, MSRTC
Vice President, ASRTU

Dear Stakeholders,

I am delighted to share the remarkable journey of the Maharashtra State Road Transport Corporation (MSRTC) in implementing the E-Bus Project. Despite the initial challenges we faced, this project underscores our unwavering commitment to sustainable and efficient public transportation. Here, we present the key milestones and the invaluable lessons for other State Transport Undertakings (STUs) to consider.

E-Bus Introduction: In 2021, MSRTC procured 150 buses under the FAME II subsidy, introducing 50 Shivai buses and 100 e-Shivneri buses, marking our initial step towards electrification. This transition was aimed at enhancing our services and reducing our environmental impact.

Challenges and Resilience: MSRTC confronted challenges due to the COVID-19 pandemic and an extensive labour strike. However, these difficulties ignited a resolve to improve our strategies and operations, making us more resilient and determined.

Strategic Revival: In the face of labour union demands and a protracted strike, a high-power committee comprising eminent members was constituted. This committee instructed MSRTC to develop a revival plan that focuses on self-sustainability and the reduction of labour union monopolies.

Visionary Fleet Augmentation: To enhance reliability, reduce wait times, and address overcrowding, MSRTC formulated a plan to expand our fleet from 15,000 to 22,000 buses by 2025. We adopted the PPP model on a significant scale and planned to procure 5,150 E-buses on the GCC model, 500 diesel buses on the GCC model, 2200 diesel buses on the outright purchase model and retrofitting of 6,000 existing diesel buses to LNG/CNG.

Electrification for Sustainability: In alignment with the State EV Policy, we aimed to achieve 25% fleet electrification by 2025. Furthermore, we pursued BS VI diesel buses and the retrofitting of diesel buses to LNG/CNG to decrease our reliance on fossil fuels, save on fuel costs, and reduce emissions.

Charging Infrastructure and Route Optimization: MSRTC meticulously planned charging station locations, depot selections, and route optimisations to ensure the efficiency of our E-Bus Project. Our in-house expertise played a pivotal role in these endeavours.

Financial Support and Viability Gap Funding: While E-buses are more cost-effective in the long term, MSRTC acknowledged the need for government support to sustain operations. We sought upfront capex subsidies and Viability Gap Funding, emphasising the importance of maintaining positive cash flow for timely payments to operators.

Concession Subsidy and Cost Efficiency: MSRTC receives a substantial subsidy for various concessions, which aids in keeping cash flow positive. Our E-Bus Project is not only cost-effective but also economical when compared to conventional ICE buses, especially considering the rising cost of diesel.

Reducing Fossil Fuel Dependency: In addition to introducing E-buses, MSRTC is committed to retrofitting 6,000 existing diesel buses to LNG/CNG. These steps aim to reduce our dependence on fossil fuels, lead to significant cost savings, and contribute to emissions reduction.

Lessons for STUs: Our journey demonstrates the importance of strategic planning, government support, and a strong commitment to sustainability and efficiency in public transportation. We encourage other STUs to consider our experiences and learnings when embarking on similar projects.

In conclusion, the MSRTC E-Bus Project serves as a testament to our dedication to sustainable and efficient public transportation. We are confident that this initiative will not only benefit our environment but also elevate the quality of life for the people of Maharashtra.

Warm regards,

Shekhar Channe, IAS

Vice Chairman and Managing Director, MSRTC

Vice President, ASRTU

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Executive Summary

This report provides an extensive analysis of the Maharashtra State Road Transport Corporation's (MSRTC) Electric Bus (E-bus) Project. The project was initiated in 2021 under the FAME II subsidy and represents a significant shift towards sustainability and electrification in public transportation. This report examines the project's background, objectives, implementation strategies, and financial considerations. It also discusses the incorporation of environment-friendly BS VI diesel buses and the retrofitting of existing diesel buses into Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) vehicles.

The Maharashtra State Road Transport Corporation (MSRTC) embarked on a transformative initiative with the procurement of 150 electric buses (e-buses) under the FAME II subsidy in 2021. Despite initial plans to replace only AC services, MSRTC expanded its vision to a comprehensive fleet augmentation strategy, incorporating 5150 e-buses on the GCC model, 500 diesel buses on the GCC model, 2200 diesel buses on the outright purchase model and retrofitting existing 6000 diesel buses to LNG/CNG, aiming for a fleet size of 22,000 buses by 2025. The project faced challenges, including the COVID-19 pandemic and labour strike. In response, a high-power committee was formed to revive operations and enhance self-sustainability.

The electrification plan on the GCC model, aligning with the State EV Policy, involves procuring mofussil-type e-buses, with M/S EV Trans Pvt Ltd winning the tender. Route planning and depot selection, driven by in-house expertise, prioritise high ridership, energy efficiency, and low bus replacement ratios. The project also includes extensive charging infrastructure development, marking a significant step towards sustainable public transportation.

Financially, MSRTC anticipates government support, emphasising the importance of upfront subsidies and Viability Gap Funding (VGF). The report highlights the need for careful financial planning, considering net earnings per kilometre and subsidy disbursement timelines.

Despite higher bid rates, the long-term cost efficiency of e-buses is projected to surpass that of conventional ICE buses, with substantial savings in staff costs and maintenance expenses.

In parallel, the addition of BS-VI diesel buses and CNG/LNG retrofitting contributes to reducing fossil fuel dependency, achieving fuel cost savings, and obtaining subsidies for carbon credits. The MSRTC E-Bus Project embodies a holistic approach to modernising public transportation, emphasising sustainability, financial prudence, and operational efficiency.

1. Introduction & Project Background

The MSRTC E-Bus Project, initiated in 2021 through the generous support of the “Faster Adoption and Manufacturing of Hybrid and Electric Vehicles” (FAME II) subsidy, stands as a groundbreaking endeavour poised to revolutionise public transportation in Maharashtra. This visionary project marks a significant departure from conventional transit modes, ushering in a new era of sustainable and environmentally conscious mobility solutions. At its core, the project's overarching goal is to minimise the carbon footprint and elevate operational efficiency and the overall quality of public transportation services throughout the state. In 2022, MSRTC expanded its electrification plan under a comprehensive fleet augmentation strategy by, incorporating 5150 e-buses on the GCC model. This tender is still the biggest e-bus tender in India floated by a single STU.

1.1 Initial Procurement and Service Replacement

In 2021, the Maharashtra State Road Transport Corporation (MSRTC) embarked on a transformative journey by acquiring a fleet of 150 electric buses, thanks to the subsidy provided under the FAME II program. This strategic move marked a significant step forward in the organisation's commitment to sustainable and eco-friendly transportation solutions.

Of these 150 electric buses, 50 were introduced as part of the "Shivai" fleet, serving as a compelling alternative to MSRTC's existing "Shivshahi" diesel AC economy service. Introducing the electric "Shivai" buses showcased MSRTC's dedication to reducing its carbon footprint and emphasised its commitment to providing passengers with a greener, more sustainable travel option. It also ensured a comfortable and efficient travel experience for passengers. The remaining 100 electric buses were integrated into the "e-Shivneri" fleet, which will be replacing the existing diesel-based premium A/C Volvo Shivneri buses operated on the Mumbai - Pune - Mumbai route.

It's worth noting that MSRTC initially intended to focus on replacing only its AC services with electric buses in the coming years. By introducing electric buses to its flagship services, the corporation is setting precedence for the wider adoption of sustainable transportation solutions in the region.



MSRTC's "E-Shivneri Bus"¹ These buses are operated as a premium AC brand between Mumbai - Pune and Thane - Pune. MSRTC has procured a total of 100 buses under the FAME II Scheme in 2023. These buses are replacing diesel-based Volvo Shivneri buses.



MSRTC's "Shiva - E"² These buses are operated as an economical AC brand on various intercity routes. MSRTC has procured a total of 50 buses under the FAME II Scheme in 2023. These buses are replacing diesel-based Shivshahi buses. The upcoming 5150 electric bus tender is set to expand Ebuses in the fleet, to be operated at various mofussil routes.

¹ Photo Courtesy: <https://www.youtube.com/@AvaliyaPravasi>

² Photo Courtesy: <https://www.youtube.com/@AvaliyaPravasi>

1.2 Navigating Labour Unrest: Lessons from MSRTC's 2021-2022 Strike

The events of November 2021 marked a pivotal moment in the history of the Maharashtra State Road Transport Corporation (MSRTC), as the majority of labour unions within the organisation united in a call for a strike. The primary demands of this significant labour movement were twofold: firstly, the recognition of MSRTC employees as government employees, and secondly, the complete merger of MSRTC into the state government's administrative framework.³



This strike garnered substantial participation from MSRTC's workforce, particularly among the ground staff (drivers, conductors and mechanics), where nearly 90% of employees actively engaged in the labour action. The massive turnout underscored the depth of the employees' dissatisfaction and the urgency of their demands.

What followed was a protracted labour strike, which persisted until April 2022. Throughout the strike, the disruption in MSRTC's services had a far-reaching effect, inconveniencing passengers and posing significant logistical and financial challenges for the organisation. Ultimately, the strike's conclusion in April 2022 marked a turning point, as it opened the door for negotiations and discussions between the labour unions, MSRTC management, and the state government. These talks addressed the grievances raised during the strike and found mutually agreeable solutions such as a revival plan of MSRTC and a change in pay scale etc.

During the ongoing MSRTC strike, Regional Transport Authorities have taken proactive measures to alleviate the inconvenience faced by passengers. Private carriages have been granted temporary permissions, allowing them to operate from MSRTC Bus Stations. This was aimed at ensuring the smooth continuation of essential transportation services, minimising disruptions caused by the strike and prioritising the well-being of the commuting public.

³ Photo Courtesy: <https://www.hindustantimes.com/>

1.3 Reviving Maharashtra State Road Transport: The Role of a High-Powered Committee

Amidst the contentious merger demand and the worker strike case that had found its way into the Bombay High Court, significant development unfolded. Recognising the gravity of the situation and the need for decisive action, a high-powered committee was convened to resuscitate the operations of the Maharashtra State Road Transport Corporation (MSRTC).

This distinguished committee comprised esteemed members, including the Chief Secretary, the Additional Chief Secretary of Transport, and the Additional Chief Secretary of Finance. Their collective expertise and authority signalled the seriousness with which the state and the judiciary regarded the challenges faced by MSRTC. The high power committee submitted a rival plan of MSRTC to the State Govt, which the Hon. Bombay High Court subsequently approved.

The primary directive issued by the high-powered committee was for MSRTC's management to craft a comprehensive revival plan. This plan was tasked with the formidable mission of rectifying the losses incurred by MSRTC, reinstating disrupted services, and, crucially, restoring ridership levels to a state of normalcy and providing financial support to MSRTC. The committee understood that this was essential to safeguard the interests of passengers who depended on MSRTC for their daily commute.

Notably, the committee's mandate extended beyond mere recovery; it called for a transformation that would render MSRTC self-sustainable. To achieve this ambitious goal, the committee recognised the necessity of addressing the issues related to labour unions and their historical monopoly within the organisation. This high-power committee's intervention not only reflected the gravity of the situation and the commitment to finding lasting solutions that would ensure the continued provision of essential public transportation services to the people of Maharashtra.

In tandem with the implementation of the revival plan, MSRTC strategically embraced self-sustainability by introducing a Public-Private Partnership model to meticulously unbundle various components, thereby achieving enhanced cost efficiency in operations. This strategic initiative is pivotal in MSRTC's commitment to significantly amplify its fleet size, transitioning from 15,000 buses to an ambitious target of 22,000 buses by the year 2025. The core emphasis lies on the procurement of electric buses, accompanied by a comprehensive plan to retrofit existing diesel buses into LNG/CNG-powered units.

2. MSRTC's Ambitious Fleet Expansion and Sustainability Plan

2.1 Electrifying Maharashtra's Transportation: MSRTC's Path to a Greener Future

As directives issued by the high-powered committee, the Maharashtra State Road Transport Corporation (MSRTC) embarked on an ambitious plan aimed at enhancing its operational capacity and significantly improving the quality of its services. This transformative initiative sought to address several critical challenges, including improving reliability, reducing wait times, alleviating overcrowding, and expanding accessibility to MSRTC buses for a wider segment of the population.

At the heart of this visionary plan was a commitment to scaling up MSRTC's fleet size from its existing 15,000 buses to an impressive 22,000 buses within the span of just three years by the target year of 2025.



MSRTC's new BS VI diesel fleet procured under Gross Cost Contract⁴

To achieve this substantial increase in fleet size, MSRTC adopted a multifaceted approach, primarily focusing on the widespread implementation of the Public-Private Partnership (PPP) model. Embracing the PPP model on such a scale was a strategic move that leveraged private sector expertise and resources to facilitate the rapid expansion of the bus fleet. This collaborative effort allowed MSRTC to tap into the efficiency and innovation that private partners could bring, accelerating the acquisition of new buses.

⁴ Photo Courtesy: <https://www.youtube.com/@AvaliyaPravasi>

The comprehensive fleet augmentation plan outlined the procurement of 5,150 electric buses (E-buses), 500 diesel buses on GCC, and 2,200 diesel buses on outright purchase. The strategic plan to incorporate 5,150 electric buses (E-buses) serves as a critical step towards aligning the corporation with the State's Electric Vehicle (EV) Policy. This forward-thinking initiative was designed to achieve a significant fleet electrification target above 15% by 2025.

In addition to the acquisition of new buses, the plan recognised the importance of retrofitting existing diesel buses to operate on Liquefied Natural Gas (LNG) and Compressed Natural Gas (CNG). This retrofitting initiative aimed to enhance the environmental performance of the existing fleet, reducing emissions and ensuring compliance with evolving emission standards.

Comprehensive Fleet procurement and upliftment plan till 2025

	Type of Bus	Total Buses
1	Electric Buses (GCC)	5150
2	Diesel Buses (GCC)	500
3	Diesel Buses (Outright Purchase)	2200
4	Retrofitting of existing diesel buses to LNG/CNG	6000

2.2 MSRTC's Pragmatic Approach to Mofussil Electric Buses

Within the scope of this ambitious project, the procurement of 5,150 electric buses (E-buses) takes on a distinct character, as these buses are designated as "mofussil type." To ensure that the procurement aligns with the specific requirements and operational context of MSRTC, the corporation meticulously outlined its bus-type specifications in the tender document.

During the pre-bid meeting, a noteworthy observation surfaced: the majority of electric bus Original Equipment Manufacturers (OEMs) in India offered limited or no options for mofussil intercity type buses. This distinction is particularly crucial given the intended operational landscape of these E-buses, which encompass both urban and rural areas, presenting varying terrains and road conditions.



⁵An MSRTC mofussil bus hurtles down a narrow asphalt road in the remote mountainous terrain of Maharashtra, vividly illustrating the diverse challenges presented by different road conditions and landscapes. Given that a significant portion of MSRTC's services operate as mofussil buses, introducing new E-buses must prioritise versatility to navigate a spectrum of road conditions and rugged terrains efficiently.

The decision to prioritise mofussil-type buses stems from the practical necessity of ensuring that the newly acquired fleet is well-equipped to navigate diverse terrain and withstand the rigours of operation across different regions. Mofussil buses, characterised by their regular floor design and good ground clearance, are better suited to tackle the challenges of uneven or less-developed road networks. This design choice is a proactive measure aimed at minimising wear and tear, enhancing the durability of the fleet, and ensuring reliable service across the diverse geographical and environmental contexts within Maharashtra.

Given the specialised nature of mofussil type requirements and the specific operational needs of MSRTC, it's noteworthy that some E-bus OEMs, which primarily offer city variants, opted to refrain from participating in the tender process.

⁵ Photo Courtesy: <https://3.bp.blogspot.com/>

3. MSRTC E-Bus Tender Summary

3.1 Primary Scope and Contract Details:

- **Primary Scope:** The primary scope of the contract is the "Supply, Operation, and Maintenance" of 5150 Electric Buses along with associated Electrical and Civil Infrastructure. This contract will be executed on a Gross Cost Contract basis.
- **Contract Period:** The contract period comprises various phases
 - 3 months for prototype inspection
 - 24 months for supply of buses
 - 12 years of operation, support, and maintenance
 - Note: The 12-year operation period is counted from the date of supply of Commercial Operation Date (COD) of the bus.
- **Subsidy:** MSRTC has requested financial support from the State Government. If this support is granted, it will be provided to the selected bidder as a subsidy at ₹20 lakhs per bus.

Details of total depots for E-Buses and charging infrastructure

- No. of depot location for operations with charging and maintenance: 101
- No. of location with only charging infrastructure: 71

*Note: The above count is subject to 10% +/- variation

3.2 Scope of Work

- **Objective:**
MSRTC aims to promote clean and green shared mobility by using electric buses. They plan to implement this through a Gross Cost Contract with an external agency responsible for the supply, operation, and maintenance of the electric bus fleet.
- **Scope:**
Procurement, operation, and maintenance of 5150 electric buses (2350 buses of 9 meters and 2800 buses of 12 meters) along with associated electrical and civil infrastructure at selected depots.
- **Performance Requirements:**
The 9-meter A/C buses must have a minimum range of 200 km on a single charge, and the 12-meter A/C buses must have a minimum range of 300 km. Buses should operate with an 80% State of Charge (SOC) considering traffic congestion. in single

charging with air-conditioning to the occupants to be maintained at 23 degree Celsius throughout the contract period.

- **Daily Operations:**

Each bus is required to cover an assured of 325 km per day as per MSRTC's schedules without interruption. There is no upper limit on the number of kilometres travelled per day. The per kilometre fee for over and above the assured kilometer shall be 75% of per km fee quoted.

- **Charging Infrastructure:**

The operator to establish charging infrastructure, including electric transformers and related civil infrastructure, at the identified depots and bus stations. Universal Charger i.e. CCS 2.0 type charging for charging electric buses to be provided by Operator

- **Maintenance:**

The operator to carry out preventive and breakdown maintenance of the buses. The Operator agrees that it shall undertake the bus maintenance activities through its OEM i.e. Olectra Greentech Limited (who is a Member of the SPV for the entire contract period.

- **Driver Training:**

The agency must provide training to drivers for operating the electric buses and conducting preliminary repair works in case of breakdowns. Training for behaviour and hygiene aspects is also required for all personnel. The operator shall provide the bus with driver possessing valid driving license with P.S.V. badge, Certificate of medical fitness from any qualified MBBS /BAMS (as per govt. guidelines) doctor and the driver must fulfill all the criteria and standards required for the post of Drivers. The driver shall follow the instructions of the authorities of the MSRTC.

- **Technology Integration:**

MSRTC-mandated devices such as VTS, CCTV, and Panic Buttons as per AIS-140 norms must be installed, with the cost and maintenance borne by the agency. MSRTC has the right to inspect the installed equipment. The cost and maintenance for the same shall be borne by the Operator. Operator to ensure to integrate with MSRTC existing VTS system before COD. Further, all the evidence by VTS to be recorded and uploaded in the billing software.

- **Charging Schedule:**

Since the MSRTC operation hours are round the clock i.e. 24 hours charging of buses should be done majorly during night parking and in between trip gaps. Opportunity charging will be allowed in between completed trips. However, sufficient charging time shall be proportionately provided as per the kilometer operated /SOC consumed in the batteries to cover the remaining schedule of the day

- **Insurance:**
Operator shall ensure the insurance of covering third party risk, passengers within GVW & other property damage including bus. The Insurance should be renewed in time. Under no circumstances shall MSRTC be made liable or responsible to any compensation to be awarded by the motor accident tribunal or court. Operator must ensure that the insurance policy is in force as per the Accidents and Insurance clause mentioned in the RFP
- **Statutory Compliance:**
Operator shall obtain himself, at his own expense, all the latest Specifications required for design, manufacture, and provide Buses in accordance with contract terms. Operator shall be required to comply with all the provisions of the Motor Vehicle Act of 1988 and Central Motor Vehicle Rules 1989, AIS: 34, 052 & 153 Bus body code and AIS:140 along with all amendments therein and other Statutory and legal requirements as applicable on the date of delivery / registration of Buses.
- **Subcontracting:**
Sub-contracting specific tasks shall be limited to operation and maintenance to experienced/ qualified subcontractors and shall be permitted based on prior intimation to MSRTC.
- **Facilities:**
The agency must set up an office and after-sales support facility at the depot sites.
- **Carbon Credit Monetization:**
Monetization of Carbon Credit will be with MSRTC. Operator will support to MSRTC in the procedures of Monetization of Carbon Credit and shall fulfill all necessary criteria related to carbon credit, including Geo-tagging etc. Any financial involvement in order to fulfil such obligations shall be borne by MSRTC. All rights with regards to any environmental green attributes shall be retained by MSRTC at its own cost.

3.3 Civil and Electrical Instructure

- **Site Allocation:**
MSRTC will provide spaces in depots for Maintenance Depots and charging stations. The Right of Way for these spaces will be granted to the selected bidder(s).
- **Maintenance Responsibility:**
The selected bidder(s) must maintain buses and charging infrastructure, covering expenses related to maintenance and operational costs.

- **Power Supply:**

MSRTC will make High Tension (11/22/33 KVA or suitable power) power supply lines available at designated depots, and the selected bidder(s) will pay the electricity bill from the date of installation.

- **Charging Infrastructure:**

The selected bidder(s) will arrange for site-level power distribution, charging equipment, and related infrastructure. The number of chargers and other details will be determined by the agency.

- **Infrastructure Development:**

The agency is responsible for developing and maintaining charging infrastructure, including transformers and electrical systems.

- **Charging Stations:**

The number of charging stations at each depot will be decided in proportion to the number of buses supplied. Multiple buses should be able to charge simultaneously.

- **Electricity Charges:**

The selected bidder(s) will bear the electricity charges for bus charging. MSRTC will provide separate meters for each depot. (Tender document) ,

- **Infrastructure Ownership:**

After the contract period, the electrical and civil infrastructure at depots for charging purposes will become the property of MSRTC. The selected bidder(s) will have no rights to this infrastructure.

3.4 Responsibilities of MSRTC

- **Infrastructure Provision:**

MSRTC will provide input electricity (11/22/33 KVA or suitable power supply) and water connections at depot locations where available and feasible.

- **Route Planning:**

The MSRTC will provide routes, frequency, and schedules for the bus fleet as part of the fleet deployment plan. MSRTC will have the authority to determine the final routes and schedules.

- **Operational Details:**

The MSRTC will provide operational and traffic schedules.

- **Vehicle Appearance:**

The MSRTC will finalize the paint scheme, graphics, and branding of the contracted

buses if necessary.

- **Permits and Fleet Management:**

MSRTC will facilitate the necessary permits and fleet management. The expenses related to this facilitation will be borne by the bidders.

- **Fare collection:**

MSRTC will provide tickets and all necessary stationery required for service operation.

- **Conductor Deployment:**

Conductors will be deployed by MSRTC for revenue collection, ticketing, and other necessary duties. In cases of conductor-less operation, a traffic controller/conductor will be provided for fare and luggage charge collection.

- **Revenue Monitoring:**

The MSRTC is responsible for monitoring revenue collection and taking actions to enhance revenue.

- **Tax Payment:**

MSRTC will pay all taxes and levies applicable from time to time which is collected from the passengers. But this does not include the taxes viz. valid vehicle insurance, certificate of fitness from RTO and road tax etc.

3.5 Project Timelines

Sr. No.	Type of Bus	Quantity	Prototype Inspection	Delivery of Buses
1.	12 M and 9 M AC Electric Bus	5150	Within 3 months from the date of signing of the contract	215 buses to be delivered in each month from date of prototype inspection. Total delivery of contracted bus to be done within 24 months

- **Delivery Timeline:**

The delivery of 5150 Electric Buses is expected to be completed within 24 months from the date of prototype inspection. Four per cent of the buses are to be delivered each month from the date of prototype inspection. A penalty will be imposed for delays, and the contract may be terminated if deadlines are not met.

- **Prototype Inspection:**

The submission of buses for prototype inspection should be done within 3 months from the date of signing the agreement. Failure to do so will result in penalties, and if not rectified within a grace period, the contract may be terminated.

- **Delivery Schedule:**

The supply of buses will be on a pro-rata basis based on actual allocation. If the selected bidder fails to deliver the required minimum quantity of buses within 12 months, it may lead to contract termination.

- **Charging Infrastructure:**

MSRTC will provide HT connection for charging infrastructure three months before the delivery of buses at respective depots/locations. Delays in providing electricity connections will result in an extended timeline for bus delivery.

- **Revision of Fee:**

Revision of Fee shall be done for all buses delivered in particular quarter (the time of one year will be commenced on completion of quarter or year in which bus is supplied) and after completion of one year of deployment/commercial operation of the buses @ 1.0% of Basic Quoted Rate

- **Electricity Rate Consideration:**

The per-kilometer rate will be initially based on the present electricity rate of the Maharashtra State Electricity Board (MSEB). Subsequent revisions will consider any discounts received from MSEDCL.

- **Electricity Consumption Statement:**

The selected bidder(s) must submit a statement of the input cost of the electricity consumed at the Charging Infrastructure 30 days prior to the expiry of the specified period.

- **Annual Escalation:**

Every 12 months throughout the contractual period for all buses that have been supplied in the respective quarter after completion of the first year of deployment/commercial operation to accommodate price escalation on account of cost of maintenance, material and manpower charges.

3.6 Penalty clauses

1. Penalties & Termination

- If the penalty for any three consecutive months is greater than equal to 3% of monthly billing amount, the penalty shall be capped at 3% of the monthly billing amount and the penalty slab will change to 5% of the monthly billing amount for the succeeding month(s); after falling into the penalty bracket of 5% of monthly billing amount, the penalty shall be capped at 5% for penalties greater than equal

to 5% of monthly billing amount. However, for penalties less than 5% of total billing amount, penalties will be paid as per actuals.

- The Operator needs to ensure penalties less than 3% of the monthly billing amount for three consecutive months to fall back into the previous 3% slab bracket. (3% of total billing amount)
 - MSRTC would have right to invoke termination of the contract if the penalty applicable consistently remains greater than equal to 5% of the monthly billing amount for three (3) consecutive months.
 - Total penalty shall be capped at 3% of Total project cost reaching which will lead to breach of contract and termination of the engagement.
2. There is no penalty cap for bus supply failures and it's additional to monthly capping for operations.
 3. No operational penalties for the first month after the first bus delivery at each depot.
 4. Payment only for operated kilometres during breakdowns, late departures, non-availability, or trip non-completion. Assured kilometres don't apply.
 5. Yearly reconciliation based on specified norms/standards.
 6. A penalty will be imposed in case of operational efficiency, quality operations or issues with the time.
 7. The operator must submit the bus prototype for inspection within 3 months of signing the agreement, if not one done within the time a penalty of Rs 1,000 per day (plus taxes) will be imposed for the next one month. After the one month grace period, the contract may be terminated and beyond the grace period, a penalty of Rs. 10,000 per day (plus taxes) will be imposed by MSRTC.
 8. In case the operator fails to deliver the buses as per the schedule, a penalty of Rs 1,000 per bus, per day will be imposed.
 9. No penalties will be imposed on the operator that will occur while fixing or removing advertisements from buses. Any damages such as repair costs for issues like color peeling, panel damage, dents and holes will be covered by the MSRTC.
 10. If the operator fails to provide roadworthy buses on time, a penalty equivalent of Rs 1,000 per day per bus will be imposed for the delay in supply.

Sl. no	Operational parameter	Norm / Standard	Penalty/remarks, if any
1.	Failure to supply buses	215 buses/month	<ul style="list-style-type: none"> • The selected bidder(s) must deliver 5150 buses within 24 months of prototype inspection. • They must supply at least 25% of the total buses within the first 12 months; failure to do so may result in contract termination and a penalty of Rs. 1,000/- per bus per day for late delivery and maximum penalty of Rs. 30,000 can be imposed for delay in supply of buses • If they meet the 25% requirement in the first year, they can deliver the rest in the second year with penalties based on cumulative delays
2.	Break- down of Contracted Buses calculated in terms of number of break downs	NIL (Zero)	<ul style="list-style-type: none"> • A penalty of ₹ 1,000 applies for each bus breakdown, defined as a mechanical failure preventing safe operation. • Cancelled kilometers won't be paid, and assured kilometers won't apply for that bus on that day.
3.	Non- Non-availability of buses in accordance with the Fleet Deployment Plan at all times	95 % availability	The Penalty ₹ 5,000 per bus per day, with no assured KM per day will be given for those buses
4.	Punctuality	Punctuality to be calculated on a day-to-day basis.	<ul style="list-style-type: none"> • If the operator delivers the bus after 30 minutes late according to the scheduled time, a Rs. 500/- penalty will be imposed. • If the bus is available after 60 minutes according to the scheduled time for a single trip, a penalty of ₹ 1,000 will be imposed and assured kilometres charges will not be applicable. • If the bus is available more than 60 minutes late for a single trip, then it will be considered as non-availability of the bus. A penalty: ₹ 5,000 per bus per day will be imposed and assured

			<p>kilometers will not be applicable, only operated kilometers shall be paid.</p> <p>No penalty for delays due to unforeseen circumstances (such as traffic jams, heavy rains, power cuts etc) beyond the operator's control.</p>
5.	Unauthorized Halt	NIL (Zero) cases	In case buses stop at the unauthorised stops then ₹ 1000 will be fined per case.
6.	Functioning of all necessary equipment of the Contracted Buses at the time of departure from the workshop.	MSRTC can inspect Contracted Buses for cleanliness, ITS equipment, safety features, and functionality before departure from the workshop or bus stand.	For minor defects (e.g., charging points, PIS boards, ITS equipment, broken passenger seats etc), if MSRTC decides to allow the bus to proceed on schedule, a penalty of ₹ 1,000 per bus will apply, regardless of the number of shortcomings.
7.	Air Conditioning unit fails during the trip	NIL (Zero)	If the air-conditioner fails to operate during the trip then the operator will replace the bus and the event will be considered as Breakdown.
8.	Efficiency	100 % efficiency (A minimum assured distance of 300 km(in case of 12m) and 200 km(in case of 9 m) to be travelled in a single charge).	<p>Buses must adhere to RFP specifications. If a bus travels less than 300 km (12m) or 200 km (9m) on a single charge, it's considered a breakdown due to non-adherence.</p> <p>Circumstances beyond the operators control such as heavy traffic, heavy rains, load beyond allowed GVW will not be considered as breakdowns</p>
9.	Driver negligence	Includes any form of negligence on the part of the driver such as without license, not following directions of MSRTC officials, non	The Penalty of ₹ 1, 000 per driver per day shall be levied for every incident of negligence, drunken driving will lead to termination of driver.

		stopping for bidding passengers, not in uniform while on duty etc	
10.	Any damage to infrastructure belonging to the MSRTC.	No damage to the Infrastructure like buildings, railing, street light, bus stop, terminals, parking places etc.	All expenses at actuals arising out of such occurrences shall be borne by the operator.
11.	Passenger travelling without ticket in conductor less operation	NIL (Zero) cases	The operator is responsible for passengers without tickets. The operator will be required to pay a penalty twice the ticket fare plus ₹ 500 per passenger, and the driver will be suspended for at least 6 months from MSRTC operations. Penalty will only be imposed if the bill is signed by the controller/conductor after verifying the count.

4. Project Planning and Post-Tender Process

4.1 Award of E-Bus Tender

This crucial phase of the plan has been entrusted to M/S Evey Trans Pvt Ltd., an operator of original equipment manufacturer (OEM) M/S Olectra Greentech Ltd. , a renowned player in the electric vehicle industry.

As outlined in the tender clause, the responsibilities and commitments of the operator, M/S Evey Trans Pvt Ltd., are clearly defined. The operator is tasked with delivering all 5,150 electric buses within a span of 24 months from the date of the Letter of Intent (LOI). This ambitious timeline emphasises the urgency and commitment to transitioning the public transportation fleet to electric power efficiently and swiftly.

However, the electrification plan extends beyond the mere acquisition of electric buses. Recognizing the pivotal role of charging infrastructure in facilitating the seamless operation of electric buses, the operator is also entrusted with the development of charging infrastructure. This infrastructure will be strategically aligned with MSRTC's route and depot electrification plan, ensuring that the charging network is efficiently integrated into the existing operational framework.

4.2 Classification of E-Bus Type

Within the comprehensive plan for procuring 5,150 buses, a nuanced classification has been established to address the diverse transportation needs and demands within Maharashtra. This classification, which encompasses a total of 2,850 buses measuring 12 meters in length and 2,300 buses measuring 9 meters in length, is a result of meticulous considerations involving traffic demand, ridership patterns, load factors, and headway.

12m Bus: The deployment of 12-meter buses is primarily tailored to high-traffic and high-demand scenarios. These buses are strategically earmarked for express routes connecting major districts, metropolitan cities, and prominent pilgrim and tourist destinations. Such routes typically witness a robust demand, with schedules characterised by good occupancy. By utilising 12-meter buses on these express routes, MSRTC aims to ensure that passengers experience efficient, comfortable, and reliable transportation services, even during peak demand periods.

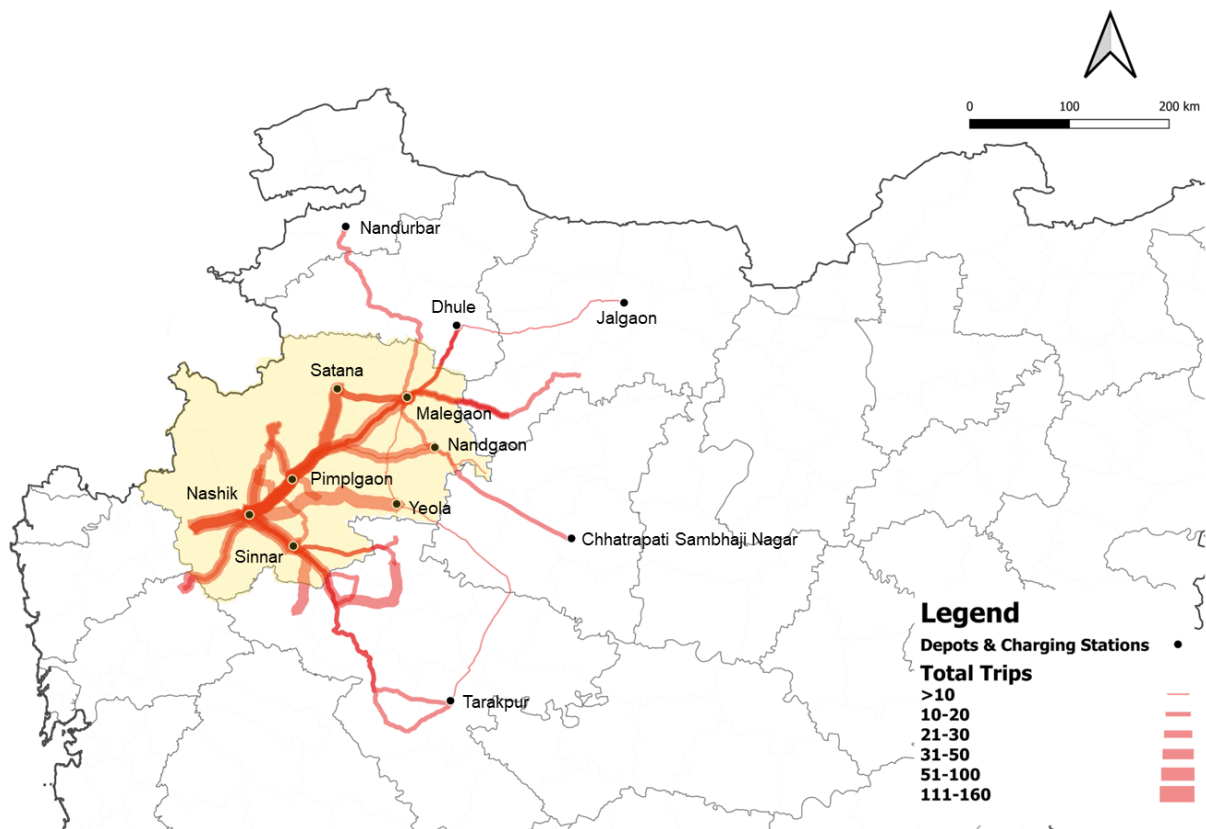
9m Bus: In contrast, the 9-meter buses are strategically earmarked for routes with mid to low demand, emphasising connectivity between district headquarters, Taluka-level towns, and villages in mofussil areas. These routes often serve as vital lifelines for residents in more remote areas. The decision to deploy 9-meter buses on these routes is purposeful, as it aims to optimise efficiency and resource allocation. In many instances, the 9-meter buses are intended to replace existing 11-meter buses that typically operate at load factor average/above average load factor. This strategic substitution ensures that the 9-meter

buses are utilised at their maximum occupancy potential, enhancing operational efficiency while maintaining service quality.

4.3 Route Selection and Planning Process

The Maharashtra State Road Transport Corporation (MSRTC) demonstrated commendable foresight and strategic planning in its approach to route planning and depot selection for the electric bus (E-bus) project. This endeavour was an entirely in-house effort, drawing upon the extensive ground-level expertise and insights from various divisions within the organisation. The comprehensive planning process went beyond merely considering battery range and daily assured kilometres; it incorporated a range of critical factors to ensure the success and viability of the E-bus project.

A pivotal element of this strategic approach was carefully selecting routes for electrification. MSRTC's strategy focused on electrifying routes with the highest ridership, passenger-kilometres (EPKM), and the lowest bus replacement ratio. By prioritising routes with these specific attributes, MSRTC aimed to optimise the cost-effectiveness and sustainability of the E-bus project. This data-driven approach ensured that the transition to electric buses would have a significant positive impact on both passenger satisfaction and operational efficiency.



An example of E-bus route and Charging Station Map of MSRTC Nashik Division. High-demand routes with the highest ridership and earnings are targeted for electrification

The central office of MSRTC in Mumbai played a pivotal role in preparing the route selection and planning methodology. Furthermore, the corporation conducted a series of capacity-building workshops at the regional level. These workshops were designed to train division-level officers, leveraging their local expertise to identify and plan routes for their respective areas. This decentralised approach not only tapped into the intimate knowledge of local conditions but also maximised the workforce's involvement in the project, fostering a sense of ownership and commitment.

One notable aspect of the E-bus project is the consideration of the replacement ratio for diesel to electric buses. On average, this ratio stands at 1.2. However, MSRTC's forward-looking approach takes into account the anticipated escalation in diesel costs in the future. Consequently, the corporation recognises that E-buses are likely to prove economically more viable than their diesel counterparts over time. This not only underscores the environmental benefits of electric buses but also highlights their potential for long-term cost savings, making them a fiscally responsible choice.

MSRTC Nashik Division Electric Bus Route Planning

Route	Origin	Destination	Route km	VGf/km	EPKM	Bus Type	Load Factor %	Existing Diesel Buses	Proposed E- Buses	km/ bus
1	Nashik	Shirdi	90.2	4.2	65.8	12	106.2	2	5	361
2	Nandgaon-Boalthan	Nashik	152	7.9	62.1	12	99.7	2	2	608
3	Sinnar	Saptashrungigad	75.5	10.9	59.1	12	95.2	2	4	302
4	Sinnar	Shirdi	90.2	11.9	58.1	12	93.6	1	4	722
5	Nashik	Ahmednagar	171.7	13.0	57	12	92.8	4	8	343
6	Nashik Road	Tribakeshwar	37.6	15.1	54.9	12	88.6	8	13	451
7	Pimpalgaon	Niphad	19.2	14.6	55.4	12	88.3	2	3	192
8	Nimani	Kasara	66.4	19.0	51	12	82.4	8	8	266
9	Satana	Nashik	91.6	19.0	51	12	82	7	20	311
10	Yeola	Nashik	87	20.1	49.9	12	81.1	16	17	266

11	Sinnar	Ahmednagar	171.7	19.9	50.1	12	80.7	4	4	687
12	Pimpalgaon	Vani	25	16.0	49	9	78.1	1	3	200
13	Nangao n-Malegaon	Chhatrapati Sambhaji Nagar	130.3	21.7	48.3	12	77.5	6	5	521
14	Nashik	Dhule	159.4	22.5	47.5	12	76.7	13	7	501
15	Malegaon	Nashik	110	25.0	45	12	74.1	15	15	440
16	Malegaon	Chalisgaon	55.8	20.8	44.2	9	72.7	3	5	223
17	Nandgaon	Nashik	115.7	25.0	45	12	72.2	10	10	370
18	Sinnar	Nashik	31.3	25.3	44.7	12	72	10	10	376
19	Satana	Malegaon	38.1	21.2	43.8	9	70.4	7	7	120
20	Nashik	Saptashrungigad	75.5	21.4	43.6	9	70.3	7	6	302
21	Nashik	Nandurbar	216.3	28.2	41.8	12	67.5	16	8	433
22	Malegaon	Ahmednagar	181.5	32.2	37.8	12	62.2	2	5	363
23	Malegaon	Pachora	110	30.6	39.4	12	61.1	4	5	440
24	Sinnar	Akole	42	29.3	35.7	9	57.4	2	4	336
25	Satana	Chalisgaon	93.9	30.6	34.4	9	55.4	1	10	225
26	Pimpalgaon	Dindori	31.3	30.9	34.1	9	54.4	1	3	250
27	Pimpalgaon	Nashik	32	33.8	31.2	9	49.8	2	8	192
28	Nashik	Dindori	27.6	-	-	9	-	-	8	331
29	Satpur	Dhule	159.4	-	-	12	-	-	8	319
30	Nashik	Kopargaon	90.3	-	-	12	-	-	3	361

31	Malegaon	Jalgaon	145	-	-	12	-	-	2	435
32	Satana	Satpur	97	-	-	9	-	-	11	300
33	Sinnar	Tribakeshwar	59.6	-	-	9	-	-	4	477
34	Sinnar	Sangamner	70	-	-	9	-	-	4	280
35	Sinnar	Kasara	97.7	-	-	9	-	-	4	391
36	Pimpalgaon	Tribakeshwar	60.3	-	-	9	-	-	8	302

* empty cells represented the new routes to be introduced.

4.4 Depot and Charging Infrastructure Development

The selection of depots and the strategic placement of charging stations within the Maharashtra State Road Transport Corporation's (MSRTC) electric bus project are critical components of ensuring the project's efficiency and reliability. This meticulous planning process took into account several key factors to optimise the electrification infrastructure.

Depot selection was primarily based on three essential criteria: existing operations, minimum dead kilometres, and the proximity of high-tension (HT) supply lines to depots or terminals. This approach minimises the need for extensive new electrical infrastructure development, as depots with nearby HT supply lines were prioritised for electrification. Furthermore, depots were selected based on their suitability for overnight bus parking and maintenance activities. Ensuring adequate parking space within depot premises was essential for the seamless operation of electric buses.

To mitigate potential operational disruptions due to power supply failures, a contingency plan was implemented. Only 30%-50% of the selected depot fleet will be electric, while the remaining 70%-50% will consist of CNG/LNG and diesel buses, serving as backup. However, in bigger cities where multiple depots are located in close proximity, MSRTC intends to develop a few depots as 100% electric depots.

The energy requirements for each charging station were determined based on the fleet size and the total routes operated by MSRTC. The operator will be responsible for installing the required number of chargers, with a combination of slow chargers (90 kWh output) and fast chargers (180 kWh output) strategically placed at terminals and depots. Terminals will exclusively feature fast chargers, facilitating opportunity charging during the day. Depots, on the other hand, will have a mix of both slow and fast chargers, allowing flexibility in response to daytime opportunity charging requirements.

An important aspect of this plan is the partnership between MSRTC and the operator, where the operator will develop the charging stations while MSRTC will provide the

necessary infrastructure. This collaborative approach ensures that charging station development aligns seamlessly with operational requirements.

The selection of depots and charging stations is carefully orchestrated to correspond with the chosen routes and the efficacy of opportunity charging during specific times. MSRTC's ambitious plan also envisions the establishment of a robust charging infrastructure network, with an average spacing of 100 kilometres across Maharashtra. Once completed, this network will rank among the most extensive charging infrastructures in India, underpinning the state's commitment to sustainable and efficient public transportation.

In pursuit of this endeavour, MSRTC has taken steps to appoint an agency to undertake the essential civil work required to bring HT supply lines and other infrastructure to the depots, further advancing the electrification project's progress. The total cost to associated with this process is estimated at Rs. 650 Cr. MSRTC is seeking financial assistance from the state govt.

4.5 Daily Vehicle Utilization

Within the framework of the tender, a critical parameter is the daily assured kilometer (km) target set for the electric buses (E-buses) at 325 km. However, astute analysis by MSRTC has revealed that E-buses can achieve a higher level of cost-effectiveness when utilized for distances ranging between 350 to 400 km per day. This strategic decision seeks to maximize the efficient utilization of E-buses, striking a balance between operational efficiency and cost optimization.

To incentivize and facilitate this extended utilization of E-buses, a progressive pricing structure has been adopted. Beyond the assured daily kilometer range of 325 km, a reduced cost per additional kilometer has been established, offering a 25% reduction. This approach makes E-buses more economically viable for longer routes. It aligns well with the goal of optimizing the utilization of E-buses, leveraging their capabilities to their fullest potential.

As per the tender specifications, the operator is required to provide 12-meter E-buses with a range of 300 km at 80% state of charge (SOC) on a single charge. For 9-meter E-buses, the range is set at 200 km at 80% SOC. These specifications necessitate the installation of larger battery packs in these E-buses compared to their counterparts currently deployed in India.

5. Project Financial Sustainability

5.1 Capex Subsidy

Despite its diligent efforts to make the electric bus (E-bus) project economically viable in comparison to conventional Internal Combustion Engine (ICE) buses, the Maharashtra State Road Transport Corporation (MSRTC) recognises the importance of continued financial support from the state government to ensure the sustainability of its operations. While the E-bus project represents a significant step toward sustainability and cost-efficiency, it's crucial to acknowledge that certain elements, such as infrastructure development and initial capital investments, require government backing.

One of the key strategies employed by MSRTC to manage the cost-revenue deficit is the careful selection of routes with high passenger-kilometers (EPK) for E-bus deployment. By focusing on routes with robust demand and ridership, MSRTC aims to optimise the utilisation of E-buses and minimise the gap between operational costs and revenue generation.

In the 2023 State Budget, there is a provision to allocate ₹20 lakh as an upfront capital expenditure (capex) subsidy per E-bus. However, it's important to note that this subsidy is not yet allocated to MSRTC; if they receive it, it is intended to be channeled to the E-bus operators. Consequently, during the bidding process, MSRTC took a proactive approach by requesting two different rates from operators—one that incorporates the anticipated subsidy and another without it. In this scenario, if the subsidy is indeed received, it will be passed on to the operators, who will be compensated based on the subsidised rate.

MSRTC's approach to securing both upfront Capex subsidies and Viability Gap Funding (VGF) from the government underscores the corporation's recognition of the multifaceted financial support required to sustain the operations of State Transport Undertakings (STUs). While the E-bus project offers long-term cost benefits and environmental advantages, the initial capital investments and operational expenditures necessitate government support to bridge the fiscal gap and ensure the continued provision of reliable public transportation services.

5.2 Opex Subsidy: Viability Gap Funding

The financial intricacies of the Maharashtra State Road Transport Corporation's (MSRTC) electric bus (E-bus) project warrant a comprehensive understanding of how various factors affect cash flow and subsidy considerations.

The average Earnings per Kilometer (EPKM) for MSRTC stands at ₹50/km. However, it's crucial to distinguish between the gross EPKM and the net EPKM that MSRTC directly receives in its farebox. Out of the current total earnings ₹50/km, only ₹35/km constitutes the net EPKM that MSRTC collects after accounting for various concessions, including a 100% concession for senior citizens above 75 years of age and a 50% concession for ladies

and senior citizen between age 65-75 and other social welfare concessions offered by state govt. The remaining Rs. 15/km accounts for these concessions and is essentially a liability borne by MSRTC till the subsidy is reimbursed by State Govt.

To address this financial aspect, the State Government has committed to providing a subsidy of ₹15/km to compensate for these concessions. However, the challenge arises due to the timing of subsidy disbursement. MSRTC expects to receive this subsidy by the end of the following month. However, the subsidy is actually reimbursed by the end of the next month by the state govt due to various administrative processes. This temporal discrepancy can result in a temporary cashflow deficit for MSRTC, potentially hindering their ability to make timely payments to the E-bus operators.

Considering the average cost of an E-bus operator per kilometre i.e. ₹ 68/km, without upfront capital expenditure (capex) subsidy, the total Viability Gap Funding (VGF) is determined as ₹18/km. However, when factoring in the net EPKM of ₹35/km available at the farebox, along with the anticipated concession subsidy of ₹15/km from the State Government, the picture becomes more nuanced. By the end of the month when payment cycle arrives, MSRTC has only ₹35/km to pay to the operator as a concession subsidy of ₹15/km are reimbursed by the state govt by the end of the next month. In addition to the VGF ₹18/km, a concession subsidy of ₹15/km also should be reimbursed at same time to keep MSRTC positive in cash flow.

Avg cost/km of E-bus (Payment to Operator) without capex subsidy	Avg. EPKM		VGF requirement as per Gross EPKM Rs. 50/km	VGF requirement as per Net EPKM Rs. 30/km
	EPKM from non Concessions (Directly receives from ticket sell)	EPKM from Senior Citize, Ladies, Students, Differently abled Concessions (Receives from State Govt.)		
Avg. Cost ₹ 68/km Actual Cost/km (12m ₹ 73/km, 9m 12m ₹ 63/km)	₹ 35/km	₹ 15/km	₹ 18/km	₹ 33/km (₹ 18/km + ₹ 15/km)

In this context, it's imperative to consider the net EPKM when determining VGF, as it represents the revenue available to MSRTC at the farebox. Moreover, the VGF should also incorporate the concession subsidy of ₹20/km, which the State Government should deposit into an escrow account. This proactive measure ensures that MSRTC remains consistently positive in cashflow, facilitating the timely release of operator payments.

While MSRTC anticipates receiving the concession subsidy by the end of the following month, the VGF amount for the E-bus project can be subtracted from the overall capex subsidy announced by the State Government i.e. 20 lakhs per bus. The combined capex subsidy for all 5150 e-buses is ₹ 1030 Cr. Since MSRTC, has determined the VGF/year in advance, this amount can be utilized as a payment security to ensure MSRTC remains positive in cash flow.

1	Per month average total payment of e-bus contractor	₹ 341.45 Cr.
2	Per month total VGF required as per total gross EPKM Rs. 50/km	₹ 90.38 Cr.
3	Per month total VGF required as per total net EPKM Rs. 30/km	₹ 190.80 Cr.

5.3 High bid rates

Despite the initial perception of higher bid rates for electric buses (E-buses) compared to the owned and hired diesel buses, a more comprehensive analysis reveals that E-buses are positioned to be more cost-efficient over the long term. This shift toward cost-efficiency is driven by several crucial factors.

First and foremost, the consideration of future fuel cost trends plays a pivotal role. As mentioned earlier, even the bid rates for E-buses may seem higher in the short term, it's essential to account for the high escalation rates of diesel, a conventional fuel source for ICE (Internal Combustion Engine) buses. In contrast, electricity, the primary energy source for E-buses, typically experiences lower escalation rates. This makes E-buses a more economically sustainable choice in the face of anticipated fuel price increases over time.

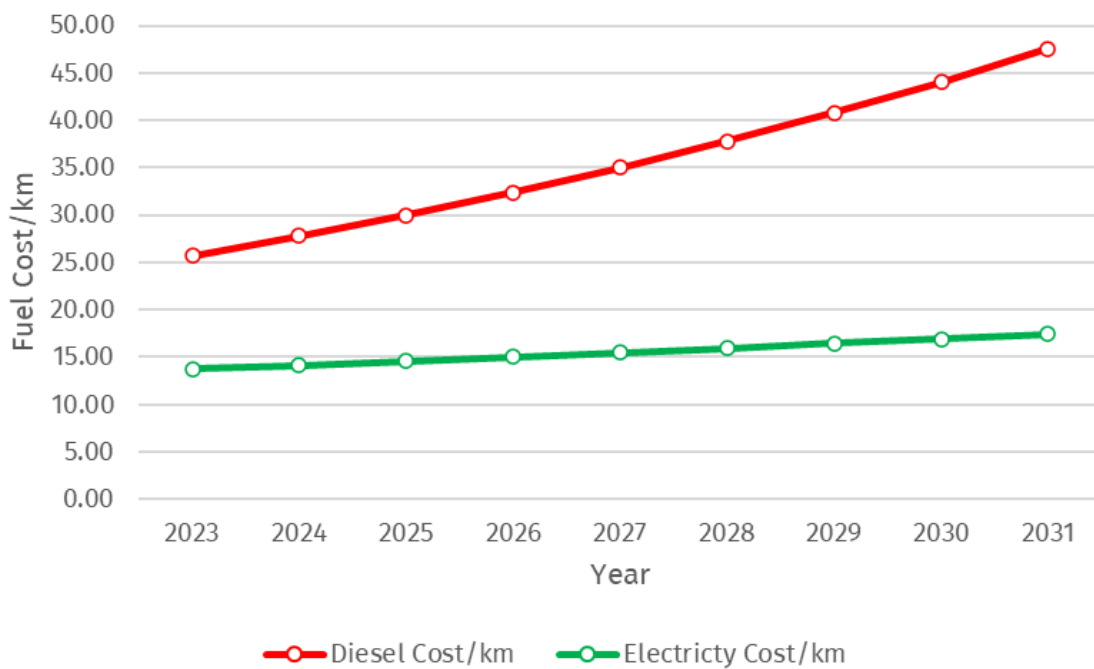
Furthermore, the operational cost per kilometer for E-buses can be significantly lower than their ICE counterparts. This is due to the inherent efficiency of electric propulsion systems, which have fewer moving parts and lower maintenance requirements compared to traditional internal combustion engines. As a result, E-buses benefit from reduced wear and tear, leading to substantial savings in repair and maintenance costs. In fact, maintenance costs for E-buses are typically estimated to be approximately 80% less than those for conventional buses.⁶

Additionally, the deployment of E-buses often requires fewer personnel per bus in comparison to their owned ICE counterparts. This results in significant staff cost savings for MSRTC, further contributing to the overall cost-effectiveness of the E-bus fleet. These staff cost savings are a testament to the increased efficiency and reduced complexity of operating and maintaining electric buses.

⁶ A GUIDANCE DOCUMENT ON ACCELERATING ELECTRIC MOBILITY IN INDIA, IIT Madras & WRI India

	Bus Type	Rate/km with Capex subsidy	Rate/km without Capex subsidy
1	12m Electric Bus from 5150 Tender (Quantity - 2350)	₹ 58	₹ 63
2	9m Electric Bus from 5150 Tender (Quantity - 2800)	₹ 68	₹ 73
3	MSRTC's average CPKM for diesel bus		₹ 58

Projection of diesel cost/km and electricity cost/km



Assumptions:

Fuel	Base Year rate/unit	km/unit	WPI Index
Diesel	₹ 90	3.5 km	8%
Electricity	₹ 11	0.8 km	3%

Based on the outlined projections, a notable trend emerges: the fuel cost for diesel buses is anticipated to be threefold higher than that of electric buses by 2031. While the current operational costs for electric buses may appear slightly elevated, a crucial insight unfolds – the trajectory toward cost parity is unmistakable. In the imminent future, electric buses are poised to emerge as significantly more cost-effective than their diesel counterparts.

6. Alternative Fuel Strategy Beyond Electrification

6.1 Transition to CNG and LNG

In tandem with the integration of 5,150 electric buses (E-buses) into its fleet, the Maharashtra State Road Transport Corporation (MSRTC) is embarking on a multifaceted approach to enhance its sustainability and reduce its reliance on fossil fuels. This holistic strategy encompasses the addition of 50 new Compressed Natural Gas (CNG) buses to its fleet and the retrofitting of 6,000 existing diesel buses into Liquefied Natural Gas (LNG) and compressed Natural Gas (CNG) operations. These concerted efforts not only symbolise a proactive commitment to environmental responsibility but also promise a host of tangible benefits for the corporation and the region it serves.

The overarching goal of this initiative is to substantially diminish MSRTC's fossil fuel dependency in the years ahead. By diversifying its fleet with CNG buses and transitioning existing diesel buses to LNG & CNG the corporation is strategically positioning itself for a future characterised by reduced carbon emissions, enhanced fuel efficiency, and considerable cost savings.



MSRTC's newly introduced CNG Bus⁷

One of the most immediate advantages of this strategy is the prospect of significant fuel savings. CNG and LNG are cleaner-burning alternatives to diesel, offering improved fuel efficiency or at least the same and reduced fuel costs. This shift represents a prudent financial decision, as it aligns with the corporation's commitment to fiscal responsibility while also contributing to a more sustainable transportation ecosystem.

⁷ Photo Courtesy: <https://www.facebook.com/groups/stkatta>

6.2 100% CNG Depots

CNG emerges as an economically compelling alternative, driven by its cost-efficiency factor. Notably, the cost per unit of Compressed Natural Gas (CNG) is approximately 20% lower than that of diesel. This financial advantage is further reinforced by the impressive operational range offered by CNG buses, capable of covering distances of up to 500 kilometres on a single tank.

To harness the full potential of this cost-effective option, the Maharashtra State Road Transport Corporation (MSRTC) has meticulously identified and designated 15 strategically positioned depots within the Mumbai, Thane, Raigad, and Pune divisions. These depots are earmarked for comprehensive development as 100% CNG depots.

The significance of these depot selections lies in their strategic proximity to the "Mumbai High Field" and the "Jawaharlal Nehru Port Trust." These geographic areas are renowned for offering the lowest per-unit cost of CNG in the entire state of Maharashtra. This strategic positioning not only enhances operational efficiency but also yields substantial cost savings for MSRTC.

6.3 Retrofitting existing 5000 buses to LNG from diesel

In parallel with the retrofitting of 1000 CNG buses, MSRTC is actively working to reduce its significant dependency on diesel. A substantial effort is underway to retrofit 5,000 existing diesel buses into LNG operation in the coming years. The tender for this ambitious retrofitting project has been awarded to three contractors, and the cost for retrofitting each diesel bus to CNG stands at Rs. 14 lakh.

Retrofitting Process:

The retrofitting process involves the transformation of conventional diesel-powered buses into CNG/LNG-fueled vehicles, making use of advanced engineering and technology. The key steps in this transformation include:

1. **Fuel System Conversion:** The diesel engine's fuel system is modified to accommodate CNG/LNG as the primary fuel source. This entails changing the fuel injection system, fuel tanks, and associated components to ensure compatibility with CNG/LNG.
2. **Cryogenic Storage:** LNG is stored onboard the bus in specially designed cryogenic tanks. These tanks maintain the LNG at extremely low temperatures to keep it in a liquid state, ensuring efficient storage and utilisation. Further, CNG is stored at a pressure of 200 Bar (kg/cm²) in specially designed tanks made of steel.
3. **Fueling Infrastructure:** Infrastructure for LNG/CNG refuelling is established at designated depots or fueling stations. This involves the installation of LNG dispensers and safety mechanisms to facilitate safe and efficient fueling.

4. **Engine Calibration:** The engine control unit (ECU) is reprogrammed to optimize the performance of the bus with LNG/CNG as the fuel source. This calibration ensures efficient combustion and reduced emissions.
5. **Safety Measures:** Comprehensive safety measures are implemented to mitigate the risks associated with handling LNG/CNG, including emergency shutdown systems, venting mechanisms, and fire suppression systems.

Benefits of Retrofitting to LNG/CNG:

1. **Cost Efficiency:** LNG/CNG is often more cost-effective than diesel, resulting in reduced fuel costs per kilometer. This translates to substantial savings for MSRTC over the operational life of the retrofitted buses.
2. **Environmental Sustainability:** LNG/CNG is a cleaner-burning fuel compared to diesel, producing lower emissions of greenhouse gases and pollutants. This transition aligns with environmental goals and reduces the carbon footprint of the bus fleet.
3. **Improved Air Quality:** Lower emissions from LNG/CNG-fueled buses contribute to improved air quality, reducing the impact of transportation on public health and the environment.
4. **Energy Security:** Reducing dependence on diesel enhances energy security by diversifying the fuel mix and reducing exposure to fluctuations in diesel prices.
5. **Compliance with Regulations:** Retrofitting to LNG/CNG helps MSRTC comply with stringent emissions regulations and environmental standards, positioning it as a responsible and sustainable public transportation provider.

7. Conclusion

The Maharashtra State Road Transport Corporation (MSRTC) embarked on a transformative journey to modernise its fleet and enhance its operational efficiency. Introducing electric buses (e-buses) marked a significant shift in the organisation's approach to public transportation. While the initial procurement of 150 e-buses was driven by the FAME II subsidy in 2021, it quickly expanded to address broader operational challenges.

In November 2021, a prolonged labour strike disrupted operations, resulting in a high-powered committee's intervention, including the Chief Secretary, Additional Chief Secretary Transport and Additional Chief Secretary Finance. This committee instructed MSRTC to devise a revival plan for financial sustainability. The comprehensive strategy aimed at creating a self-sustaining structure through the adoption of a public-private partnership model to scale the fleet from 15,000 to 22,000 buses by 2025. This included procuring 5150 e-buses, 2700 diesel buses, and retrofitting 6000 diesel buses into LNG/CNG.

The e-bus project aligned with the state's EV policy, targeting 15% fleet electrification by 2025, later increased to 25%. Strategic assignment of 9m and 12m buses based on traffic demand, ridership, load factors, and headway ensured cost-efficiency. In-house expertise informed route planning and depot selection, factoring in ridership, EPKM, and bus replacement ratios. A charging station network, an average of 100km apart, will facilitate e-bus operations, with slow and fast chargers at depots and terminals for uninterrupted service.

Despite making the e-bus project economically competitive, MSRTC sought government financial support to sustain operations. The upfront capex subsidy of Rs. 20 lakhs per bus was a critical component. However, ensuring cash flow positivity for operator payments necessitated considering net EPKM and including the concession subsidy in the Viability Gap Funding (VGF).

7.1 Key Learnings:

1. **Holistic Approach to Modernization:** MSRTC's journey from diesel to electric buses and other alternative fuels exemplifies the need for a comprehensive and forward-thinking approach to fleet modernisation. Addressing operational challenges requires a multifaceted strategy that goes beyond initial procurement.
2. **Labour Relations Management:** The labour strike underscored the importance of effectively managing labour relations and ensuring that the interests of all stakeholders are considered when implementing significant changes in the organisation.
3. **Strategic Planning:** The strategic selection of routes, depot locations, and charging infrastructure played a pivotal role in the success of the e-bus project. In-house expertise and careful analysis of variables such as ridership and cost-effectiveness are vital.
4. **Government Support:** Financial support from the government, including subsidies and Viability Gap Funding, is crucial to making sustainable and environmentally friendly public transportation economically viable. Gross Cost Contract (GCC) projects, featuring a fixed cost per kilometer, prove instrumental in efficiently determining the VGF for the entire contract period. This streamlined approach not only facilitates the upfront acquisition of funds from the government, ensuring positive cash flow, but also enhances the accountability of State Transport Undertakings (STUs). By linking VGF requirements to targeted farebox revenue, GCC projects foster a more transparent and accountable financial framework for sustainable public transportation initiatives.
5. **Diverse Fuel Options:** MSRTC's approach to diversifying its fuel options, including CNG and LNG, demonstrates a commitment to reducing fossil fuel dependency and aligning with environmental goals.
6. **Cost Efficiency:** The e-bus project showcased the potential cost-efficiency of electric buses, including savings in staff costs and maintenance expenses.
7. **Environmental Impact:** MSRTC's efforts to transition to cleaner fuels and reduce emissions align with broader environmental goals and carbon credit monetization opportunities.

In conclusion, MSRTC's transformative initiatives serve as a model for other public transportation organisations seeking to modernise their fleets, reduce emissions, and ensure financial sustainability in an evolving landscape of mobility and environmental concerns.

AIMS AND OBJECTIVES OF ASRTU

- To undertake and promote studies in matters concerning passenger road transport industry.
- To render common services to the members and assist them in such matters as standardization of equipment, purchase of materials at economic prices by entering into Rate Contract/Trial Rate Contract/Vendor Development or otherwise, promotion of efficiency of Road Transport services and reduction in the operational costs of Transport Undertakings.
- To provide and promote facilities for advancing the skill of persons employed or to be employed in the transport undertakings through instruction, training and research.
- To encourage the adoption by the members of modern tools of scientific management like work study, budgetary control etc. with a view to increasing the efficiency and productivity of the state transport undertakings by organizing courses of instruction and by the diffusion of useful knowledge on these subjects among its members.
- To arrange seminars, inter-unit visits and Inter-state visits, as well as sponsor delegation to attend national and international conference/workshops etc. in the field of transport management.
- To encourage and assist in securing uniformity and standardization in the working of the member undertakings.
- To help and coordinate the activities and working of all the committees appointed by the Association and of all institutions which further the objectives of the Association.



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