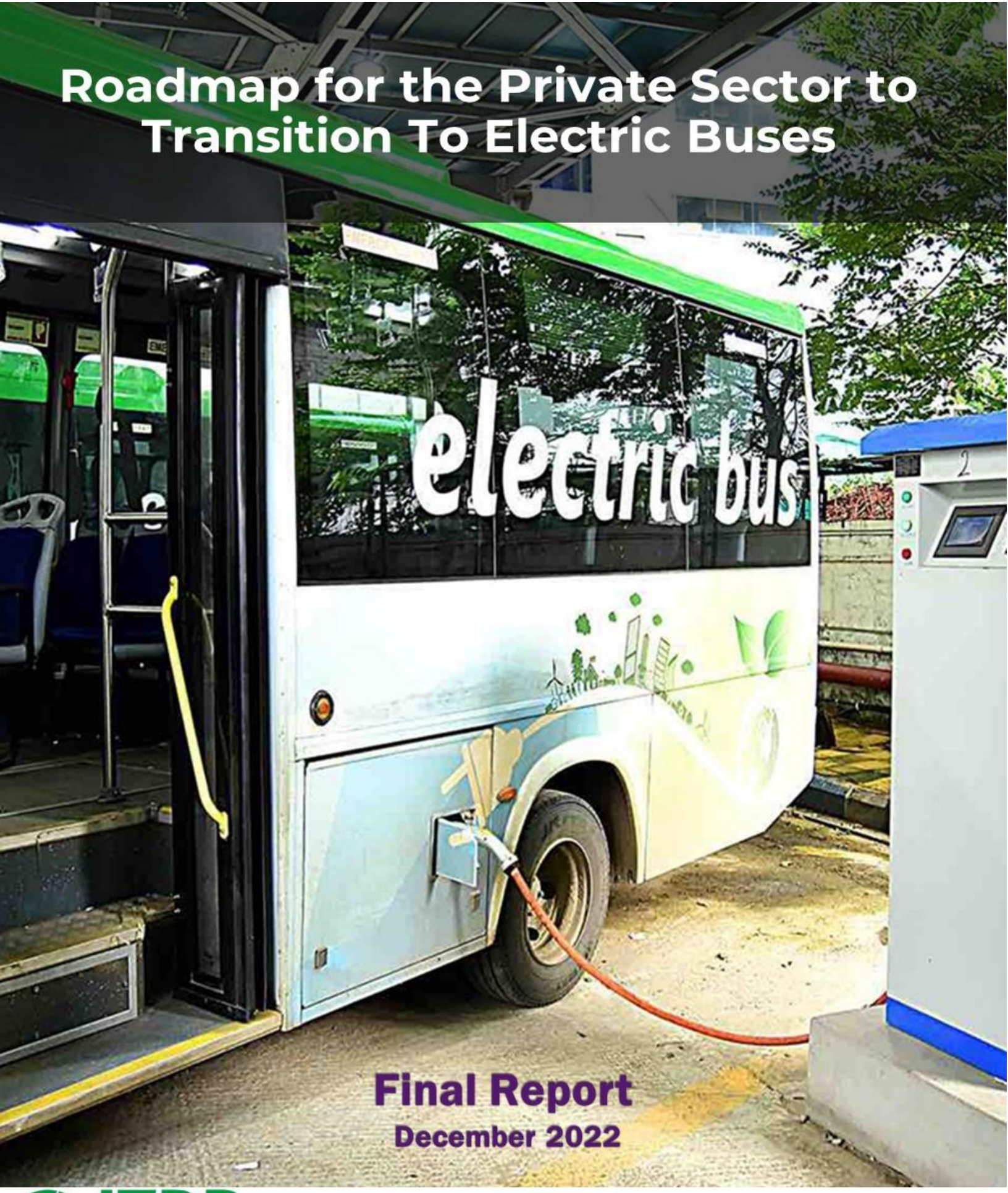
Roadmap for the Private Sector to Transition To Electric Buses



Final Report

December 2022

ITDP INDIA
Healthy Streets . Healthy Cities . Happy Lives

SGA sustainable mobility solutions

Table of Contents

List of Figures

1 Background

It is estimated that just over 50,000 stage carriage buses operate in Indian cities. This is much less than the total stock of buses required to cater to existing demand. This required stock is estimated to be between 130,000 to 206,000 buses. The existing stock of buses is mainly ICE based (Diesel and CNG buses). It is estimated that together these contribute to more than 12,000 metric tons of CO2 per day (Gandhi et al., 2021).

Though the majority of current urban bus stock is deployed in large metropolitan cities and are operated either by public bus companies on either a net cost or a gross cost basis. However, a significant number of these buses operate in smaller (tier 2 and 3) towns. Majority of these are operated by private operators under stage carriage permit. Clearly electrification and expansion of current urban public bus stock is critical in achieving emission reduction targets in the city.

Multiple urban public bus companies have embarked on the electrification journey with assistance from government run FAME schemes. However, the benefits of these schemes or any other subsidy schemes for electrification is currently not extended to privately operated stage carriage buses. It is expected that private operators will play a critical role in overcoming the large gap between supply and demand in our cities. It therefore becomes even more important that a framework for smooth and seamless transition to electrification by current and future. These private operators of urban public buses are put in place.

The current study has been initiated by ITDP India Ltd. to understand the current issues and give a set of recommendations in electrification of stage carriage buses by private operators in urban areas. The focus geography for this study is Tamil Nadu. The objective of the study is to understand and document the gaps leading to slow uptake of electrification by private operators operating under stage carriage permits on urban routes in Tamil Nadu.

This study presents a national overview of current urban bus operations, along with an overview and demand of urban stage carriage bus operations in Tamil Nadu. It presents the road map (up to 2050) of urban bus operations in Tamil Nadu along with listing of resource requirements to achieve the same. It also lists assessment of gaps to achieve electrification of urban bus services in the state along with a list of policy recommendations that can help overcome these bottlenecks.

2 Overview of Urban Bus Operations

This section presents an overview of bus operations in India based on literature review on operations by different operators. The scope of urban bus operations in Tamil Nadu is also presented and discussed. This includes projections of urban bus demand the breakup between urban and non-urban operations.

2.1 Urban Bus Operations Business and Operational Strategies in India

The urban bus service system is the most important component of public transportation. In India, public bus companies form the backbone of bus-based mobility in India. Public bus companies namely State Transport Undertakings (STUs) or City Transport Corporations operate the majority of urban bus services in the country. These are under the control of State Transport Departments with an objective to serve the mobility needs of the residents of that State, a region, or a City.

One of the major challenges that most STU's and transport corporations currently face is their inability to recover operational costs through their current revenue sources. They are operating in losses ranging from 6 to 27 percent, over the past decade (MoRTH, 2017). Their losses can be attributed to multiple reasons including increased costs caused by inefficiencies in planning and operations, reduced revenue caused by providing access to buses in low demand areas and the lack of financial support from the City governments for the subsidized fares offered to students and senior citizens etc.

Moreover, the involvement from the private sector in the provision of on-demand bus transport presents an opportunity for Indian cities to scale up capacity and meet the rising demand for everyday commutes. Enabling more innovation in public transport is crucial for less congested urban roads and more liveable cities (CSE, 2019).

The key indicators which govern the operations and strategies for urban bus transport system are permit conditions, fare, route, vehicle, and operational characteristics. The present status of each of these indicators in India have been explained as follows:

2.1.1 Permit conditions

Currently the bus permits are issued exclusively for STUs to maintain the sustainable environment and uniformity, hence, making it accessible to each bus-based public transport user. The State Transport Authority (STA) declares scheme for grant of stage carriage permit from time to time, depending upon the requirement of buses on different route of the city. These permits are issued under section 72 of Motor Vehicles Act, 1988. The permit holders can operate their bus under their allotted routes for picking up passengers from one place to another. All private stage carriage buses come under this category as well.

2.1.2 Fare

The fares are also regularized by STA based on the various conditions and factors that need to be considered according to the varying scenarios of different geographies where the buses operate. All STA have permit stage systems. For example, in larger cities fare per km varies between 80 paise to 1 Rs whereas fare per km in case of smaller cities varies from 2 to 3 Rs. This is because trip length in the smaller cities is shorter hence, fare per km is more. In large cities people are traveling longer distances and that is why fare per km is less. As per stage permit system, Tamil Nadu has the lowest fare (SGArchitects, 2021).

The current policy framework in which public buses operate in India allows little room for innovation due to restrictions on permits and capping of premium fares by law in some states.

The critical factors (Shridhar, 2016) which impacts as well helps in determining the fare for the bus operators are:

1. Fuel price: Fuel is the major economic controller and plays a significant role in determining the bus fare as it is the primary facilitator of bus movements.
2. Route networking: Mostly all bus operators desire to operate their buses on a high demand route thus creating a competitive market to determine the fare.
3. Geographical Context: Ticket fares may also vary as per context specific requirements such as climatic condition, festive or peak travel season which impacts the demand of bus transport
4. Demand and Supply: The bus fare changes according to demand and supply. When demand is high or low, the price can be accordingly higher or lower.
5. Taxation: Tax rates impact fare prices as an increase in tax causes an increase in costs, and the changed amount is to be borne by the passenger.

2.1.3 Operational Characteristics

Coming to operational characteristics, it has been observed that vehicle utilizations play a significant role in urban bus operations. Currently there is no government mechanism to provide the support for the operators as fare remains static or low. Hence, these operators majorly focus upon covering a greater number of kms in a day (i.e., higher vehicle utilization) to achieve the financial viability. For example, in Tamil Nadu on an average, vehicle utilization is 250 kms catering more than 1200 trips per day per bus to make profit.

2.1.4 Vehicle Characteristics

In Indian context mostly ICE buses ranging from 10.5 m to 12 m length are prevalent on roads as compared to CNG and electric buses. CNG buses penetration are majorly limited to metropolitan cities whereas electrification of buses is evolving gradually.

2.1.5 Route Characteristics

As per literature review it has been observed that routes are shorter in length in urban scenario. The route length usually varies in the range of 10-15 km in most of the cities. However, in the cities where the population is more than 10 million, the bus route length is generally higher than 20 kms thus impacting the profitability of bus operations as fare is regularized based on variation in the distance travelled.

2.2 Urban Bus Demand in Tamil Nadu

As per Census 2011, there are a total 794 cities / municipalities/ towns in Tamil Nadu. Out of which, at present only 12 cities have operational city bus services, provided by a total of 7,909 buses. Whereas more than 60 sites have a population of more than 1,00,000 and hence require some form of city bus (SGArchitects, 2021). The current total requirement in these cities is 15,800 buses. Thus, there is a huge gap between demand and capacity of urban bus services in the state. To effectively meet both the current and latent demand of bus services, a long-term resource plan would help in facilitating the cost, finances, and other resource requirements in the cities of Tamil Nadu.

3 Road Map for Electrification of Urban Buses in Tamil Nadu

At present the share of privately operated stage carriage buses in Tamil Nadu (out of total fleet of existing urban stage carriage buses) is more than 53%. As per reports (SGArchitects, 2021) in 2030, the total urban stage carriage bus demand in the state would be about 20,300 buses in a total of 63 cities. This number will be 23,300 in 74 in 2040 and 22,200 in 84 cities by 2050. While the state embarks on bridging the supply demand gaps, it will simultaneously need to focus on 100% electric bus fleet targets by 2050. The transition to the e-buses fleet from ICE / CNG buses would need to take place simultaneously starting today. Currently there is no operational stage carriage electric bus in the state. However, it is estimated that a gradual transition to achieve 100% operational electric bus fleet in Tamil Nadu by 2050, will need to start with induction of about 280 urban (stage carriage) e-buses (across the state) in 2023. By 2030, more than 5,800 e-buses should be operational in 63 cities, by 2040, this number should be 16,800 buses operating in 74 cities and by 2050, we should have an all-electric fleet of more than 22,000 buses in 84 cities (Figure 1).

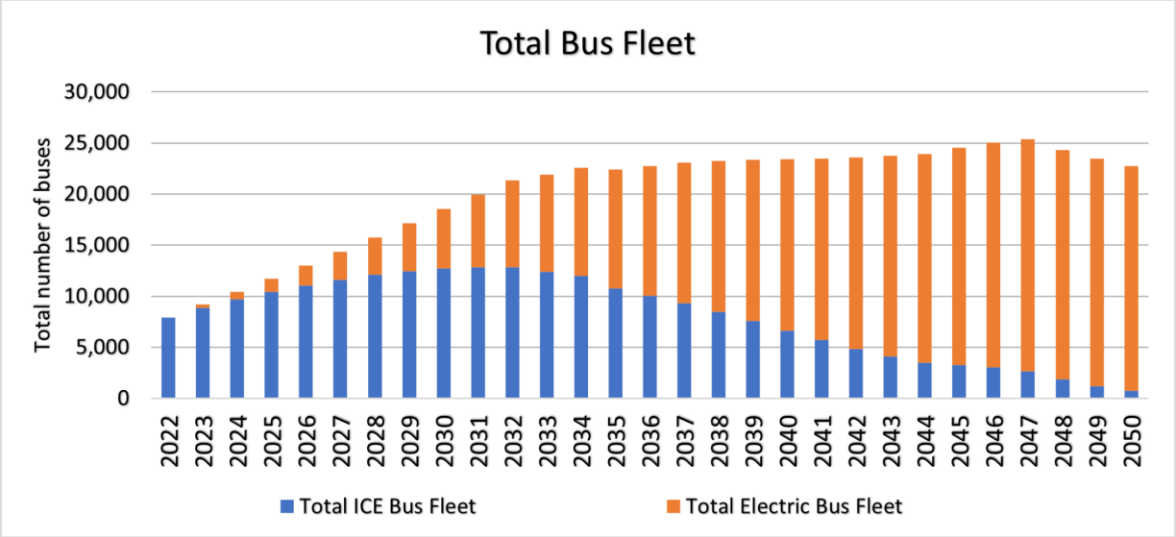


Figure 1: Bus Fleet Requirement up to 2050

It is evident from the current trends that as the population in the state increases, buses required per lakh population will also go up. Hence, in order to meet the bus based public transport requirements in the future, the state needs to urgently invest in closing the current supply and demand gap. Figure 2 presents the projected bus supply and demand gap (in a low ambition scenario) in Tamil Nadu, while Figure 3 presents the annual breakup of induction of ICE and electric urban stage carriage buses to achieve a 100% electric bus fleet by 2050 (SGArchitects, 2021).

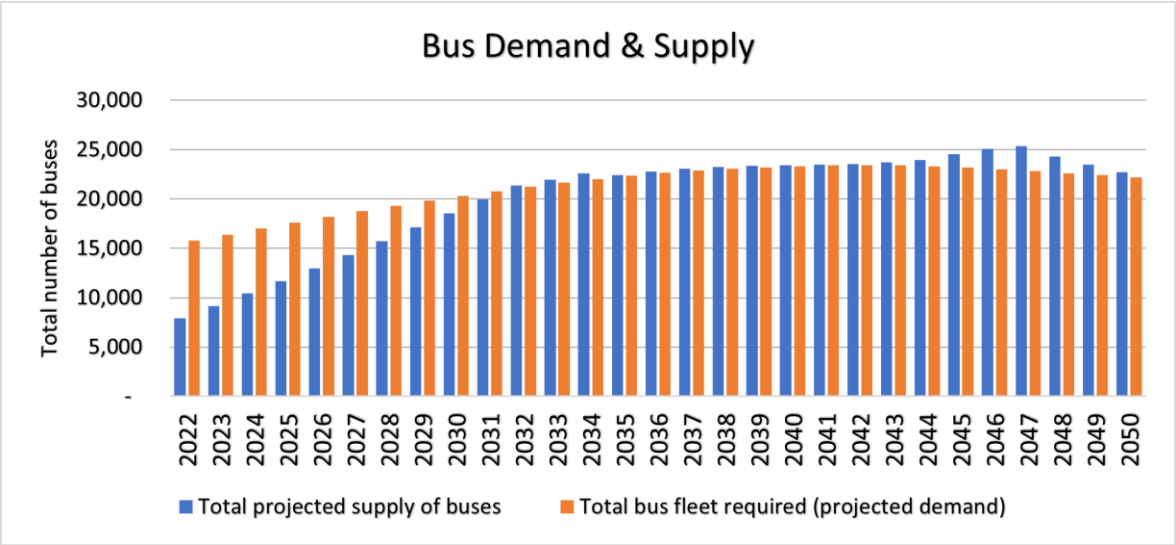


Figure 2: Bus Demand & Supply up to 2050

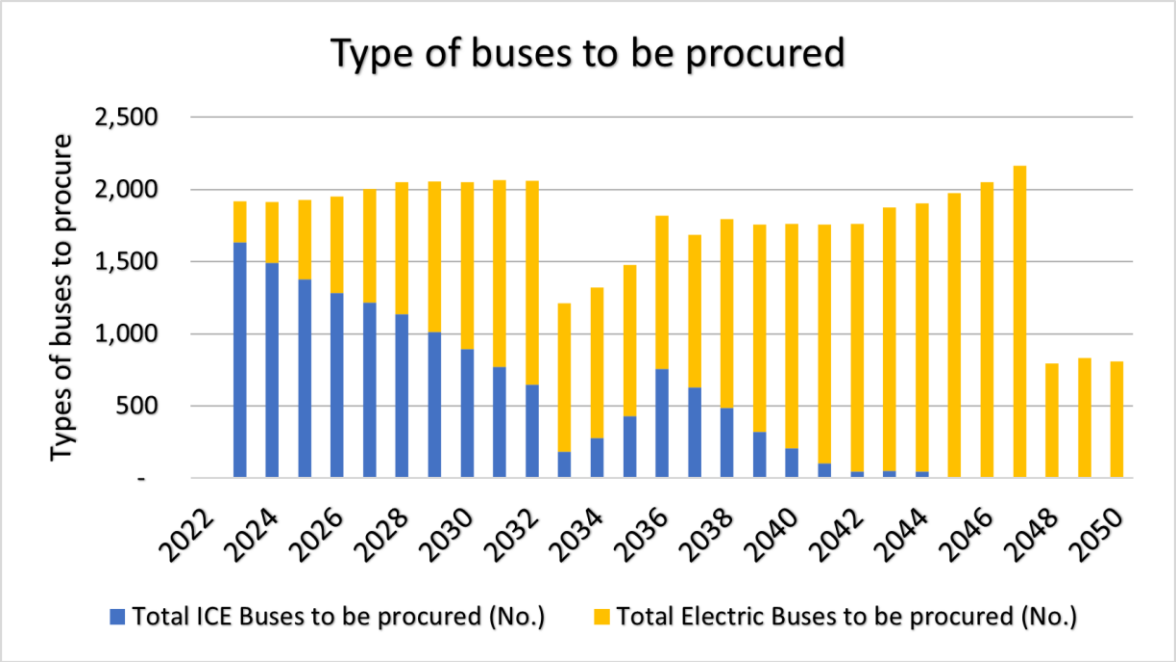


Figure 3: Type of buses to be procured up to 2050

Significant investment is required in expanding and electrifying the fleet of urban stage carriage buses in Tamil Nadu. This investment is not just in e-buses, but an equal focus is required on developing e-bus infrastructure including land and charging facilities. This requires acquiring significant land for developing terminals, depots and charging stations. As we prepare to cover the fleet deficit, the land requirement would increase from close to 166 hectares in 2023 to 408 hectares in 2030, 518 hectares in 2040 and will be just under

500 hectares in 2050. Figure 4, Figure 5 & Figure 6 presents the graphs showing land and other infrastructure requirements for Tamil Nadu up to 2050.

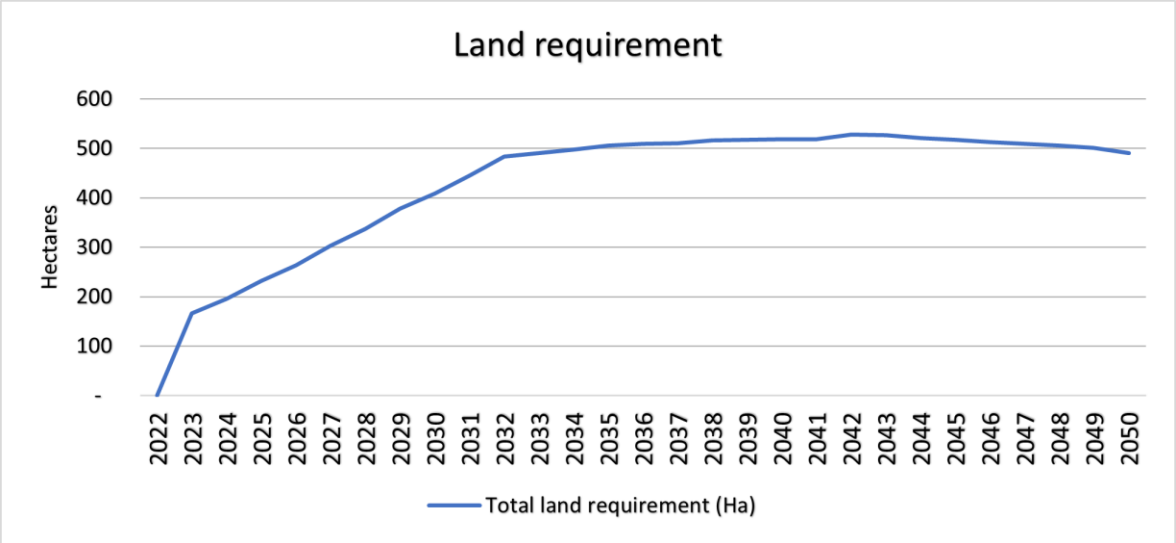


Figure 4: Land Requirement up to 2050

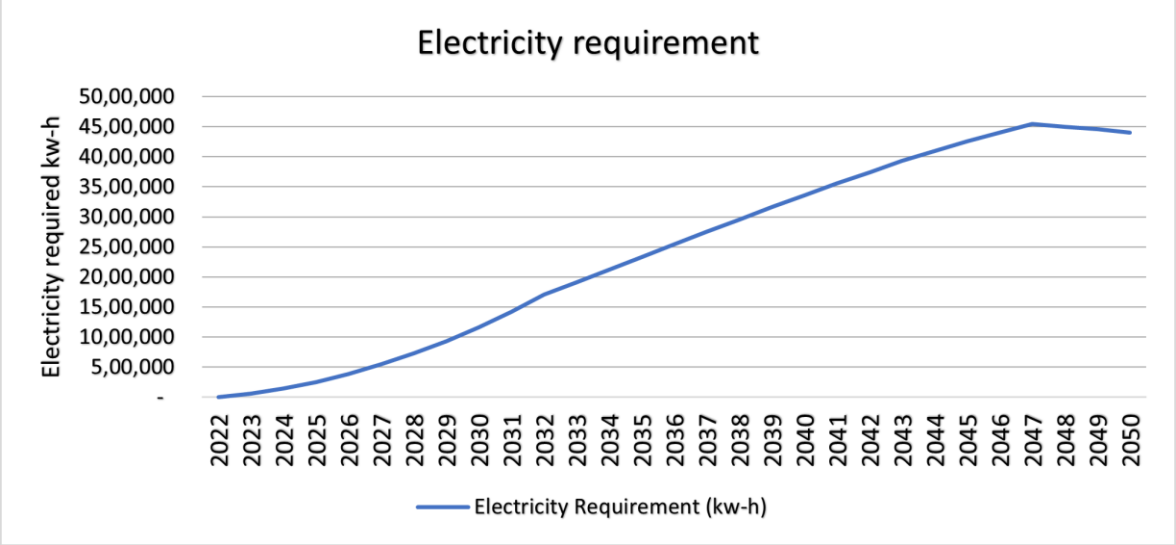


Figure 5: Energy Requirement up to 2050

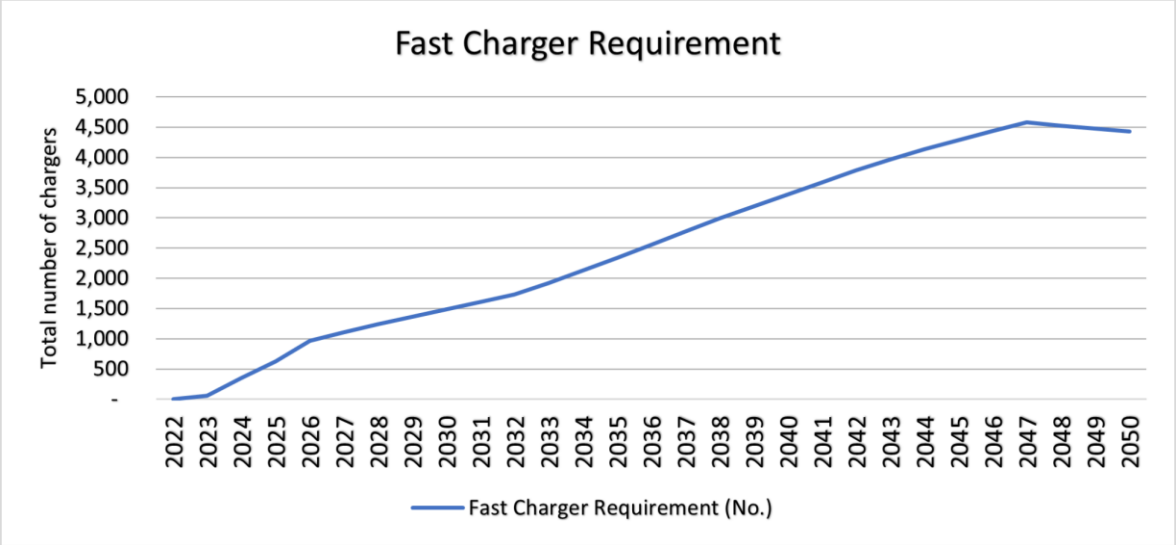


Figure 6: Fast Charger Requirement up to 2050

Fast bus charging infrastructure is an essential precursor to the adoption of electric e-buses on stage carriage operations. The state will need to ensure investments are made in bus charging infrastructure to ensure its development in line with the planned induction of electric buses. The number of fast charging stations required for urban stage carriage buses (both public and private combined) will increase from about 60 in 2023 to 1,500 in 2030, 3,400 in 2040 and 4,400 in 2050 (Figure 6). The energy demand for electric buses is expected to grow in line with bus demand, from about 60 MW-h in 2023 to 1,200 MW-h in 2030, 3,400 MW-h in 2040 and 4,400 MW-h in 2050 (Figure 5).

The total annual investment requirement for development of all urban bus services in the state and transition to e-bus (including bus depot and terminal development cast, bus procurement, any operational viability gap, etc.) is estimated at an average of - 5,500 crore per annum up to 2030, 5,300 crores from 2030 to 2040 and 4,800 crores from 2040 to 2050 (Figure 7). It needs to be noted that the cost of charging infrastructure development is not accounted for as the same is included as service cost (opex business model) in the operational cost. Also, the manpower requirement (Figure 8) for urban stage carriage bus services will increase in one with the increase in fleet. It shall increase from an estimated requirement of 48,000 personnel in 2023 to 96,000 in 2030 and will exceed 1,20,000 after 2040.

In order to meet at least some parts of the overall resource requirements (such as land development, subsidies to support e-bus transition, etc.) for providing a user responsive and efficient bus-based public transport in each city of Tamil Nadu, an active support from the State Government will be required. Here mobility will need to be viewed as essential service to be provided (even at subsidized rates in some conditions) by the state. It thus means that the State Government may need to define a new budget head in the Tamil Nadu Transport Department Budget, which can cover the annual budgetary requirements of all State and

City Transport services. Additionally, the city government may need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could include innovative use of land use provisions, similar to transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

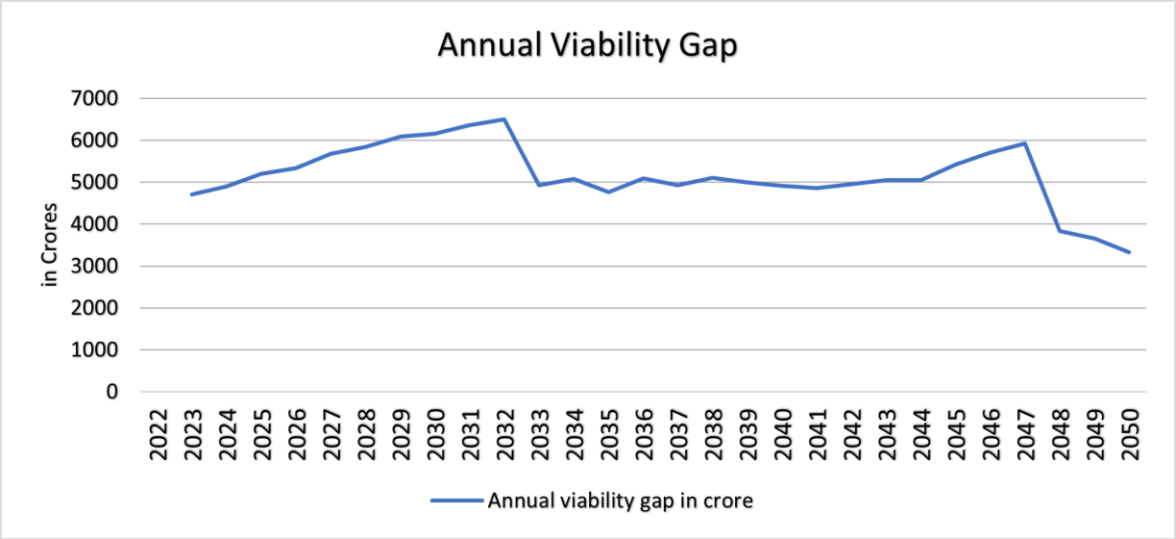


Figure 7: Annual Viability Gap up to 2050

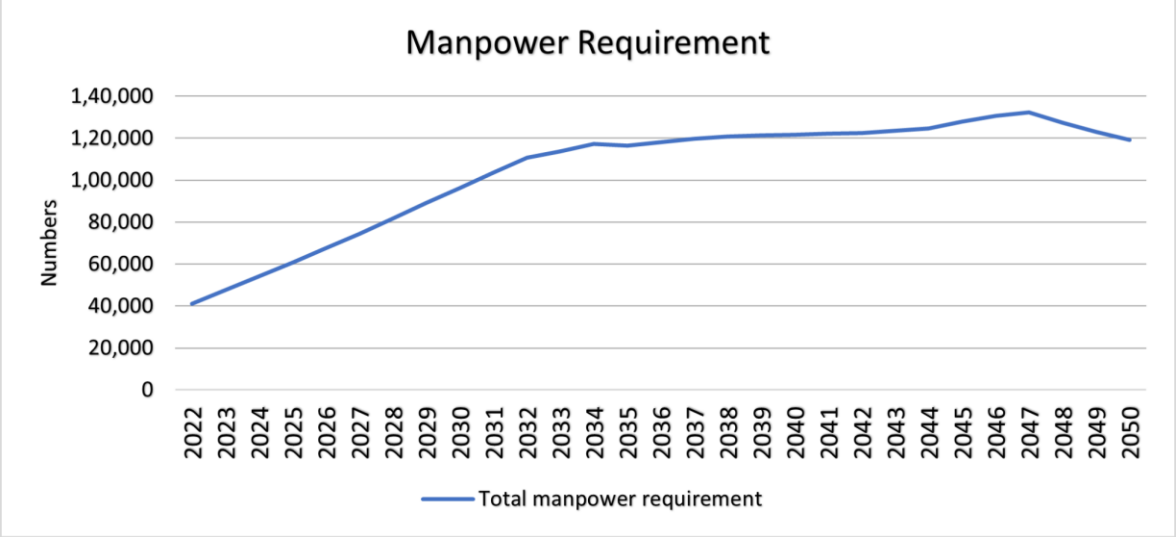


Figure 8: Manpower requirement up to 2050

4 Business Model for Urban Electric Buses

This section details the approach and the methodology for development of the business model as well selection of routes for evaluation and the input values used in it.

4.1 Business Model Development Approach and Methodology

The business model development was undertaken in the following three steps

1. Literature review for identifying indicators and their mathematical relationship in an e-bus business model. Literature review was also used to identify input values not available from observations or from bus manufacturers (OEMs).
2. Constructing the business model framework and developing the model in a spreadsheet format.
3. Development of questionnaire / checklist for recording route and bus model specific data.

4.2 Business Model Inputs

For the preparation of the business model, close to 80 bus specific, route specific, scenario specific, default values (based on research and literature review) and user inputs have been added in the model to prepare the base model. And a total of eight probable bus models (for electrification of the current fleet) have been included in the model. Based on bus and route specific inputs from existing bus models, projections were worked out over the service life of the bus to estimate the future demand of available E-bus models in the market. The business model includes factors relating to bus specification (battery size, energy consumption, seating capacity, etc.) and operational details (route length, vehicle utilization, fleet utilization, etc.).

4.3 Business Model Outputs

The two key outputs of the business model are cost per km (CPK) and earning per km (EPK) for each bus model on each route. These outputs are also generated for the current (Diesel) bus for validation purposes. The difference between EPK and CPK provides the profit per km, which can be averaged over the service life of the bus or over specific time periods (for example the loan tenure). After the business model was developed, its outputs were validated using existing data on routes operated by existing diesel buses. Route data and the existing diesel bus specific data was input in the model and the outputs were compared with reported CPK and EPK.

The findings from business model and long-range resource requirement estimate for e-bus transition (of urban bus services) have been used to support the findings from consultative discussions with the operators (as a part of gap assessment process) and also to support the policy recommendations.

5 Gap Assessment

In Tamil Nadu currently less than 8,000 buses on urban routes are operational in 12 cities. Less than half of these are operated by public bus companies (mainly in Chennai) while others are privately operated under route permits. These private operators are small fleet owners and own between 1 to 5 buses each. Government operators enjoy subsidies and other financial support for operations from the state government; they are also recipients of state support and funding schemes to support electrification. Private operators on the other hand, are expected to cater to more than half of the growing demand of urban bus operations including future e-bus operations, without much state support. This generates the need to study the potential gaps in electrification of urban bus services by private operators. To achieve this the team has interacted with private operators, including Mr. Dharamraj who heads Tamil Nadu chapter of Bus and Car Operators Confederation (BOCI). This chapter presents the findings from this gap assessment exercise which covers operational and financial viability. This assessment was undertaken in two parts. Feedback and suggestions for overcoming critical bottlenecks in electrification was collected in a consultative format. Subsequently a business model was developed to generate quantitative values to support these suggestions.

5.1 Findings of Consultative Discussions with Operators

A current project team has captured insights from private and public stage carriage bus operators on the bottlenecks in the electrification of their fleet operating on non-urban routes. The key findings from these interactions are as follows:

1) **Subsidy** - For outright purchase, operators look forward to capital cost reduction to a level where the cost of an electric bus is not more than 1.5 to 2 times the cost of the currently available equivalent ICE bus models. This may require extending subsidy schemes to private operators.
2) **Interest rate and loan tenure** - One of the biggest demerits of going electric in the outright purchase model, is the upfront capital cost requirement. In the absence of significant subsidies this will result in a significant interest cost based on the interest rate of loan from banking and non-banking corporations. This results in losses during the loan tenure for the operators. Operators are not in a position to sustain these losses in the initial years even if the operations would result in overall profits over the life cycle of the bus. Increases in loan tenure (in the absence of reduction in interest rates) only increase the interest cost and add to the overall TCO of the bus. Operators therefore seek significantly lower interest rates (between 4% to 6%) than current market rates (about 9%) coupled with the increase in tenure to at least six years to ensure profitability even during the loan tenure.
3) **Charging infrastructure** - Private bus operators cannot invest in charging infrastructure which needs to be made available by a third-party service provider on the lines of public charging infrastructure available at designated terminal points of the routes.

4) **Lease Model** - Public operators favor a GCC model to an outright purchase model to cushion the impact of high capital investment requirements. In the case of private operators, the favorable model is a lease model (a mix of wet and dry lease options), where bus including AMC and insurance is provided by the lessor, while the staff, permit, taxes (GST, etc. on fare) and energy cost is borne by the lessee.
5) **Permit Conditions** - Use of electric buses by private operators requires revision to permit conditions. This may be required in terms of revising the schedule and operational hours for buses to accommodate charging time, and also changes in ownership conditions to allow the operation of leased buses.
6) **Electricity Cost** - The model currently estimates Rs. 9 per kW-h as the total cost of electricity (including service charge by charging infrastructure provider). It is expected (given the estimated scale of demand) that the service cost by charging infrastructure providers will not exceed Rs. 2.5 per kW-h. A service cost of Rs. 2.5 per Kw-h has been used in the e-bus business model for urban operations. The findings of this model have been shared below.

5.2 Findings of Business Model

The project team conducted interviews with private bus operators on urban routes, mainly in the cities of Trichy and Coimbatore. As a part of these interviews data was collected to assess the current operational, trip, vehicle, and business characteristics. This data was collected using a questionnaire format. A total of three operators were interviewed, and the data collected from them has been presented in Annexure 1. This data was fed in a worksheet-based business model and the findings from these models have been used to buttress the requirements for overcoming gaps in electrification of urban bus services (especially by private operators) in Tamil Nadu.

The key highlights from the data and the interviews are that on an average the operators collect a revenue of about Rs. 13,600 per day from ticket sales and the average bus utilization per day is about 250 km, average daily occupancy is about 70% (however during peak hours occupancy can be 200%). The staged fare (post revision in 2019) in most cities in Tamil Nadu is about Rs.4 for stage and additional Rs. 1 for each subsequent stage (each stage is 2km). It is estimated that the average trip length by buses in these cities is about 3.5km. This implies that the average passenger fare per km is about Rs. 1.85, and the total EPK is about Rs. 54.5/km. Currently the operators are making a profit of about Rs. 3.5 per km average over the lifetime of the bus. They make an average loss of about Rs. 5.5 per km during the loan tenure (3 years), while the profit after the loan tenure is about Rs. 12.5 per km. The current service life of a diesel bus on urban routes is about 6 years.

Using these operational and route specific inputs in models with vehicle specifications for three different models (from 3 OEMs) of comparative 12m non-AC electric buses, it is assessed that only one such model (OEM no. 2) is profitable. The average profit for OEM2 over the expected service life of 12 years for the bus is about Rs. 5.71 per km. OEM1 and OEM3 are estimated to return an average loss of Rs. 2.4 and Rs. 4.1 per km respectively.

However even for OEM2, the losses over the loan tenure (first 4 years) are significantly higher than diesel buses, but so are profits over the last 8 years of the service life of the bus. The losses over the first four years (over the loan tenure) average at about Rs. 23 per km, but profits over the subsequent eight years average at about Rs. 28.8 per km. Similarly, losses for buses from OEM1 and OEM3 over the first four years is about 36.3 and 48.9 per km respectively, while the profit over the subsequent eight years is Rs. 26 and 27.7 respectively.

It is evident that operators of stage carriage urban buses will need to bear significant losses during the first four years of operations of electric buses, due to the high capital cost of the bus. These losses can be cushioned by state support in the form of subsidies on bus capital cost or on interest rates. However, this may not be a sustainable model. It is estimated that a mix of wet and dry leas model where the operations cost (electricity and crew) is borne by the operator or the lessee while the fleet and its maintenance (including insurance) cost is borne by the lessor (can be the OEM or a third party) can create a win-win citation for all. If the lessor can provide electric buses at a lease cost of between Rs. 27.5 to 30 per km with a minimum guarantee of 87,000 to 90,000 km of operations per year, both the lessees and the lessor can avoid losses.

In both the outright purchase and the lease model, the operator will remain unable to arrange for a charging infrastructure, and this will need to be provided by a third party on a service cost basis. This is because the majority of urban bus operations (urban bus operations outside major cities such as Chennai) are undertaken by private operators on permit basis. These private operators own a small fleet size (between 1-5) which is not sufficient for them to invest in fast charging infrastructure which can cost upward of Rs. 40 lakh per station. This makes a case for charging infrastructure to be provided by third party charging service providers at bus terminals operated (and charged for) by the Municipal Corporations.

However, the cost of these services will need to be limited to manage the minimum required levels of profitability. It is estimated that if the electric bus adoption on urban services grows as per the road map (Chapter 3), the average electricity demand for urban buses per charger shall be about 660 Kw-h per day in the first 10 years, and average of about 1,000 Kw-h per day in the subsequent years. However, charging infrastructure for urban and non-urban bus services can be combined. This will mean that the average electricity demand per charger per day for the first ten years will be 1,100 Kw-h while for the period after that it will be average of about 1,900 kw-h. We estimate that at these average demand levels, charging service providers can offer these services at between Rs. 2.50 to 3.0 Rs. /Kw-h for the first ten years and between Rs. 1.25 and Rs. 1.5 per Kw-h in the subsequent years. Hence the total energizing cost to the operator can be kept at less than Rs. 10 per kw-h, provided a promise of minimum demand can be made to these service providers.

6 Policy Recommendations

Assessment of gaps and bottlenecks for operators in electrification, be it from financial viability point of view or from availability of charging infrastructure point of view, suggests the need for government support to operators by way of fiscal and non-fiscal incentives as well through e-bus ecosystem development support. These incentives and support mechanisms need to be included in the State Electric Vehicle policy. Listed here are proposed policy recommendations that can help operators overcome these gaps and accelerate electrification of urban bus services in the state. However, these are also applicable for non-urban services.

The objective of the recommended policy provisions is to accelerate electrification of stage carriage buses on both urban and non-urban routes by both public and private operators. To achieve this an incentive-based strategy using a range of measures targeting e-bus adoption and EV ecosystem can be adopted. The range of incentives that can be included to catalyze acceleration of stage carriage e-bus adoption on both urban and non-urban routes can be categorized as fiscal incentives for adoption, non-fiscal incentives for adoption and incentives for development of EV-ecosystem. These have been presented below:

6.1 Fiscal and Non-Fiscal Incentives for adoption

Fiscal incentives to catalyze acceleration of e-buses include incentives which offer monetary benefits including subsidies, as a motivator and demand generator. Non-fiscal incentives include incentives without direct monetary implication on the government. These may include measures such as regulatory relaxations. The proposed fiscal and non-fiscal incentives to accelerate e-bus adoption on both urban and non-urban routes in Tamil Nadu have been listed below:

- Direct fiscal incentive of Rs. 10,000 per kW-h with a total upper limit of Rs. 30,00,000 per bus should be offered to all operators of stage carriage buses. To kickstart the acceleration to electric buses, a total of 3,000 to 4,000 buses may need to be incentivized (both for public and private operators) over a two to three-year period of which at least 1,000 should buses on urban operations. State wise fleet size to be incentivized will vary. This will incentivize investments in bus charging infrastructure and accelerate adoption of e-buses.

- Banking and non-Banking Financial Corporations can offer a low-interest loan to operators on the purchase of approved models of e-buses for a maximum of six-year tenure and approved models of e-bus batteries for a maximum tenure of four years, with no additional collateral requirement. The reduced compounded interest rate shall vary between 4% to 6% based on the loan tenure, bus model and the credit profile of the consumer. The State Government may directly finance the reduced interest rates to the Banking and Non-Banking Corporations and/or support the same in accessing low-cost finance from different sources such as development banks.

- State government can play an active role in the incorporation of a company (SPV) or a division within an existing government entity (such as the State Transport Undertaking or STU) to allow aggregation of bus demand by different private operators and/or availability of buses to the stage carriage bus operators (especially private operators) on a lease model. The State government shall establish a fund for purchase of minimum 500 e-buses. These buses shall be owned, maintained, serviced, and managed either by the newly constituted SPV or the STU. This entity shall then offer the buses on a lease model to operators. The lease tenure shall be a minimum of three years, with lease payable on a quarterly basis. The lease cost may vary based on the age of the model, and the maximum service life of bus models offered can be 12 to 15 years. The average per quarter lease cost of a bus of length >10.5m (minimum 50-seater) shall be between Rs. 6,00,000 and Rs. 6,50,000 for urban operations and Rs. 7,50,000 and Rs. 10,50,000 in non-urban operations depending on vehicle model (AC, Non-AC, etc.), vehicle utilization battery pack size and route characteristics. Additionally, the state government can also create an enabling environment to encourage OEMs and other organizations to offer electric buses on a lease model on a commercial basis.

6.2 EV Ecosystem development incentives

Incentives are required to accelerate setting in place the EV ecosystem that is necessary to accelerate e-bus adoption. The components of this ecosystem may include charging infrastructure and battery management systems. The details of proposed policy provision to encourage setting in place an enabling EV ecosystem to accelerate e-bus adoption are as following:

- Identification of land parcels within existing bus terminals, depots or at other government sites in the vicinity of such bus terminals/depots for the development of fast charging stations for buses. The area requirement of such a land parcel is expected to be between 70 to 120 sq.m. per bus charging station. This land parcel shall be offered at nominal (long term) lease cost or for free to charging service provider (CSP) companies. A separate special purpose vehicle (SPV) may need to be established by the State Governments for bus charging service provision. The CSP shall invest in the development, operations and maintenance of the charging infrastructure including all equipment and manpower and recover the cost from the consumer on a per unit basis as per norms laid out by the state. This cost shall include the energy costs and additional service charge. The energy cost shall be at the rate offered by the DisComs which shall not exceed the rate at which electricity is purchased from the TransCo by the AME[1]. The service charge shall not exceed Rs. 3.0 per kW-h. The State may offer minimum daily energy consumption guarantee per charger. This may vary annually over a 10-year period from 500 kW-h in year one to 1,350 kW-h in 10th year. The service life of electronic equipment at each charging station shall be 10 years. The chargers should have specifications that promise a rate of charge for at least 70% state of charge (SoC). For example, it

[1] AME: Average Monthly Earnings.

should achieve 90% SoC from 20% SoC in under 40 minutes for a 150 kW-h battery or 20% to 90% SoC for a 260 kW-h battery in under 70 minutes - in all weather conditions. The state may offer additional subsidies on purchase of charging equipment to CSP to achieve a maximum service charge of Rs. 3.0 per kW-h. The maximum capping of service charge and minimum guarantees are applicable for a 10-year period and shall be revised by the state government post that.

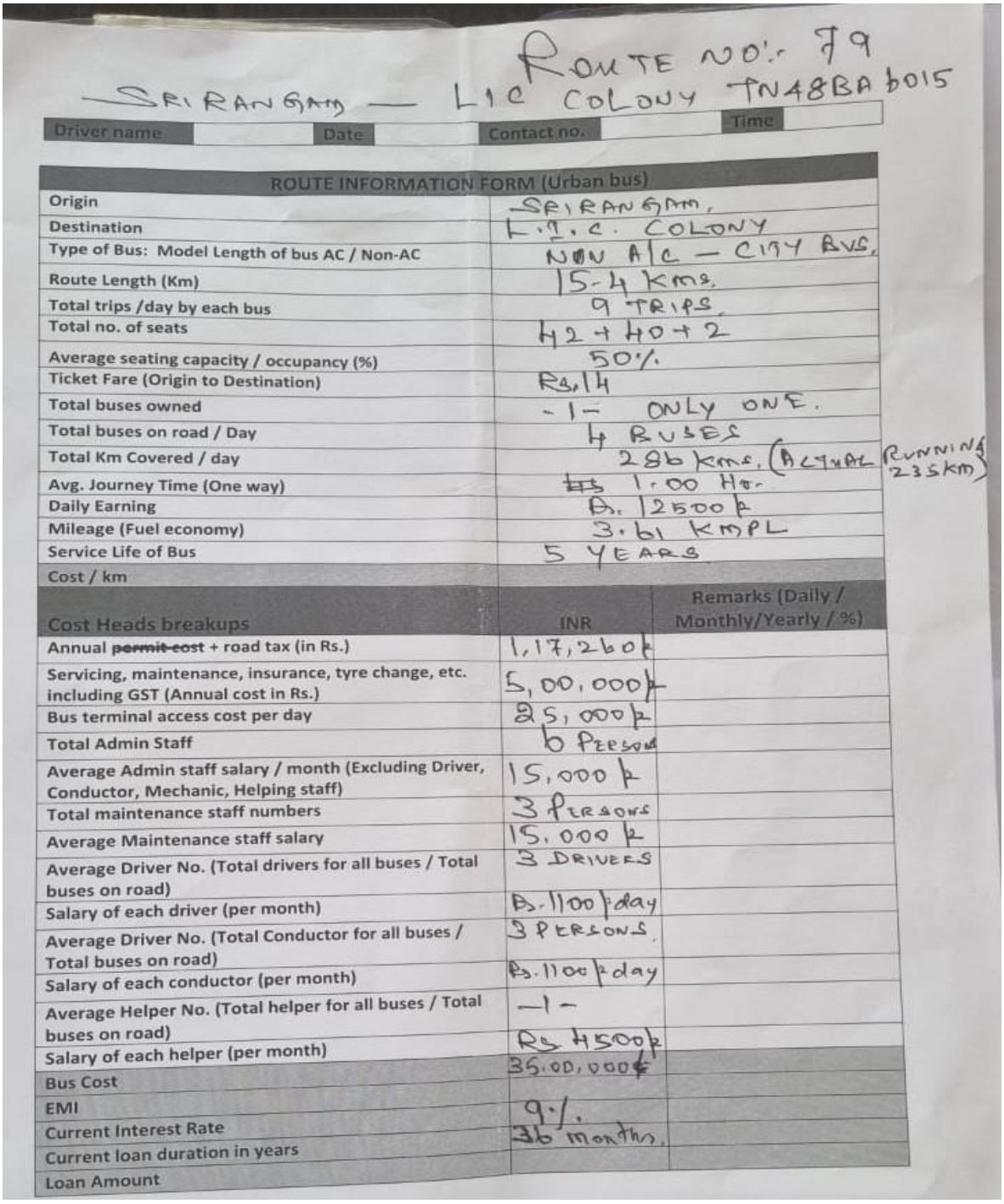
- State Government shall encourage setting up of battery recycling units through separate fiscal and non-fiscal incentives. It is expected that such infrastructure shall not only facilitate effective battery management and promotion of battery second life but shall also promise financial benefits to bus operators looking to replace their batteries. The fiscal and non-fiscal incentives should be targeted to offer bus operators a minimum of 40% cost of the current battery market value (cost of cells excluding casing) if the residual capacity of the battery is 80% or more at the time of buy back.

- State governments through the transport department should revise permit conditions and permit numbers specific to electric buses. These shall be referred to as e-bus permits. Additional e-bus permits shall be introduced and offered to private stage carriage operators for operations by electric buses. Existing standard permit holders shall be allowed to migrate to e-bus permits without any additional fees. In addition, these permit conditions shall be relaxed. e-bus permit fees shall be free of cost for the first four years. For the following years, permit fees shall not exceed 50% of the current/standard bus permit fees. The permit shall have an increased service operation time ceiling by 2 hours. This will account for additional charging time required for e-buses. e-bus permits shall be offered on both owned and leased buses, therefore permit holders can operate a self-owned or a leased bus on the allotted route. e-bus permits would not have any limits on the route length and thus more routes will be accessible to e-bus permit holders.

Annexures

Annexure 1

Route Information Data by Private Operator 1



ROUTE NO:- 79

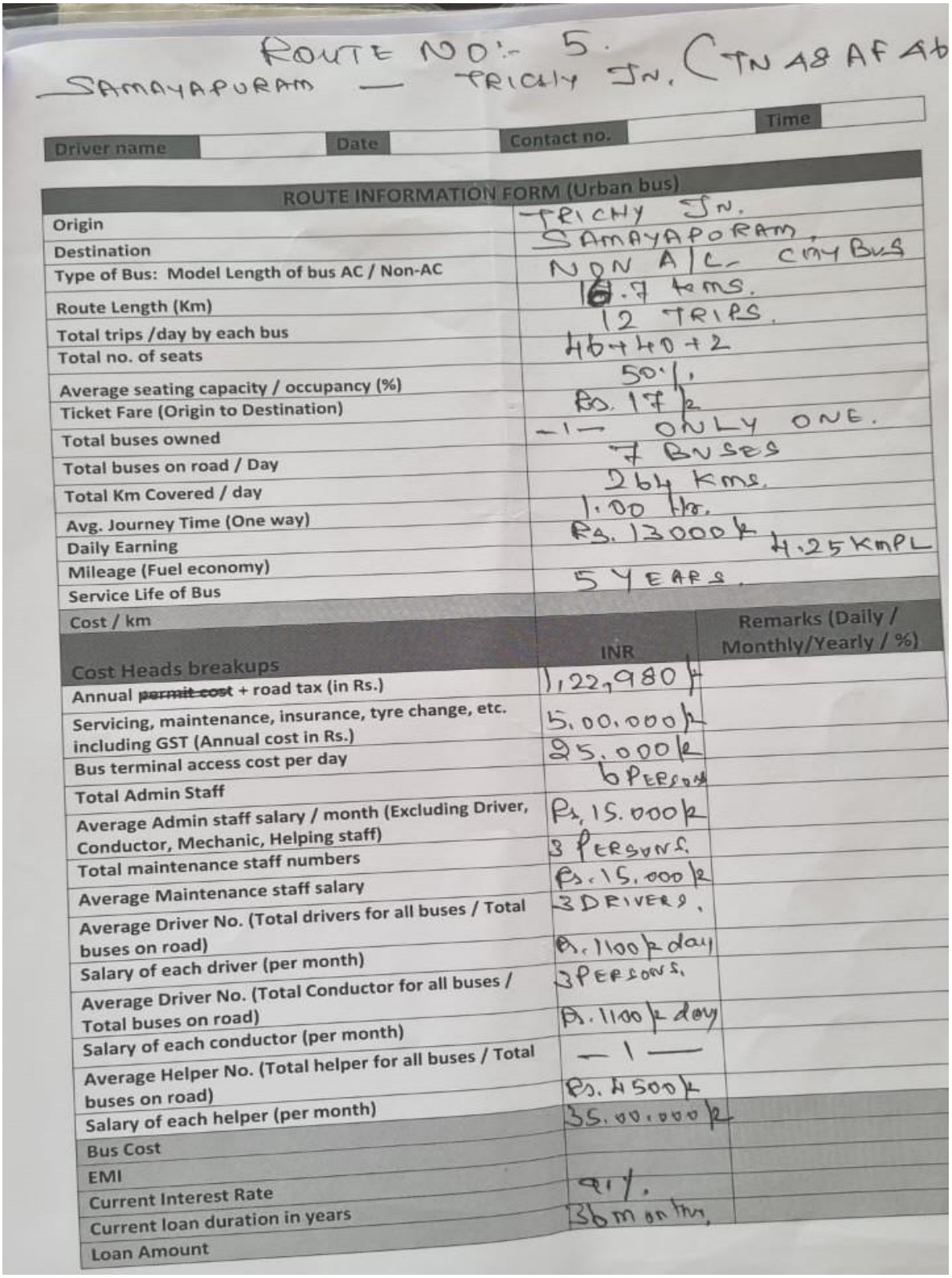
SRIRANGAM — L.I.C COLONY TN48BA 6015

Driver name		Date		Contact no.		Time	

ROUTE INFORMATION FORM (Urban bus)	
Origin	SRIRANGAM,
Destination	L.I.C. COLONY
Type of Bus: Model Length of bus AC / Non-AC	NON A/C — CITY BUS,
Route Length (Km)	15-4 Kms,
Total trips /day by each bus	9 TRIPS,
Total no. of seats	42+40+2
Average seating capacity / occupancy (%)	50%
Ticket Fare (Origin to Destination)	Rs.14
Total buses owned	-1- ONLY ONE.
Total buses on road / Day	4 BUSES
Total Km Covered / day	286 Kms. (ACTUAL RUNNING 235 Km)
Avg. Journey Time (One way)	1.00 Hr.
Daily Earning	Rs. 12500/-
Mileage (Fuel economy)	3.61 KMPL
Service Life of Bus	5 YEARS
Cost / km	

Cost Heads breakups	INR	Remarks (Daily / Monthly/Yearly / %)
Annual ~~permit cost~~ + road tax (in Rs.)	1,17,260/-	
Servicing, maintenance, insurance, tyre change, etc. including GST (Annual cost in Rs.)	5,00,000/-	
Bus terminal access cost per day	25,000/-	
Total Admin Staff	6 PERSON	
Average Admin staff salary / month (Excluding Driver, Conductor, Mechanic, Helping staff)	15,000/-	
Total maintenance staff numbers	3 PERSONS	
Average Maintenance staff salary	15,000/-	
Average Driver No. (Total drivers for all buses / Total buses on road)	3 DRIVERS	
Salary of each driver (per month)	Rs.1100/-day	
Average Driver No. (Total Conductor for all buses / Total buses on road)	3 PERSONS.	
Salary of each conductor (per month)	Rs.1100/-day	
Average Helper No. (Total helper for all buses / Total buses on road)	-1-	
Salary of each helper (per month)	Rs 4500/-	
Bus Cost	35.00,000/-	
EMI	9%	
Current Interest Rate	36 months.	
Current loan duration in years		
Loan Amount		

Route Information Data by Private Operator 2



ROUTE NO:- 5.

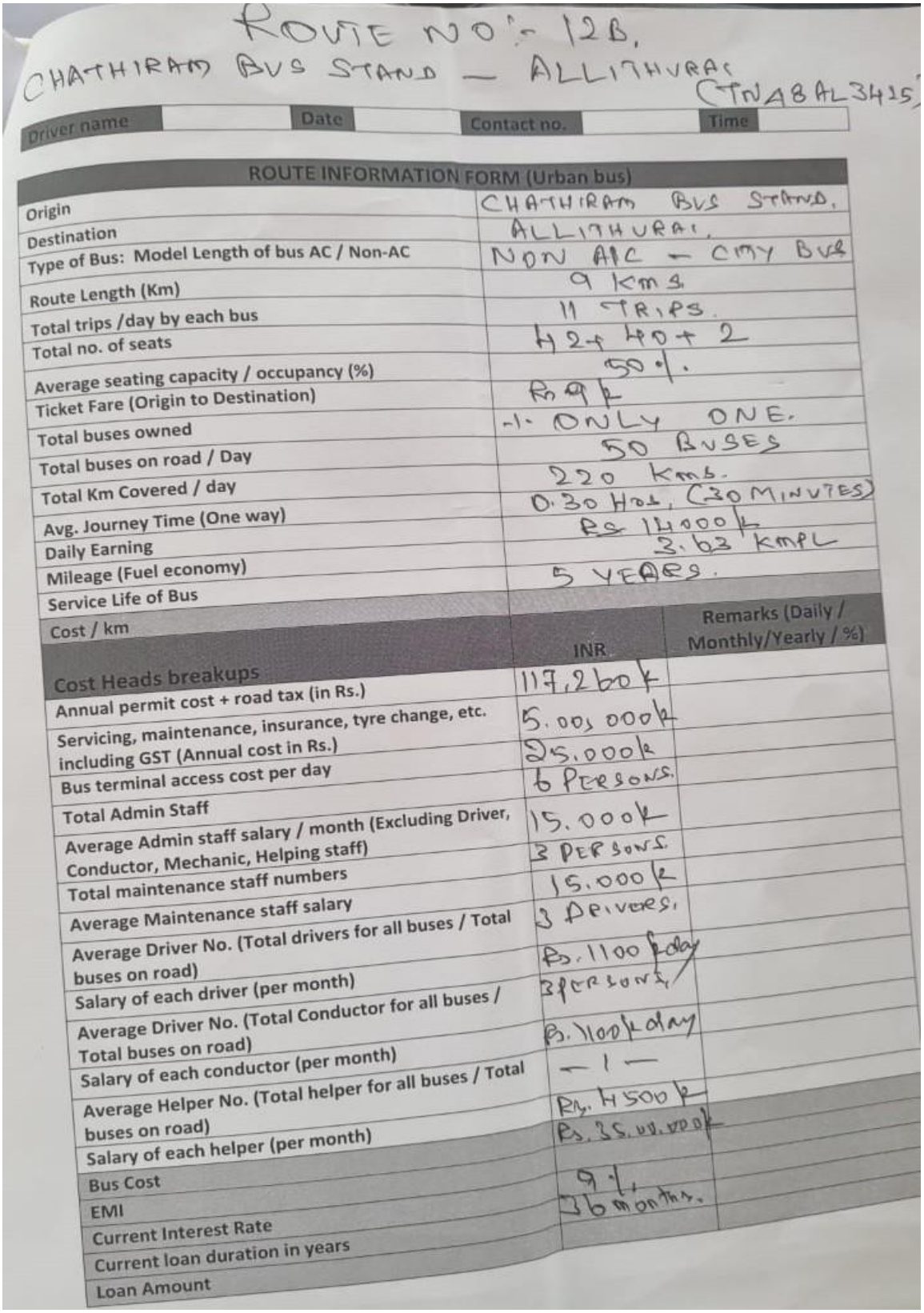
SAMAYAPURAM — TRICHY JN. (TN 48 AF 4

Driver name		Date		Contact no.		Time	

ROUTE INFORMATION FORM (Urban bus)	
Origin	TRICHY JN.
Destination	SAMAYAPORAM.
Type of Bus: Model Length of bus AC / Non-AC	NON A/C CITY BUS
Route Length (Km)	16.7 kms.
Total trips /day by each bus	12 TRIPS.
Total no. of seats	46+40+2
Average seating capacity / occupancy (%)	50%.
Ticket Fare (Origin to Destination)	Rs. 17/-
Total buses owned	— 1 — ONLY ONE.
Total buses on road / Day	7 BUSES
Total Km Covered / day	264 kms.
Avg. Journey Time (One way)	1.00 Hr.
Daily Earning	Rs. 13000/-
Mileage (Fuel economy)	4.25 KmPL
Service Life of Bus	5 YEARS.
Cost / km	

Cost Heads breakups	INR	Remarks (Daily / Monthly/Yearly / %)
Annual ~~permit cost~~ + road tax (in Rs.)	1,22,980/-	
Servicing, maintenance, insurance, tyre change, etc. including GST (Annual cost in Rs.)	5,00,000/-	
Bus terminal access cost per day	25,000/-	
Total Admin Staff	6 PERSONS	
Average Admin staff salary / month (Excluding Driver, Conductor, Mechanic, Helping staff)	Rs. 15,000/-	
Total maintenance staff numbers	3 PERSONS.	
Average Maintenance staff salary	Rs. 15,000/-	
Average Driver No. (Total drivers for all buses / Total buses on road)	3 DRIVERS.	
Salary of each driver (per month)	Rs. 1100/- day	
Average Driver No. (Total Conductor for all buses / Total buses on road)	3 PERSONS.	
Salary of each conductor (per month)	Rs. 1100/- day	
Average Helper No. (Total helper for all buses / Total buses on road)	— 1 —	
Salary of each helper (per month)	Rs. 4500/-	
Bus Cost	35,00,000/-	
EMI		
Current Interest Rate	9%.	
Current loan duration in years	36 months.	
Loan Amount		

Route Information Data by Private Operator 3



ROUTE NO:- 12B.

CHATHIRAM BUS STAND — ALLITHURAI (TN 48 AL 3415)

Driver name		Date		Contact no.		Time	

ROUTE INFORMATION FORM (Urban bus)	
Origin	CHATHIRAM BUS STAND.
Destination	ALLITHURAI.
Type of Bus: Model Length of bus AC / Non-AC	NON AIC — CITY BUS
Route Length (Km)	9 kms
Total trips /day by each bus	11 TRIPS.
Total no. of seats	42+40+2
Average seating capacity / occupancy (%)	50%
Ticket Fare (Origin to Destination)	Rs 9/-
Total buses owned	1. ONLY ONE.
Total buses on road / Day	50 BUSES
Total Km Covered / day	220 kms.
Avg. Journey Time (One way)	0.30 Hrs. (30 MINUTES)
Daily Earning	Rs 14000/-
Mileage (Fuel economy)	3.63 KMPL
Service Life of Bus	5 YEARS.
Cost / km	

Cost Heads breakups	INR	Remarks (Daily / Monthly/Yearly / %)
Annual permit cost + road tax (in Rs.)	117,260/-	
Servicing, maintenance, insurance, tyre change, etc. including GST (Annual cost in Rs.)	5,00,000/-	
Bus terminal access cost per day	25,000/-	
Total Admin Staff	6 PERSONS.	
Average Admin staff salary / month (Excluding Driver, Conductor, Mechanic, Helping staff)	15,000/-	
Total maintenance staff numbers	3 PERSONS.	
Average Maintenance staff salary	15,000/-	
Average Driver No. (Total drivers for all buses / Total buses on road)	3 DRIVERS.	
Salary of each driver (per month)	Rs. 1100 /day	
Average Driver No. (Total Conductor for all buses / Total buses on road)	3 PERSONS.	
Salary of each conductor (per month)	Rs. 1100/- day	
Average Helper No. (Total helper for all buses / Total buses on road)	— 1 —	
Salary of each helper (per month)	Rs. 14500/-	
Bus Cost	Rs. 35,00,000/-	
EMI	9%	
Current Interest Rate	36 months.	
Current loan duration in years		
Loan Amount		

Bibliography

CSE. (2019). *The Cost of Urban Commute: Balancing.* New Delhi: Centre for Science and Environment. From https://www.cseindia.org/the-cost-of-urban-commute-9664

SGArchitects. (2021, June). *National Bus Resource Requirement: Road Map for Overcoming the Gaps.* Delhi: SGA. Retrieved December 15, 2022

Shridhar, V. (2016, December 29). On-demand Buses in India: Opportunities and Challenges in Implementation. Retrieved December 16, 2022 from https://wri-india.org/blog/demand-buses-india-opportunities-and-challenges-implementation