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ELECTRIC BUS FINANCING PROJECT

IN FORTALEZA

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SUMMARY

LIST OF ACRONYMS

AC	Alternating Current
ANEEL	Brazilian Electricity Regulatory Agency
ANP	National Agency of Petroleum
ANTP	National Association of Public Transport
ARCE	Ceara State Regulatory Agency of Delegated Public Services
BNDES	National Bank for Economic and Social Development
BNEF	Bloomberg New Energy Finance
BRT	Bus Rapid Transit
BYD	Electric vehicle manufacturer
CAF	*Corporación Andina de Fomento*
CAPAG	Capacity to Pay municipalities
CEF	Caixa Econômica Federal
CETESB	Environmental Technology and Sanitation Company
COFIEX	External Financing Commission
COOTRAPS	Cooperative of Autonomous Passenger Carriers of the State of Ceará
CTC	Companhia de Transportes Coletivos
DC	Direct current
eCaRR	Electric vehicle with regular fast charging
ENEL	Multinational that operates in the field of electricity and gas generation and distribution
ETUFOR	Urban Transportation Company of Fortaleza
FINAME	Machinery and Equipment Financing Line
GHG	Greenhouse gases
GEIPOT	Transport policy integration executive group
IBGE	Brazilian Institute of Geography and Statistics
ICMS	Tax on Circulation of Goods and Services
HDI-M	Municipal Human Development Index

OPI	Organizational Performance Index
IPCA	Broad National Consumer Price Index
IPECE	Institute of Research and Economic Strategy of Ceará
IPK	Index of Passengers per Kilometer
ITDP	Institute for Transportation and Development Policy
LOM	Municipal Organic Law
MDR	Ministry of Regional Development
METROFOR	Companhia Cearense de Transportes Metropolitanos
OSO	Operational service orders
PASFOR	Sustainable Accessibility Plan of Fortaleza.
GDP	Gross Domestic Product
PMA	Average Annual Route
PMF	Fortaleza Municipal Government
Proconve	Car exhaust testing program
RMF	Metropolitan Region of Fortaleza
SAIN	Secretariat of International Economic Affairs
SEINF	Municipal Secretariat of Urban Development and Infrastructure
SINDIÔNIBUS	Union of Passenger Transport Companies of the State of Ceará
SOFR	Secured Overnight Financing Rate
SPE	Special-Purpose Entity
STA	Sustainable Transportation Award
STCO	Public Bus Transport System
STPC	Complementary Public Transport System
STTP	Public Passenger Transport Systems
TLP	Long-Term Rate
TUSD	Use of distribution system tariff
USEPA	United State Environmental Protection Agency
WRI	World Resources Institute
ZEBRA	Zero Emission Bus Rapid-Deployment Accelerator

INTRODUCTION

This report is part of **Product 6.1 – Financing project for electric buses in City 1 and 2, in Portuguese and English**, produced under the contract of consulting services for analysis, structuring, and implementation of studies and projects of electric buses in Brazil, part of the Electromobility Transition Project in Brazilian Cities.

This version refers to the financing project for acquiring electric buses developed for the **municipality of Fortaleza**. The development of the work, which occurred interactively between the team of consultants and the city teams through several technical discussions, is reported in this document composed of 6 chapters, described below.

Chapter 1 – Context presents the contextualization of the reality of the municipality, the initial premises for the preparation of the Financing Project, an analysis of the current operating contracts, and discusses the critical points to be considered for the pilot project, such as the tariff structure of electricity and mechanisms for disposal of assets – buses and batteries.

Then, **Chapter 2 – Alternatives of business models** brings a conceptual discussion of the possibility of business models considered for the pilot financing project, contextualizing the issues and central elements to enable the large-scale implementation of electric buses in the municipality.

Chapter 3 – Design of the Pilot Project in the Municipality discusses the four central aspects of the financing pilot project (operational, legal, economic, and social aspects). In it are considered the specificities of the municipal reality, the guidelines on possible contractual solutions, and the development of the economic-financial evaluation model.

Chapter 4 – Asset financing explores possible options and alternatives related to sources of financing for public transport, with particular emphasis on the possibilities for the defined business model.

Chapter 5 – Recommendations for implementation and monitoring guides the objectives of the public administration for the construction of short, medium, and long-term goals for the electromobility of public transport in the municipality and recommends instruments for monitoring indicators and training of drivers and maintenance staff.

And finally, **Chapter 6 – Pilot Financing Project** addresses the financing strategy for the solution chosen by the stakeholders consulted. Thus, the implementation steps are presented, from the consolidation of public definitions to the request for financing.

1. CONTEXT

This chapter presents the contextualization of the municipality's reality based on the findings made throughout the development of the study. First, it introduces a characterization of the city regarding its demographics, urban mobility system - with a focus on public transport - and its advances regarding the transition to electromobility until the beginning of the project.

From these aspects, the chapter then presents the initial premises for the elaboration of the Financing Project, defined together with the municipality team, such as the quantity and size of vehicles to be replaced, lines in which they should operate (spatial coverage), types of technologies, among others.

This chapter also explores contracts for the operation of public transport services currently in force in the municipality to provide an understanding of the existing legal framework, which can directly influence the implementation of pilot financing projects.

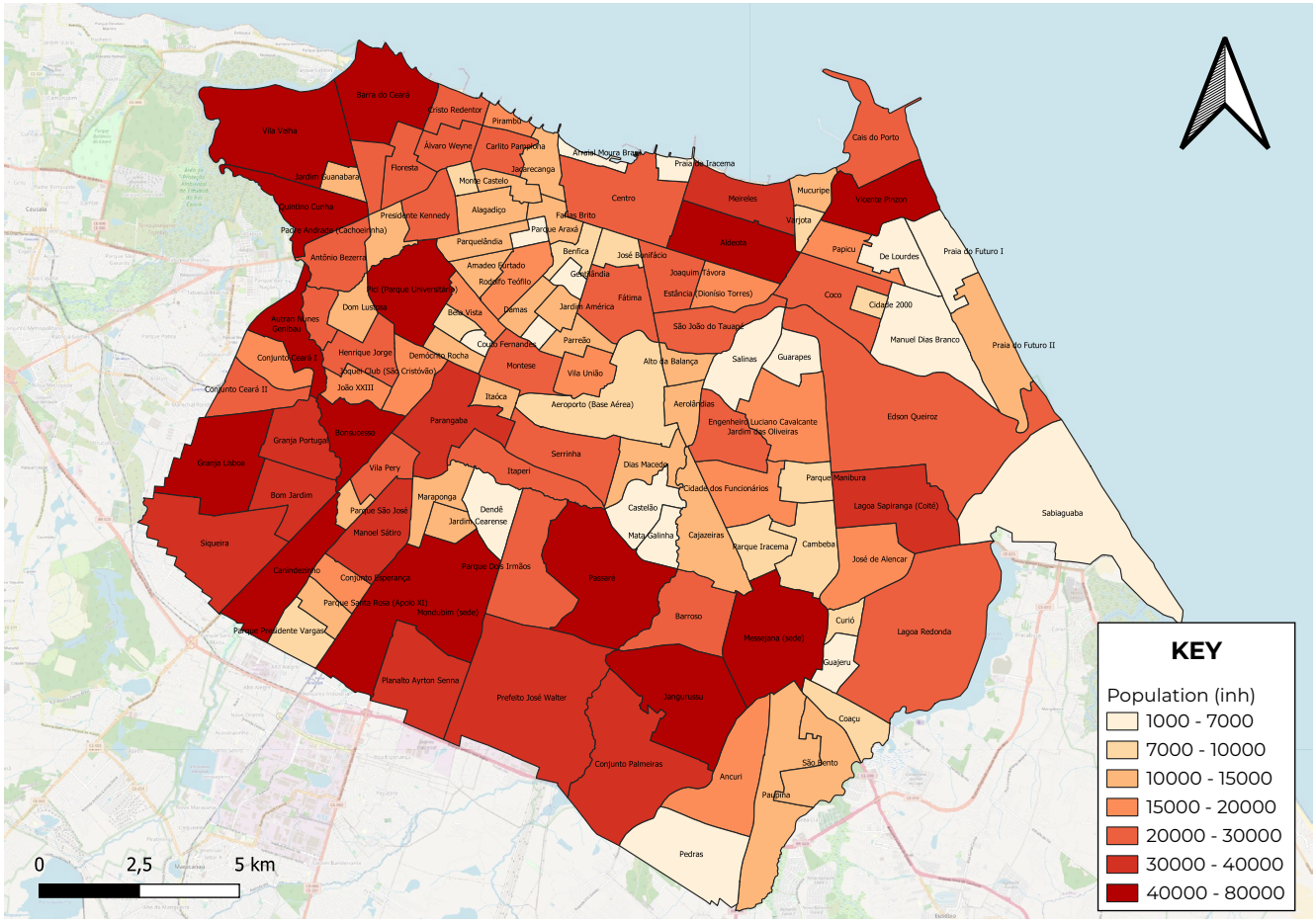
Finally, the chapter also supports the municipality in understanding the critical points to be considered for the pilot project, such as the electric power tariff structure and asset disposal mechanisms – buses and batteries.

1.1 CARACTERIZATION

1.1.1 Socioeconomic aspects

The municipality of Fortaleza, located in the country's Northeast region, is the capital of the State of Ceará and is located north state. According to 2021 data from the Brazilian Institute of Geography and Statistics (IBGE), it has an estimated population of approximately 2.7 million inhabitants, representing about 30% of the State of Ceará. Considering data from the 2010 Census, the municipality has the highest population density among the country's capitals, with about 7,786 inhabitants per square kilometer. Figure 1 presents the distribution of the population by neighborhoods of Fortaleza.

Figure 1 – Population by neighborhoods of Fortaleza

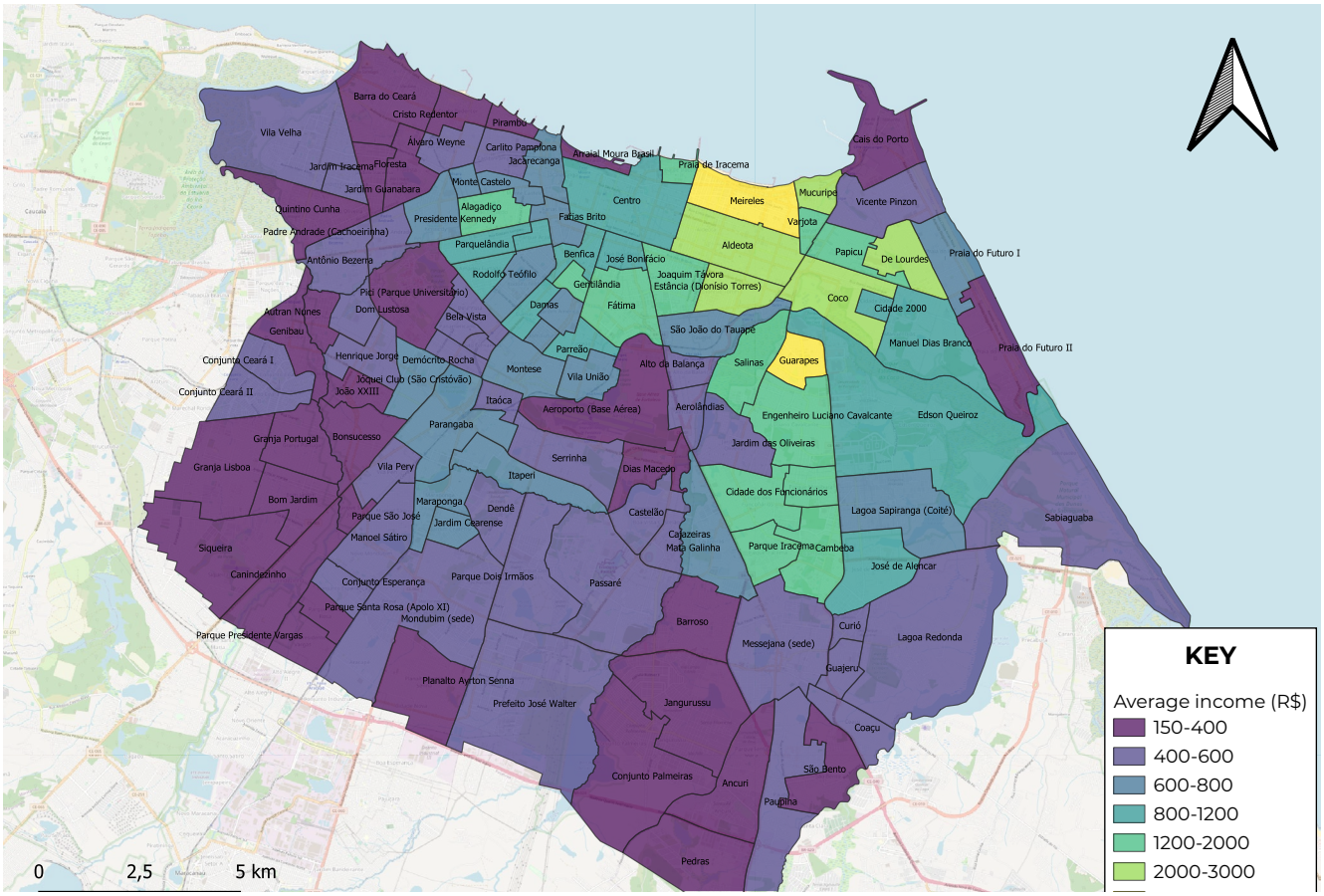


Source: Municipal Secretary of Finance, Fortaleza Municipal Government (2015). Available at: https://mapas.fortaleza.ce.gov.br.

Through the map presented, it can be identified that the municipality of Fortaleza has a population concentrated in neighborhoods in the suburbs, mainly in the northwest region (represented by the neighborhoods Vila Velha, Barra do Ceará, and Jardim Guanabara), southwest (Granja Lisboa, Bonsucesso and Canindezinho) and south (Messejana and Jangurussu). The northernmost region also has populated neighborhoods like the Aldeota and Vicente Pizon.

A survey conducted by the Institute of Research and Economic Strategy of Ceará (IPECE, 2019 [1]) shows that the municipality of Fortaleza is the only municipality in the Northeast that is in the 10 largest Gross Domestic Product (GDP) in the country, being 9th in the ranking. This year, the GDP of the municipality was about 67 billion reais. The per capita income of Fortaleza is R$ 25,254, the 22nd capital in this topic, considering the total of 27 capitals. The average monthly wage of formal workers is 2.7 minimum wages. Fortaleza is in the 301st position of 5,570 municipalities compared to municipalities in other countries. The spatial distribution by middle-income neighborhoods is shown in Figure 2.

Figure 2 – Average income per neighborhood of Fortaleza

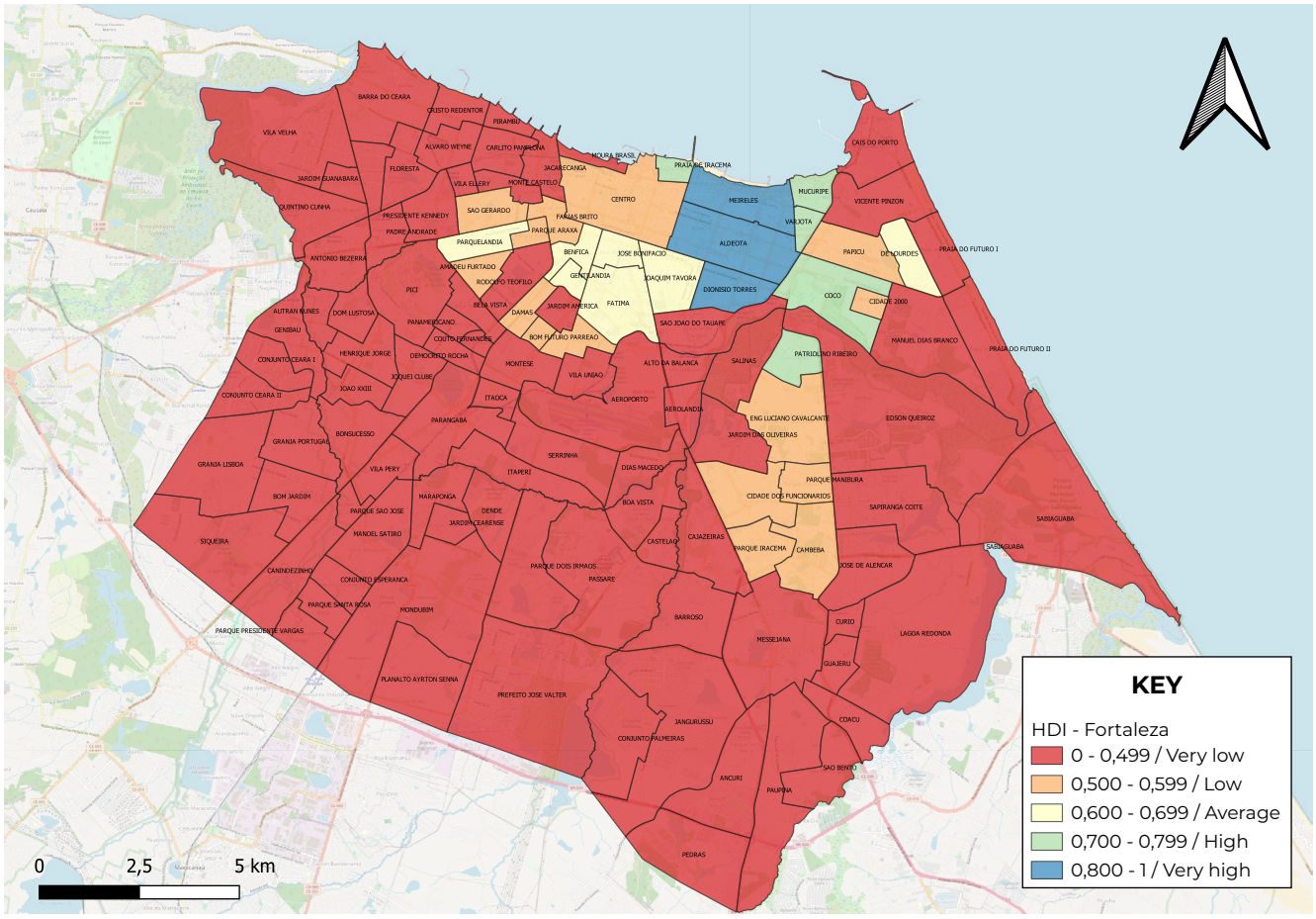


Source: IBGE Censo (2010). Available at: https://mapas.fortaleza.ce.gov.br.

The map indicates that the neighborhoods with the highest income are concentrated in the area of the "expanded center," such as the neighborhoods Aldeota, Dionísio Torres, Meireles, and Cocó. There are also neighborhoods with higher middle income around the axis of Washington Soares Avenue, such as Guararapes, Salinas, Eng. Luciano Cavalcante, among others. The most peripheral neighborhoods tend to have lower levels of average income. It is possible to notice that the neighborhoods with the largest population, presented in Figure 1, tend to have lower income levels.

Another important measure to evaluate is the Municipal Human Development Index (HDI-M), composed of data on life expectancy at birth, education, and GDP. In the case of Fortaleza, the HDI-M is 0.754, according to IBGE data. This value is considered high. However, considering the social inequality of the municipality, it is interesting to evaluate the spatial distribution of this indicator, presented in Figure 3.

Figure 3 – Municipal Human Development Index (HDI-M) by neighborhoods of Fortaleza



Source: IBGE Censo (2010). Available at: https://mapas.fortaleza.ce.gov.br.

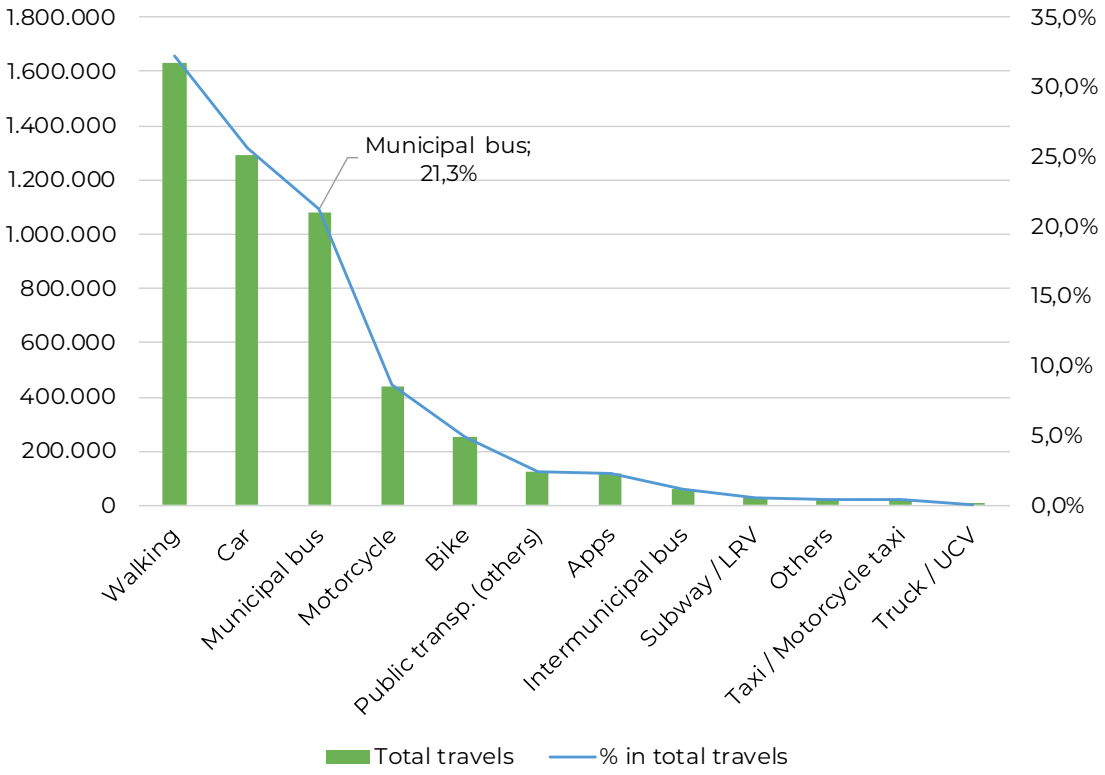
The spatial distribution of HDI is very similar to the monthly income map. Thus, neighborhoods with higher incomes, in general, have higher HDI. By classification, it can be affirmed that the periphery neighborhoods have very low HDI (below 0.5). Compared with the population distribution, it can be affirmed that most neighborhoods with a high population have very low HDI.

1.1.2 General aspects of urban mobility

In 2022, Fortaleza's municipality is completing the mobility plan called PASFOR - Sustainable Accessibility Plan of Fortaleza. The plan's main objective is to provide the city of Fortaleza with a sustainable multimodal transport system that promotes accessibility, prioritizes the modes of non-motorized and motorized transport of high capacity, and increases the well-being and quality of life of people. Furthermore, regarding the study area, municipalities in the area of influence of the municipality were contemplated, covering part of the Metropolitan Region of Fortaleza.

According to data obtained through the Origin-Destination Survey, carried out in 2018 under PASFor [2], about 5 million daily displacements occurred in the municipality of Fortaleza. The main modes used were: walking (32.2%), automobile (25.6%), municipal buses (21.3%), motorcycle (8.6%), and bicycle (4.9%). About 1 million displacements were made by municipal public transport, considering the standard for working days in 2018. Data on travels made per day are shown in Figure 4.

Figure 4 – Travels made by the main mode of transport

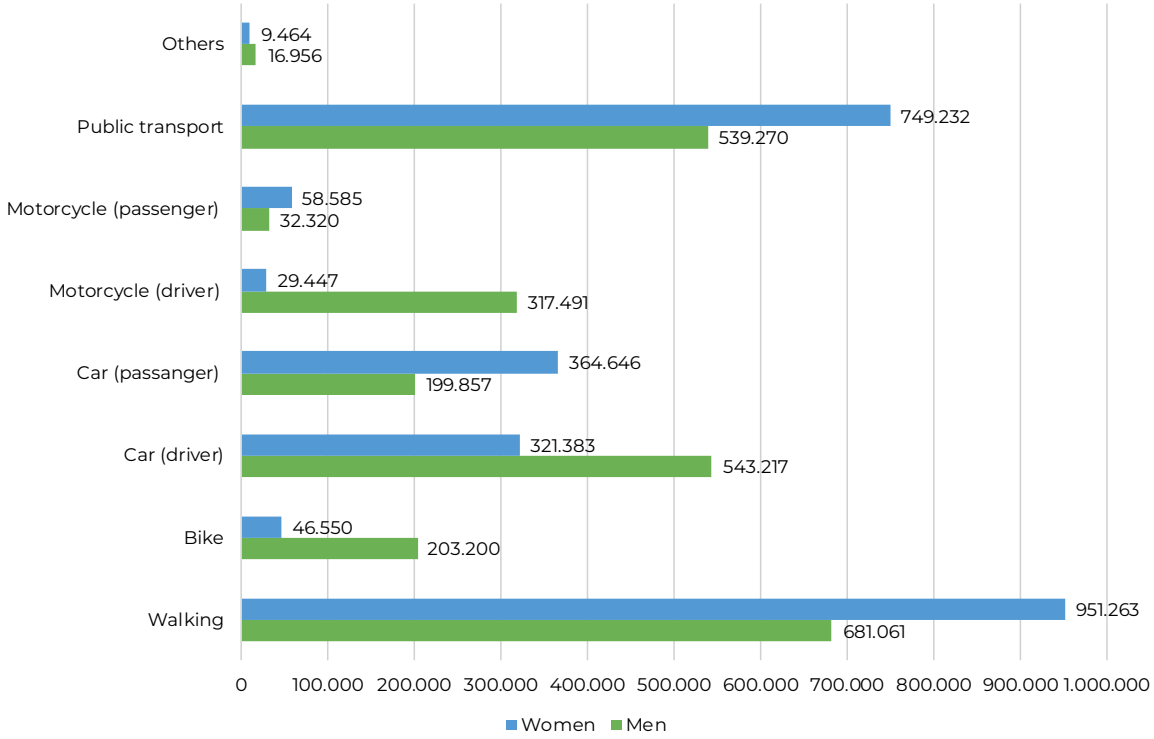


Source: PASFOR.

It is worth noting that the data reflects the reality before the Covid-19 pandemic. The effects of the pandemic significantly altered the standards of displacement, especially for those that use public transport. For example, during May 2020 (first lockdown), the system had the lowest demand of the entire pandemic, with 5 million monthly. Prior to the pandemic, this value was close to 23 million, so there was a 78% drop in demand during this period.

Regarding gender, it is evaluated that there is a significant difference between the use of modes of transport by men and women. In general, men are the majority as drivers in automobiles (63%), mainly with motorcycles (92%), while women are the majority as passengers in automobiles (65%) and motorcycles (64%). In public transportation, women account for the majority of displacement, with about 58% of travel. The modal division data by gender are presented in Figure 5.

Figure 5 – Number of travels mode and by gender



Source: PASFOR.

Also, regarding gender, the data indicated that the mobility index, or the amount of daily travels per day per person, is considerably different for the entire Pasfor study area, including the Metropolitan Region of Fortaleza (RMF). The male mobility index is 1.89 travels per day, while the female is 1.67, which indicates that gender interferes significantly with mobility standards.

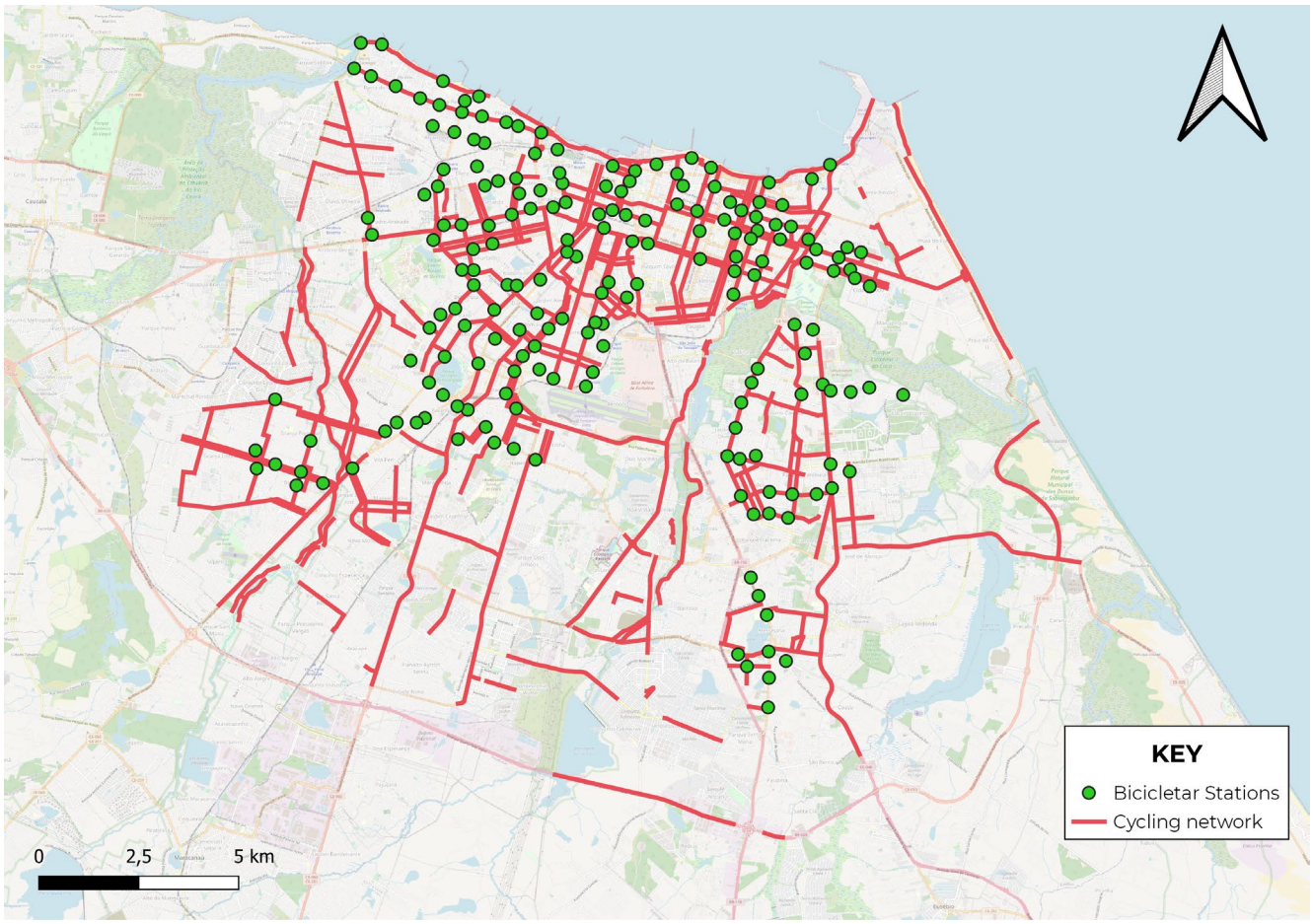
As for the fleet, the municipality of Fortaleza has nearly 1 million and 180,000 thousand vehicles and, therefore, a motorization rate of 436 vehicles for 1,000 inhabitants. About 50% of the fleet consists of automobiles, while 29% of the fleet consists of motorcycles and scooters. Between 2010 and 2021, there was an increase in the acquisition of automobiles by 45% and motorcycles and scooters by 115%. Therefore, some public transport users are migrating to motorcycles, contributing to the fall in demand for the system since 2015.

Although the plan is not yet completed, the municipality has advanced on the agendas of sustainable mobility, especially since 2014. This advance is materialized through the expansion of the cycling network by 497% since January 2013, reaching about 410 kilometers in length. Currently, 60% of the municipality's population resides at a distance of up to 300 meters from some cycling infrastructure. According to the Institute for Transportation and Development Policy (ITDP Brazil [3]), Fortaleza is the Brazilian capital with the largest number of people living near the cycling network.

Fortaleza also presents a public bicycle-sharing system called Bicicletar, which has 210 stations installed in various neighborhoods of the municipality, including in peripheral locations. Currently, the system is the largest in the country in proportion to stations per inhabitant. The expansion to the peripheral areas was possible due to the implementation of the policy of allocating resources from the rotating public parking.

There are also actions carried out to promote the use of the bicycle, such as the Mini-Bicicletar (shared bicycle system for children), Bike Sem Barreiras (bicycles available for people with disabilities and reduced mobility), and the Ciclofaixa de Lazer (temporary routes for bicycles use during Sundays). The stations of the shared bicycle system and the cycle network of Fortaleza are presented in Figure 6.

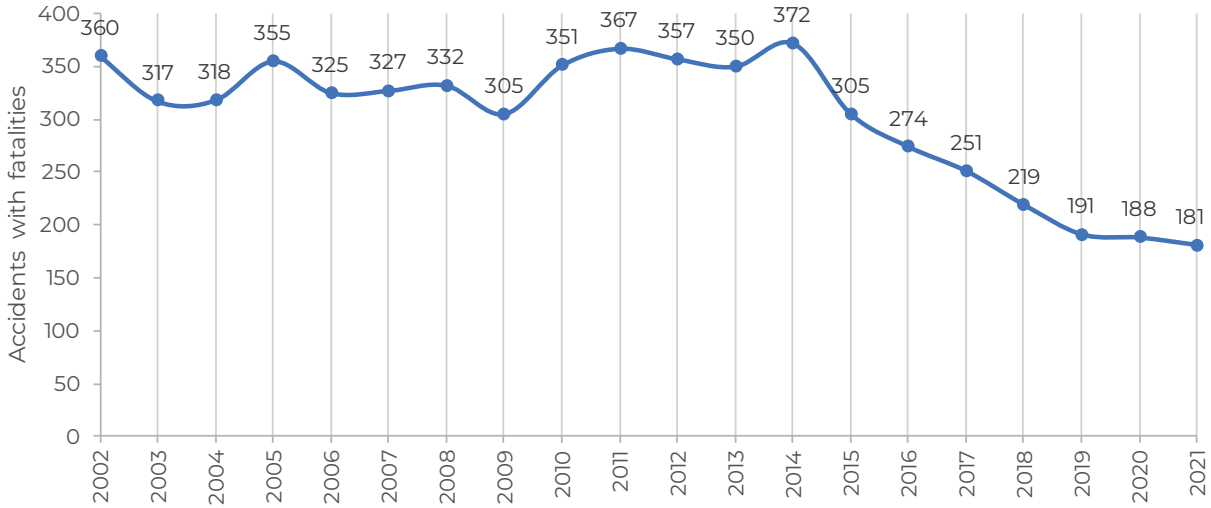
Figure 6 – Stations of the shared bicycle system and cycle network of Fortaleza



Source: Fortaleza Municipal Government.
Cycle network available at: https://www.google.com/maps/d/u/0/viewer?hl=pt-BR&mid=1eqNX-fl3ENPC8_1tqzbRDYZFQmA&ll=-3.763440591394993%2C--38.536152872901 08&z=15. Bicicletar stations available at: https://www.google.com/maps/d/u/0/viewer?ll=-3.774351502087665%2C-38.563958361682 29&z=12&mid=1cdCpSt6yZgx4Jw9SMz9EYOlm-1A-Z797.

The municipality also implemented actions aimed at improving road safety that resulted in a 51.3% reduction in fatalities between 2014, when there were 372 fatalities, and 2021 when 181 fatalities were recorded. To achieve these levels of reduction, Fortaleza started actions of urban design, implementation of areas of calm traffic, readjustment of maximum regulated speed in critical arterial roads, expansion, and modernization of the semaphoric network, in addition to the implementation of support elements for pedestrian circulation, such as the installation of elevated lanes and safe cornering. Figure 7 shows the time series of accident data involving fatal victims in Fortaleza.

Figure 7 – Time series of accidents with fatalities



Source: Annual Report on Road Safety in Fortaleza (RASV, 2021 [4]).

As explained below, the municipality also greatly improved the quality of the municipal public transport system, improved the quality of the fleet, implemented temporal tariff integration, reformed terminals, and increased the priority network for buses. As a result of these policies to promote sustainable mobility, in 2019, the capital received the Sustainable Transportation Award (STA), sponsored by the Institute for Transportation and Development Policies (ITDP) and the Transit Center, with support from the World Bank.

The STA is selected by a committee composed of leading organizations in the area of urban development and the promotion of sustainable mobility. ITDP, World Bank, WRI Ross Center for Sustainable Cities, CODATU, ICLEI, Clean Air Asia, GiZ, Instituto Clean Air, and Despacio are some of these organizations. According to this committee, the municipality of Fortaleza has wined the selection for implementing policies to promote public transport, walking, and transport by bicycle, reducing CO2 and improving road safety.

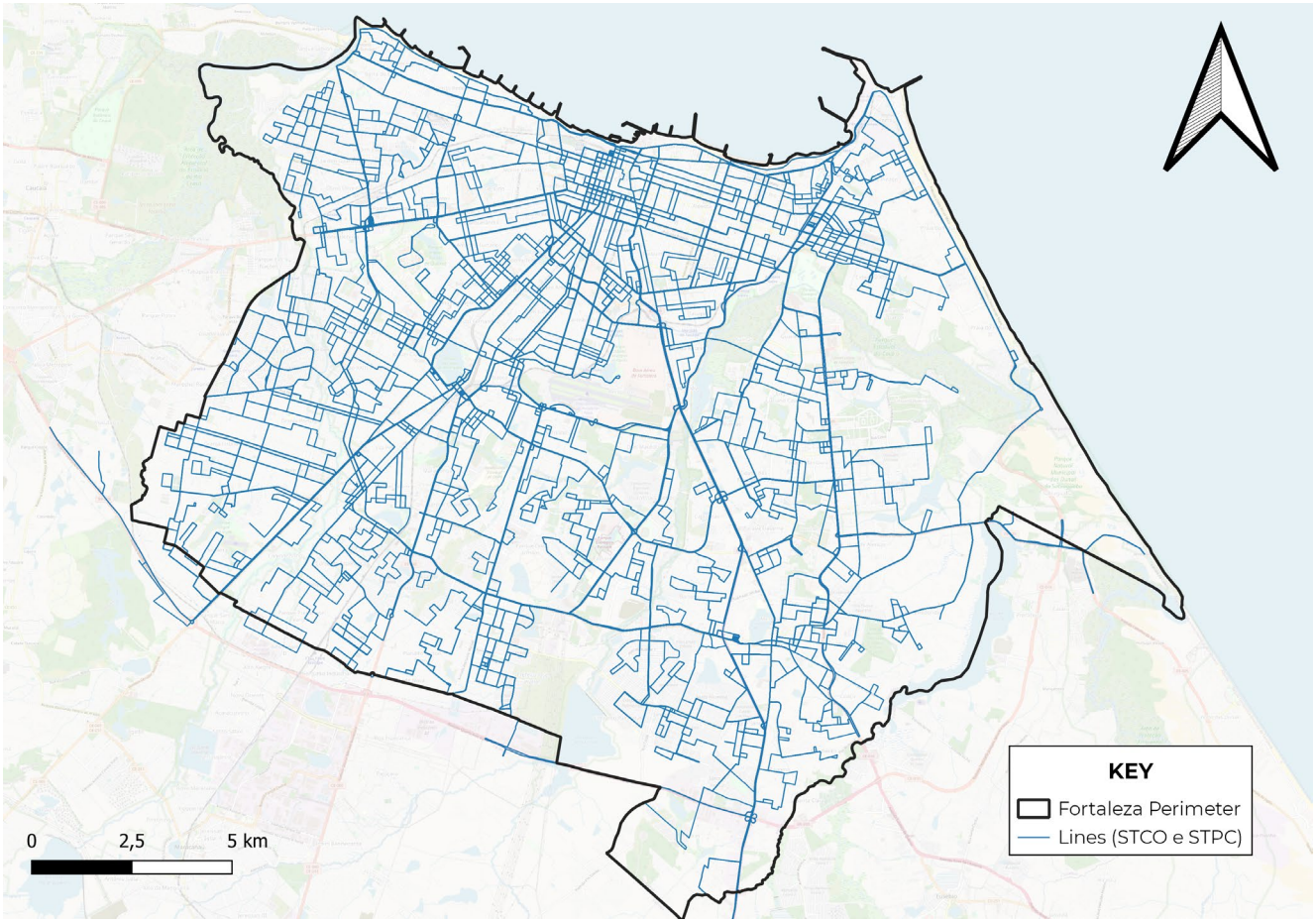
1.1.3 The municipal public transport system

Since 2013, the city of Fortaleza has implemented improvements in the municipal public transportation system, with the implementation of the Bilhete Único (which guarantees intertemporal tariff integration), expansion of the public transport priority network (exclusive bus lines and BRTs), and terminal renovation. During this period, the municipality increased the priority network from 3.3 kilometers to 130.2 kilometers. In addition, Fortaleza offers free wi-fi internet access to 100% of the bus fleet, and 35% of the fleet has air conditioning. Regarding the renovation of terminals, the municipality recently completed the improvement of Antônio Bezerra and Messejana terminals and the construction of the mini terminals of Washington Soares Avenue and the José Walter neighborhood.

The municipality of Fortaleza presents the operation of the Public Passenger Transportation Systems (STTP/FOR), which is managed by the Fortaleza Municipal Government (PMF) through the Urban Transportation Company of Fortaleza (ETUFOR). The system consists of two subsystems: the Public Bus Transport System (STCO, operated by the public transport companies linked to Sindiônibus, and the Complementary Public Transport System (STPC), operated by the Cooperative of Autonomous Passenger Carriers of the State of Ceará (COOTRAPS).

According to analyses carried out within the scope of PASFOR, Fortaleza has a broad service coverage through the municipal public transport network, with about 97% of the entire territory served, considering a 500 meters accessibility distance around the routes of the lines. The spatial distribution of the STCO and STPC lines is shown in Figure 8.

Figure 8 – Municipal public transport system lines (STCO and STPC)



Source: ETUFOR.

In Fortaleza, the set of railway lines, operated by the Companhia Cearense de Transportes Metropolitanos (METROFOR) and by the metropolitan and inter-municipal transport system on tires is managed by the Ceara State Regulatory Agency of Delegated Public Services (ARCE).

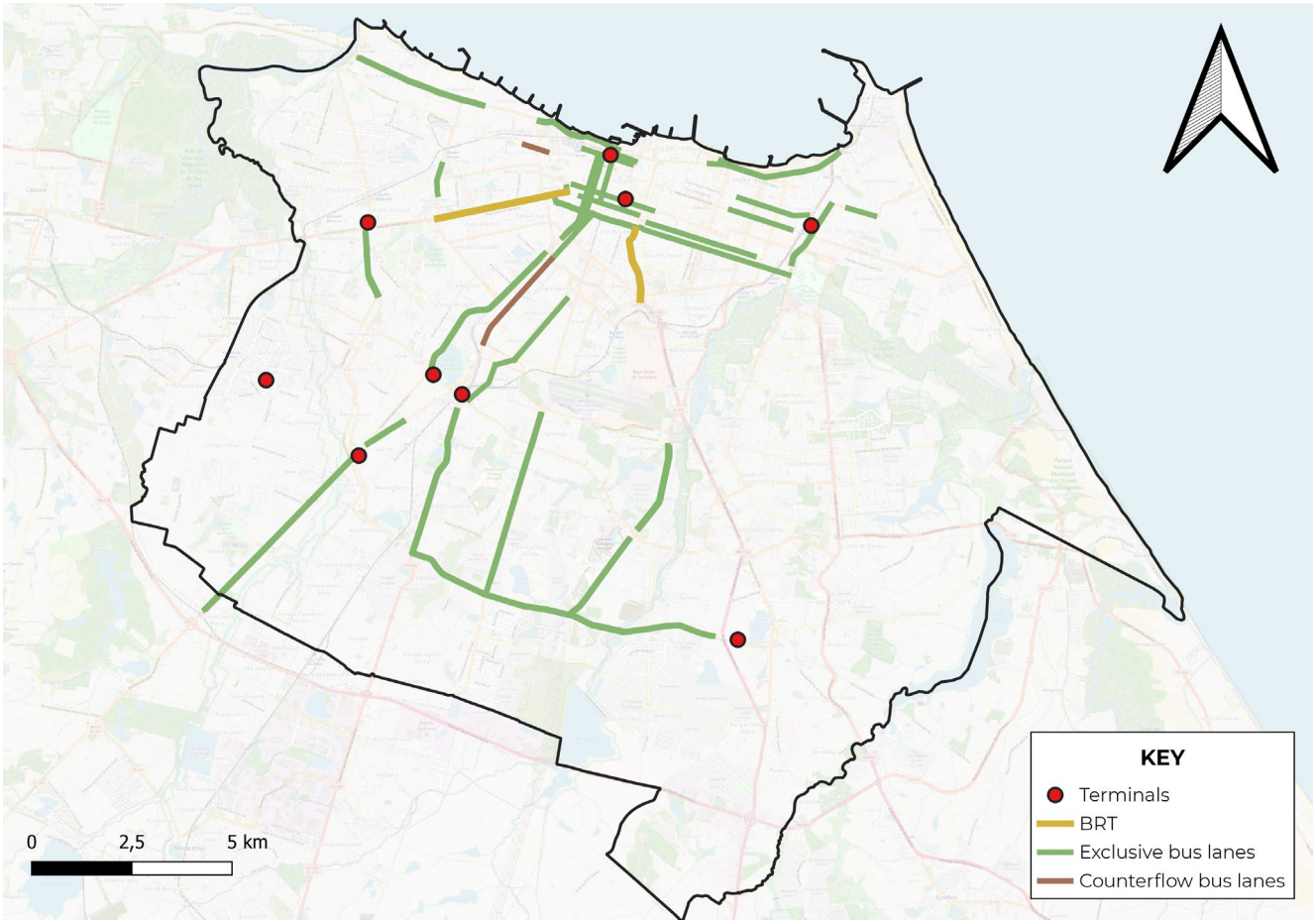
Ideally, all services should operate in such a way as to contemplate an integrated network to provide higher quality and more efficient service for society. However, the set of services is characterized by isolated networks, organized autonomously and, therefore, competing with each other. Within PASFOR, related proposals for a physical and tariff integration of the different systems aim to design a single integrated network.

The municipal system operates in an integrated way and is structured in a feeder-trunk system from terminals and mini-integration terminals in the neighborhoods. Since 2013, a temporal tariff system using electronic ticketing has integrated STPC and STCO. Before this integration with the electronic ticket, the integration of the municipal service was allowed only within the integration terminals. After implementing this technology, the integration is possible at any point in the municipality for two

hours. The integration with the metropolitan and municipal lines is also carried out through the Bilhete Único Metropolitano; however, there is still no integration with the subway.

According to data provided by the municipality, Fortaleza currently has a network of 132.3 km of priority infrastructure for buses, with 118.7km of exclusive bus lines, 10.3km of BRT, and 3.3km of exclusive bus lines in the counterflow. In addition, the system includes 9 integration terminals, being 2 open terminals (Coração de Jesus and José de Alencar), and 7 closed terminals (Papicu, Antônio Bezerra, Lagoa, Parangaba, Messejana, Conjunto Ceará, and Siqueira). The road infrastructure of priority public transport and terminals are presented in Figure 9.

Figure 9 – Road network for priority public transport and terminals

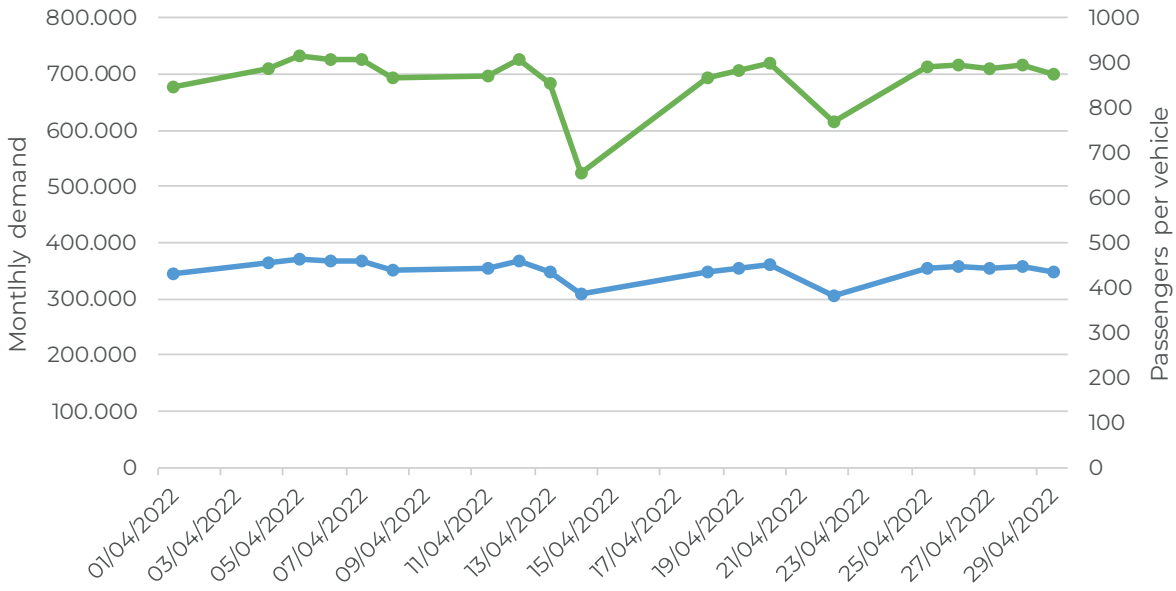


Source: Fortaleza Municipal Government.

Data from April 2022 made available through the Urban Transportation Company of Fortaleza (ETUFOR) indicate that the monthly demand was approximately 14 million departures, representing a drop of about 40% of pre-pandemic demand, a period in which the typical monthly demand was 23 million.

Considering the last week of April, without the influence of holidays, the demand during working days varied between 700,000 and 717,000 passengers per day, representing about 65% and 67% of the demand indicated in PASFOR, which was 1.77 million in 2018. Figure 10 illustrates the monthly demand data and passengers per fleet during April weekdays.

Figure 10 – Monthly demand and passenger per fleet on April weekdays



Source: ETUFOR (2022).

1.1.4 Advances with the Electromobility agenda

Until May 2022, the municipality of Fortaleza had no practical experience with implementing an electric bus project. However, as provided above, the city has implemented policies to promote sustainable mobility through expanding the cycling infrastructure and the priority network for public transport. It also implemented a public system of shared bicycles, among other measures.

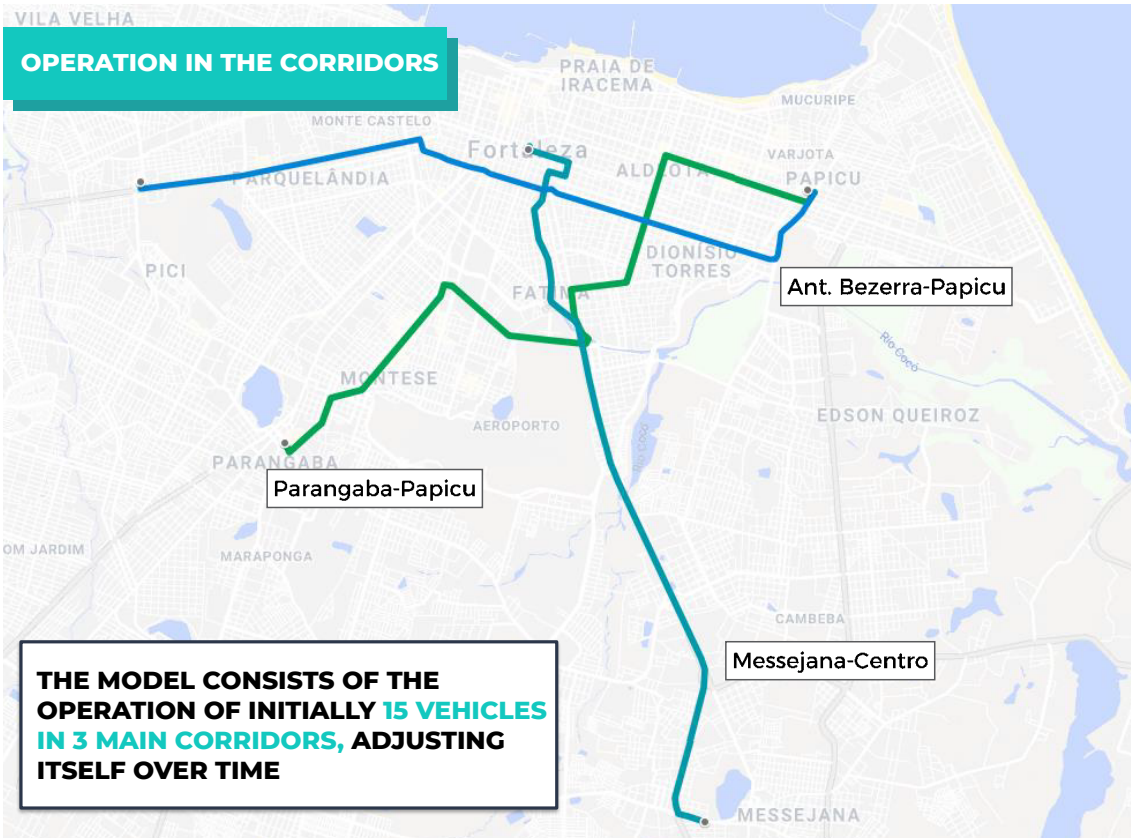
In 2019, to identify the strengths and challenges of Electromobility, a conceptual model of a pilot project was elaborated for the implementation of electric buses in the fleet of the municipal public transport system. The proposal focused on the initial phase of implementing electric buses, allowing adjustments to the later stages of fleet electrification through the learning obtained in this initial phase. For the preparation of the pilot project, the following premises were established:

- Keep the tariff balance unchanged;
- Anticipate a global trend;

- Implementation of the pilot model;
- Possibility of adjustments in the model;
- Start a self-sustaining chain.

Regarding the operational model, it was defined that the pilot project would consist of the operation of 15 vehicles in 3 main corridors: Antônio Bezerra-Papicu (lines 222 and 200, for example), Parangaba-Papicu (lines 044 and 045, for example), and Messejana-Centro (lines 226 and 650, for example). Therefore, with the traditional plug-in, a night charging model was proposed in the garages of the companies that operate the lines defined. For the vehicle, a bus body shell of up to 13.2m and a high floor was defined. Figure 11 introduces the itineraries of the lines chosen for the electric bus pilot project during the initial study.

Figure 11 – Itinerary of the lines chosen for the pilot project during the initial study



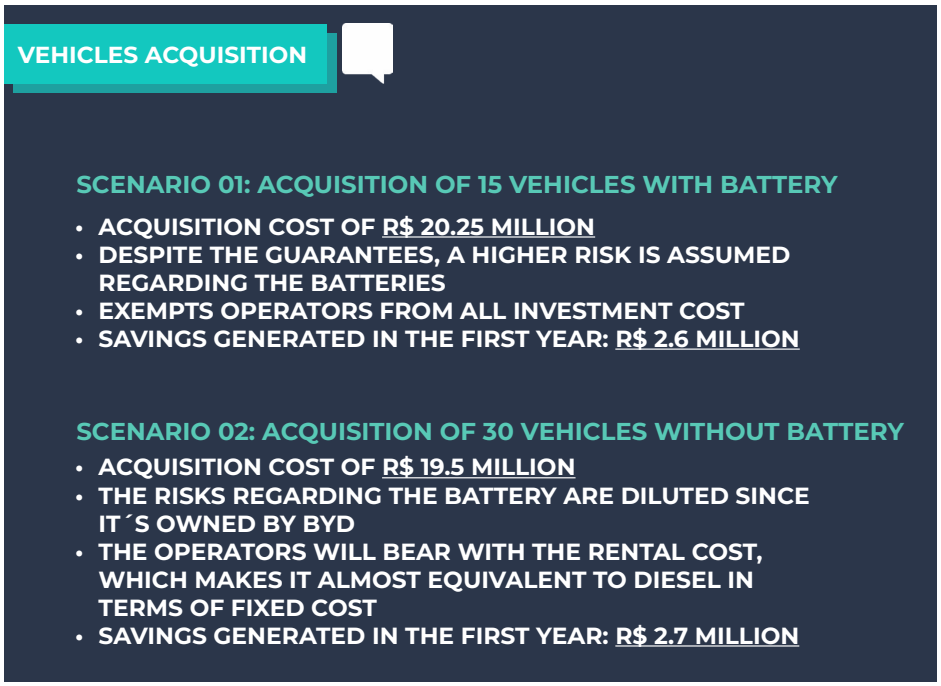
Source: Fortaleza Municipal Government.

The model also addressed a communication strategy to disseminate the project's concept and benefits. The strategy consisted of applying a differentiated adhesive to buses, highlighting the project's environmental benefits, installing solar panels to complete the energy supply, and quantifying the reduction of emissions and noise to disseminate the results to society.

Regarding the stakeholders involved in the model, the Fortaleza Municipal Government was chosen for its support in raising funding and in the initial acquisition of vehicles and infrastructure. Sindiônibus would be responsible for the operation of buses, infrastructure upgrades, training, and other topics. Enel came as an electricity supplier for the network's adequacy, and the World Resources Institute (WRI) with the technical support for detailing the operational and financial models, in addition to acting as a facilitator in the exchange of electromobility experiences with other cities.

Costs associated with purchasing vehicles and batteries were defined, and some premises were established for the initial financial modeling. Two alternative scenarios were established: acquiring 15 vehicles with battery and 30 without battery. In the first scenario, a higher risk would be assumed with batteries, considering the uncertainties of the duration of the battery's useful life and the arrangement of the battery at the end of the useful life. Second, operators would bear the battery rental cost, similar to the acquisition of diesel buses. Attention points and costs from the study period (2019) under each scenario are presented in the figure below.

Figure 12 – Points of attention and costs associated with each scenario



Source: Fortaleza Municipal Government

In both scenarios, the savings generated by reducing operating costs associated with electric buses compared to diesel-powered buses were estimated. In addition, the project indicated that the economy of the operation of electric buses was associated with an Electromobility fund that would subsidize the purchase of future electric vehicles.

The uncertainties related to Electromobility, such as operating costs and the duration of the battery's useful life, in addition to the high costs associated with the acquisition of vehicles and infrastructure, are barriers that have hindered the pilot project implementation so far. In addition, Fortaleza's public transport system, as in other cities in the country, is experiencing a crisis related to the drop in demand since 2015, more accentuated by the Covid-19 pandemic. These conditions implied the need to grant subsidies by the Fortaleza Municipal Government and the Government of the State of Ceará to ensure the system's financial sustainability without compromising the quality of the public transport service for passengers.

1.2 INITIAL ASSUMPTIONS

From interactions with the team of the Fortaleza Municipal Government, specifically the Urban Transportation Company of Fortaleza, some initial premises were defined for the design of the electric bus pilot project. The technical team made a few changes in the conceptual model elaborated in 2019 for the pilot project, considering some acquired learnings.

For the fleet project, the choice of **15 electric vehicles of the heavy type (14m), high floor, and 5 doors** was made. This fleet would only operate on lines **222 - Antônio Bezerra/Papicu/Antônio Sales and 026 - Antônio Bezerra/Messejana**. The justification for the choice of lines is based on the fact that they are trunk lines of high daily mileage, with vehicles traveling up to 280 kilometers per day, connecting 3 terminals (Antônio Bezerra, Messejana, and Papicu) to the commercial center of Fortaleza. They are also among the system's most demanding lines, with many routes giving preference to public transport (in BRT or exclusive lines). The data of travel, extension, and operating companies per line are presented in Table 1.

Table 1 – Operational characteristics of lines 222 and 026

Characteristics	Line 222 Antônio Bezerra/Papicu	Line 026 Antônio Bezerra/Messejana
Daily travels (business day)	64 travels	85 travels
Extension per travel	26.9 kilometers	42 kilometers
Fleet	9 vehicles	16 vehicles
Operating companies	Auto-Viação São José, Vega S/A and Santa Cecília	Auto-Viação Fortaleza and Vega S/A

Source: Urban Transportation Company of Fortaleza (ETUFOR).

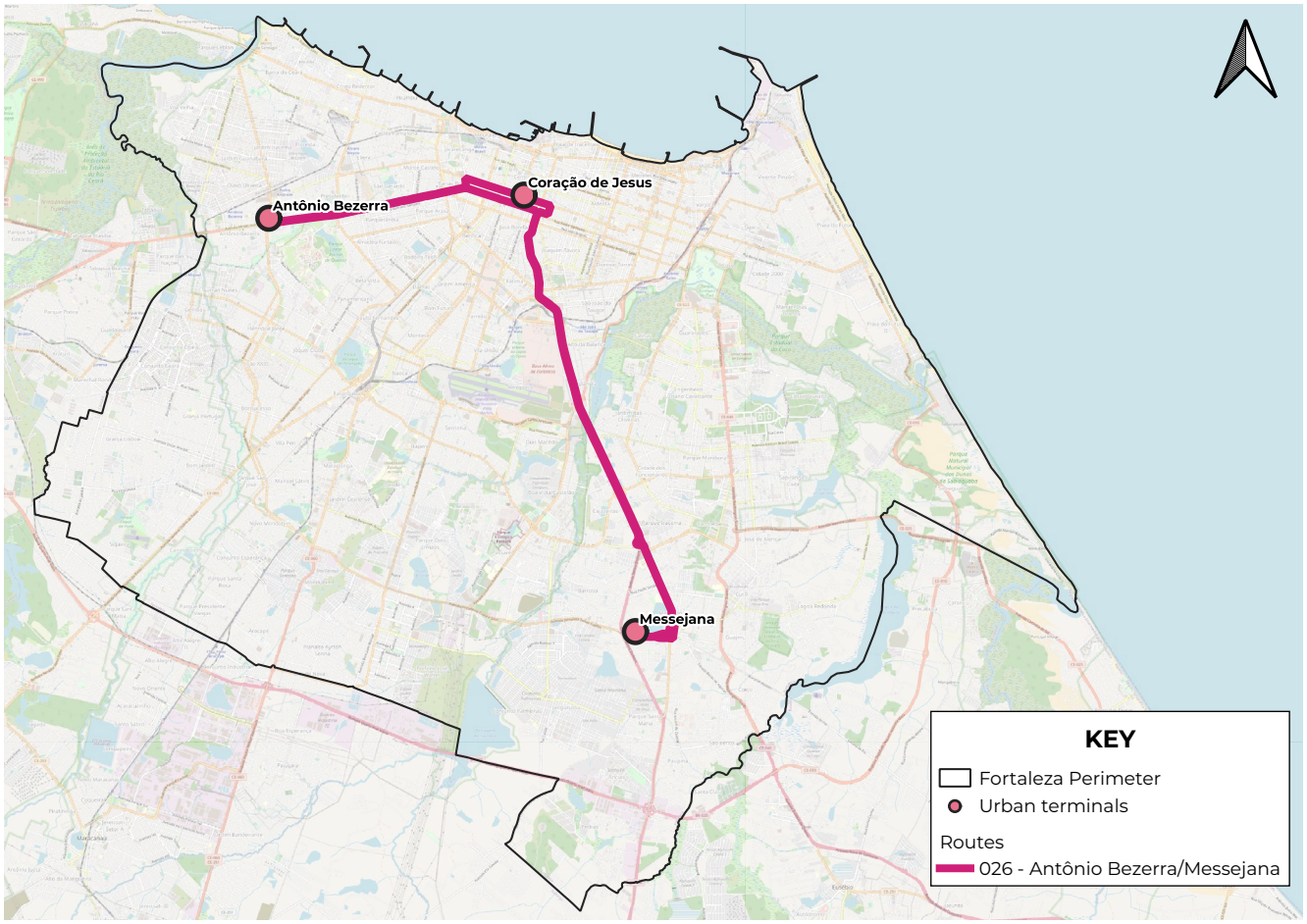
Line 222 – Antônio Bezerra/Papicu has 9 fleet buses and is co-operated by three different companies (Auto-Viação São José, Vega S/A, and Santa Cecilia). The route has an extension of 26.9km per complete travel (round

trip) and makes 64 travels per business day. Line 026 – Antônio Bezerra → Messejana has 16 fleet buses and is also co-operated by two companies (Auto-Viação Fortaleza and Vega S/A). This line has a larger extension, with 42km per complete travel and 85 travels per business day. The routes of the lines are shown in Figure 13 and Figure 14.

Figure 13 – Route of 222 line - Antônio Bezerra/Papicu

Source: Urban Transportation Company of Fortaleza (ETUFOR).

Figure 14 – Route of 026 line – Antônio Bezerra/Messejana



Source: Urban Transportation Company of Fortaleza (ETUFOR).

Concerning the charging infrastructure, the municipality had opted, in the conceptual model made in 2019, for the traditional plug-in and night charging in garages. **In the current pilot project, two scenarios are evaluated, also with traditional plug-in: i) slow charging in garages and ii) slow charging in garages and opportunity charging in The Antonio Bezerra Terminal.** Since this terminal is the common one for operating the two defined lines, its choice came naturally.

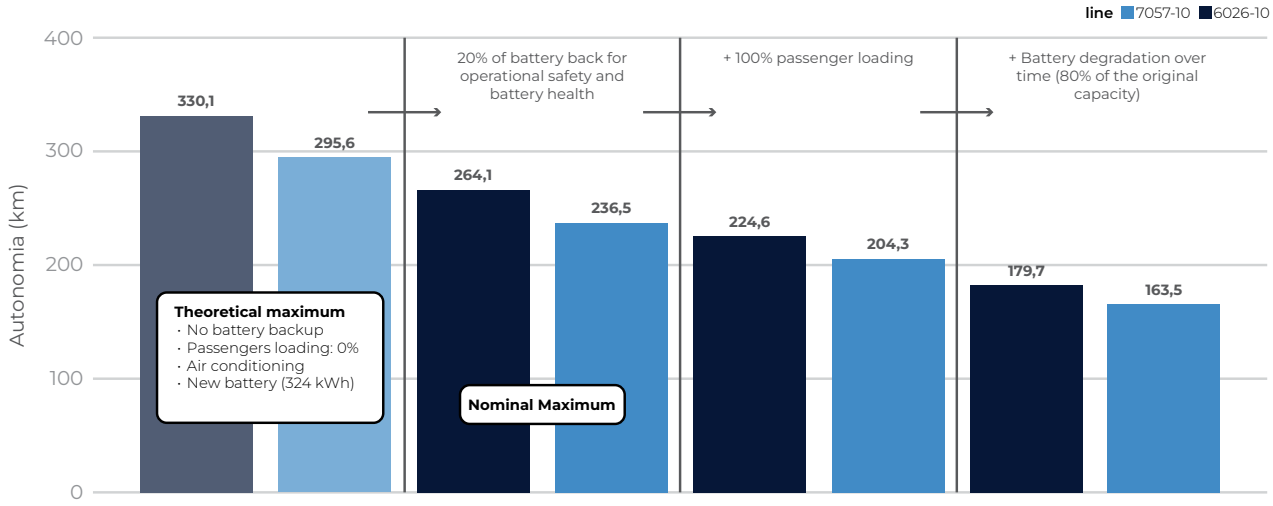
For the selection of vehicles, operational premises were established: passenger loading, technical battery reserve, autonomy, full charging time, charging rate, maneuver time in the terminals, and travel duration between the terminal and garages.

Several experiments with electric bus projects point to 250 kilometers of autonomy per load. Currently, some municipalities are defining the minimum autonomy in contracts, as in the following cases: Bogotá (260 kilometers), the pilot project of São Paulo (250 kilometers), and São José dos Campos (250 kilometers). However, these autonomies refer to the batteries maximum capacity. Therefore, for operating effectively, an

operational reserve of 20% of the total charge should be considered to preserve battery health and operational emergencies.

For the premise of autonomy, a study developed by the Zero Emission Bus Rapid-Deployment Accelerator (ZEBRA, 2022 [5]) project was considered. It discussed the operational and economic performance of the transition from a diesel bus fleet to a fleet of electric battery buses, considering the experience of São Paulo[1]. Results of simulation of energy consumption were obtained to analyze the impact of different parameters on the performance of electric bus autonomy. The simulation was performed for the 20 lines operated by a company, and the results of two lines were highlighted: the highest (705710) and the lowest energy consumption (602610). The results are shown in Figure 15.

Figure 15 – Impact of key variables on the estimated autonomy of electric buses operating lines 705710 and 602610



Source: ZEBRA (2022).

The results indicate that the autonomy of an electric bus for the reality of the routes of the 20 lines under study, considering the operation with 20% battery reserve for operational safety and battery health and with 100% passenger loading, is between approximately 205 and 225 kilometers per charge. Based on a more conservative analysis and rounding, Fortaleza's study **considers the autonomy of 200 kilometers**, with a battery reserve of 20% and a loading of 100% passengers.

It is noteworthy that the municipality of Fortaleza has coastal plain relief and is predominantly flat, with an average altitude of 16 meters from sea level. This configuration allows the electric bus to have lower energy consumption and, therefore, greater autonomy.

1 Análise da implantação de ônibus zero emissão na frota de um operador da cidade de São Paulo. ZEBRA, 2022. Available at: https://theicct.org/wp-content/uploads/2022/03/hdv-brasil-analise-da-implantac%CC%A7a%CC%83o-de-o%CC%82nibus-zero-emissa%CC%83o-sa%CC%83o-paulo-mar22.pdf.

However, the municipality's climate has high temperatures most of the year, with minimum temperatures above 20°C and an average of 27°C. For reasons of thermal comfort, this situation indicates the importance of operating the vehicle with air conditioning, which reduces the vehicle's autonomy, as previously presented.

The bus body shell of a 13.2-meter vehicle and high floor technical sheet[2] was considered for a total charging time. This type is the standard vehicle considered for the study. Thus, the **complete charging period is 5 hours**. As charging rate (% of the battery per minute and kilometers per minute), the premise of linear charging was used, considering the complete charging time of 5 hours and full charge autonomy of 250 kilometers. Therefore, the values obtained were 0.333% per minute and 0.833 km per minute.

For the opportunity charging time in the Antônio Bezerra Terminal, the premise of maneuver time of the vehicles of 10 minutes (5 minutes on arrival and 5 minutes on departure), and the minimum time for charging opportunity of 20 minutes (already disregarding maneuver times) were used. Thus, **to select a stop at the terminal as eligible for opportunity charging, a stop of at least 30 minutes (10 minutes of maneuver and 20 minutes for charging) is necessary**.

For garage charging, the period between leaving the Terminal towards the garage after the day's last travel and the following day's first travel was considered. **For the available time of the night charging calculation, a terminal-garage travel time of 30 minutes was considered.** The values of the parameters used are shown in Table 2.

Table 2 – Parameters' premises for the selection of vehicles eligible for the electrical project

Parameter	Value
Full charge autonomy	250 kilometers
Technical battery reserve	20%
Operational Autonomy (80%)	200 kilometers
Full charging time	5 hours
Charging rate	0,333% per minute / 0,833 kilometers per minute
Total maneuver time in terminal	10 minutes
Travel time between terminal and garage	30 minutes

Source: Own elaboration.

2 Vehicle with 13.2m body and high floor technical sheet. Available at: http://www.byd.ind.br/2020/wp-content/uploads/2020/12/BYD-D9A-20.410-v.-7.0-2020_print-min.pdf.

From the definition of these premises and the obtaining of the timetables of the vehicles that operate the lines, it is possible to identify which and how many vehicles meet the autonomy of each established scenario: i) recharge only in garages and ii) recharge in garages and opportunity recharge in the Antônio Bezerra terminal. The results of operational scenarios appear in topic 3.

1.3 CURRENT REGULATORY ENVIRONMENT

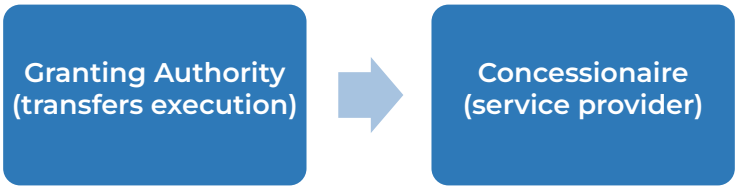
This item presents an evaluation of the contracts for the operation of public transport services currently in force in the municipality to provide an understanding of the existing legal framework, which can directly influence the implementation of pilot financing projects.

1.3.1 National perspective

The Federal Constitution, in Article 175, establishes that public service is provided directly or by delegation. The constitutional provision was established by Federal Law n° 8987/1995, which regulates the concession and permission regime, and Federal Law No. 11,079/2004, which regulates private-public partnerships.

In the concession contract, the Granting Authority shall be the federal entity constitutionally competent to provide specific service and may delegate its execution to the private. In turn, the Concessionaire will be the legal entity of private law, constituted of private individuals who will relate to the user through public service provision. This means the direct legal relationship is between the Grantor and the Concessionaire. The granting authority delegates the provision of the public service to the concessionaire, as demonstrated in the figure below

Figure 16 – Legal relationship between Granting Authority and Concessionaire



Source: Own elaboration.

Specifically, concerning public transport, Federal Law No. 12,587/2012 defined rules for urban mobility and instituted the remuneration rate as a form of payment for this service. Considering that the contracts concluded by the city were the result of bidding procedures before 2012 and concluded based on Federal Laws No. 14,133/2021 (bidding) and No. 8,987/1995 (concession), some notes on the contract defined in those laws are made, on a preliminary basis.Article 23 of the Concessions

and Permits Law establishes the essential clauses of the contract and, among them, stand out:

- The object, area, and term of the concession;
- The manner, form, and conditions of service provision;
- The criteria, indicators, formulas, and parameters defining the quality of the service;
- The price of the service and the criteria and procedures for the adjustment and revision of tariffs;
- The rights, guarantees, and obligations of the granting authority and the concessionaire, including those related to the foreseeable needs for future change, expansion, and modernization of the service, improvement, and expansion of equipment and facilities;
- User's rights and duties to obtain and use the service ;
- Inspection methods for installations, equipment, execution of the service methods and practices, as well as the indication of the competent agency to exercise it;
- The contractual and administrative penalties to which the concessionaire is subjected and the application method.

The administrative contracts have as characteristic the so-called exorbitant clauses that, due to the protection of the public interest, allow: unilateral change, by the Government, of the execution clauses, provided that the maintenance of the economic-financial rebalance of the Contract (art. 9§4), the unilateral termination of the contract before the end of the established period, the inspection and supervision of the execution of the contract and the direct application of contractual and administrative sanctions. These prerogatives aim to ensure that the public service is provided in line with the needs of the citizen. These prerogatives aim to ensure that the public service is provided in line with the needs of the citizen.

Contracts must provide tariff review mechanisms to ensure economic-financial rebalance (art. 9º, § 2º), and if the government unilaterally changes the execution of the contract, it must ensure the initial economic-financial rebalance simultaneously with such change (Art. 9º, § 4º).

With the termination of the contract, two simultaneous situations are triggered: a) the rights and privileges transferred to the concessionaire and the reversible assets, that is, assets described in the contract that automatically pass to the ownership of the grantor with the termination of the concession; b) there will be an immediate takeover of the service by the granting authority, proceeding to the necessary withdrawals, evaluations, and settlements (Art. 35, §1 and 2º).

1.3.2 Concession contracts

The Fortaleza Municipal Government has the competence to plan, organize, implement and execute directly under concession regime, permission, or other forms of contracting, as well as regulate, control, and supervise public transport, as established by the Municipal Organic Law - LOM, in its Article 8, item V c/c Article 219 and following.

The Municipality of Fortaleza, represented by the Municipal Secretariat of Urban Development and Infrastructure - SEINF, published the public bidding no. 03/2012, whose object was the concession for the operation and provision of the urban public passenger transport service in the municipality of Fortaleza - CE for the 5 (five) areas of operation. The legal grounds were the Bidding Law (Law 8666/93, repealed by law 14.133/2021, as well as the Law of concessions and administrative permissions (Law 8987/95, and the type of bid defined was the best technique and price (higher offer for the granting of the concession).

ETUFOR-Empresa de Transporte Urbano de Fortaleza S/A, a mixed economy company, the city's transport management body, linked to SEINF, is responsible for supervising the services.

On 31 May 2012, five concession contracts were concluded:

- Contract n.º 11/2012: Leste Consortium (Viação Urbana Ltda + Auto Viação Fortaleza LTDA.) [6]

- Contract No. 12/2012: Consortium Antônio Bezerra (Veja S/A + Transporte Urbanos S/A + Santa Cecilia Ltda + Santa Maria ltda) [7]

- Contract n.º 12/2012: Consortium Expresso 5 (Auto Viação Ltda + Viação Siará Grande LTDA + Frectar Ltda + Cearense Transporte Ltda + Terra Luz S.A) [8]

- Contract No. 14/2012: | Consortium Parangaba (Auto Viação Dragão Ltda + Maraponga Transporte Ltda + Auto Viação São José Ltda) [9]

- Contract No. 15/2012: Messejana Consortium (Auto Viação Fortaleza Ltda + Auto Viação Dragão Ltda + Rota expressa S/A + Veja S/A) [10]

The term of these contracts is 15 years, counted from signature, with the possibility of an extension for an equal period, through a reasoned act of the Chief Executive of the Municipal Executive. In this sense, the Contract establishes that, for renewal, some conditions are mandatory (item 02.02): a) the original conditions of qualification; b) the maintenance of performance standards; (c) the absence of a severe deficiency in the performance of the contract and; d) public interest.

The remuneration of the services depends on the tariff collection and legally instituted subsidies (clause 9) and two modalities of review, the ordinary and extraordinary (item 09.01.02).

The ordinary review takes place annually, in November, and is carried out by the transport management agency, using the calculation method specified in Annex 06 of the Public Notice, and must be approved by the Granting Authority (items 10.01 and 10.02). The extraordinary review is based on: (i) unilateral modification of the conditions by the granting authority; (ii) occurrence of fortuitous cases; (iii) causes of economic imbalance; (iv) specific legal changes that have a significant impact on service revenues or costs (item 11.01.01).

The contract allows the Concessionaire to subcontract third parties in the advisory activities related to the activities of advisory or complementary to the service, as well as the implementation of associated projects, not establishing any relationship with the Granting Authority (clause 14.01).

The corporate change will be possible, provided that it does not affect the performance of the Contract (clause 13.02), under Article 27 of Law No. 8,987/95, which established that the entry of new shareholders is possible provided that: (i) has the prior consent of the Granting Authority; (ii) meets the requirements of technical capacity, financial suitability and legal and fiscal regularity necessary for the assumption of the service; (iii) undertakes to comply with all the clauses of the contract in force.

The contract has clauses that determine the operational characteristics of itineraries, frequencies, and schedules, determined by ETUFOR. Besides, it defines the average fleet age, tariff conditions, and gratuities listed in the legislation.

The operation of the service is established in Clause 3, providing that the operational characteristics of the service (itinerary, frequency, schedule, and fleet of the lines) can be changed at the discretion of the granting authority whenever necessary to meet the needs of users, under service order, respecting the economic-financial rebalance of the contract (item 3.5).

Annex 1.4 of the Public Notice presents the basic specifications of the vehicles of the fleet, and the concessionaire must use only vehicles that meet the specifications contained in said annex, assuming adjustments that improve the conditions of comfort and safety of users, provided they are approved by the Grantor (item 03.08).In addition, the average fleet age must be under 4.5 years (item 03.09).

Among the obligations of the Granting Authority, there is the duty to stimulate the increase of the quality and productivity of the service and environment preservation. (item 06.01.16).

The adoption of electric buses is a “new service“ since it was not foreseen in the initial scope. Therefore, implementing the new service is possible if there is a determination of the Municipal Government or an agreement between the parties. It also depends on the maintenance of the economic-financial rebalance of the contract.

The contract also establishes a rule for the change and expansion of services (clause 12). If the Granting Authority determines the implementation of new services in the operation area, using different vehicles from the fleet initially planned during the term of the concession, the operation of the concession goes under the responsibility of the Concessionaire, with no option to refuse to operate the new service, provided that the necessary period for the mobilization and maintenance of the financial-economic rebalance of the contract is ensured (clause 12.02).

It is clear, therefore, that the new services may lead to an extraordinary revision that, according to the contract, takes place "whenever exceptional conditions, duly proven, affect the economic-financial rebalance" (clause 11.01).

There is no reversal in the goods affected by the concession (clause 18). The possibility of intervention is disciplined in Clause 19 and the possibility of extinction in Clause 17, with a specific item for expiry (item 17.03.01)

To date, there are four contractual addenda, namely:

- 1st Addendum to implement and operate the special public transport service by an application in the respective area of operation. Using vehicles with a passenger transport capacity below the indicated in the planned fleet. The remuneration results from collecting the amounts charged to users of this service and can be complemented through the exploitation of activities generating alternative revenues. It is authorized to set the amount charged to each passenger based on its criteria, with no rebalance of the economic-financial rebalancing.

- 2nd Amendment for the Concessionaire to assume the responsibility for the implementation and operation of the public transport system expansion in the respective area of operation. It must offer 40 (forty) additional vehicles in the operating fleet for 60 (sixty) days, to be allocated during the peak hours of use of the system;

- 3rd Amendment for the Concessionaire to assume the responsibility of implementing and operating the expansion of the public transport system in the respective area of operation. It must offer 40 (forty) additional vehicles in the operating fleet for 30 (thirty) days, to be allocated during the peak hours of use of the system;

- 4th Amendment to grant subsidy to the Concessionaire, ensuring the generality of public transport and preserving the economic-financial rebalance in concession contracts, limited to R$ 6,400,000.00 (six million, four hundred thousand reais), referred to the May to December 2021 period. The payments are at the discretion of the Executive Authority and with measurement in a study of economic-financial rebalance.

Finally, it is worth saying that, due to the pandemic, a drastic reduction in revenues made it difficult to comply with contractual commitments. As a result, on July 8, 2021, Fortaleza faced a significant strike, claiming wage increases due to two years without adjustment, a change in health insurance, and mandatory vaccination for workers removed from the priority list to receive immunization against COVID-19.

Given the scenario, the employer's union reported the impossibility of granting the agreement between employers and workers with a real salary increase due to a reduction in the movement of people. The reason for this situation is the social distancing and the reduction of revenue, given the sanitary measures to contain the progress of the pandemic in cities caused.

Table 3 below provides a summary table of the evaluated documents.

Table 3 – Summary table of contracts and addenda - Fortaleza

CONTRACT					
Contract	N° 11/2012 - SEINF	N° 12/2012 - SEINF	N° 13/2012 - SEINF	N° 14/2012 - SEINF	N° 15/2012 - SEINF
Date of signature	05/31/2012	05/31/2012	05/31/2012	05/31/2012	05/31/2012
Operation Area	1	2	3	4	5
Private Partner	Leste Consortium	Antônio Bezerra Consortium	Expresso 5 Consortium	Parangaba Consortium	Messejana Consortium
Modality	Concession	Concession	Concession	Concession	Concession
Grant Amount (in Millions of R$)	4,09	4,12	4,10	4,13	4,15
Term of validity	15 years	15 years	15 years	15 years	15 years
Contractual extension forecast	15 years	15 years	15 years	15 years	15 years
Remuneration policy	Tariff collection + subsidy	Tariff collection + subsidy	Tariff collection + subsidy	Tariff collection + subsidy	Tariff collection + subsidy
Tariff review	Annual (November)	Annual (November)	Annual (November)	Annual (November)	Annual (November)
Transfer grant/ corporate control	Admitted	Admitted	Admitted	Admitted	Admitted
With Addendum	Yes (5)	Yes (5)	Yes (5)	Yes (5)	Yes (5)
Average fleet age (maximum)	4,5 years	4,5 years	4,5 years	4,5 years	4,5 years
New technologies foreseen	Yes (item 05.01.30, fls. 45 Public Notice)				
Considers environmental compensation	No				
Provides for training actions	Yes (Item 01.04.06, fls. 5 Public Notice)				
Provides for social inclusion and gender actions	No				

CONTRACTUAL ADDENDUM 1					
Contractual Addendum date	09/30/2019	09/30/2019	09/30/2019	09/30/2019	09/30/2019
Contractual Addendum Object	In the respective area of operation, deploy and operate the special public transport service by application. Use of vehicles with a passenger transport capacity below the capacity of the vehicles indicated in the fleet provided in the Basic Project Annex. The remuneration results from tariff collection charged from users of this service and can be complemented by exploiting activities generating alternative revenues. Authorization to set own criteria for the amount charged to each passenger.				
CONTRACTUAL ADDENDUM 2					
Contractual Addenda date	02/11/2021	02/11/2021	02/11/2021	02/11/2021	02/11/2021
Contractual Addenda Object	In the respective area of operation, the CONCESSIONAIRE assumes the responsibility of implementing and operating the expansion of the public transport system. It offers 40 (forty) additional vehicles in the operating fleet for 60 (sixty) days, to be allocated during the peak hours of use of the system, defined by INTERVENER. The implementation of the expansion must comply with the technical criteria defined by the INTERVENER, responsible for its inspection.				
Econ-Financ. Rebalance	FINANCIAL-ECONOMIC REBALANCE: To maintain the financial balance of the Contract in front of the expenses incurred for the execution of the temporary expansion of the public transport system in its area of operation, two monthly installments of R$ 974,184.16 will be passed on to the CONCESSIONAIRE, totaling R$ 1,948.68.32.				
CONTRACTUAL ADDENDUM 3					
Contractual Addendum date	05/28/2021	05/28/2021	05/28/2021	05/28/2021	05/28/2021
Contractual Addendum Object	In the respective area of operation, the CONCESSIONAIRE assumes the responsibility of implementing and operating the expansion of the public transport system. It offers 40 (forty) additional vehicles in the operating fleet for 30 (thirty) days, to be allocated during the peak hours of use of the system, defined by INTERVENER. The implementation of the expansion must comply with the technical criteria defined by the INTERVENER, responsible for its inspection.				
Econ-Financ. Rebalance	ECONOMIC-FINANCIAL REBALANCE: To maintain the financial balance of the contract in front of the expenses incurred for the execution of the temporary expansion of the public transport system in its area of operation, R$ 974,184.16 will go to the CONCESSIONAIRE				
CONTRACTUAL ADDENDUM 4					
Contractual Addendum date	06/21/2021	06/21/2021	06/21/2021	06/21/2021	06/21/2021
Contractual Addendum Object	To ensure the generality of public transport and the preservation of the economic-financial rebalance in concession contracts, a subsidy is granted to the CONCESSIONAIRE, limited to R$ 6,400,000.00 (six million, four hundred thousand reais), referred to the May to December 2021 period.				
Econ-Financ. Rebalance	SUBSIDY: As a subsidy, 8 (eight) installments are passed on to the CONCESSIONAIRE, with an amount of R$ 800,000.00, for May to December 2021, totaling the limit amount of R$ 6,400,000.00. The payments are at the discretion of the Executive Authority and with measurement in a study of economic-financial rebalance prepared by the INTERVENER.				

Source: Own elaboration.

1.4 GUIDELINES FOR THE PILOT PROJECT

Section 3.2 of this Report presents a detailed analysis of the premises and methodology used for the financial modeling of the Electromobility Transition Pilot Project. Such assumptions stem from a combination of market constraints on which the agent responsible for the operation of electric vehicles will not interfere, such as the diesel price, with a set of variables on which the operator will be able to intercede. For example, the way electricity is contracted, the bases for acquiring vehicles and others, and its financing model.

In this context, the following section presents a brief evaluation of the electricity tariff structure, while section 1.4.2 – Mechanisms for the disposal of buses and batteries deals with the disposal mechanisms of buses and batteries.

1.1.5 Electricity tariff structure

The large-scale operation of electric vehicles, covering a significant percentage of the fleet in operation in the municipality, will have as a by-product a significant demand for energy for the movement of this fleet. This volume of energy demand enables the entity responsible for the operation of electric vehicles to qualify as a “free consumer” or “special consumer.”

Under the regulating terms of the National Electric Energy Agency, a Free Consumer has contracted a demand with a distributor exceeding 1000 KW. This consumer can purchase any type of energy: conventional or incentivized, special or not. As of January 2023, consumers with a load equal to or greater than 500kW and any voltage level may be qualified as free consumers.A special consumer is a unit, or a set of consumer units established in contiguous areas or registered under the same CNPJ, whose demand contracted with the distributor is equal to or greater than 500 KW and less than 1500 KW. This type of consumer can contract the following energies:special incentivized energy (there is a transfer of discount on TUSD) and

- special conventional energy (there is no transfer of discount on TUSD).

This volume of contracted energy demand is much higher than the expected consumption with vehicles linked to the Pilot Project, covering the load of 15 Padron-type vehicles. The pilot project considers the energy cost for “Captive Consumers,” those who purchase energy from the Regulated Commercialization Environment.

In the case of Fortaleza, the responsible distributor is ENEL - CE, whose values are reproduced below.

Figure 17 – Energy distribution values

DIRETORIA DE MERCADO _ ENEL CEARÁ
Gestão de Créditos e Operações Comerciais
Faturamento CE

BANDEIRA TARIFARIA ESCASSES HIDRICA
0,142
BANDEIRA TARIFARIA VERMELHA PATAMAR1
0,09492
BANDEIRA TARIFARIA AMARELA
0,01874
0,006559 65%
0,011244 40%
0,016866 10%

TARIFA DE FORNECIMENTO - BAIXA TENSÃO
Tarifas Grupo B homologadas pela ANEEL

RESIDENCIAL BAIXA RENDA - B1	VERDE			AMARELA			VERMELHA PAT1			VERMELHA PAT2		
	kWh			kWh			kWh			kWh		
	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE
0 A 30 kWh	0,10243	0,09002	**0,19245**	0,10243	0,09058	**0,19901**	0,10243	0,18494	**0,28737**	0,10243	0,23202	**0,33445**
31 a 100 kWh	0,17559	0,15432	**0,32991**	0,17559	0,16556	**0,34115**	0,17559	0,24924	**0,42483**	0,17559	0,29632	**0,47191**
101 a 220 kWh	0,26339	0,23148	**0,49487**	0,26339	0,24835	**0,51173**	0,26339	0,32540	**0,58879**	0,26339	0,37348	**0,63687**
ACIMA 220 kWh	0,29265	0,25720	**0,54985**	0,29265	0,27594	**0,56859**	0,29265	0,35212	**0,64477**	0,29265	0,39020	**0,68285**
B1 - RESIDENCIAL NORMAL	kWh			kWh			kWh			kWh		
	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE
	0,33158	0,25720	**0,58878**	0,33158	0,27594	**0,60752**	0,33158	0,35212	**0,68370**	0,33158	0,39020	**0,73078**

SUB-GRUPOS - B2 E B3 _OUTROS	kWh			kWh			kWh			kWh		
	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE
B2 - R U R A L	0,29179	0,22633	**0,51812**	0,29179	0,24507	**0,53686**	0,29179	0,32125	**0,61304**	0,29179	0,36833	**0,66012**
B2 - RURAL IRRIGANTE 8,5 horas	0,07878	0,06111	**0,13989**	0,07878	0,06617	**0,14495**	0,07878	0,08674	**0,16552**	0,07878	0,09311	**0,17823**
B2 - SERV PUBLICOS IRRIGACAO	0,27853	0,21604	**0,49457**	0,27853	0,23478	**0,51331**	0,27853	0,31096	**0,37345**	0,27853	0,35804	**0,37345**
B3 - AGUA, ESG, E SANEAMENTO	0,31169	0,24177	**0,55346**	0,31169	0,25938	**0,57107**	0,31169	0,33099	**0,64268**	0,31169	0,38377	**0,68693**
B3 - DEMAIS CLASSES (Com, Ind e Poder Público)	0,33158	0,25720	**0,58878**	0,33158	0,27594	**0,60752**	0,33158	0,35212	**0,68370**	0,33158	0,39920	**0,73078**
B4a - ILUMINACAO PUBLICA	0,18237	0,14146	**0,32383**	0,18237	0,16020	**0,34257**	0,18237	0,23838	**0,41675**	0,18237	0,28346	**0,46583**
B4b - ILUMINACAO PUBLICA	0,19895	0,15432	**0,35327**	0,19895	0,17306	**0,37201**	0,19895	0,24924	**0,44819**	0,19895	0,29632	**0,49527**

TARIFA DE FORNECIMENTO - TARIFA BRANCA
Tarifas Grupo B homologadas pela ANEEL

B1 - RESIDENCIAL TARIFA BRANCA	VERDE									AMARELA									VERMELHA PAT1									BANDEIRA ESCASSES HIDRICA		
	kWh PT			kWh INT			kWh FP			kWh PT			kWh INT			kWh FP			kWh PT			kWh INT			kWh FP			kWh PT		
	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE
TUSD + TE	0,87213	0,29599	1,26812	0,55763	0,24458	0,80221	0,24313	0,24458	0,48771	0,87213	0,41473	1,28686	0,55763	0,26332	0,82095	0,24313	0,26332	0,50645	0,87213	0,49091	1,363	0,55763	0,3395	0,89713	0,24313	0,33950	0,58263	0,87213	0,53799	1,41012

SUB-GRUPOS - B2 E B3 _OUTROS TARIFA BRANCA	kWh PT			kWh INT			kWh FP			kWh PT			kWh INT			kWh FP			kWh PT			kWh INT			kWh FP			kWh PT		
	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE	TUSD	TE	TUSD+TE
B2 - R U R A L	0,74585	0,34847	1,09432	0,47774	0,21523	0,69297	0,20963	0,21523	0,42486	0,74585	0,36721	1,11306	0,47774	0,23397	0,71171	0,20963	0,23397	0,44360	0,74585	0,44339	1,1892	0,47774	0,31015	0,78789	0,20963	0,31015	0,51978	0,74585	0,49047	1,23632
B2 - RURAL IRRIGANTE 8,5 horas							0,05660	0,05811	0,11471							0,05660	0,06317	0,11977							0,05660	0,08374	0,14034			
B2 - SERV PUBLICOS IRRIGACAO	0,71195	0,33263	1,04458	0,45602	0,20545	0,66147	0,20010	0,20545	0,40555	0,71195	0,35137	1,06332	0,45602	0,22419	0,68021	0,20010	0,22419	0,42429	0,71195	0,42755	1,1395	0,45602	0,30037	0,75639	0,20010	0,30037	0,50047	0,71195	0,47463	1,18658
B3 - AGUA, ESG, E SANEAMENTO	0,83135	0,37223	1,20358	0,53110	0,22991	0,76101	0,23085	0,22991	0,46076	0,83135	0,38985	1,22119	0,53110	0,24752	0,77862	0,23085	0,24752	0,47838	0,83135	0,46146	1,29280	0,53110	0,31913	0,85023	0,23085	0,31913	0,54998	0,83135	0,50571	1,33706
B3 - DEMAIS CLASSES (Com, Ind e Poder Público)	0,88441	0,29599	1,2804	0,56500	0,24458	0,80958	0,24559	0,24458	0,49017	0,88441	0,41473	1,29914	0,56500	0,26332	0,82832	0,24559	0,26332	0,50891	0,88441	0,49091	1,3753	0,56500	0,3395	0,9045	0,24559	0,33950	0,58509	0,88441	0,53799	1,4224

Tarifas fixadas pela resolução ANEEL Nº 2.859, de 22/04 /2021, com aplicação a partir de 22/04/2021.

Source: ENEL CEARÁ.

The distribution of energy parameters used by ENEL - CE led to the adoption of the following parameters for calculating the costs of supplying this input under the Pilot Project

- 30% of energy in Green Flag, 30 % in yellow flag, and 40 % in red flag.
- Taxes on energy purchases:
    - PIS / Pasep: 0,77%
    - Cofins: 3,56%
    - ICMS (MG): 27,00%
- Expenditure on demand with expenditure on energy consumption: 7,0%

Based on these parameters, the company responsible for operating the vehicles must decide on the charging model, as explained in the following chapters. If charging is restricted to night, 100% of the demand will be contracted in the off-peak period. In the opportunity charging model, it is considered that about 10% of the total charge will be carried out during peak tariffs, 10% in the intermediate period, and the most significant part, 80%, would remain carried out off-peak.

Considering all these elements, the value for energy with the opportunity charging is R$ 0.987747 per kw/h. On the other hand, if the operation is restricted to night charging, acquiring the full energy at the off-peak tariff, the tariff value will be R$ 0.817746 per kw/h.

1.4.1 Bus and battery disposal mechanisms

Electric bus technology is relatively new, and there are few real examples of electric fleets reaching the end of their useful life. However, unlike conventional buses, electric buses have fewer moving parts in the engine, so they are expected to demand less maintenance while offering a longer useful life (Mahmoud et al., 2016 [11]). Thus, battery degradation is likely to be the first factor to be considered for replacement. For this reason, it is suggested to align battery disposal plans with the expiration of the battery warranties, according to the “How to Enable Electric Bus Adoption in Cities Worldwide” manual prepared by WRI in 2019 [12].

Still, in the technical and operational planning of the project to implement electric buses in the fleet of the public transport system of a municipality, it is necessary to address issues regarding the destination of vehicles and batteries after the end of their useful lives. The establishment of disposal mechanisms during the initial stage of the project

tends to reduce uncertainties and favor the project's economic viability, according to the Electromobility Guide (MDR [13]). The "How to Enable Electric Bus Adoption in Cities Worldwide" manual presents four options, as the battery warranty expires and/or the battery becomes too degraded for bus operation:

- **Replace the battery and continue to operate the bus with the same operator for additional years.** This scenario is more likely since the bus usually has a longer useful life than the battery.

- **Replace the battery and sell the bus to third parties.** The bus operator might not want to bear the cost of a new battery unless the total cost of resale compensates for installing a new battery.

- **Sell or dispose of the bus and keep the battery through recycling or second-life use.** This scenario is most likely to happen when the market for used batteries destined for recycling or other uses is mature, and the bus chassis is old.

- **Sell or dispose of both the bus and battery.** This scenario is most likely to happen when the residual values of batteries and buses are unclear or too low, and the battery replacement cost is higher than the value received if everything was sold.

It is known that it is difficult to predict the cost and availability of vehicle batteries. However, costs are decreasing rapidly and are expected to continue to decrease over the next decade (BNEF, 2018 [14]). Although estimates of future costs vary due to uncertainties, most forecasts illustrate the same overall trend, as estimated by Bloomberg New Energy Finance: the cost of batteries should continue to halve, reaching $70/kWh by 2030, according to the WRI manual, 2019. In addition, many studies focus on recycling and the second-life use of batteries.

"Second life" refers to the transition from using batteries in vehicles to application in stationary energy storage and peak demand management. The degradation of batteries in vehicles results in a reduction in operating autonomy, which makes their use inappropriate over time. Thus, batteries can still support grid and facilities services (Stringer and Ma, 2018 [15]).

It is indicated that the decision on the final disposal of batteries and vehicles at the end of their useful life depends on criteria, such as projections of battery costs, the market value of batteries after the end of their useful life, and projections of the costs of electric buses. For example, if the cost of battery replacement drops and the residual value of electric buses and used batteries increases to a certain point, replacing bus batteries may be a more appropriate option than acquiring new buses.

On the contrary, if the capacity of electric buses in the future increases significantly compared to costs, purchasing new buses and disposal of old ones may be a better solution for operators.

It is estimated that these factors are difficult to predict, so the agency should adopt a set of criteria for selecting any of these options. These conditions should be assessed regularly to assist in timely decision-making. Considering the current advances in battery technology improvement and cost reduction, the pilot project trend should be battery replacement and continuation of the operation of electric vehicles.

After the end of their useful life, batteries still retain about 80% of their storage capacity, as previously presented, so they can be reused for peak energy displacement (in which energy consumption tends to be more expensive) and energy storage. The displacement of the peak energy consists of charging the batteries during the idle moment of the power grid, and during peak hours, the batteries can be used to reinforce the supply of electric vehicles. The benefits of this practice include cost reduction, emission reduction, and integration with renewable energy sources (Walker et al., 2015 [16]).

The cost of reusing a battery pack into storage energy elements is more cost-effective than purchasing new batteries (MDR, 2022). However, it is worth noting that it is necessary to evaluate the economic impacts of this reuse, given the trend of reduction of batteries, to guarantee the project's economic viability.

Energy storage consists of supporting the implementation of smart grids, i.e., electrical energy distribution and transmission systems through digital resources, operating more efficiently through greater control of energy flow. For the implementation of this smart grid, it is necessary to have an energy storage system that can be done through second-life batteries. Although there are uncertainties and the model is still under development, there are initiatives to use second-hand batteries as energy storage in China and the United States.

An alternative or a subsequent way to use second-life batteries deals with recycling critical materials to produce batteries. The development of this practice would result in a lower demand for raw materials (which represent about 60% of the battery cost), a drop in emissions, and a decrease in impacts resulting from mining and refinement (IEA, 2020 [17]). However, Brazil's batteries' disposal and recycling policies and regulations were developed before the electric vehicle market, not contemplating lithium-ion batteries.

Thus, it is imperative to develop a construction and regulation that directs the proper handling of batteries in electric buses to reduce

uncertainties and foster the recycling industry. Meanwhile, using second-life batteries as storage and peak energy displacement should gain relevance (MDR, 2022).

Currently, transport operators in large cities, which usually have higher requirements in terms of fleet age, tend to resell buses, still in good condition, to companies in smaller cities or for other private purposes, such as company employees' transport. Therefore, there is a chain of reuse of conventional buses over their useful life, which makes this market more consolidated and reliable for asset owners.

That said, it is essential to continuously promote the adoption of technology throughout the country, based on the good experiences obtained by the cities that have already implemented the electrification of the fleet, to consolidate the electric bus market, allowing better use of the vehicle throughout its useful life.

2.

BUSINESS MODEL ALTERNATIVES

This chapter presents the possible business models evaluated with the Agents responsible for planning and managing public transport for implementing the Electromobility Transition Pilot Project in public transport by bus. A Transition Pilot Project should not be understood as an end but rather as part of a broader process that seeks to develop the foundations to support the transition on a broader scale.

Throughout the debates, the municipality has as its goal the electrification of 40% to 50% of its fleet in the long term. With such an ambitious goal, it becomes crucial to understand what the first steps should be and how these steps will determine the subsequent dynamics of a broader transition. Therefore, this chapter seeks to contextualize the issues and central elements to enable, as soon as possible, the large-scale implementation of electric buses in Brazilian cities.

Initially, the chapter introduces the theoretical bases for constructing a business model, including financial instruments and instruments of legal nature, with different alternatives for allocating responsibilities, risks, and rights to public and private parties developing this transition project. It also presents the barriers and opportunities found in the technical discussions and identified during the training, considering each business model for electric buses.

According to constitutional principles (Article 37), the responsibility for urban public transport is the municipal authority, which may adopt as a form of execution of the service the direct operation or delegation to the private party, according to Article 175 of the Federal Constitution. Federal Laws 8,666/93 – Bidding and Contracts Signed with the Public Administration, repealed by Law 14.133/2021, and 8987/95 – common concession, regulated this constitutional provision subsequently expanded by Federal Law 11.079/04, which deals with contracting models and execution of public services under the aegis of public-private partnerships.

The common concession discussed below is the most usual form of public transport delegation, anchored in Federal Law 8987/1995. In this model, the Government is responsible for planning the operation and delegates its execution to the private sector. The allocation of financial risks is shared, and a significant part of the management and operation risks of the system goes to the operators.

It is essential to highlight that the contractual form developed is a direct result of the business model understood as the one creating the best conditions for developing services in a balanced way. The business model seeks to create positive incentives for improving services in favor of the user, in favor of the system's economic-financial balance, and, in a broader way, for the society, to encourage the reduction of the emission of polluting gases from the vehicle operation. When implementing an electric bus fleet, among several challenges intrinsic to the activity, the need for alignment between all stakeholders (governments, operators, funders, manufacturers, and technology suppliers) stands out for an efficient transition.

Public transport concession contracts generally establish, as a municipality attribution, the supervision and management of services, and, as a role of private initiative, the programming and operation. Depending on the principles in the regulatory standards, contracts may include very restrictive clauses that discourage investment in more daring or high-risk innovation projects.

In cases of greater rigidity, the low flexibility and lack of synergy between the parties reduce the opportunities for increased risk sharing and innovations that optimize and modernize the service, constituting one of the main obstacles to introducing electric buses as technological innovation. Therefore, the risks of this investment are still high, despite the undeniable benefits and externalities (which should be seen as intangible assets of the business model).

The following tables present the most popular modalities of contracting public services for projects. These forms can adapt to the business modeling of electric buses. Table 4 shows the modalities for planned projects "from scratch" (greenfield systems), while Table 5 presents the possibilities for projects already implemented and that can undergo modifications over time (brownfield systems).

Table 4 – Modalities for contracting unimplemented public services (greenfield systems)

Modality	Characteristics	National and international examples	Regulatory standards
Availability contract	Private investor builds the system and transfers the transaction to the granting power. Public agents may delegate the operation to specialized agents or take over the process through a public company. Part of the revenue from the service administration remunerates the private investor. The remuneration is for the asset rental to the public authority during the contract period or for payments linked to the transfer of ownership if this occurs immediately after completing the works.	In Brazil, the main availability contracts are present in the sanitation sector. The São Paulo State Basic Sanitation Company (Sabesp), responsible for water supply and sewage treatment in the state, has made numerous bids for the construction and maintenance of water and sewage treatment plants. In the transport sector, the most common experiences are international; for example, in England, with airports and basic infrastructure for public transport systems.	The supply contract's technical framework considers the requirements for providing services. The technical framework may be objective, precisely defining what should be done; when the contracted party proposes the best technical solution for the infrastructure to be implemented.
Common or sponsored grant with asset reversal	Classic concession model in the area of rail transport. The concessionaire receives a basic project and is in charge of the system's implementation, operation, and maintenance for a defined period. The ownership of the operating assets is the granting power, but the concessionaire retains possession of them and can depreciate the investments made according to the temporal distribution of demand. At the end of the concession period, the concessionaire reverts the assets to the granting power without charge.	National Examples: - Line 4 of the São Paulo Subway; - Line 6 of the São Paulo Subway; - Lines 5 and 17 of the São Paulo Subway; - Lines 1 and 2 of the Salvador Subway.	The standardization of projects emphasizes the quality of the service offered to the user and the quality of the assets to be implemented. As assets return to the government at the end of the contract, there is stricter compliance with the quality standards in the deployment and maintenance conditions.
Common concession or traditional transport permit	Standard in motorized municipal urban transport projects throughout Brazil. The concessionaire makes the investments, operates the services following the contractual standard, and maintains ownership of the assets indefinitely, including at the end of the contract. No reversal of assets in favor of the granting power at the contractual termination, so no concession applies.	Municipal public transportation systems in São Paulo, Rio de Janeiro, Brasília, Campinas, and several other Brazilian municipalities. This model is used in metropolitan regions of São Paulo, Recife, Fortaleza and other parts of the country.	Different normative models. The most common provides for a higher level of planning and programming by the granting power, directly affecting the responsibility matrix of the parties. Generally, standardization focuses on service quality, observing indicators such as maximum occupancy and interval between departures at or outside peak hours, among others. The standardization concerning the quality of investments is reflected in the type of vehicle that will be used, at the maximum age, and in related themes

Source: Own elaboration.

Table 5 – Modalities of contracting public services already implemented (brownfield)

Modality	Characteristics	National and international examples	Regulatory standards
Concession of operation of public assets	Concession model usually applied to newly built projects, in which the granting power develops the infrastructure and hires the operation. It differs from outsourcing due to the risk of demand assumed by the private stakeholder, in addition to other risks of an operational nature.	Common in road concessions implemented by the government, transferring the operation to the private sector. In the transport sector, it is common to delegate urban terminals to the private sector, but still experimental in projects involving the movement of passengers.	Technical milestone for the operation. New investments during the concession are negotiable but are generally the responsibility of the granting power.
Concession for the renewal and operation of public assets	A model widely used to improve existing systems in which the public assets used in the provision of services are in a state of degradation. The concessionaire assumes the operation and is responsible for continuous improvements throughout the operating period.	- Supervias in Rio de Janeiro - CPTM Lines 8 and 9 in São Paulo	Strict regulation of the standard of services, but any technical framework is established according to the possibilities of improvements and investments verified throughout the concession. New investments during the concession are negotiable and usually involve the grantor. It requires a robust regulatory agency.

Source: Own elaboration.

As can be seen, there is a strong correlation between the business model intended to be developed for implementing electromobility and the contractual structure that will govern the relationship between the municipality and private agents. Different legal arrangements can be used in single contracting and segregated contracting.

The choice of the type of public procurement may depend on the business models designed and best suited for each case. However, it is essential to highlight that, for the structuring of common concession contracts and public-private partnerships, the adequate allocation of risks, performance indicators, the payment system (rates or government contribution), penalties, the risk matrix, and the economic-financial balance system are central points of the contract. They define the set of incentives for the action of each party in the contractual relationship. Table 6 presents the possible concession types for electromobility projects.

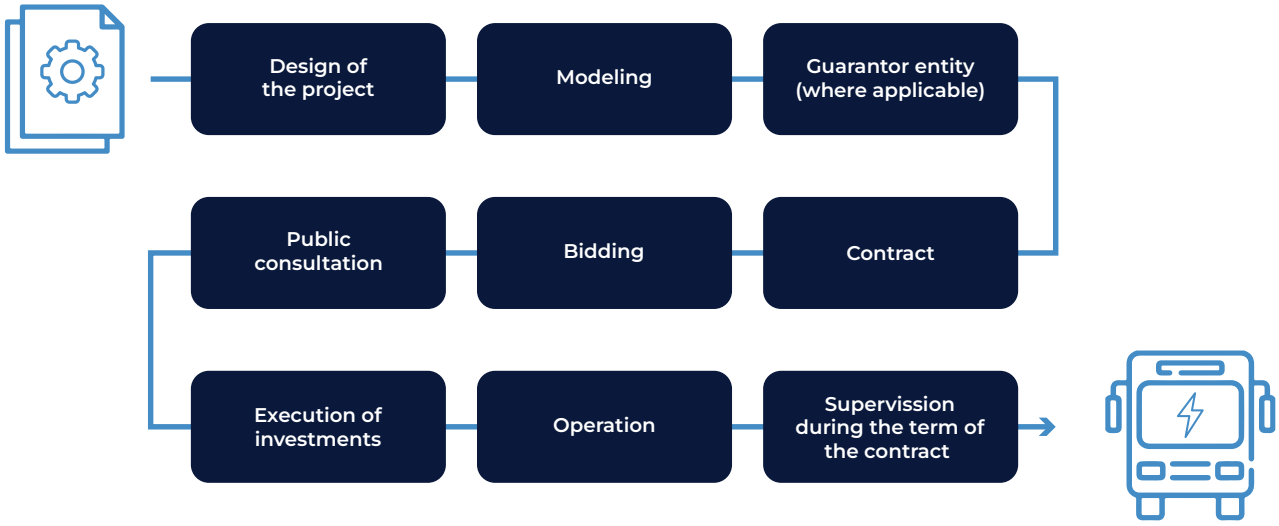
Table 6 – Possible concession types for electromobility projects

Type of concession	Common	Sponsored	Administrative
Concept	It is the delegation of public services, public works, and public service permits, whose remuneration comes from the tariff collected.	It is the delegation of public services or public works from the Federal Law n.º 8,987/95 in cases where it involves, in addition to the tariff charged to users, monetary compensation from the public partner to the private partner.	Service contract in which the public administration is a direct or indirect user, even if it involves the execution of work or the supply of goods.
Remuneration	By tariff collected.	Payment by the public administration + tariff paid by the user	Contribution from the public administration.
End-user relationship	The private partner is directly related to the end user and charges the rate.	The private partner is directly related to the end user and charges the rate.	The private partner has no direct relationship with the end user, which is the public administration.
Goals	Defined in the contract.		
Regulation and supervision	Defined in the contract and may include mechanisms of performance indicators.		

Source: Own elaboration.

The steps for contracting one of the modalities and delegating services follow the synthetic path illustrated in Figure 18.

Figure 18 – Public service delegation process



Source: Own elaboration.

The city may consider the alternatives described in the following items to formulate and evaluate the most appropriate business modality for public transport projects (involving all or partial electric bus components).

2.1 PUBLIC OPERATION

The first alternative is the constitution of a public company dedicated to implementing and operating an electric fleet system. The public company would also articulate the organizations responsible for the operation and implementation of associated infrastructures.

This alternative has already been adopted in São Paulo, but not for electric buses. Just by example, Companhia do Metropolitano de São Paulo and CPTM were founded to implement, operate and maintain the São Paulo metro railway system. The bus system of São Paulo was, in the past, operated by a public company, the Companhia Municipal de Transportes Coletivos (CMTC). In Rio de Janeiro, Flumitrens was created to explore the rail transport system, while Metrô Rio explored lines 1 and 2 of the subway system.

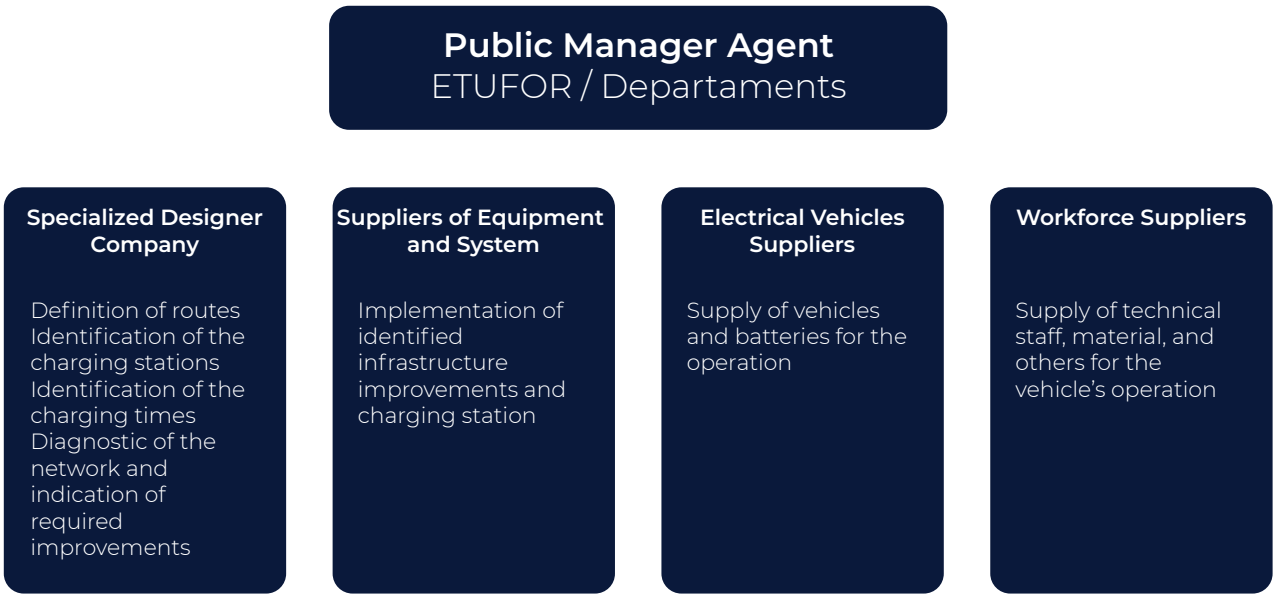
Subsequently, a relevant part of these systems was delegated to the private sector. In São Paulo, lines 4, 5, 6, 17, and 18 of the São Paulo Metro were the object of delegation, in addition to lines 8 and 9 of the CPTM. In Rio de Janeiro, Flumitrens' operation was delegated to the current Supervia, as well as Metrô Rio, which is also managed by a private concessionaire. São Paulo's tire transport system was delegated to the private sector in the early 1990s.

Regarding the adoption of electric buses, the only relevant example is the experimental operation of internal passenger circulation at the Campus of the State University of Campinas, UNICAMP. On this Campus, the University City Hall, through several agreements signed with suppliers and research institutes, made it possible to replace combustion vehicles with electric vehicles, collecting relevant information and pointing out possible improvements in these systems. However, there are no large-scale operations of this kind.

2.2 MODEL OPERATIONALIZATION

The operationalization of this model is summarized in the following schematic figure.

Figure 19 – Operationalization of the public operation model



Source: Own elaboration.

The implementation of this model begins with identifying the agent responsible for developing the project and the proper attribution of responsibilities. Etufor or one of the State Secretariats may have operational technical training focused on the management and implementation of projects and enterprises of public services and urban infrastructure. The choice of this model does not imply the need to hire its own labor by the project managing agent, but rather in the subcontracting of specialized companies responsible for the attributions of:

- Design the entire system properly, including vehicle typologies, charging points, electrical charge to be supported, and network adjustments, among others.
- Suppliers of equipment, systems, and civil constructions, responsible for the implementation of recharge systems.
- Suppliers of electric vehicles, according to the selected technology.
- Companies supplying labor aimed at the handling and maintenance of vehicles.

The Public Administrator becomes, in this model, an integrator agent of technologies to the identified needs of the pilot project. The integrator's role implies relevant responsibilities and knowledge absorption by the public sphere.

2.3 LEGAL ASPECTS

In this alternative, there is no delegation, which means that the implementation and operation of the public transport service will be carried out by the Municipality. Thus, the public entity will be responsible for the system's planning, financing, acquisition, operation, and maintenance.

This context implies the need for the immediate and future availability of resources, bidding for the acquisition of goods and services, and availability or hiring of personnel for the management of the operation of the system, all carried out under the aegis of Federal Law 14.133/2021.

Specifically on electrification and considering that public service delegates already operate the service, the Government (Grantor) will define the routes, identify the points and times of recharge, and will be responsible for the evaluation and diagnosis of the network, acquiring and operating the assets including bus, battery, and recharge.

This results in real difficulties of operational overlap, that is, risks in the management of the operation of electric buses concomitant with the existing operation and insufficient technical staff specialized for the operational management of assets.

The administrative activity intertwined with the Legal System of Public Law imposes a long, complex, and bureaucratic path of management of personnel, goods, and services that will happen concomitantly with an existing operation and that requires a budget to support all expenses.

2.4 BARRIERS AND OPPORTUNITIES

Several interactions were performed with the Municipal Government's technical team to identify each business model alternative's main difficulties and positive points. In the case of the alternative of Public Operation, it was identified that this model has as a strong point the partnership of the State Government, which has given support via subsidies in the municipality's transport system. The model would also assign greater control to the government in implementing the fleet transition policy. As opportunities of the model, it is understood that the feasibility of the project through The Public Operation would ensure an improvement of the system's quality.

As a weakness of this model, it has been raised that it is a more bureaucratic operation for operation and planning and requires closer supervision. It was mentioned that Fortaleza has already had experience with a public company (Companhia de Transportes Coletivos – CTC), and it is evaluated that, as the transport operation is very dynamic, bureaucracy makes this operation very challenging. Other weaknesses addressed are the challenges imposed when there are assets in the ownership of the government, and the current timing is challenging.

It was also raised that the current technical team of the government is reduced, and there is no contingent needed to conduct the operation other than that establishing a public company could compromise the sustainability of the municipality's budget.

As challenges for the Public Operation Model, the definition of the origin of the resource for viability is identified, in addition to the management of mechanisms for eliminating batteries and vehicle replacement at the end of useful life by the government. In addition, the absence of external financial contributions to the municipalities was also identified as a barrier. The barriers and opportunities of the Public Operation model are presented in Table 7

Table 7 – Barriers and opportunities of the Public Operation model

Positive points and opportunities	Negative points and barriers
The current partnership of the Municipal Government with the State Government can facilitate the feasibility of the project	Dynamics of the transport operation and the excessive bureaucracy of government are not compatible
Greater control of the government in the implementation of the fleet transition policy	Challenges imposed on the possession of assets by the government
Improving the quality of public transport	Contingent of the government is insufficient to conduct the operation
-	May compromise the sustainability of the municipality's budget
-	Absence of external financial contribution to municipalities
-	Public management of battery disposal and replacement of vehicles at the end of their useful life

Source: Own elaboration.

2.5 INTEGRAL INCORPORATION OF ELECTROMOBILITY INTO EXISTING CONCESSION CONTRACTS

This alternative is the most common in public transport service contracts. The amendment of Concession Contracts for these functions corresponds to the most used model in Brazil, such as the municipalities of Bauru, Santos, Maringá, and the Federal District.

It is guided by the full delegation of the acquisition of vehicles, systems, operation, and maintenance of these vehicles to the private initiative. The full delegation implies the integrality of the pre-operational activities of the electric fleet, from the preparation of executive projects (through the acquisition of resources, the means of implementation, and the integration of investments) to the beginning of the effective operation and commercial operation of the services, would be attributed to the private sector without any activities delegated to the cities (except those exclusively linked to regulatory aspects).

Once the acquisition or leasing of electric buses and their components is completed, systems integration and operation preparation, the operator becomes fully responsible for managing and commercially exploiting the system — including the maintenance and conservation of assets and the provision of services related to urban mobility, among other responsibilities.

One of the main risks of this phase is associated with investment costs, demand, operation, and macroeconomic fluctuations, which are fully or partially attributed to the private sector. In the current scenario, characterized by the financial fragility of the operating companies due to COVID-19, the risk of not obtaining, or increasing the credit necessary for the acquisition of fleet and charging equipment is added to the most common risks in this type of operation.

The risk of default should be absorbed by the financial agents who will finance these investments and not result from the change of vehicular technology but from the drastic reduction in demand for public transport that has been observed throughout the pandemic period and is still observed today.

The transition to electromobility is impossible without the investors being willing to make resources available to operators. The list of risks allocated to the private sector excludes those mandatorily attributed to the grantor, such as the risk of variations in the economic-financial balance of the concession resulting from force majeure situations. At the end of the concession, all assets are held by the private sector, except those mandatorily reverted to the granting authority.

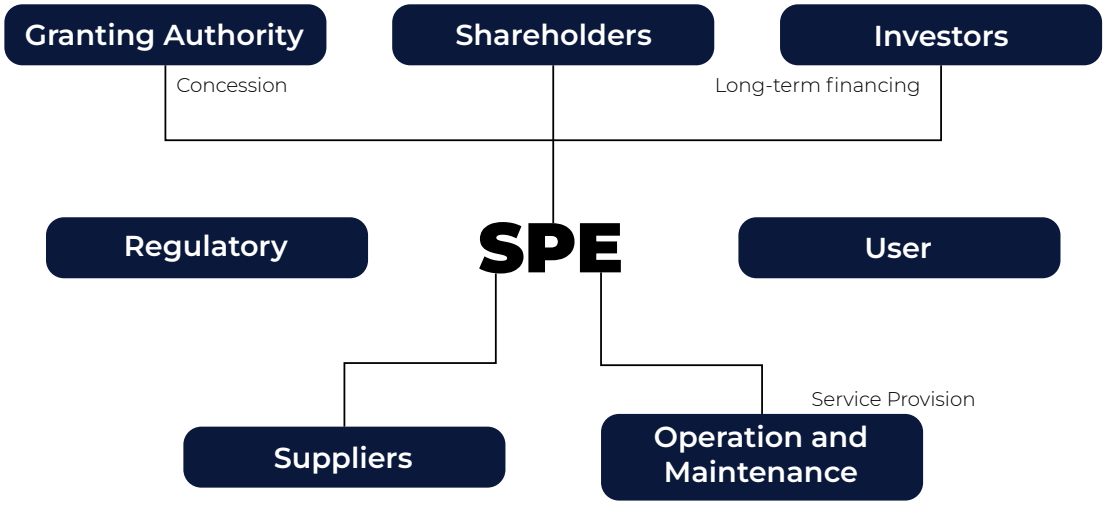
Adopting this alternative allows the city to enjoy the social and environmental benefits arising from the implementation of electromobility without having to disburse excessive resources to do so.

For the private sector, the necessary consideration for the assumption of responsibilities is the need to remunerate the capital used in the enterprise adequately. Without adequate remuneration for the capital used, there will be no incentive (or reason) for the investment to occur. This is particularly important in the case of electric buses, given their high initial cost of investment and complexity of planning and operation.

The following diagram points out the positioning of the main agents involved in structuring the project in a global concession model. The operators are organized in the form of Special-Purpose Entity, entities specially constituted by the Shareholders for executing the Concession Contract by a direct delegation of the Grantor.

As responsible for the execution of the services, it is up to the SPE's to contract financing for the acquisition of electric vehicles and charging equipment (Providers), as well as the execution of the provision of services (Operation in favor of users) and maintenance of assets in perfect conditions, under the terms put in the Concession Contract (Maintenance). The Regulatory Agent regulates both the quality of the Operation and maintenance, formally designated for this, in this case by ETUFOR. Thus, in a global concession, there is a concentration of activities for the SPE, responsible for all stages of the production process of generating services, from planning activities, financing, acquisition, and maintenance of assets, and use of these assets for the provision of services to the end user.

Figure 20 – Model of implementation and operation of electric buses under total private responsibility in a single contract



Source: Own elaboration. Note: LP – Long Term.

In electromobility projects that adopt this condition, the activities of acquisition, implementation, integration of systems, operation, and maintenance are directly performed by the contracted company. Some examples are present in the Federal District (DF), Santos (SP), Bauru (SP), Maringá (PR), and Campinas (SP).

The contracts signed in these cities mention investments in acquiring electric vehicles and charging systems in the original financial equation. Based on the model, subsequent investments and operating costs depend on the recovery of the financial balance. It is worth noting that, in all these cases, electromobility is in the experimental phase. Therefore, these systems' acquisition, operating, and maintenance costs will go to the private sector by reviewing the initial economic-financial balance.

2.5.1 Operational aspects

The operationalization of this business model is done by negotiating between the Granting Authority and the private concessionaires. This negotiation process should necessarily involve:

- The deadlines for the implementation and operation of the fleet of electric vehicles desired by the Municipality;
- The lines on which the new vehicles purchased will be used;
- The operational programming of these vehicles, including the number of travels, operational mileage, dead mileage, and the need for additional reserve vehicles on account of charging;
- The revision of the economic and financial equation of contracts, including:
    - The increase in investments in electric vehicles and the suppression of diesel vehicles that are no longer purchased;
    - The increase in investments in systems, reforms of civil works and projects;
    - The increase in variable costs with electric vehicles, including current energy prices, maintenance productivity parameters, lubricants, and others,
    - The reduction of variable costs with combustion vehicles, considering the replacement of the mileage traveled by combustion vehicles with electric ones.
    - The residual value, under market conditions, of vehicles and systems.
- The way of recompressing the contractual economic-financial balance, such as the granting of possible increases in the need for

remuneration by the local government, the extension of contractual deadlines, and the reduction or exemption of other contractual charges.

Once all the issues have been established, the Concessionaire company fully assumes the attribution of execution, and the Government is responsible for regulating and monitoring the contractual execution.

2.5.2 Legal aspects

Under Law No. 8.987/1995, the common concession delegates the execution of the public service to the private agent at his own risk and within a specified period. The duration is established following the appropriate time for amortization, depreciation, and investment return.

In this case, the implementation and operation of electric buses are under full private responsibility in a single contract. The private company becomes entirely responsible for acquiring and maintaining the asset, managing the system, and providing the service.

Concerning the acquisition of vehicles and batteries, the main acquisition models are the purchase of the bus or leasing:

I. Purchase with equity, where the total amount is paid in advance, either by the government or a private company responsible for supplying the vehicles assuming the operational and technology risks;

II. Purchase with financing, where the part is paid in advance and part via a loan, either by the government or a private company responsible for supplying the vehicles, assuming the operational and technology risks. In this case, due to credit risk, there is a risk of increasing the cost of the loan;

III. Full leasing, with payment by use of the bus for a certain period.

IV. Partial leasing, where specific components are paid for a specified period.

In this model, the Concessionaire decides between purchasing a battery and a bus or purchasing the bus and renting the battery, or renting the bus and battery. In addition, it considers and assumes the battery charging infrastructure, and nothing reverts to the Government.

This decision reflects on an existing concession contract, with the insertion of new obligations to the Concessionaire, which will have repercussions on the time and financial aspects of the contract.

The contractual amendment is the legal way to resolve this situation in existing contracts. Thus, it must be clear about time and cost to enable the measurement of the amendment's term and its economic reflexes.

2.5.3 Barriers and opportunities

Regarding the Global Concession model, the identified positive points address the condition that current contracts close in the short/medium term and alternative revenues are already provided for in these existing contracts. Moreover, in principle, the Global Concession model would not require the implementation of investments by the government.

One of the opportunities identified in this model is that the consortium that provides service has a greater dominance over the system's operation. It is evaluated that the possibility of linking resources to goals and guidelines for improving the transportation system, which results in improving quality for users, is an opportunity of this model.

As weaknesses, it is evaluated that the terms of the current contracts need to be reformed entirely to cover the transition to Electromobility. It is also evaluated that the current financial situation of the operators is a challenge for this alternative, considering the economic impacts arising from the fall in demand since 2015 and expanded due to the covid-19 pandemic.

Due to this current financial situation, it is understood that the project would present greater difficulties for long-term expansion through the Global Concession model, given the uncertainties related to the technology and market chain of Electromobility. Therefore, the barriers and opportunities of the Global Concession model are presented in Table 8.

Table 8 – Barriers and opportunities of the Global Concession model

Positive points and opportunities	Negative points and challenges
Current contracts close in the short/medium term	Need to reformulate current contracts to cover the transition to Electromobility
Possibility of alternative revenues is contemplated in current contracts	Current financial situation of operators hinders implementation through the Global Concession model
At first, it would not require investment by the government	Greater difficulty in expanding the project in the long term
Current operators have greater mastery over system operation	-
Possibility to link resources to system improvement goals and guidelines	-

Source: Own elaboration.

2.6 PUBLIC ACQUISITION OF VEHICLES AND PRIVATE OPERATION

In this model, the city can enable the adoption of electric buses through conventional bidding for the acquisition of vehicles and implementation of charging systems, governed by the terms of Federal Law No. 8.666/1993 (current Law No. 14.133/2021), with the subsequent lease of vehicles to the concessionaires of the Public Transport System.

The alternative of public purchase followed by the leasing of assets relieves the Concessionaire companies not only of investments in electric vehicles, which would be a relevant barrier to the implementation of the enterprise, but also of making investments in the renewal of combustion vehicles that will be replaced.

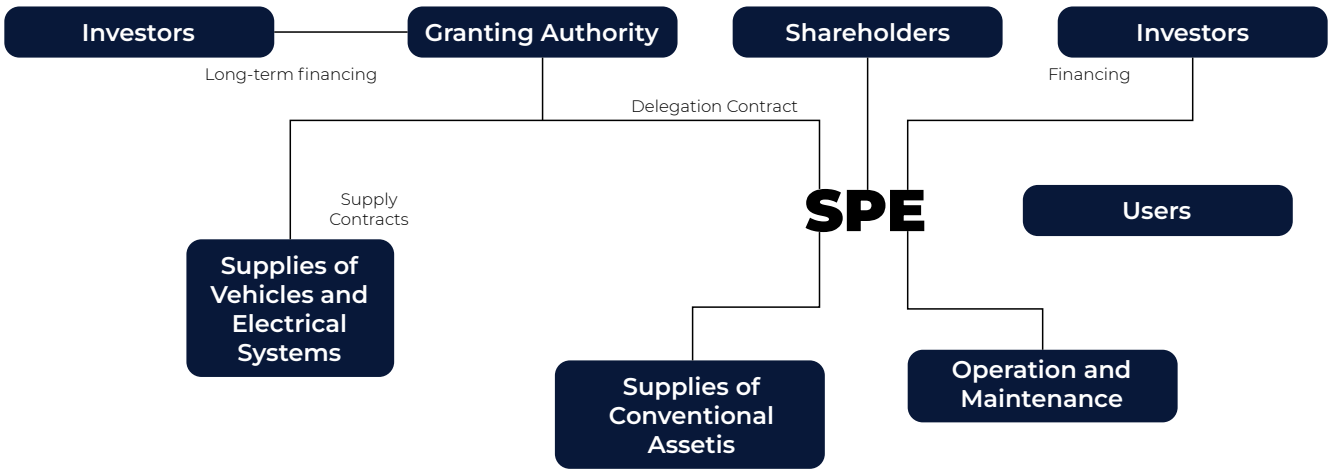
Thus, this model results in a temporary relief in the need for cash or the provision of guarantees to funders of companies, which replace the purchase of fleet with their rental directly from the Government.

This model, simple from a financial point of view, needs attention to its technical part so that the conditions of use and maintenance of vehicles rented to concessionaires are well defined not to incur risks of excessive or inappropriate use that may compromise the quality and functionality of public assets.

The following figure summarizes the contract annexes and how the role of the main players adjusts to the construction of the proposed solution. The Granting Authority, in this case, the Municipality of Fortaleza, represented by ETUFOR, becomes responsible for the acquisition of the Fleet Providers and charging equipment for electric vehicles. To this end, it will have different sources of funding that are used in financing projects and programs with a high social, economic and environmental impact. These vehicles purchased by the Granting Authority are made available through rental or a simple section of right of use assigned to the Concession Contract as a reversible asset.

In this organization of agents, it will be up to the SPE's to perform the provision of services (Operation in favor of users) and maintenance of assets under conditions established in the terms outlined in the Concession Contract (Maintenance). However, the quality of the Operation and Maintenance continues to be regulated by the Regulatory Agent. Thus, there is a functional division of activities between the Granting Authority, responsible for financing and acquiring assets related to electromobility, and the SPE, responsible for the operation and maintenance of the assets.

Figure 21 – Model of responsibility for the implementation and operation of electric buses shared between public and private entities



Source: Own elaboration. Note: LP – Long Term.

2.6.1 Operational aspects

The implementation of this model is done in three stages. The first stage is fully contractual, in which the conditions for rental of the fleet acquired between the Government and the private initiative are negotiated. The rental contract will involve the definition of values, as suggested in the next chapter of this Report, operating conditions such as lines, charging locations, the number of daily travels, and others, as well as the asset maintenance conditions. After this stage, in the second stage, the Granting Authority carries out the financing and acquisition of electric vehicles and systems and eventually contracts civil constructions for its implementation. Finally, in the third stage, the vehicles are leased to the concessionaires and put into operation.

2.6.2 Legal aspects

In the shared model, the service is delegated to the private for the operation of the service. However, the acquisition of electric vehicles and the implementation of charging systems will be the responsibility of the Granting Authority. These assets will be delivered to the Concessionaire and classified as goods linked to the Concession and, therefore, reversible.

At the time of delivery, it is vital to establish (i) what is delivered, (ii) how it will be maintained, (iii) on the return, what is expected to be received, and under what conditions.

In ongoing contracts, attention is essential regarding the assets' lifetime and the Concession's time. Therefore, the reversal of assets present in the contracts is a topic that deserves attention. First, it has the possibility of forcing the public authority, at the end of the contract, to incorporate obsolete or useless goods. On the other hand, even if the burden of demobilizing and correctly destining these assets is attributed to the future concessionaire, the government assumes this cost since it is incorporated into the cash flow supporting the bidding. Thus, considering that the assets return to the government at the end of the contract, it is essential to observe more rigorously the quality standards in the implementation and maintenance conditions.

2.6.3 Barriers and opportunities

As a positive point in the public and private shared responsibility model, the greatest control by the government in implementing the policy is identified. On the other hand, the main downside is the difficulty of defining public investment in a way that does not compromise the financial sustainability of the public authorities. Another challenge is establishing conditions (parameters) for returning the property (bus and infrastructure) at the end of the contract.

The challenges identified in the model in question deal with the absence of external financial contribution to the municipalities for the feasibility of these types of projects. For this reason, a listed barrier addresses the definition of the source of the public resource for project implementation. In addition, the difficulty of acquiring assets by the government was also addressed, given the existing bureaucratic obstacles. The barriers and opportunities of the Public and Private Shared Responsibility model are presented in Table 9.

Table 9 – Barriers and opportunities of the Public and Private Shared Responsibility model

Positive points and opportunities	Negative points and challenges
Greater control of the government in the implementation of the project	Difficulty in defining the origin of the public resource to enable the project without compromising the financial sustainability of the municipality
-	Difficulty in establishing conditions for the return of the property at the end of the contract
-	Absence of external financial contribution to enable this type of project
-	Difficulty in the acquisition of assets by the government, given the existing bureaucratic obstacles

Source: Own elaboration

2.7 IMPLEMENTATION AND PRIVATE OPERATION IN SPECIALIZED CONTRACTS

By adopting this alternative, the city enables specialized contracting, a contract for deploying vehicles and systems, and other operating assets.

The separation of the implementation, management, and operation of electromobility in two contracts aims to bring the efficiency of specialized agents to the system. The first contract, aimed at implementation, defines the agent responsible for deploying vehicles and charging infrastructure, including civil works and systems, in a long-term contract. The remuneration of the contract may be carried out in two different ways: (i) income for the availability of the assets to the Granting Authority or (ii) rental of assets to the private operator. It is important that this contract involves only, or predominantly, the deployment of such assets. As the maintenance of the systems and, where appropriate, the maintenance of the vehicles themselves are incorporated into the contract, partially or completely, the arrangement would constitute an administrative public-private partnership (PPP), with long-term remuneration for the asset made available.

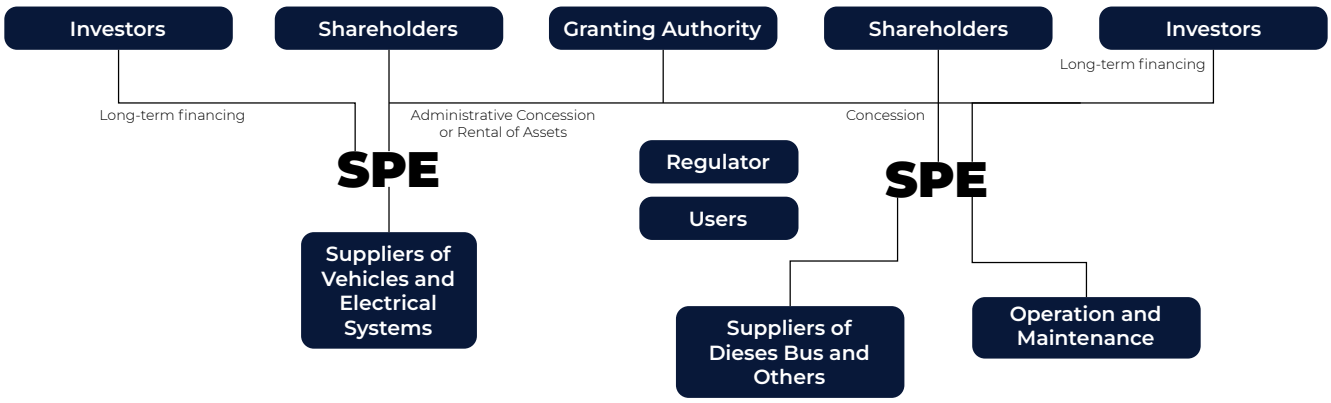
The second contract represents the current structure of operational concession contracts, in which the operating agents would lease, directly from the first SPE or indirectly through the Granting Authority, the electric vehicles for the performance of the electromobility operation. Thus, operators would have the advantage of specialization in their activities, which reduces factors of use of drivers and personnel for operational support, supervision, and control, among others.

The examples of implementation and operation in specialized contracts were observed in the implementation of the Santiago electromobility in “Red Metropolitana” or “Red.” The energy distribution company, ENEL, acquired and leased the vehicles for private operation with guaranteed receipt from the Central Government of Chile. In Colombia, a Joint Venture formed by Volvo with local operators successfully implemented and operated electric vehicles in the Transmillennium corridor.

The following figure summarizes the organization of agents in this conception. It is observed that the first SPE, to the left of the chart, is the entity specialized in acquiring assets, and for this, in the hiring of long-term funders focused on electromobility. Through a Contract signed with the Granting Authority, the vehicles purchased and financed are made available to the second SPE, to the right of the figure, which has an operational nature, being responsible for the operation and, usually, for the maintenance of these assets. Based on the operation of assets related to electromobility, the second SPE provides the services directly to the end

users of public passenger transport. In this model, the Granting Authority is not the borrower of financing necessary for acquiring assets but a specialized agent in purchasing and renting assets to third parties.

Figure 22 – Model of implementation and operation of electric buses under private responsibility in two specialized contracts.



Source: Own elaboration. Note: LP – Long Term.

2.7.1 Operational aspects

The specialization of contracts in this model implies a more relevant active role of the Granting Authority in the planning and managing of contracts to manage the interfaces between the supply and use of electric vehicles and systems. To this end, the Granting Authority should initially carry out a comprehensive planning process on the lines on which electric vehicles will be deployed, carrying out appropriate locations for charging and sizing equipment and systems, and detailing how the operation will be carried out. Then, based on these projects, they can contract the acquisition or availability of vehicles, systems, and civil reforms for their implementation, from a specialized operator. In the second contractual aspect, it is necessary to review the economic-financial balance of existing contracts. It must deal with replacing investment costs from the combustion vehicles' operation to the electric vehicles' one.

2.7.2 Legal aspects

In the implementation contract, regarding the acquisition of assets (bus, battery, systems, and civil constructions), the Government may opt for direct acquisition, ruled by Federal Law 14.133/2021, or rental, leasing, ruled by the norm. As it evolves toward a model that incorporates a greater number of functions associated with maintenance and eventually replacement of assets at the end of its useful life, the long-term contract may migrate to a Public Private Partnership model in the administrativev concession modality. If well developed and managed, these two contracts can represent increased efficiency in the service provided and quality gain for the end user It's possible to plan an alternative in which you can split the contracts for

operation, provision of vehicles, and infrastructure. In this scenario, the division of responsibility takes place between three stakeholders, with higher levels of specialization, different metrics of remuneration, and incentives for the search for efficiency. It is important to note that the greater the breach of contract, the greater the responsibility of the Granting Authority in planning and managing contractual interfaces.

2.7.3 Barriers and opportunities

In this model, one of the positive points is the fleet operation by the operators already used to the operation. The private one presents greater ease in managing the fleet, considering the dynamics of the system's operation. The separation of contracts is a possible positive aspect of this model in the case of a new tender. Moreover, at first, the investment would not be necessary by the government and by current operated ones.

As the main opportunity, it was indicated that there are ongoing talks with ENEL (energy concessionaire of the State of Ceara), which IPLANFOR is coordinating. These conversations are still at an early stage, but ENEL has already presented a complete menu of products.

As a negative point, conflicts related to the interface of existing contracts are identified since the operator does not own the fleet, which would result in difficulty defining responsibilities in cases of claims or similar situations. During the capacity training, it was addressed that the main challenge of this model is the difficulty in identifying stakeholders interested in investing in Electromobility. The barriers and opportunities of the Public and Private Shared Responsibility model are presented in Table 10.

Table 10 – Positive and Negative Points of the Implementation and Private Operation model in Two Contracts

Positive points and opportunities	Negative points and challenges
Separation of contracts can be evaluated as a strong point	Conflicts related to the interface of the different contracts
Investment by the government and current operators would not be necessary	Difficulty in defining responsibilities in claims or similar situations
Existing negotiations with the energy concessionaire of the State of Ceará regarding the possibility of partnerships. Negotiations are in the early stages.	Difficulty in identifying stakeholders interested in investing in Electromobility

Source: Own elaboration.

3.

DESIGN OF THE PILOT PROJECT IN THE MUNICIPALITY

This chapter presents the discussion of the four central aspects of the Project (operational aspects, legal aspects, economic and financial aspects, and social aspects) according to the context and discussions with the municipality team.

First, the specificities of the municipal reality are considered, based especially on the definition of its operational scenarios, such as the number of lines, characteristics of fleets, mileage total, type of vehicle technology, and charging, among others.

Next, guidelines on possible contractual solutions for the implementation of electromobility are pointed out, considering institutional, financial, and legal issues.

After, the chapter indicates the path to the design and development of the economic-financial evaluation model so that the municipality can structure its electromobility project.

The input data, such as energy, fuel, lubricants, parts, and accessories costs, are presented and considered, and the reflections and choices of the premises taken to obtain the operating costs of electric buses are addressed; the costs of acquiring vehicles and infrastructure; their useful life, residual value, depreciation, and remuneration rate.

The analyses of the results found and the comparison of possible scenarios for electrification in the municipalities are also presented:

- Evaluation of CAPEX and OPEX avoided and total in each of the scenarios for the project horizon
- Economic evaluation of the replacement of part of the fleet by electric vehicles.

Finally, the chapter explores the social perspectives related to the support of electromobility for the pilot project designed for the municipality. Social impacts, such as territorial, gender, race, income inequalities, and environmental impacts, are considered.

3.1 DEFINITION OF OPERATIONAL SCENARIOS

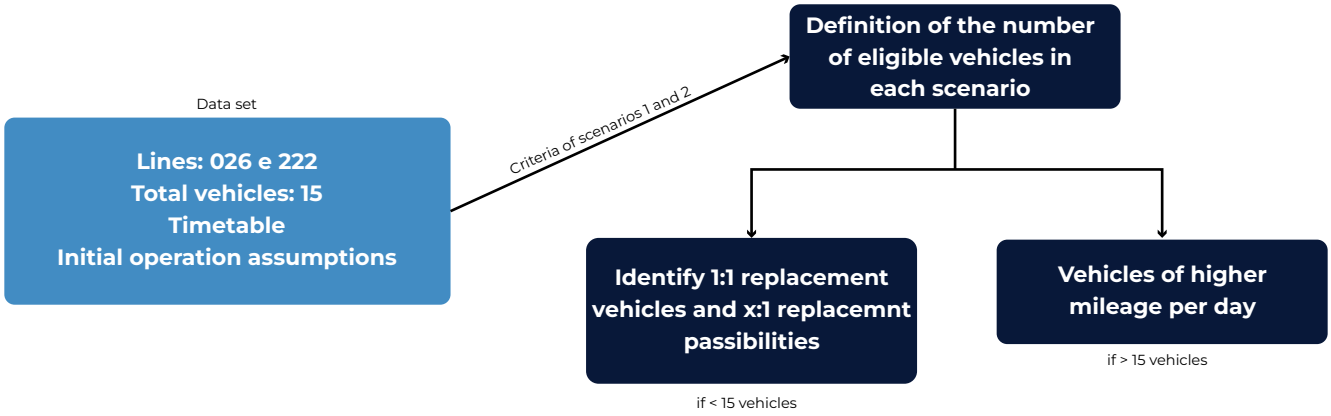
As discussed earlier, the municipality of Fortaleza established in the conceptual model of the pilot project elaborated in 2019 that the operation of electric buses would be through charging only in garages using traditional plug-in technology. Therefore, for the current modeling of the pilot project, considering the learning obtained and experiences of other cities, **two scenarios will also be evaluated with traditional plug-in: scenario 01 - slow charging in garages, scenario 02 - slow charging in garages and opportunity charging in The Antonio Bezerra Terminal.** The choice for this terminal is evident since it is the common terminal for the operation of the two defined lines.

As previously presented, the pilot project will include **15 electric vehicles of the heavy type (14m), high floor, and 5 doors**. This fleet will operate exclusively on lines **222 - Antônio Bezerra/Papicu/Antônio Sales and 026 - Antônio Bezerra/Messejana**. For selecting the 15 vehicles, the premises adopted and presented in topic 1.2 and the hourly grids of the vehicles operating the lines in question will be used.

Vehicles with a daily mileage (kilometers) lower than operational autonomy will be evaluated to select eligible vehicles. In scenario 01, the autonomy is fixed at 200 kilometers. Therefore, vehicles eligible for vehicle replacement, in the ratio of 1 electric vehicle to 1 conventional vehicle (1:1) in scenario 1, will be those with daily mileage smaller than 200 kilometers. In scenario 02, autonomy depends on the downtimes of each vehicle at the Antônio Bezerra terminal.

If the number of eligible vehicles exceeds 15, the highest daily mileage will be selected since the economic benefit of the electric bus is mainly due to the lower costs associated with the operation. If the quantity is less than 15 vehicles, the possibility of replacing more than one electric vehicle with a conventional vehicle will be identified so that the fleet of electric vehicles approaches the desirable fleet in the study. The flowchart of the analysis is shown in Figure 23

Figure 23 – Analysis flowchart for vehicle selection



Source: Own elaboration.

Next, the amounts of charging infrastructure are identified. For the charging infrastructure in the garages will be carried out an analysis of the operation throughout the day of the vehicles per company operating the selected vehicles. This analysis will identify if there is a possibility of optimizing the charging infrastructure in garages. For example, if the 4 selected vehicles of a company have an operation that allows the use of only 3 chargers since there will only be 3 simultaneous charges.

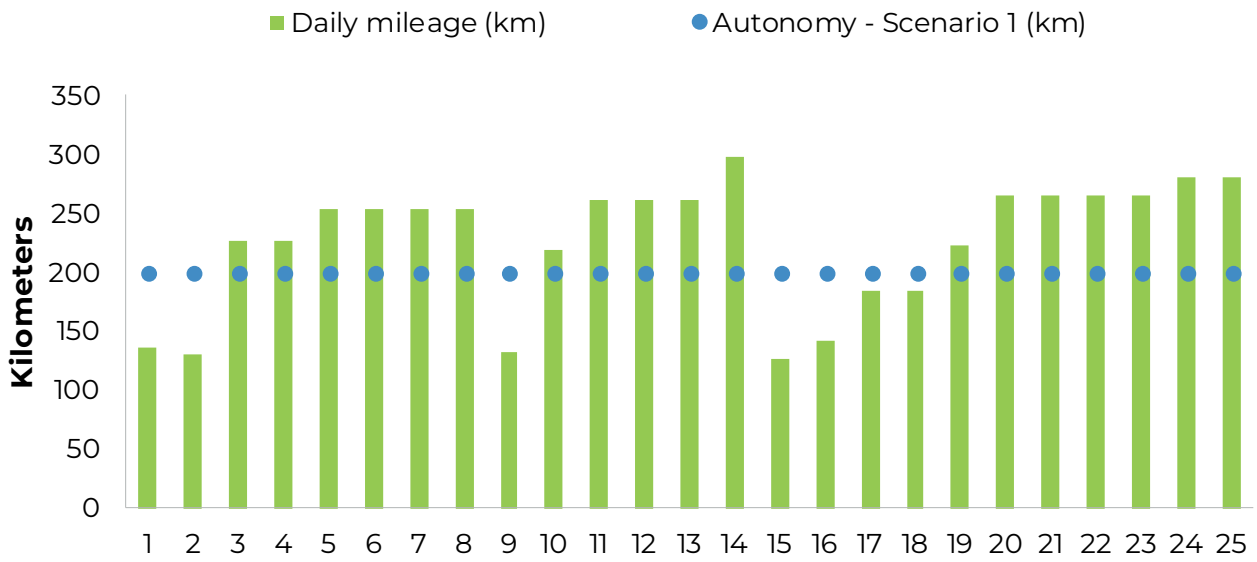
In the case of the charging infrastructure in the terminals, an operation analysis will be carried out throughout all selected vehicles to identify the number of opportunity charging carried out simultaneously in the Antônio Bezerra Terminal, considering the current operation of these vehicles.

3.1.1 Scenario 01

a) **Vehicle selection:**

Considering the hourly grid of vehicles through operational service orders (OSO) lines 222 and 026, respectively, from 12/22/2021 and 12/28/21, and the assumptions adopted for scenario 01, daily shootings per vehicle and autonomies related to the scenario were obtained. The results of the vehicle selection are presented in Figure 24 and Table 11.

Figure 24 – Comparison chart between daily mileage and autonomy (scenario 01)



Source: Own elaboration.

Table 11 – Results of vehicle selection in scenario 01

Bus ID	Line	Operator	Daily mileage (km)	Scenario 1 Autonomy (km)	Eligible in Scenario 1?
12	026 - Antônio Bezerra/Messejana	Vega	126	200	Yes
25	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	131,2	200	Yes
18	222 - Antônio Bezerra/Papicu/Antônio Sales	Vega	132,6	200	Yes
17	222 - Antônio Bezerra/Papicu/Antônio Sales	São José	136	200	Yes
10	026 - Antônio Bezerra/Messejana	Vega	142,5	200	Yes
15	026 - Antônio Bezerra/Messejana	Vega	184,5	200	Yes
16	026 - Antônio Bezerra/Messejana	Vega	184,5	200	Yes
5	026 - Antônio Bezerra/Messejana	Fortaleza	219,4	200	No
14	026 - Antônio Bezerra/Messejana	Veja	222,6	200	No
19	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	227,1	200	No
21	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	227,1	200	No
20	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	254	200	No
22	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	254	200	No
23	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	254	200	No
24	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	254	200	No

Bus ID	Line	Operator	Daily mileage (km)	Scenario 1 Autonomy (km)	Eligible in Scenario 1?
1	026 - Antônio Bezerra/Messejana	Fortaleza	261,4	200	No
3	026 - Antônio Bezerra/Messejana	Fortaleza	261,4	200	No
4	026 - Antônio Bezerra/Messejana	Fortaleza	261,4	200	No
6	026 - Antônio Bezerra/Messejana	Vega	264,6	200	No
7	026 - Antônio Bezerra/Messejana	Vega	264,6	200	No
8	026 - Antônio Bezerra/Messejana	Vega	264,6	200	No
9	026 - Antônio Bezerra/Messejana	Vega	264,6	200	No
11	026 - Antônio Bezerra/Messejana	Vega	281,1	200	No
13	026 - Antônio Bezerra/Messejana	Vega	281,1	200	No
2	026 - Antônio Bezerra/Messejana	Fortaleza	297	200	No

Source: Own elaboration.

The results indicate that only 7 vehicles are eligible for 1:1 replacement of the 25 vehicles in the fleet of the two lines. Therefore, to operate with a larger number of electric buses in scenario 01, replacing more than one electric vehicle with a conventional vehicle is necessary.

To make this second selection, vehicles with greater mileage and operated by the same company were considered to facilitate the operational optimization of these vehicles. Therefore, the 6 vehicles of the company Santa Cecilia with IDs 19, 20, 21, 22, 23, and 24 were selected. The total mileage of these vehicles is 1470 kilometers per day. Therefore, considering the autonomy of 200 kilometers per day, it would take 8 electric vehicles for this replacement.

Thus, the model proposes 15 electric vehicles replacing 13 conventional vehicles. Of the 13 vehicles selected, 7 are operated by the company Santa Cecilia, 5 by Vega s/a, and 1 by the company Autoviação São José. Of the selected vehicles, 4 operate on line 026, and 9 operate on line 222. The total daily mileage of vehicles is 2,507.50 kilometers. The vehicles to be replaced are shown in Table 12.

Table 12 – Vehicles selected in scenario 01

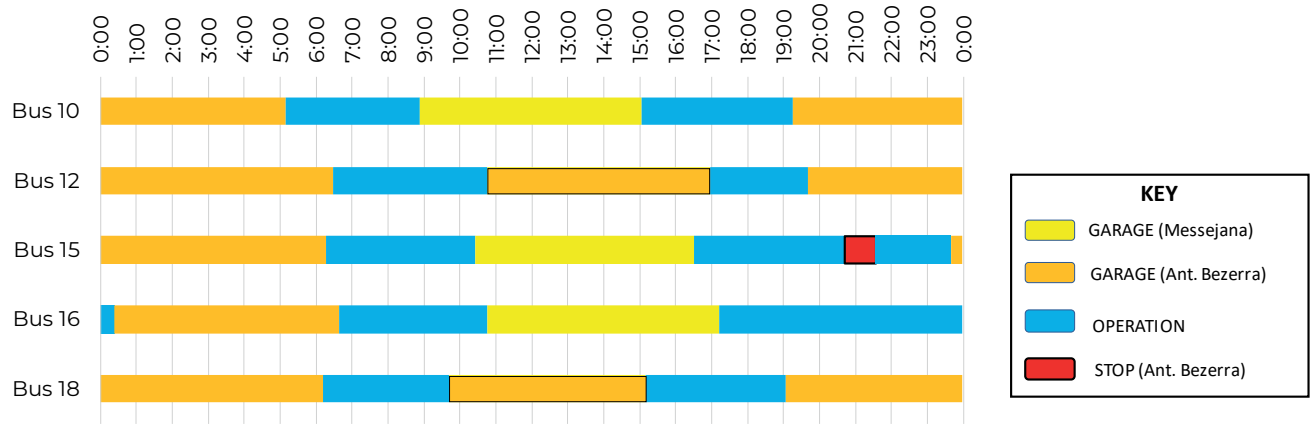
Bus ID	Line	Operator	Table	Daily mileage (km)
12	026 - Antônio Bezerra/Messejana	Vega	12	126
25	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	9	131,2
18	222 - Antônio Bezerra/Papicu/Antônio Sales	Vega	7	132,6
17	222 - Antônio Bezerra/Papicu/Antônio Sales	São José	8	136
10	026 - Antônio Bezerra/Messejana	Vega	9	142,5
15	026 - Antônio Bezerra/Messejana	Vega	15	184,5
16	026 - Antônio Bezerra/Messejana	Vega	16	184,5
19	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	1	227,1
21	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	3	227,1
20	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	2	254
22	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	4	254
23	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	5	254
24	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	6	254

Source: Own elaboration.

b) **Charging infrastructure in garages:**

As stated earlier, to obtain the amount of charging infrastructure in the garages, an operation analysis will be conducted throughout the day of the vehicles per company operating the selected vehicles. This analysis will identify if there is a possibility of optimizing the charging infrastructure in garages. Figure 25 shows the operation of the 5 vehicles operated by Vega S/A.

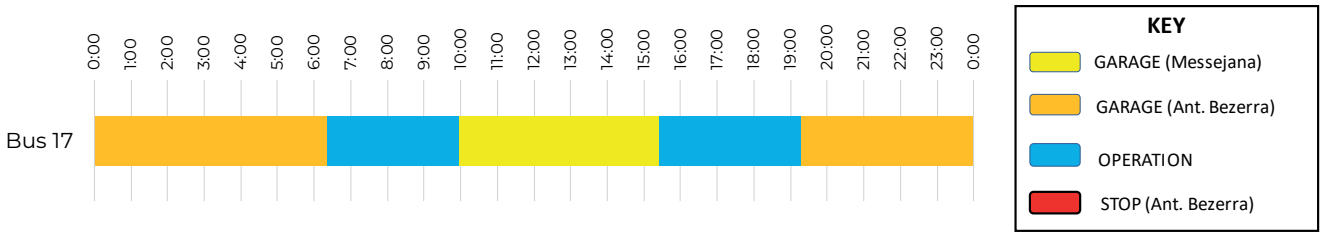
Figure 25 – Daily operation of selected vehicles of Vega S/A company



Source: Own elaboration.

There is a window of opportunity for optimizing the number of chargers since buses 12 and 18 return to the garage of the Antônio Bezerra terminal at lunchtime. Therefore, **3 chargers** will be required in the garage of Vega S/A transport company. Figure 26 shows the operation of the vehicle operated by the company Autoviação São José.

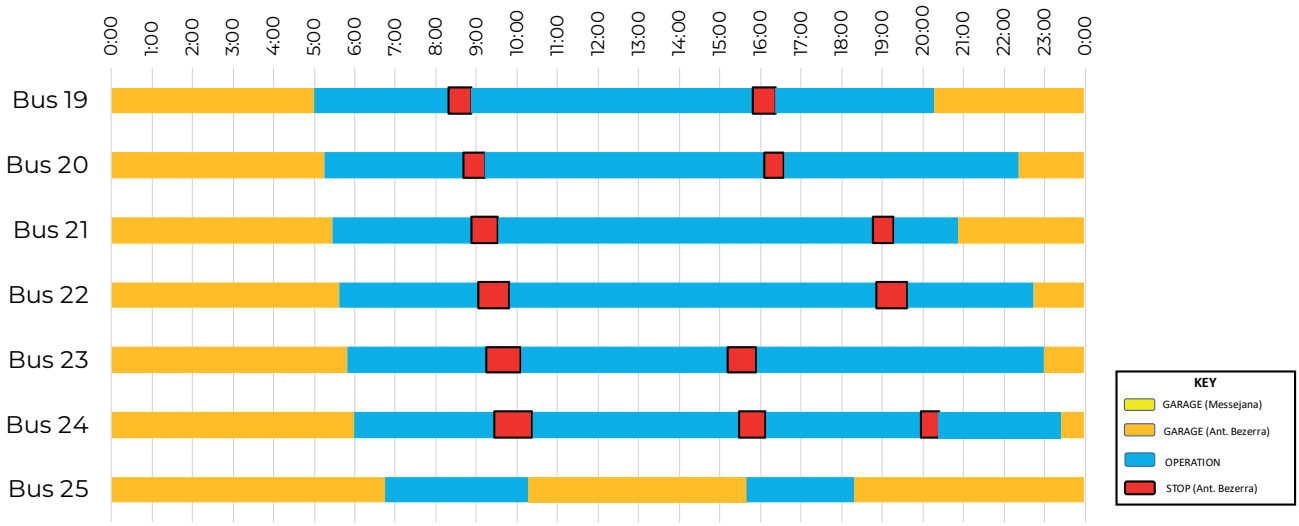
Figure 26 – Daily operation of the selected vehicle of Autoviação São José company



Source: Own elaboration.

Only one vehicle of the Autoviação São José will be used, so **1 charger** is necessary for the garage of this company. Figure 27 shows the operation of the 7 vehicles operated by the company Santa Cecilia.

Figure 27: Daily operation of selected vehicles of Santa Cecília company



Source: Own elaboration.

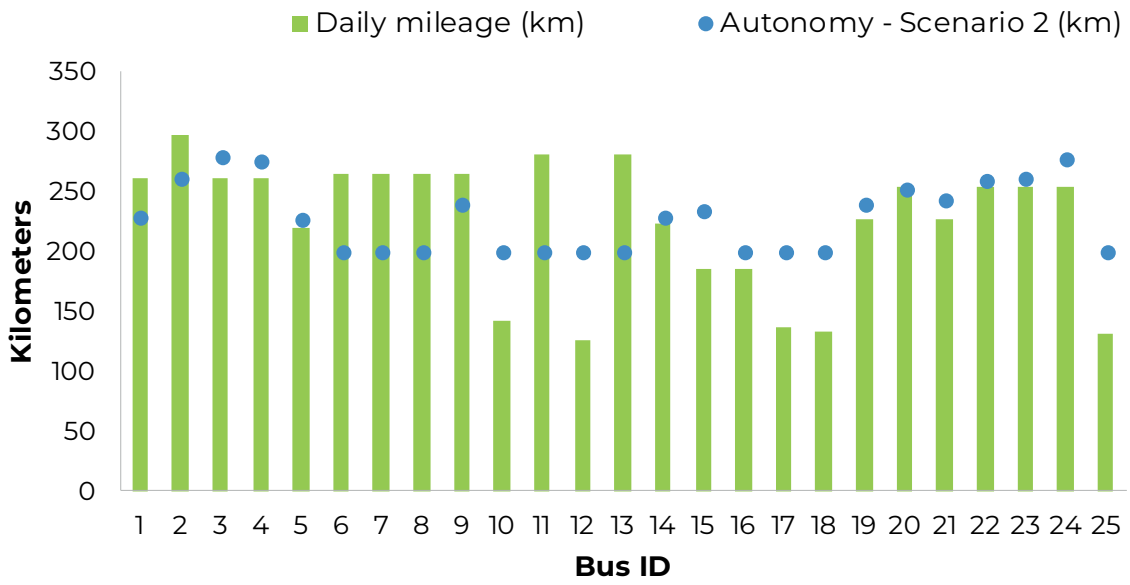
There will be 8 electric vehicles to replace 6 conventional operating vehicles. (10, 12, 15, 16, 17 and 18). It is considered that bus 20 (which will not need a replacement) will charge during lunchtime. The other 8 must charge at night and, based on operation restrictions, during other hours. Therefore, it is considered **8 chargers** in the garage of the company Santa Cecilia. Therefore, 12 chargers will be needed in the garages in this scenario.

3.1.2 Scenario 02

a) **Vehicle selection:**

Considering the hourly grid of vehicles through operational service orders (OSO) lines 222 and 026, respectively, from 12/22/2021 and 12/28/21, and the assumptions adopted for scenario 02, daily shootings per vehicle and autonomies related to the scenario were obtained. The results of the vehicle selection are shown in Figure 28 and Table 13.

Figure 28 – Comparison chart between daily mileage and autonomy (scenario 02)



Source: Own elaboration.

Table 13 – Results in vehicle selection in scenario 02

Bus ID	Line	Company	Time to charge (min)	Daily mileage (km)	Scenario 2 Autonomy (km)	C2
3	026 - Antônio Bezerra/Messejana	Fortaleza	94	261,4	278,3	Yes
4	026 - Antônio Bezerra/Messejana	Fortaleza	91	261,4	275,8	Yes
22	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	72	254	260,0	Yes
23	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	73	254	260,8	Yes
24	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	92	254	276,7	Yes
19	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	47	227,1	239,2	Yes
21	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	51	227,1	242,5	Yes
14	026 - Antônio Bezerra/Messejana	Vega	34	222,6	228,3	Yes
5	026 - Antônio Bezerra/Messejana	Fortaleza	33	219,4	227,5	Yes
15	026 - Antônio Bezerra/Messejana	Vega	41	184,5	234,2	Yes
16	026 - Antônio Bezerra/Messejana	Vega	0	184,5	200,0	Yes
10	026 - Antônio Bezerra/Messejana	Vega	0	142,5	200,0	Yes
17	222 - Antônio Bezerra/Papicu/Antônio Sales	São José	0	136	200,0	Yes
18	222 - Antônio Bezerra/Papicu/Antônio Sales	Vega	0	132,6	200,0	Yes
25	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	0	131,2	200,0	Yes
12	026 - Antônio Bezerra/Messejana	Vega	0	126	200,0	Yes
2	026 - Antônio Bezerra/Messejana	Fortaleza	73	297	260,8	No
11	026 - Antônio Bezerra/Messejana	Vega	0	281,1	200,0	No
13	026 - Antônio Bezerra/Messejana	Vega	0	281,1	200,0	No
6	026 - Antônio Bezerra/Messejana	Vega	0	264,6	200,0	No
7	026 - Antônio Bezerra/Messejana	Vega	0	264,6	200,0	No
8	026 - Antônio Bezerra/Messejana	Vega	0	264,6	200,0	No
9	026 - Antônio Bezerra/Messejana	Vega	47	264,6	239,2	No
1	026 - Antônio Bezerra/Messejana	Fortaleza	35	261,4	229,2	No
20	222 - Antônio Bezerra/Papicu/Antônio Sales	Sta Cecília	63	254	252,5	No

Source: Own elaboration.

The results indicate that 16 vehicles are eligible for 1:1 replacement of the 25 vehicles in the fleet of the two lines. Therefore, as presented in the analysis flowchart, the 15 vehicles with the higher mileage were selected. Thus, the model proposes 15 electric vehicles replacing 15 conventional vehicles.

Of the 15 vehicles selected, 3 are operated by the company Autoviação Fortaleza Ltda, 5 by Vega S/A, 1 operated by the company Autoviação São José and 6 by the company Santa Cecilia. Of the selected vehicles, 7 operate on line 026, and 8 operate on line 222. The total daily mileage of vehicles is 3,092.30 kilometers. The vehicles to be replaced are shown in Table 14.

Table 14 – Vehicles selected in scenario 02

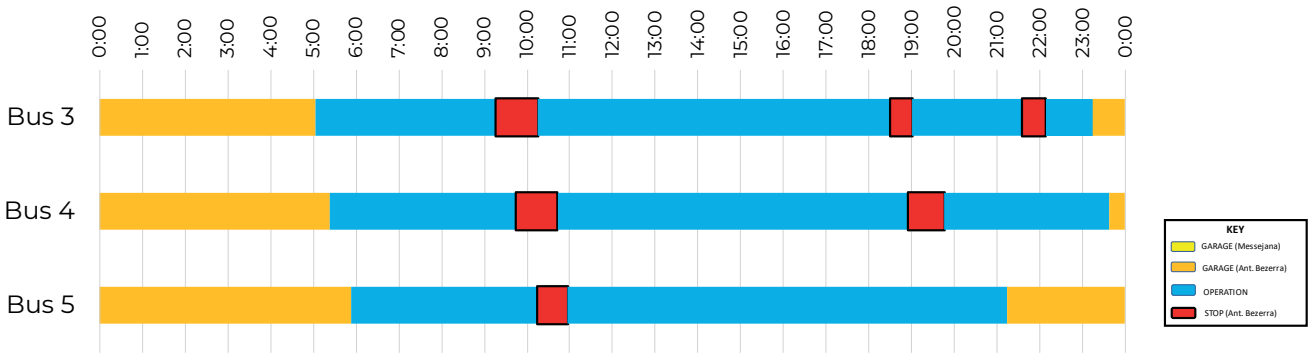
Bus ID	Line	Company	Table	Daily mileage (km)	Scenario 02 Autonomy (km)	C2
3	26 - Antônio Bezerra/Messejana	Fortaleza	6	261,4	278,3	Yes
4	26 - Antônio Bezerra/Messejana	Fortaleza	8	261,4	275,8	Yes
22	222 - Antônio Bezerra/Papicu/ Antônio Sales	Sta Cecília	4	254	260,0	Yes
23	222 - Antônio Bezerra/Papicu/ Antônio Sales	Sta Cecília	5	254	260,8	Yes
24	222 - Antônio Bezerra/Papicu/ Antônio Sales	Sta Cecília	6	254	276,7	Yes
19	222 - Antônio Bezerra/Papicu/ Antônio Sales	Sta Cecília	1	227,1	239,2	Yes
21	222 - Antônio Bezerra/Papicu/ Antônio Sales	Sta Cecília	3	227,1	242,5	Yes
14	26 - Antônio Bezerra/Messejana	Vega	14	222,6	228,3	Yes
5	26 - Antônio Bezerra/Messejana	Fortaleza	10	219,4	227,5	Yes
15	26 - Antônio Bezerra/Messejana	Vega	15	184,5	234,2	Yes
16	26 - Antônio Bezerra/Messejana	Vega	16	184,5	200,0	Yes
10	26 - Antônio Bezerra/Messejana	Vega	9	142,5	200,0	Yes
17	222 - Antônio Bezerra/Papicu/ Antônio Sales	São José	8	136	200,0	Yes
18	222 - Antônio Bezerra/Papicu/ Antônio Sales	Vega	7	132,6	200,0	Yes
25	222 - Antônio Bezerra/Papicu/ Antônio Sales	Sta Cecília	9	131,2	200,0	Yes

Source: Own elaboration.

b) **Charging infrastructure in garages:**

For charging in garages, an operation analysis will be carried out throughout the day of the vehicles per company operating the selected vehicles. This analysis will identify if there is a possibility of optimizing the charging infrastructure in garages. For example, figure 29 shows the operation of the 3 vehicles operated by the company Autoviação Fortaleza.

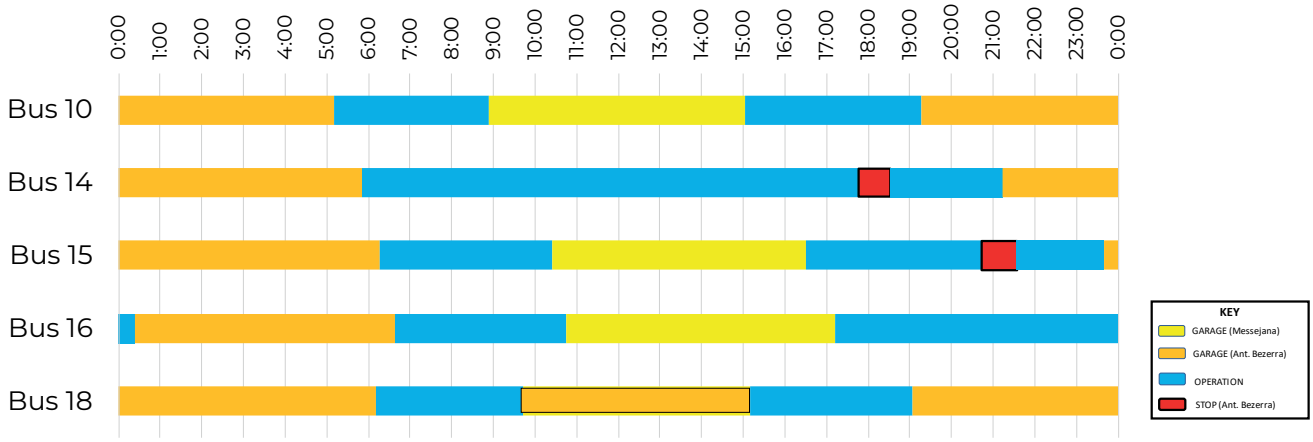
Figure 29 – Daily operation of selected vehicles of Autoviação Fortaleza Company



Source: Own elaboration.

There is no window of opportunity for optimizing the number of chargers. Therefore, 1 charger per vehicle will be necessary, being **3 chargers** in the garage of Autoviação Fortaleza. Figure 30 shows the operation of the vehicle operated by Vega S/A.

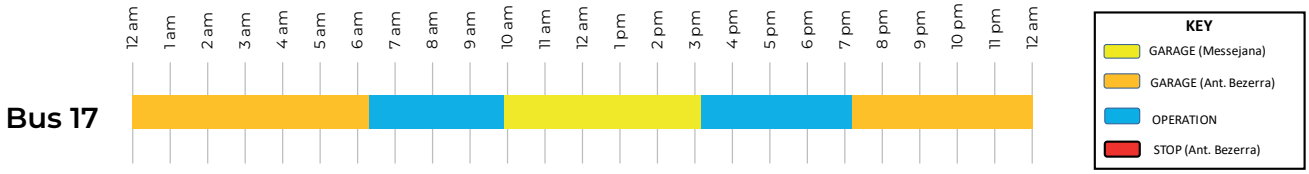
Figure 30 – Daily operation of selected vehicles of Vega S/A company



Source: Own elaboration.

There is a window of opportunity for optimizing the number of chargers, given that bus 18 returns to Ant. Bezerra garage at lunchtime. Therefore, **4 chargers** will be required in the garage of Vega S/A Transporte Urbano. Figure 31 shows the operation of the vehicle operated by the company Autoviação São José.

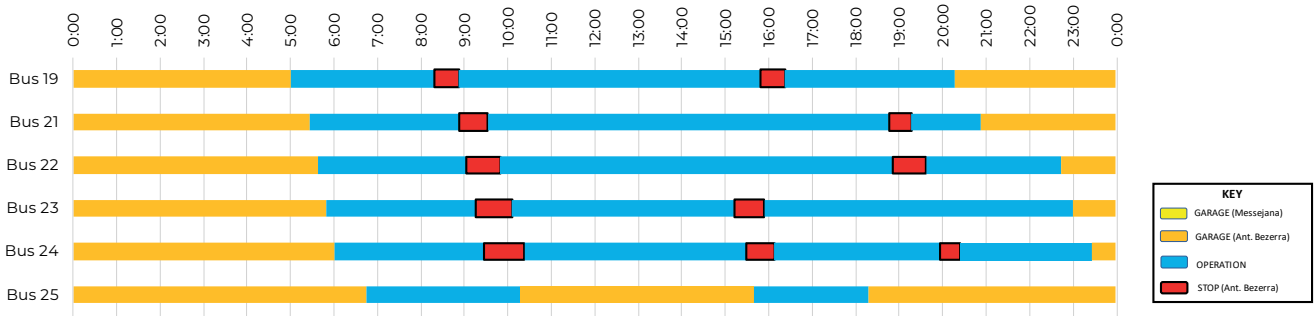
Figure 31 – Daily operation of selected vehicles of Autoviação São José company



Source: Own elaboration.

Only one vehicle of the Autoviação São José will be used, so **1 charger** is necessary for the garage of this company. Figure 32 shows the operation of the 6 vehicles operated by the company Santa Cecilia.

Figure 32 – Daily operation of selected vehicles of Santa Cecília company



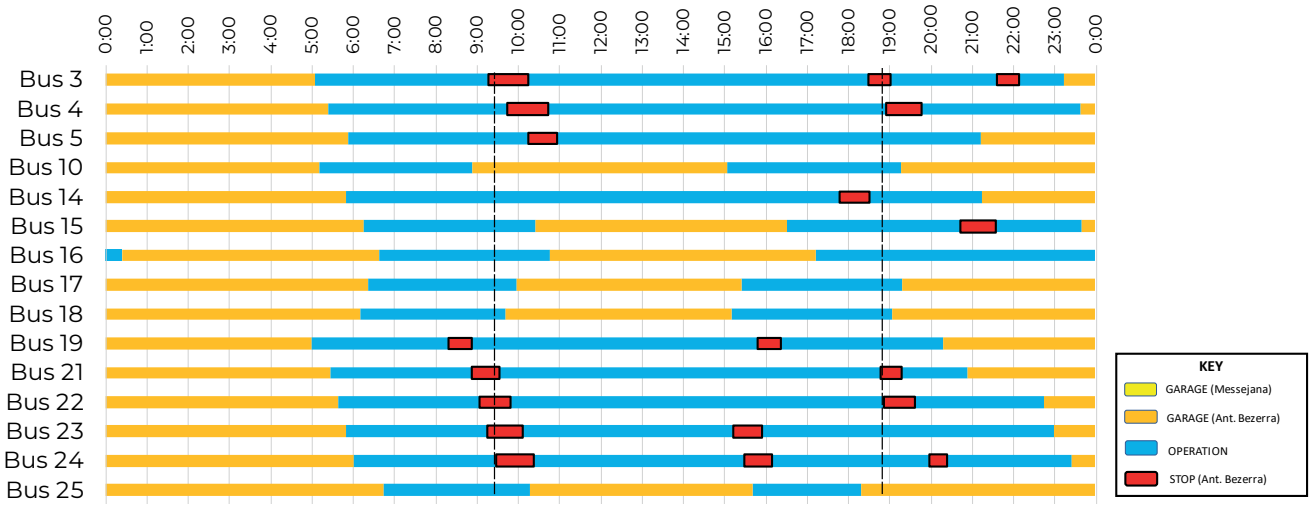
Source: Own elaboration.

It evaluates a window of opportunity for optimizing the number of chargers since vehicle 25 can charge during a stop at noon. Thus, at least 5 chargers will be needed in the garage of the company Santa Cecilia. Therefore, 13 chargers will be needed in the garages for this scenario.

c) **Charging infrastructure in The Antônio Bezerra Terminal:**

To quantify the charging infrastructure in the terminals, an operation analysis was conducted throughout all selected vehicles to identify how many opportunity chargings will be carried out simultaneously in the Antônio Bezerra Terminal, considering the current operation of these vehicles. The operation of the 15 vehicles selected in the scenario and the charging times throughout the day are presented in Figure 33.

Figure 33 – Daily operation of 15 vehicles selected in scenario 02



Source: Own elaboration.

By analyzing the distribution of opportunity chargings, there is the possibility of up to 5 simultaneous chargings. Thus, 5 chargers of opportunity will be necessary **for the Terminal Antonio Bezerra**.

3.1.3 Summary table

Table 15 – Summary table of operational scenarios

Parameters	Scenario 01	Scenario 02
Fleet	15 electrics, substituting 13 diesel	15 electrics, substituting 15 diesel
Charging infrastructure in garages	12 chargers	14 chargers
Charging infrastructure at Antônio Bezerra Terminal	-	5 chargers
Total mileage per day	2.507.5 kilometers	3.082.30 kilometers

Source: Own elaboration.

3.2 ECONOMIC AND FINANCIAL EVALUATION

The financial evaluation of the Pilot Project for Transition to Electromobility was made to determine the impacts of the adoption of new technologies on the cost invested by the operating agents and its reflection on the variation in the need for revenues to be generated, either by variation in the value of the user's tariff or by a subsidy from the Municipality in favor of operating companies. The following are the methodological principles used to indicate the data sources and, finally, the final results.

3.2.1 Methodology

The methodology adopted for the economic and financial evaluation of the Pilot Project for Transition to Electromobility can be called "planned budget replacement." In this model, we used a typical cost sheet adopted by the public transport sector, which included the fixed and variable costs resulting from using electric vehicles, and the same costs of combustion vehicles replaced by electric vehicles are deducted. Thus, in the model of "planned budget replacement," the differential from added costs of the system with and without the adoption of electric vehicles is calculated.

The Tariff Sheet was initially proposed by the Executive Group for the Integration of Transport Policy (GEIPOT)[3] in 1982, through the launch of the Practical Instructions for Calculating Urban Bus Tariff, and updated with the edition of the methodology in 1996. The conception of the tariff sheet model aimed to harmonize the calculation of the value of the tariff for the public transport user among the various entities of the federation, unifying the methodological procedures and suggesting indicators that would assist the agency that had a technical limitation to make a complete survey of their prices and tariff parameters.

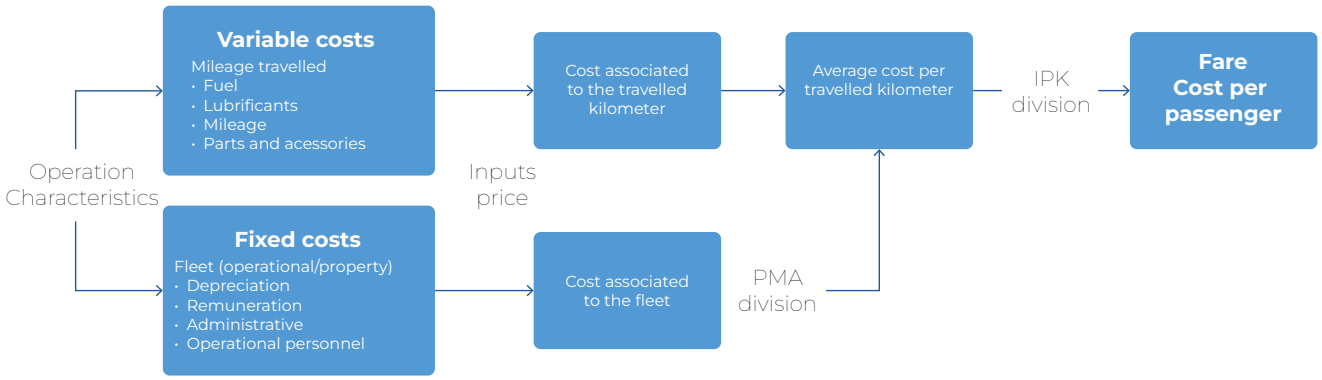
After the decision to restructure the federal transport sector in 2001, which led to the extinction of GEIPOT, the tariff sheet remained in use by most public transport managers in different municipalities, states, and Federal Government. However, motivated by the popular demonstrations of June 2013, in 2016, the Frente Nacional de Prefeitos and the Associação Nacional de Transportes Públicos, ANTP, made a great effort to review and update the tariff sheet for the current conditions of provision of public passenger transport services. This effort resulted in calculating new productivity parameters and sources of reference information, many of which were used in the present Study.

3 In 1965 the Executive Group for the Integration of Transport Policy (GEIPOT) was created through Decree No. 57,003 of October 11, 1965, with the objective of coordinating and developing a series of transport studies (as a Brazilian counterpart to an agreement signed with the International Bank for Reconstruction and Development). Later in 1969, GEIPOT was transformed into a Study Group for The Integration of Transport Policy, making it subordinate to the Minister of State for Transport. GEIPOT was transformed into a Empresa Brasileira de Planejamento de Transportes through Law No. 5,908 of August 20, 1973, maintaining the acronym GEIPOT.

The tariff sheet is a synthetic representation of the economic costs arising from the provision of public transport services. Private companies contracted for public services must be adequately remunerated. The process must respect the form and quantity defined by the management agency, either directly by the grantor or by tariff user payment. This being the case, it is correct to state that the tariff sheet aims to convert the costs arising from the provision of public services in the way defined by the Granting Authority, considering the value of the tariffs paid by transport users.

The following figure presents the schematic design of the methodology used in determining the user's tariff:

Figure 34 – Tariff calculation methodology



Source: Own elaboration.

It is appropriate to cite the calculations performed expeditiously from this general conception. Cost sheets are divided into two parts, variable and fixed. The variable costs are those arising from the operation of the vehicle and include the following items:

- Fuels
- Lubricants
- Mileage
- Parts and accessories

Variable costs are obtained according to the consumption of each input per kilometer traveled (by the vehicle) multiplied by its respective unit price. Fixed costs are independent of the operation of the vehicle, and the following items fall into them:

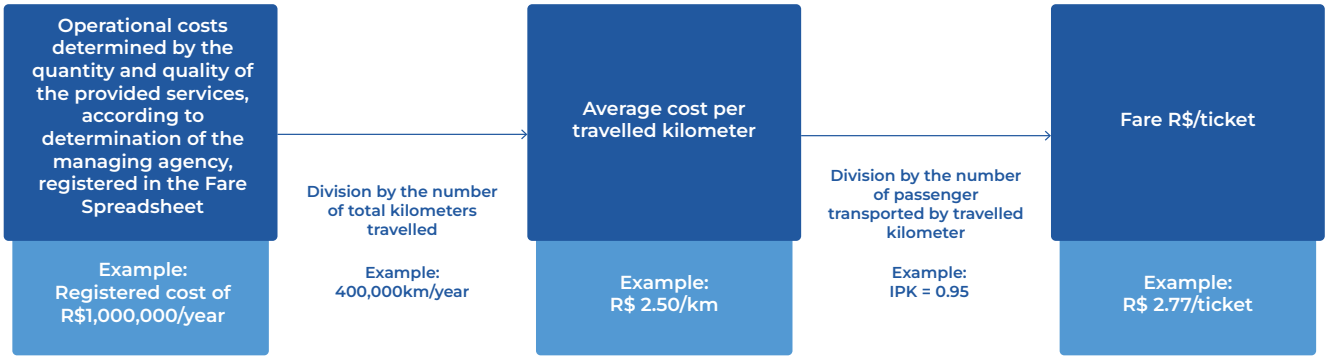
- Depreciation
- Remuneration

- Administrative
- Operation personnel

After the fixed costs of each vehicle are calculated, these are transformed into costs per kilometer. This transformation is made by the quotient between the total annual fixed cost and the Average Annual Route - PMA, which in turn is obtained by the total kilometers traveled annually in the operation of the lines, by service characteristic, divided by the number of vehicles destined to the operation of the system, including reserves.

The final value of the tariff paid per user is obtained by the sum of costs per kilometer (considered variable and fixed) divided by the Index of Passengers per Kilometer (IPK), calculated by the ratio between the number of passengers transported and the number of kilometers traveled. The following figure simplifies the methodological detailing described:

Figure 35 – Example of tariff calculation



Source: Own elaboration.

In the “planned budget replacement” model, adopted for the transition to Electromobility, the variable unit costs of electric vehicles and combustion were calculated, as well as the variations in fixed costs with depreciation and capital remuneration. Therefore, the replacement of a part of combustion vehicles by electric vehicles shall not be considered to lead to relevant changes in:

- Operational staff costs, especially drivers, inspection, and operational control staff.
- As for maintenance staff costs, no relevant changes were considered. On the one hand, the processes associated with the maintenance of electric motors tend to be more straightforward than the maintenance of combustion engines. On the other hand, the new technologies introduced by electric vehicles should demand new specialized activities, creating new maintenance positions. For the Pilot Project,

due to the proportionally reduced number of combustion vehicles replaced by electric vehicles, there should be no significant change in the number of employees allocated to these activities. But it is recommended to calculate these values before starting operations.

- Administrative staff costs should not change significantly due to technological replacement.

The productivity parameters and unit costs set out below were multiplied by the number of vehicles and by the operational and non-operational mileage detailed in the other chapters of this report to obtain the total costs of the situation with and without electric vehicles. This comparison, or "planned budget replacement," indicated what would be the monetary impact on the concession contracts of the operating companies.

3.2.2 Input data and assumptions

The Concession Contracts for the operation of the public transport system of Fortaleza have their own equation signed at the bidding process time. In this equation, the various parameters that underpin the remuneration model of the Concessionaire companies were established. Currently, the tariff adjustment process includes the parameters presented in the proposal, and part of these parameters has been subject to ordinary contractual revision in the past.

Therefore, for the financial analysis of the transition to electromobility to be performed consistent with local conditions, the main data associated with fixed and variable costs of combustion vehicles were extracted from the tariff sheet.

The data refer to February 2022, the focal point for the realization of the comparations. However, according to common fluctuations in prices such as fuel, energy, and vehicles, the comparison results may vary depending on the month of operation. The primary data sources are pointed out below:

- Parameters of consumption of diesel, oil, lubricants, parts, and accessories of combustion vehicles: Parameters from the Fortaleza Tariff Adjustment Sheet in force for February 2022.

- Diesel price parameters: average prices announced by the National Agency of Petroleum, ANP, for fuel distributors in Fortaleza. Note that the average size of a bus company is usually smaller than that of a distributor, so the value of diesel may eventually be underestimated.

- Price parameters of diesel vehicles: prices considered in the Fortaleza tariff sheet

- Price parameters of electric vehicles with plug-in charging or by Ultracapacitor: Quotation formalized in the event of a Procedure of Expression of Interest carried out by the City of Rio de Janeiro in 2020 for the BRT Project of Avenida Transbrasil, adjusted for exchange variations. U.S. dollar values were compared at prices observed in other international projects. Possible differences are due to the incidence of taxes, which in Brazil is higher than in other countries, and to the circumstances in force in the production chain of heavy vehicles. Furthermore, quotations may vary significantly between the present date and the effective acquisition date of the vehicles due to various factors such as exchange rate, supply or scarcity of supplies, and others. Nevertheless, there may be a reasonable difference in the price of vehicles for each State of Brazil due to the rates and ways of calculating the incidence of ICMS.

- Energy price parameters: values according to the tariff grid provided by ENEL - CE for February 2022, detailed in item 1.4.1 of this Report.

- Energy consumption parameters, lubricants, parts, and accessories of electric vehicles: bibliographic references on international experience, including the following studies:

    - Ministério de Desenvolvimento Regional do Brasil e Banco Interamericano de Desenvolvimento, "GUIA DE ELETROMOBILIDADE, Orientações para estruturação de projetos no transporte coletivo por ônibus." 2022. [13]

    - Grütter, Jürg, Grütter Consulting AG: "Rendimiento Real de Buses Híbridos y Eléctricos. Rendimiento ambiental y económico de buses híbridos y eléctricos basados en grandes flotas operacionales." [18]

    - Orbea, Jone: "Modelos de negocio para la adopción de flotas eléctricas: Experiencias Internacionales". World Resources Institute, October 2017. [19]

    - Corporación Andina de Fomento: "La electromovilidad en el transporte público en América Latina", 2019. [20]

    - The World Bank: "GREEN YOUR BUS RIDE, Clean Buses in Latin America, Summary report," Janeiro de 2019. [21]

Based on the bibliographic research formulated and the consolidation of the various sources used to calculate the "planned budget substitution" model, the following detailed parameters were consolidated:

Table 16 – Parameters considered for calculating the "planned budget replacement" model - Part 1 of 2

	Heavy			Padron		
	Diesel	**Plug-In**	**Ultracapacitor**	**Diesel**	**Plug-In**	**Ultracapacitor**
Vehicle Investment						
Initial Purchase Price - Vehicle	561,672	1.450.000	2.000.000	595,000	1.525.000	2.200.000
Price Renewal - Vehicle (year 7)	561,672	0	0	595,000	0	0
Price Renewal - Battery (year 7)	0	725,000	0	0	725,000	0
Variable Cost						
Fuel Consumption / Energy						
Fuel price or Kw/h	0.429	1.149	1.300	0.453	1.282	1.600
Consumption with Parts and Accessories	5,23%*	0,9877	0,9877	5,23%*	0,9877	0,9877
Lubricant consumption	7,50%*	21,063	21,063	7,50%*	22,313	22,313
Equipment	5,00%	0,25%	0,25%	3,00%	0,25%	0,25%
Cost of the Charging Station in R$		105,000			105,000	
Infrastructure						
Cost of the Charging Station in R$		15,000			15,000	

**Cost reference of a diesel vehicle*

Source: From MDR, 2022; Grütter Consulting AG, 2015; Orbea, 2017; CAF, 2019; and World Bank, 2019.

Table 17 – Parameters considered for calculating the "planned budget replacement" model - Part 2 of 2

	Articulated 18 m			Articulated 23 m		
	Diesel	Plug-In	Ultracapacitor	Diesel	Plug-In	Ultracapacitor
Vehicle Investment						
Initial Purchase Price - Vehicle	1.447.731	3.229.067	4.057.000	1.750.000	3.610.480	4.350.000
Price Renewal - Vehicle (year 7)	0	0	0	0	0	0
Price Renewal - Battery (year 7)	0	1.370.850	0	0	1.587.300	0
Variable Cost			0,00			
Fuel Consumption / Energy			1.900			
Fuel price or Kw/h	0.698	1.250	0,5882	0.759	1.370	1.900
Consumption with Parts and Accessories	5,23%*	0,9877	37,950	5,23%*	0,9877	0,9877
Lubricant consumption	7,50%*	54,290	0,25%	7,50%*	65,625	65,625
Equipment	0	0	0	0	0	0
Cost of the Charging Station in R$	0	105,000	0	0	105,000	0
Infrastructure	0	0	0	0	0	0
Cost of the Charging Station in R$	0	15,000	15,000	0	15,000	15,000

**Cost reference of a diesel vehicle*

Source: From MDR, 2022; Grütter Consulting AG, 2015; Orbea, 2017; CAF, 2019; and World Bank, 2019.

3.2.3 Results

From the product between the unit values of productivity, the prices of inputs, and the volumes of kilometers traveled by electric vehicles and no longer covered by combustion vehicles, the variable operating cost values exposed below were reached:

Table 18 – Variable operating costs

	OPEX ADDED/ YEAR	OPEX AVOIDED / YEAR
Energy / fuel	1.481.619,84	2.769.832,26
Lubricants / arla	20.773,74	138.491,61
Parts and Accessories	334.687,50	669.375,00
TOTAL ANNUAL	**1.837.081,08**	**3.577.698,87**
TOTAL 7 YEARS	**12.859.567,58**	**25.043.892,11**

Source: Own elaboration.

The variable costs are expected to present the most significant differences in favor of electric vehicles. Considering the consumption parameters compiled from the literature on the subject and the prices in force in February 2022, the expenditure on energy will be about 23.80% of the expenditure on fuel in combustion vehicles. The costs of parts and accessories will be about 50% of the costs of combustion vehicles, while the costs of lubricants will be only 15% of the expected costs. In total, the average costs for electric vehicles will be, on average, 28.18% of the costs per kilometer per combustion vehicle. With a safe operation of 200 km per day to not reach the minimum level of 20% of the battery in 25 days per month, the annual cost differential will be R$ 1,740,617.79. For seven years projected, the total accumulated will be R$ 12,184,324.53.

On the investment side, the differential price between conventional combustion vehicles and electric vehicles, added to the costs of investments in charging systems and civil constructions necessary for their implementation, results in the following table.

Table 19 – CAPEX added and avoided

	CAPEX ADDED	CAPEX AVOIDED
Fleet		
Initial Investments	22.875.000,00	8.925.000,00
Equipment		
Chargers	2.362.500,00	
Infrastructure	337.500,00	
TOTAL 15 YEARS	**25.575.000,00**	**8.925.000,00**

Source: Own elaboration.

Thus, there is an increase of R$ 16,650,000.00 due to the planned replacement of combustion vehicles with electric vehicles. This amount is close to the savings in operating costs variable over the remaining 7 regulatory years of the Concession Contract. However, this account should add to the cost of the capital remuneration and amortization rates, resulting in the aggregate analysis set out in the following table.

Table 20 – Aggregate analysis

Electric Vehicles	Initial inv.		Useful life (years)		Residual Value		Annual Depreciation		Annual Compensation				Variable Costs	Planned costs
	Vehicle	Battery	Vehicle	Battery	Vehicle	Battery	Vehicle	Battery	Deadline	Int. Rate	Vehicle	Battery		
Articulated	0	0	15	7	5,00%	0,00%	0	0	6	8,95%	0	0	**1.837.081,08**	**6.100.571,08**
Padron	12.000.000	10.875.000	15	7	5,00%	0,00%	760,000	1.553.571	6	8,95%	869,940	556,179		
Heavy	0	0	15	7	5,00%	0,00%	0	0	6	8,95%	0	0		
Equip-ment	2.362.500		7		0,00%		337,500		6	8,95%	120,825	0		
Infrastruc-ture	337,500		7		0,00%		48,214		6	8,95%	17,261	0		
Total	**25.575.000**						**2.699.286**		**1.564.204**					

Diesel Vehicles	Initial inv.	Useful life (years)	Residual Value	Annual Depreciation	Annual Compensation			Variable Costs	Planned costs
	Vehicle	Vehicle	Vehicle	Vehicle	Deadline	Int. Rate	Vehicle		
Articulated	0	12	5,00%	0	7	8,95%	0	**3.577.698,87**	**4.928.118,31**
Padron	8.925.000	10	10,00%	803,250	7	8,95%	547,169		
Heavy	0	8	10,00%	0	7	8,95%	0		
Total	**8.925.000**			**803,250**	**547,169**				

Variation in Annual Costs	**1.172.452,77**

Source: Own elaboration.

It is concluded that, according to the calculation of costs per tariff sheet, there will be an additional cost to be covered by some alternative resource source. These may come from the price increase in tariffs or direct subsidies to cover this cost difference of approximately R$ 1,172,452.77 per year.

It should be noted, however, that this model has as an implicit premise the full delegation of the activities of acquisition, implementation, operation, and maintenance of electric vehicles by the private initiative.

3.3 LEGAL ASPECTS UNDER THE DEFINED MODEL

In Fortaleza, the form of the public service of public transport is regulated in Federal Law No. 8987/1995 (common concession). The Government is responsible for the design and delegates the execution to the private, with the allocation of financial risks to operators.

It is important to recall that Municipal Law No. 10,586/2017 instituted the Low Carbon Urban Development Policy of Fortaleza and, among the guidelines disciplined in Article 5, there is mention, in item V, regarding the prioritization of non-motorized models and the circulation of public transport over individual transport in the ordering of the road system. Furthermore, it set a target of 15.5% by 2020 and 20% in 2030 of greenhouse gas (GHG) emissions, as well as the strategy of developing and encouraging actions that promote the use of clean energy with an emphasis on public transportation.

Regarding public transport, it is possible to start the transition by implementing the electric bus fleet. This passage brings together several challenges intrinsic to the activity, highlighting the need for alignment between all stakeholders (governments, operators, funders, manufacturers, and suppliers of technology) for the transition to be efficient.

From a technical point of view, the premises were divided into two scenarios:

- Scenario 01: operation with night charging in garages with a total of 15 electric vehicles and 2,507.5 km/day

- Scenario 02: operation with charging in The Antonio-Bezerra Terminal and garages and 3,092.30 Km/day

Table 21 – Scenario 01: operation with night charging in garages with a total of 15 electric vehicles and 2,507.5 km/day

Company	Vehicles replaced-quantity	Line	Charging infrastructure - chargers
Vega S/A Transporte Urbano	04	Line 026-Ant.Bezerra/ Messejana	3 (garage near Ant. Bezerra)
Auto Viação São José	01	Line 222 - Antônio Bezerra/Papicu	01
Santa Cecília	9 vehicles; 1 with 1:1 replacement and 8:6	Line 222 - Antônio Bezerra/Papicu	08

Source: Own elaboration.

Table 22 – Scenario 02: operation with charging in The Antonio-Bezerra Terminal and garages and 3,092.30 Km/day

Company	Vehicles replaced-quantity	Line	Charging infrastructure - chargers
Auto Viação Fortaleza	03	Line 026-Ant.Bezerra/ Messejana	03 in the garage
Vega S/A transporte Urbano	04	Line 026-Ant.Bezerra/ Messejana	04 in the garage (near Antônio Bezerra terminal)
Auto Viação São José	01	Line 222 - Antônio Bezerra/Papicu	01 in the garage
Santa Cecília	06	Line 222 - Antônio Bezerra/Papicu	06 in the garage
Vega S/A transporte Urbano	01	Line 222 - Antônio Bezerra/Papicu	5 at Antônio Bezerra Terminal

Source: Own elaboration.

In this context, to formulate and evaluate the most appropriate business modality for public transport projects (involving all or part of electric bus components), the city was able to consider four alternatives:

1. Full public responsibility
2. Private responsibility or Global Concession
3. Shared responsibility between the public and private in a single contract
4. Private responsibility in two contracts

During the Electric Bus Financing Pilot project, training was held, the dialogue was opened with the Public Authorities, and all possibilities for the transition were discussed. However, considering the local characteristics and the collective passenger transport contracts in force, the choice for the pilot project was the Private Responsibility or Global Concession, that is, obligation with the Concessionaire and resulting in the economic-financial rebalancing of the contract. In this sense, it must follow some essential aspects of the current contracts and present some legal points that must be observed to carry out the proposal.

In Fortaleza, there are 5 contracts signed on May 31, 2012, whose term is 15 years (second clause) and with the possibility of extension for an equal period.

- Contract n.º 11/2012: Leste Consortium (Viação Urbana Ltda + Auto Viação Fortaleza LTDA.)

- Contract nº 12/2012: Antônio Bezerra Consortium (Veja S/A + Transporte Urbanos S/A + Santa Cecilia Ltda + Santa Maria ltda)

- Contract n.º 12/2012: Consortium Expresso 5 (Auto Viação Ltda + Viação Siará Grande LTDA + Frectar Ltda + Cearense Transporte Ltda + Terra Luz S.A)

- Contract n.14/2012: Parangaba Consortium (Auto Viação Dragão Ltda + Maraponga Transporte Ltda + Auto Viação São José Ltda)

- Contract No. 15/2012: Messejana Consortium (Auto Viação Fortaleza Ltda + Auto Viação Dragão Ltda + Rotaexpressa S/A + Veja S/A)

The general rules defined in the contract determine:

I. The term of the contract for 15 years and allowed its extension for a single time by reasoned act of the Executive Authority, respecting the conditions set out in item 02.02;

II. The operational characteristics of the service (itinerary, frequency, schedule, and fleet of the lines) can be changed at the municipality's discretion whenever necessary to meet the needs of users, respecting the economic and financial balance of the Contract (item 02.03);

III. The average age of the fleet is a maximum of 4.5 years. (item 05.01.09):

IV. The Granting Authority must stimulate the increase in quality and productivity of the service and environment preservation(item 06.01.16);

V. The Concessionaire is obliged to accept the implementation of other services using different vehicles from the fleet provided for in Annex 1 (Basic Project) of the Public Competition Notice in 03/2012. Annex 1.4 presents the basic specifications of the fleet vehicles, and the concessionaire must use only vehicles that meet the specific ones contained

in the Annex, assuming adjustments that improve the conditions of comfort and safety to users, provided the Grantor's approvement;

VI. The Granting Authority may determine the implementation of new services in the area of operation, using vehicles differentiated from the fleet provided for in Annex 1 during the concession term. The operation is the responsibility of the concessionaire, that may not refuse to operate a new service, provided that the necessary duration is ensured and the maintenance of the economic and financial balance of the contract (Clause 12.02);

VII. Ensure the CONCESSIONAIRE the period necessary for its mobilization and promote the calculation of the remuneration of the provision of services according to specific cost sheet, in cases of implementation of other services, using different vehicles from the fleet provided for in Annex 1 (Basic Project) of the Public Competition Notice03/2012, during the term of the CONCESSION (item 06.01.21)

VIII. The assets affected by the concession will not be reversible; (buses and undercarriage, respectively, do not integrate the collection of reversible assets, either because such assets, at the end of contracts, will have a high depreciation that its inclusion in the contractual economic structure would not be justified, or because such assets may become obsolete, due to the advent of new technologies) (clause 18.1)

The Concession Contract defines the duration, obligations, and compensations from tariff collection and subsidies and presents legal space for the insertion of the electric bus fleet.

Therefore, a technical study that underpins the contractual change and establishes the technical conditions that involve the insertion of the electric fleet is necessary. It must include the type and number of buses to purchase, the infrastructure required for charging and dimensioning the charges, the location of charging points, the training of personnel for operation with the definition of the manual to be observed, the definition of the delivery method of the vehicle to the Concessionaire, complete operation's starting date, specifications for operational issues that may compromise the provision of the service.

Moreover, from an economic point of view, it is necessary to calculate the value of the imbalance and ways to pay for an economic-financial rebalancing of the contract with the respective budget allocation that supports the obligation.

Sure, too, that the Granting Authority should prepare its staff for the due inspection of the operation, considering that the vehicular technology in the municipality is new and will be integrated with the standard operation.

Finally, and if, after studies, there is an extension of the contractual period, the act of authorization comes from the Chief Executive and, as an addendum rule concluded, should be published in the official gazette and forwarded to the External Control Agency (Court of Audit).

3.4 ASPECTS OF SOCIAL IMPACT

In this topic, some aspects will be addressed regarding the lines defined for the operation of electric buses. Among these aspects is the characterization of the general demand of these lines and the attendance to the nearby population considering aspects of income, gender, and race.

3.4.1 General demand

The lines defined for the operation of electric buses (026 - Antônio Bezerra/Messejana and 222 - Antônio Bezerra/Papicu) present relevant demand in relation to the public transport system. Regarding ticketing demand (without considering the demand of terminals), line 026 has the 29th highest demand, while line 222 is 40°, of the total of about 300 lines that make up the system. It is worth noting that the lines are trunk lines, and about 25% of the total demand is composed of demand in the terminals, so these lines should be in even higher positions considering the total demand.

Ticketing data is easily accessible. However, the demand at the terminals is known only through research at on-site departure. Therefore, the survey of departure carried out in 2018 within PASFOR was used to obtain the total demand for these lines. Knowing that the current demand of the system is between 60% and 70% for the 2018 levels, the premise was adopted that the current demand in the terminals presents a ratio of 65% in relation to the values obtained in the PASFOR survey conducted in the pre-pandemic period.

ETUFOR released ticketing demand data from 04/27/2022 (Wednesday) of the lines under analysis. Line 026 had the highest demand, with 5,926 passengers on the day, while line 222 had 4,579 passengers on the day. Applying the factor of 0.65 in the demand of the terminals of the research conducted by PASFOR in 2018, the values of 2,006 daily departures on line 026 and 1,746 daily departures on line 222 were obtained. Thus, it is evaluated that the daily demands are 7,932 passengers on line 026 and 6,325 on line 222. The values are shown in Table 23

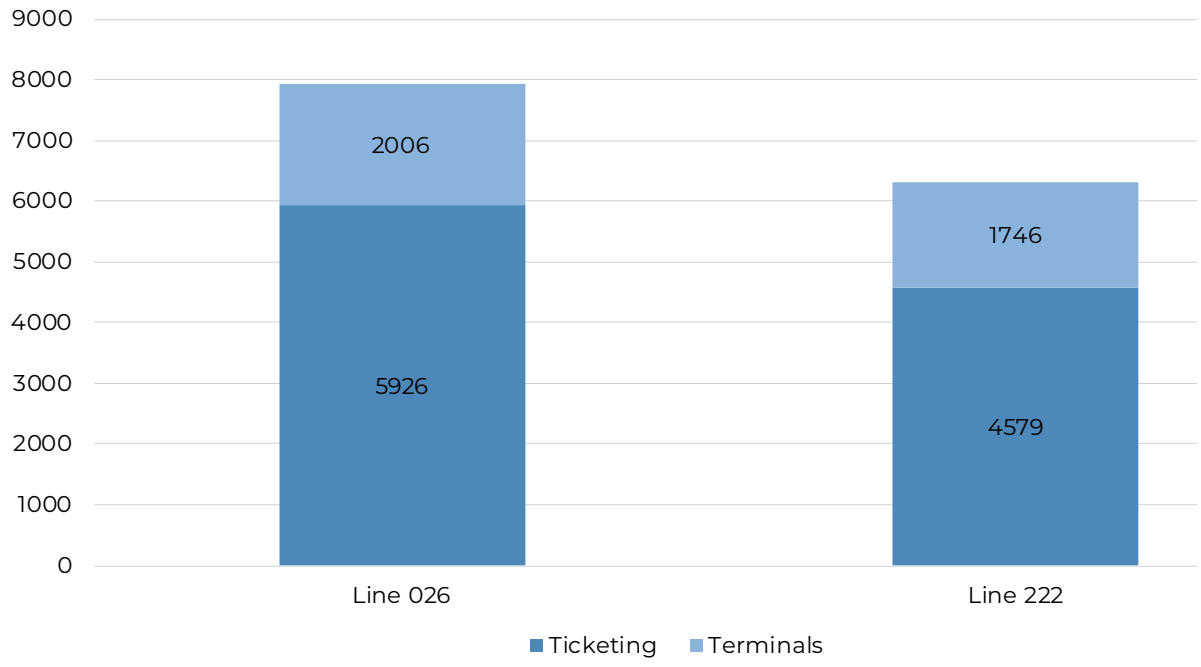
Table 23 – Daily demand for lines 026 and 222

Line	Type	Total	%
Line 026	Ticketing	5,926	74,7%
	Terminals	2,006	25,3%
	Ticketing + terminals	7,932	100,0%
Line 222	Ticketing	4,579	72,4%
	Terminals	1,746	27,6%
	Ticketing + Terminals	6,325	100,0%

Source: Own elaboration.

As previously stated, the demand in the terminals is about 25% of the total daily demand. This indicates that, despite being trunk lines, the lines have plenty of power along the routes. The chart with the daily demand values per line by type is shown in Figure 36.

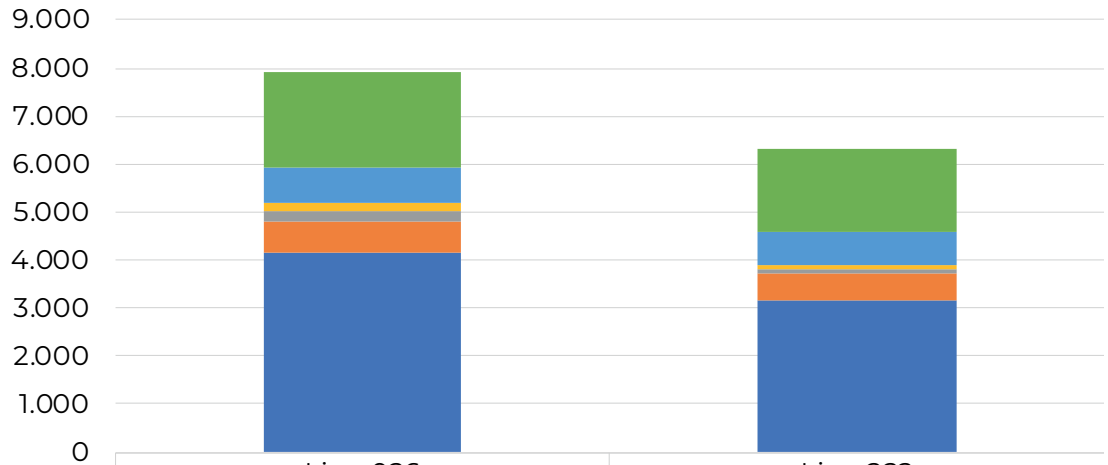
Figure 36 – Demand data by access type



Source: Own elaboration. Data from ETUFOR and PASFOR.

Through ticketing data, it was also possible to identify the classification of the type of departure, that is, the number of departures via full ticket, half, and gratuity, among others. The data are shown in Figure 37.

Figure 37 – Daily demand by classification



	Line 026	Line 222
Terminal integration	2.005	1.746
Temporal integration	756	687
Disabled person	156	95
Gratuity	197	71
Half price	681	582
Full price	4.136	3.144

Source: Own elaboration. Data from ETUFOR.

Concerning line 026, about 13% of the demand is composed of gratuities or discounts (half, deficient, and gratuity), and 35% represents some type of integration (terminal or temporal), enhancing the integration in the terminals. Concerning the demand in the terminals, there is a greater predominance in the Messejana terminal, 61%, while the Antônio Bezerra terminal has the remaining 49%.

In line 222, about 12% of the demand comprises gratuities or discounts, and approximately 38% comprises some type of integration. The proportions are similar to those of line 026. Concerning the demand in the terminals, there is a more significant equivalence between the terminals, with a greater predominance of the Antônio Bezerra terminal, with 54% of total demand, while the remaining 46% of shipments are in the Papicu terminal.

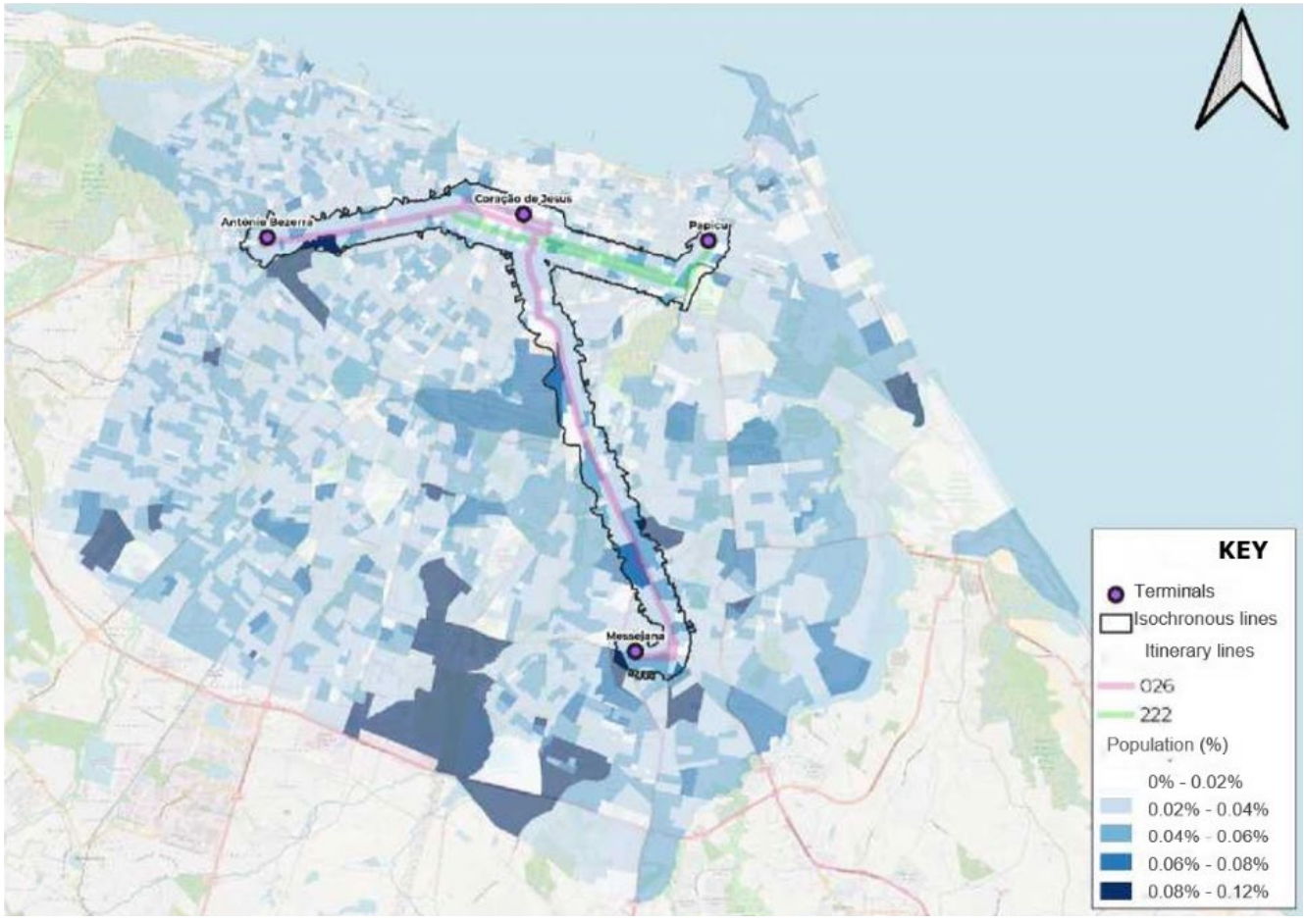
3.4.2 Population close to the lines considering aspects of income, gender, and race

To evaluate the service of these lines, indicators were analyzed, measuring the percentage of the population that resides within a certain radius from line routes defined in the pilot project. The indicators consider

income, gender, and race criteria: percentage of the total population, black women, and low-income households (monthly household income per capita less than 1/2 minimum wage). For the calculation of these indicators, data from the 2010 IBGE Census were used.

As the lines defined for the pilot project are trunks (which connect terminals), the indicators were also analyzed considering the spatial coverage of the feeder lines of the contemplated terminals. Therefore, for the trunk lines, a coverage radius of 500 meters of the routes was considered, while for the feeder lines, as smaller capacity lines, a coverage radius of 300 meters was considered. In addition, isochronous were elaborated to obtain the indicators. Next, Figure 38 shows the spatial coverage of the defined lines and thematic map with the population percentage per census tract.

Figure 38 – Spatial coverage of trunk lines and population percentage

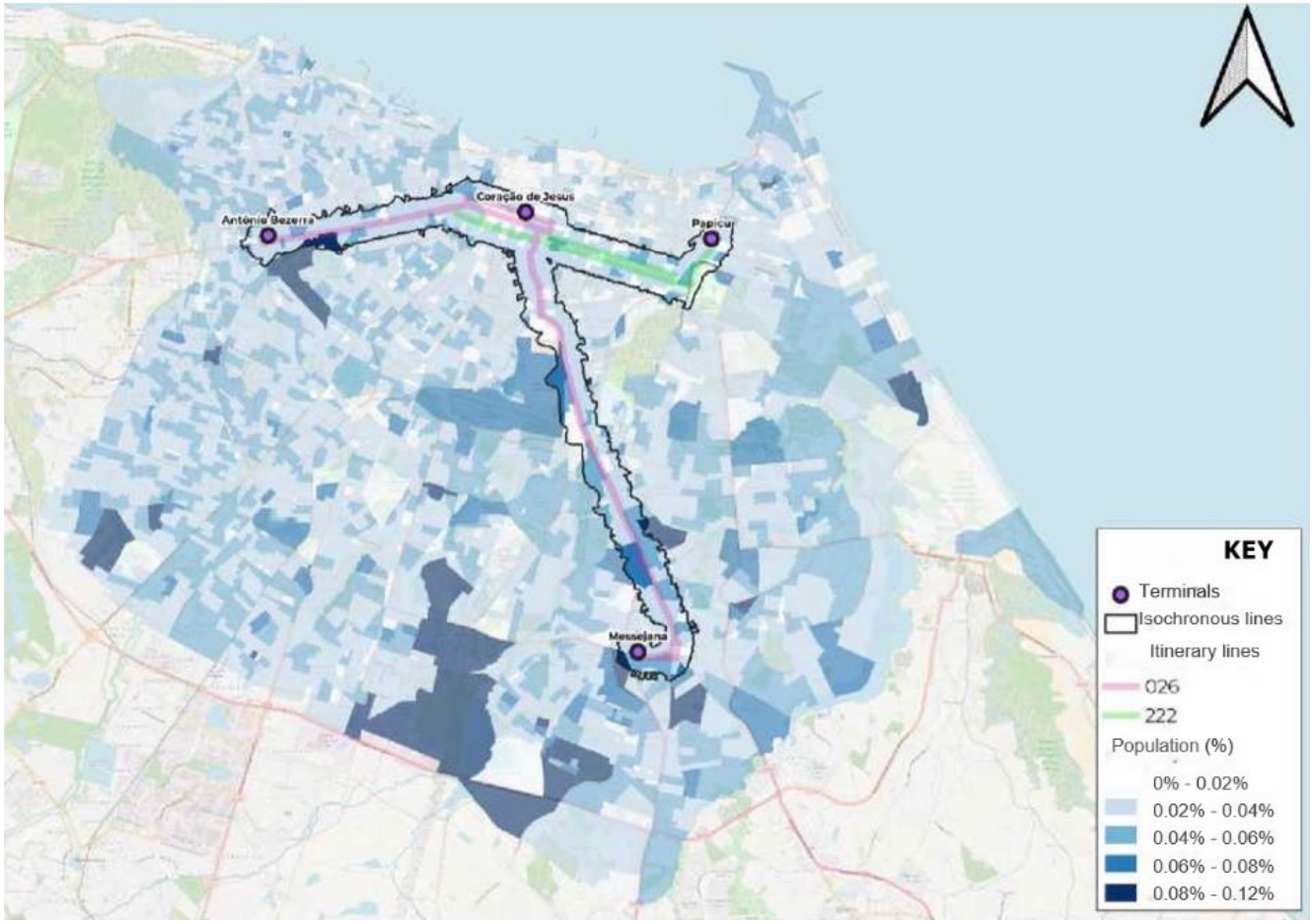


Source: Own elaboration. Data from ETUFOR and the IBGE 2010 Census.

The data indicate a higher proportion of the population along the route of line 026, closer to the Messejana region. However, it is noticed that there is a greater concentration of the population around the terminals served. Considering the itineraries of the lines defined for the pilot project, about 8.4% of the population of Fortaleza is served by the lines considering a walkability radius of 500 meters. This represented about 205,000 people in 2010, when Fortaleza had a population of 2.4 million people.

According to an estimate conducted by IBGE, the population of Fortaleza has grown about 10.24% since the last census. Adopting this growth homogeneously throughout the city, the route of the lines currently covers about 250,000 people. Figure 39 shows the spatial coverage of the defined lines and feeder lines of the contemplated terminals, in addition to a thematic map with the population percentage per census tract.

Figure 39 – Spatial coverage of trunk and feeder lines and population percentage

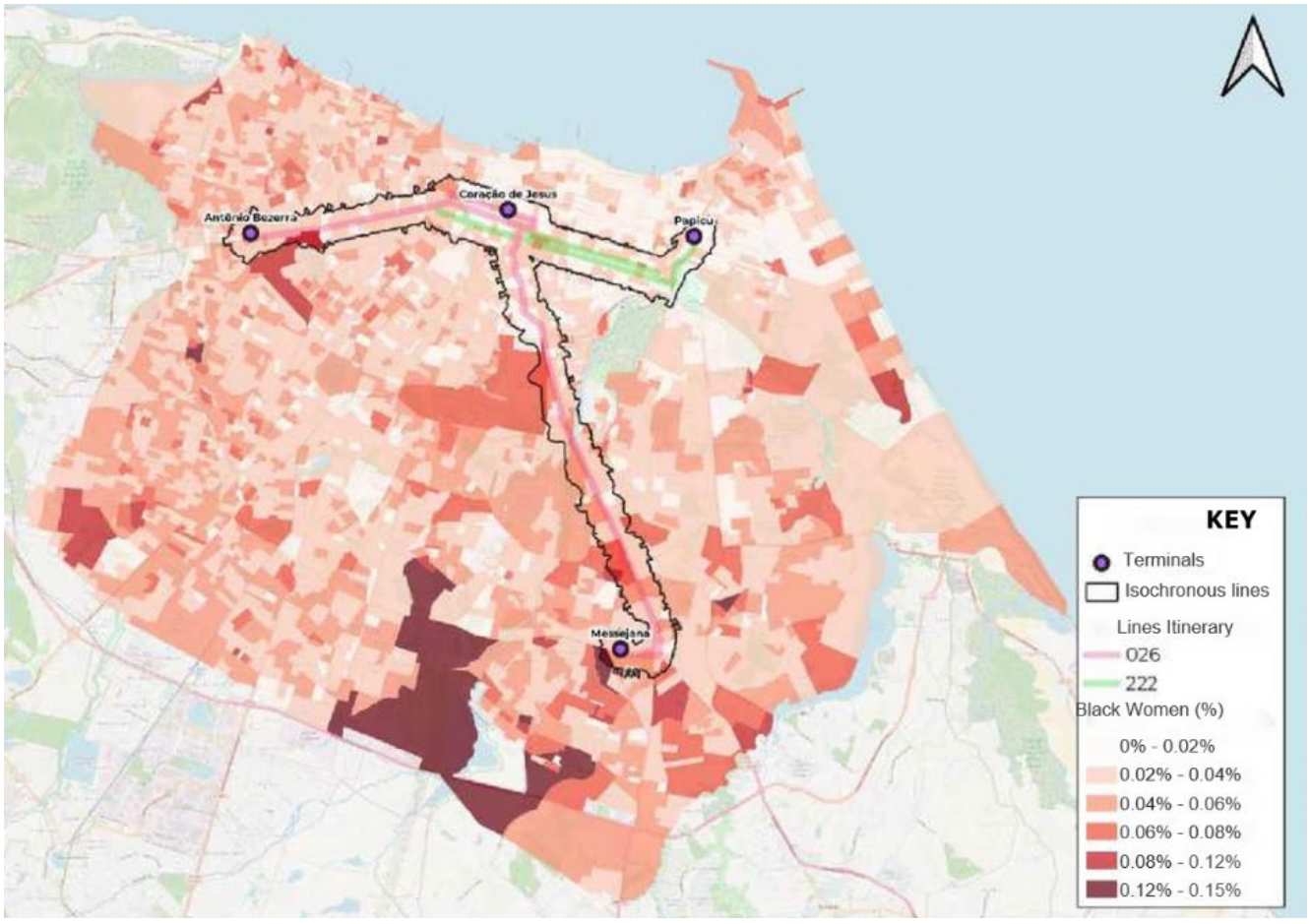


Source: Own elaboration. Data from ETUFOR and the IBGE 2010 Census.

With the integration of the trunk lines with the feeder lines in the terminal, there is significantly greater spatial coverage. However, as previously pointed out, it can be noted that there is a higher proportion of the population around the terminals compared to the itinerary of the lines. Considering the itineraries of the pilot project's trunk lines and the pilot project feeders, about 43.7% of Fortaleza's population is served by the trunk and feeder lines in question, considering a walkability radius of 500 meters for the trunk lines and 300 meters for the feeder lines.

This represented about 1.07 million people in 2010 when Fortaleza had about 2.4 million people. Therefore, by adopting the growth of the population of Fortaleza, considering the last census, homogeneously for the entire municipality, it can be affirmed that the spatial coverage of the trunk lines of the pilot project and feeder lines cover about 1.18 million people. Next, to analyze accessibility considering gender and race criteria, Figure 40 shows the spatial coverage of the lines defined in addition to a thematic map with the percentage of black women per census tract.

Figure 40 – Spatial coverage of trunk lines and percentage of black women

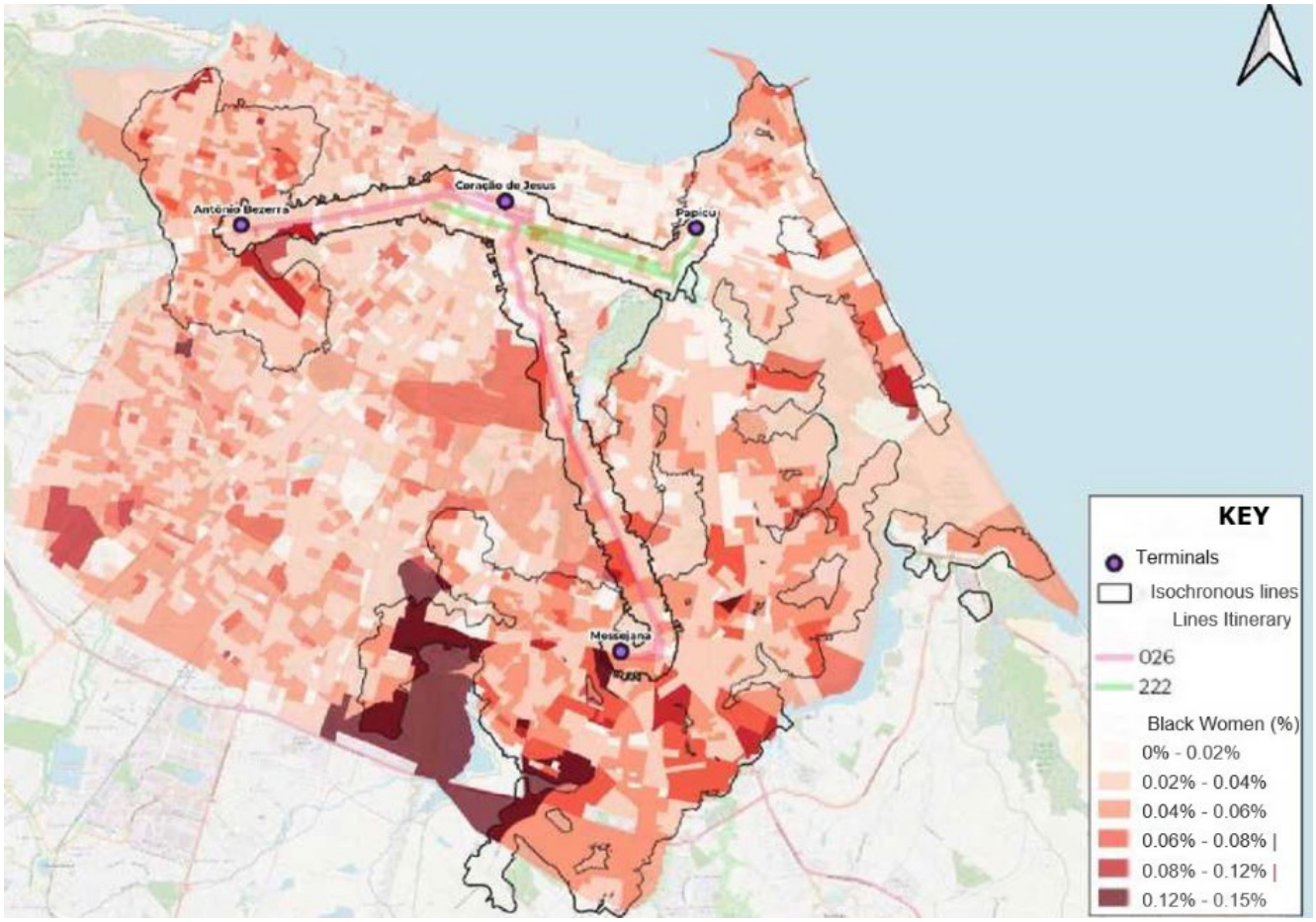


Source: Own elaboration. Data from ETUFOR and the IBGE 2010 Census.

As in the total population indicator, the data indicate a higher proportion of women along the itinerary of line 026, around the Region of Messejana. Considering the itineraries of the lines defined for the pilot project, about 7.3% of the black women's population is served by the lines considering a walkability radius of 500 meters. This figure shows about 60,000 black women in 2010 when Fortaleza had about 816,000 black women.

Adopting the growth of the population of Fortaleza from 2010 to 2021 as a premise of the same growth of black women, it can be affirmed that the route of the lines currently covers about 65,000 black women. Figure 41 shows the spatial coverage of the defined lines and feeder lines of the contemplated terminals, in addition to a thematic map with the percentage of the population of black women per census tract.

Figure 41 – Spatial coverage of trunk and feeder lines and percentage of black women



Source: Own elaboration. Data from ETUFOR and the IBGE 2010 Census.

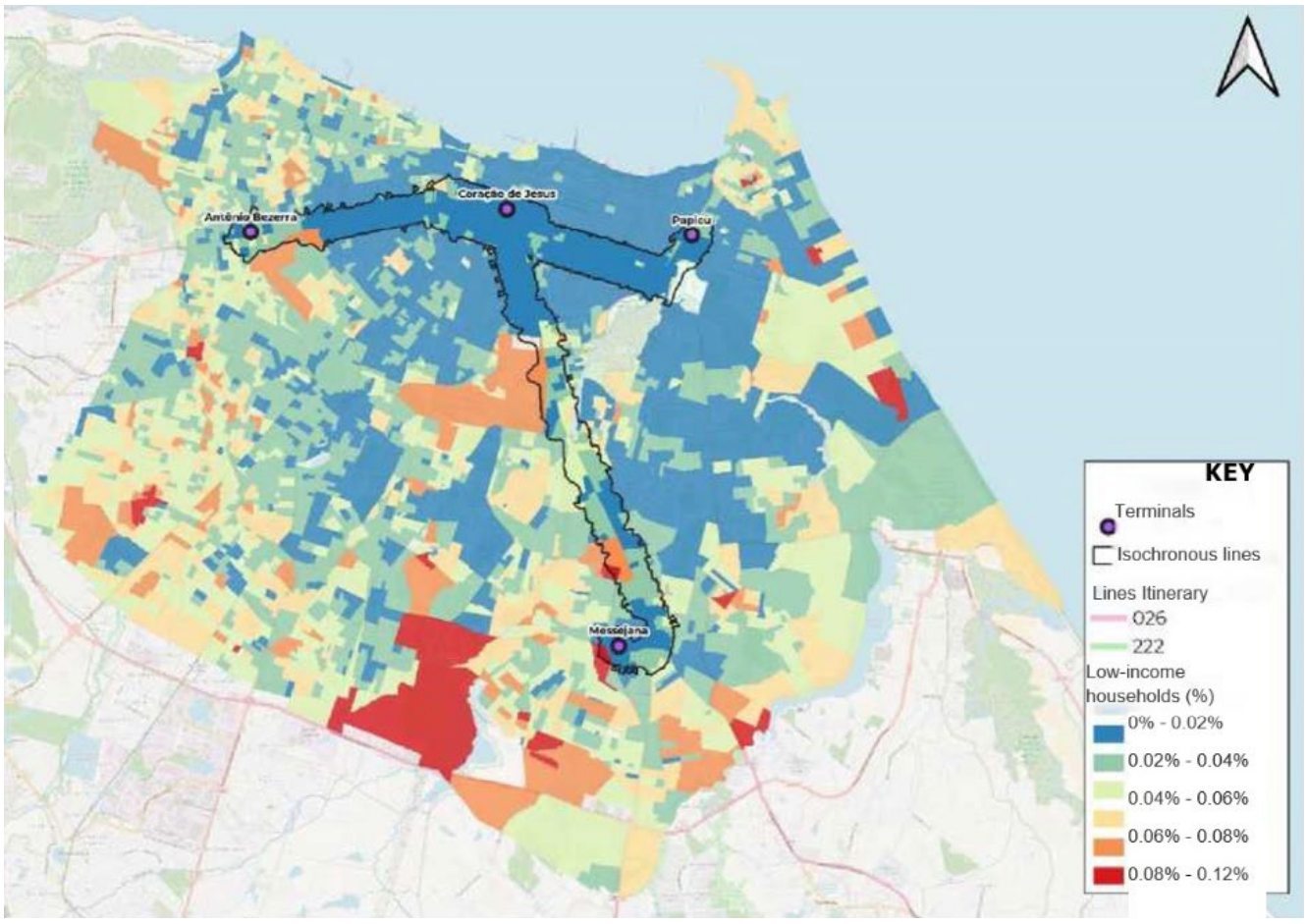
As previously pointed out, the integration of the trunk lines with the feeder lines in the terminal attributes to an expressively broader spatial coverage. It is noted that there is a higher concentration of black

women around the terminals in peripheral neighborhoods. Considering the itineraries of the pilot project's trunk lines and the pilot project feeders, about 43.4% of the black women's population is served by the trunk and feeder lines in question, considering a walkability radius of 500 meters for the trunk lines and 300 meters for the feeder lines.

This proportion represents about 354,000 black women in 2010 when Fortaleza had about 816,000. Therefore, adopting the growth of the population of Fortaleza from 2010 to 2021 as a premise of the same growth of black women, it can be affirmed that the route of the lines currently covers about 390,000 black women.

Next, to analyze accessibility in the lines considering income criteria, Figure 42 shows the spatial coverage of the lines defined in addition to a thematic map with the percentage of low-income households (with nominal monthly income lower than half a minimum wage).

Figure 42 – Spatial coverage of trunk lines and percentage of low-income households



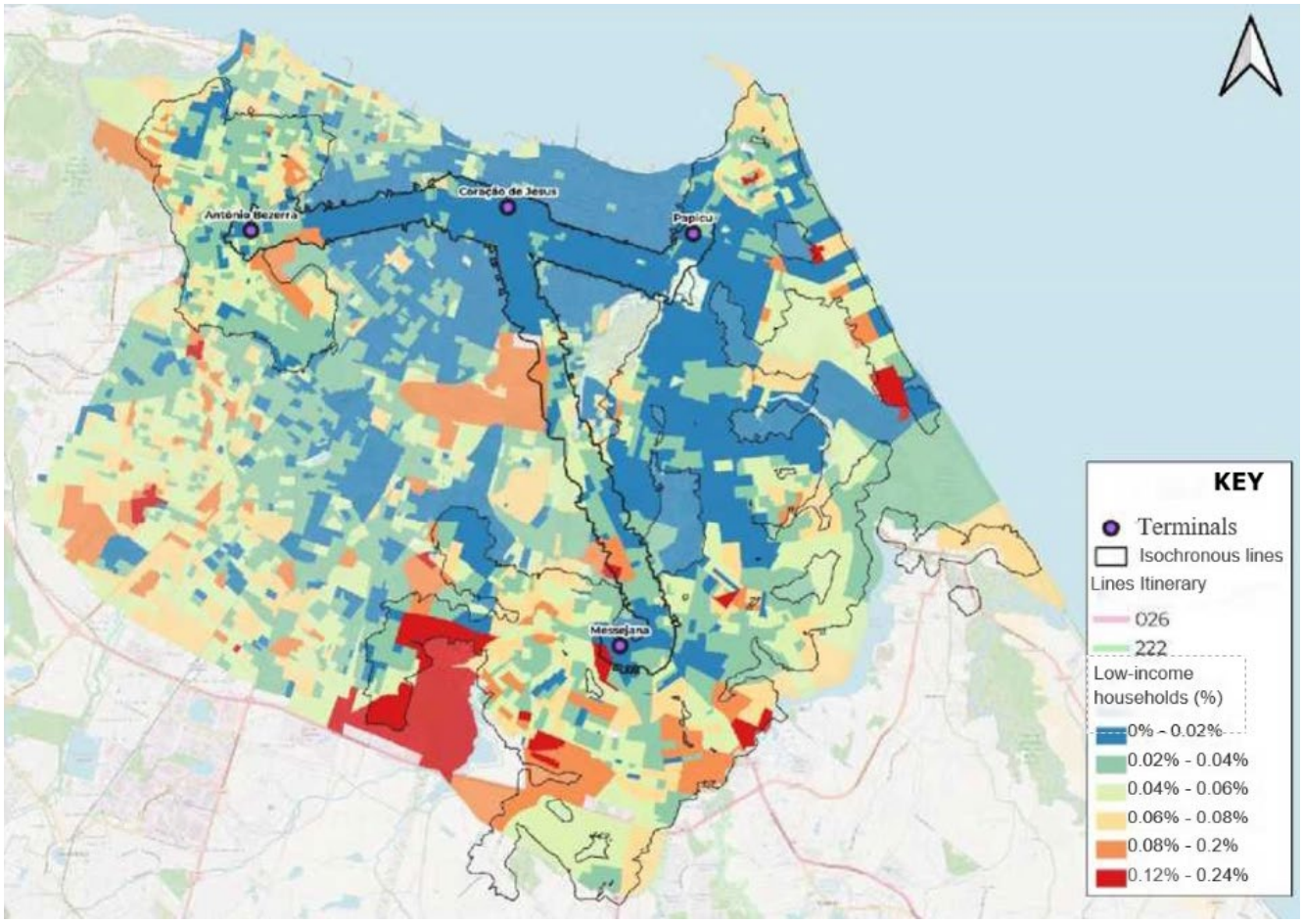
Source: Own elaboration. Data from ETUFOR and the IBGE 2010 Census.

It is verified that the itinerary of the defined lines passes through areas that do not concentrate, in a significant way, the low-income population. This is because they are trunk lines that connect terminals and the downtown. It is verified that the low-income population resides mainly around the terminals in the municipality's southwest area.

Considering the itineraries of the lines defined for the pilot project, about 8.4% of the population of Fortaleza is served by the lines considering a walkability radius of 500 meters. This value represents about 10,000 low-income households in 2010 when Fortaleza had 224,000 of them.

Adopting the growth of the population of Fortaleza from 2010 to 2021 as a premise of the same growth of low-income households, it can be affirmed that the itinerary of the lines currently covers about 11,000 black women. Figure 43 shows the spatial coverage of the defined lines and feeder lines of the contemplated terminals, in addition to a thematic map with the percentage of low-income households per census tract.

Figure 43 – Spatial coverage of trunk and feeder lines and percentage of low--income households



Source: Own elaboration. Data from ETUFOR and the IBGE 2010 Census.

As in the case of other indicators, it is evaluated that there is a higher concentration of low-income households around the terminals in peripheral neighborhoods. Considering the itineraries of the pilot project's trunk lines and the pilot project feeders, about 42.9% of the low-income households are served by the trunk and feeder lines in question, considering a walkability radius of 500 meters for the trunk lines and 300 meters for the feeder lines.

This proportion represents about 96,000 low-income households in 2020, when Fortaleza registered approximately 224,000 households. Therefore, adopting the growth of the population of Fortaleza from 2010 to 2021 as a premise of the same growth of low-income households, it can be affirmed that the route of the lines currently covers about 106,000 low-income households.

Next, to analyze the accessibility to the lines considering income criteria, Figure 42 shows the spatial coverage of the lines defined in addition to a thematic map with the percentage of low-income households (with nominal monthly income lower than half the minimum wage). Finally, the summary of the values of the indicators is presented in Table 24.

Table 24 – Summary of social impact indicators

Indicators	TL*	% TL	TL + FL*	%TL + FL	Total
Population - 2010	205,208	8,4%	1.068.920	43,7%	2.444.850
Population - 2021	226,815	8,4%	1.181.957	43,7%	2.703.391
Black Women - 2010	59,438	7,3%	354,027	43,4%	816,078
Black Women - 2021	65,724	7,3%	391,465	43,4%	902,378
Low-Income Households - 2010	9,923	4,4%	96,119	42,9%	224,026
Low-Income Households - 2021	10,973	4,4%	106,283	42,9%	247,717

*TL = Trunk lines
**LA = Feeder lines

Source: Own elaboration. Data from ETUFOR and the IBGE 2010 Census.

3.5 ENVIRONMENTAL ASPECTS

It is also worth noting that replacing Euro 5 technology vehicles with electric vehicles will lead to a considerable reduction in total emissions.

To calculate the reduction of emissions of polluting gases, we used the methodology of the U.S. Environmental Protection Agency - USEPA, also adopted by the Environmental Technology and Sanitation Company - CETESB. This methodology was adapted to reflect the parameters imposed by the current legislation regarding the renewal of the vehicle fleet.

It is generally assumed that pollutant emissions and fuel consumption are related to speed variation and distances traveled. However, the emission of pollutants is also influenced by the characteristics of the fuels and conditions of the vehicles themselves (model, type, age, state of conservation, etc.). Five primary pollutants resulting from evaporative emissions are considered: carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbons (HC), nitrogen oxide (NO_x), and sulfur oxide (SO_x).

The emission of pollutants such as HC, CO, CO_2, and NO_x is inversely proportional to the average speed of the vehicles, being the other constants. However, replacing combustion vehicles with electric vehicles on the average speed of public or individual transport was considered irrelevant. Thus, no changes in the emission standards of diesel vehicles were considered between situations with and without the project.

This methodology calculates the emission factors for light and heavy vehicles, considering the speed of the test cycle of 31.5 km/h (USEPA - U.S. Environmental Protection Agency). Then, the volume of emissions is multiplied by the estimated volume of kilometers for each type of vehicle, Padron, and articulated.

In the case of the Public Transport System of Fortaleza, there is a new situation: since January 1, 2012 all new vehicles have been adequate to the emission standards of type Euro 5. However, the standards established by Proconve (Vehicles Emissions Control Program) indicate that from 2022 it has become mandatory to use Euro 6 technology so that in the future, the expectation of emissions of vehicular pollutants will be reduced again.

The following table shows the emission patterns of toxic gases and particulate matter based on the different vehicle profiles.

Table 25 – Emission standards of toxic gases and particulate matter based on different vehicle profiles

	Heavy Bus - Euro 5	Heavy Bus - Euro 6
	g/km	g/km
CO	1,876368472	0,538525438
HC	0,284858743	0.018
NO_x	8,430206915	2,631368031
SO_x	0,82	0.164
CO_2	1209	1209
Mat. Particulado	0,151048327	0,021488924

Source: CETESB

The volume of gas emissions proportional to fuel consumption was considered for the other vehicle profiles, according to the table presented below.

Table 26 – Gas emission volume

	Heavy		Padron		Articulated 18 m		Articulated 23 m	
	Euro 5	Euro 6	Euro 5	Euro 6	Euro 5	Euro 6	Euro 5	Euro 6
Fuel Consumption	0.429		0.453		0.698		0.759	
Emissions (g /km)								
CO	0,00170	0,00050	0,00180	0,00053	0,00277	0,00081	0,00301	0,00088
HC	0,00120	0,00010	0,00127	0,00011	0,00195	0,00016	0,00212	0,00018
NO_x	0,04020	0,01260	0,04245	0,01330	0,06541	0,02050	0,07110	0,02228
SO_x	0,01490	0,00300	0,01573	0,00317	0,02424	0,00488	0,02635	0,00531
CO_2	0,18010	0,18010	0,19018	0,19018	0,29303	0,29303	0,31852	0,31852

Source: Own elaboration.

For the case on screen, it was also considered the replacement of diesel vehicles by Euro 6 vehicles, according to the standards established by Proconve for 2022, reaching the conclusion that some 280 kilos of pollutants emitted per year will be avoided, according to the results set out below.

Table 27 – Avoided emissions

Avoided emissions (Kg/year)	
CO	1,99
HC	1,40
Nox	47,03
Sox	17,43
CO2	210,72
Total	**278,58**

Source: Own elaboration.

Thus, only the vehicles contemplated in the Pilot Project of Transition to Electromobility will avoid almost two tons of pollutants over a 7-year horizon.

4.

ASSET FINANCING

This chapter explores the viable options and alternatives related to funding sources for public transport, with particular emphasis on the possibilities for the defined business model.

In addition to these perspectives, viable sources of funding for the pilot project are presented that can contribute to the municipality's understanding of its alternatives for financing vehicles and equipment.

4.1 SOURCES OF PRIVATE FUNDING

The sources of financing aimed at the private sector seek to create funding channels for operating companies to acquire vehicles, equipment, and systems. But, of course, this will only be the case if this responsibility is effectively allocated to this agent. According to practices adopted in the sector, there are two primary sources of financing, such as:

The National Bank for Economic and Social Development, BNDES, mainly the Finame Line (Financing of Machinery and Equipment) and commercial banks linked to vehicle manufacturers.

In the case of the acquisition of vehicles and small financial volumes of systems, the financing operation with BNDES must necessarily be carried out through transfer by a financial agent. The financial agent assumes the credit risk of the operation, usually recounting the assets (vehicles and equipment) as collateral for their loans. However, given the inherent difficulty in rescuing assets that are used in the provision of an essential public service as collateral, it is common and necessary for financial agents to have additional guarantees. These guarantees may be third-party guarantees from the Concessionaires' shareholders or the subrogation of contractual guarantees in the Concession Contracts.

If the line used for financing is FINAME, the most common line for the acquisition of combustion vehicles, the cost of the operation corresponds to the Long-Term Rate, TLP (currently in IPCA + 5.0% per year), plus a sector spread of 1.3% added to the transfer cost and risk of the financial agent.

The default is a funding rate corresponding to the IPCA plus about 12.5% per year. For this type of supply to be implemented, it is necessary to accredit the equipment supplier with FINAME, according to requirements set by BNDES. Financing conditions may be improved in the case of the acquisition of electric vehicles and charging equipment through the use of lines called the "Climate Fund," as evaluated below.

An alternative source of financing for purchasing combustion vehicles that is sometimes less costly is the financing via banks of automakers in the form of direct credit to consumers. To this end, automakers have their fundraising sources and naturally associate financing with acquiring vehicles. The financing conditions follow the market conditions, and the vehicle is the main guarantee of the operation. Similar to the financing operations carried out with the BNDES transfer agent, the credit analysis will also include the contractual aspects associated with the provision of services and the packaging of the financed companies.

Depending on the source, direct credit to the consumer may be less costly than operations originating in BNDES, especially if the source of the resource used by automakers is international funding.

The progressive migration of this market to operations characterized as "Project Finance" is also worth mentioning. In this modality, the financing credit is based on the cash generation of the project, with limited guarantees from the Operating Company. To organize a Project Finance operation, it is necessary:

- That the borrower is an SPE
- Linking system receivables to a specific account, which will pay financial agents in the order of preference contractually established
- SPE's shares are linked as an additional guarantee

Such operations are operations of high complexity, so currently, there are no Project Finance operations in mobility projects on buses, although these are common in rail projects. However, it is observed that the market is migrating to this model to reduce the dependence of operating companies' balance sheets as a subsidiary guarantee for financial agents.

As a positive aspect, adopting these financing solutions assumes positive implications on topics such as governance, transparency, and financial management of the system.

4.2 SOURCES OF PUBLIC FUNDING

It is important to consider the existence of several municipal funding channels based on programs and projects. In particular, projects involving issues such as environmental sustainability, technological innovation, and social impact tend to be well evaluated in various funding channels. On the other hand, administrative and institutional aspects may represent a time challenge, given the need to approve indebtedness with the city council. Besides, in the case of international financing operations, it will still be necessary to approve the operation with the External Financing Commission, COFIEX, a body composed of different spheres of federal management and whose Executive Secretariat is the Secretariat of International Economic Affairs - SAIN, from the ministry of the economy. In addition to the approval of COFIEX, the seal of the international committee of international affairs of the Brazilian Senate is necessary.

In addition to institutional aspects, limits on indebtedness can be an additional challenge for different municipalities. Currently, the Municipal Government of Fortaleza has a Capacity to Pay Score, CAPAG, defined by the National Treasury as "C," due to Indicator II - Current Savings, which deals with the relationship between Current Expenditure and Adjusted Current Revenue, whose calculated value is 97.13%.

As for transactions directly contracted with commercial banks, it is observed as the main challenge is the acceptance of credit risk. In case of default by the Municipality, the Bank must turn to the queue of creditors, being subject to receiving a judiciary bond representing a fraction of the amount financed. For this reason, credit analysis usually prevents conventional financing operations.

As main sources of national financing, we find economic, social, and technological development agencies, such as BNDES, FINEP, and Caixa Econômica Federal, CEF. These agencies transfer constitutional credit lines, which often favor conditions compared to commercial banks' operations. Nevertheless, these agencies prioritize projects with high social, economic, and technological impact, as is undoubtedly the case with the transition to electromobility. In addition to conventional operations, we also highlight the possibility of using ProTransporte, a line developed and managed by the Ministry of Regional Development, which has as its main transfer agent the Caixa Econômica Federal.

At the international level, multilateral development agencies have a significant presence aimed at financing States and Municipalities. As cited, these agencies work with dedicated funding for a program or project that has a high social, economic, and technological impact. The favored financing conditions have as a counterpart the need for approval in the committee of international affairs of the Senate and COFIEX.

In addition to direct credit operations to the municipality, it is observed the possibility of the borrower as a public operational company or a public investment company. Independent public companies may be indebted outside the public sector limit but need to prove that the cash generation of their operation is sufficient to pay off the contracted indebtedness.

On the other hand, investment companies are a specific solution for managing the city's assets. Moreover, investment companies have regulatory autonomy to operationalize financial decisions within certain public policies of the municipality, given their long-term sustainability.

5.

RECOMMENDATIONS FOR IMPLEMENTATION AND MONITORING

This chapter guides the objectives of the public administration for the construction of short, medium, and long-term goals for the electromobility of public transport in the municipality – mainly considering the inputs identified and shared by the team during discussions and training. It addresses the importance of building a shared vision for the implementation of electromobility and the definition of clear objectives that should be aligned with this vision. Here are also addressed the guidelines for defining measurable goals that allow evaluating the progress of the transition to Electromobility and the definition of deadlines for the execution of associated activities.

In addition, it recommends instruments for the definition of indicators and for monitoring the desired results. Besides, it highlights how electrification can contribute to the qualification of public transport in the country and data that need to be collected to monitor and evaluate the efficiency of electric buses in the face of these expectations.

5.1 VISION, OBJECTIVE, GOALS, AND DEADLINES

Although the pilot project is an initial step toward the transition of the bus fleet from the public transport system to Electromobility, this stage requires a strategic definition of how the implementation of the policy takes place in the municipality of Fortaleza, with the establishment of vision, objectives, goals, and deadlines.

The Vision deals with what one wants to achieve in the future, defining the project's ambition. The vision must incorporate the framework one wishes to achieve, and one should avoid extensive definitions or visions that are very difficult to reach, considering the current level. It is important that the vision is also of consensus of all the stakeholders involved and is aligned with the multiple interests and the other strategies adopted by the municipality. For the Fortaleza project, it is defined as:

VISION:

"In 2040, the municipality of Fortaleza shall have 40% of its public transport system fleet operating with battery electric buses."

For the vision to become a reality, it is necessary to establish clear and concise objectives to develop the changes that must occur and must be aligned with the vision. The objectives must reflect especially the benefits that the transition to Electromobility will bring to the municipality of Fortaleza. Therefore, for the Fortaleza project, the following objectives were defined:

Objective:

a) **Reduction of emissions from the public transport system;**

b) **Improvement of the quality of service for the user;**[4]

c) **Reduced system operating costs.**

After the definition of objectives, measurable goals should be established to monitor the meeting of the defined objectives. The goals seek to guide the actions that must be performed in the short, medium, and long term. The goals for the Fortaleza project are presented below:

Goals:

a) **Reduction of particulate matter emissions by 40% by the municipal public transport system in 2040;**

b) **Achieve a satisfaction score above 7.0 for overall service quality**

c) **Reduction of the operational costs of the municipal public transport system by 25% in 2040.**

The actions and deadlines for meeting the vision, objectives, and established goals are presented in Table 28.

4 Satisfaction score obtained on the overall quality of the service was 4.67; collection carried out under PASFOR. It is noteworthy that this research was carried out for the public transportation service of the entire Metropolitan Region of Fortaleza. It is possible that the satisfaction rate considering only the municipal system presents a higher value

Table 28 – Actions and deadlines to achieve the vision, objectives, and goals established

Actions	2022	2024	2026	2028	2030	2032	2034	2036	2038	2040
Definition of the scope of the pilot project										
Charging infrastructure planning										
Business model planning and definition										
Definition of the financial equalization of the pilot project										
Implementation of the pilot project (15 vehicles)										
Training and capacitation of technical, management, and mechanical staff										
Evaluation of the benefits, challenges, and learnings of the pilot project										
Planning for fleet transition escalation by up to 40%										
Business model review for transition escalation										
Review of concession contracts										
Evaluation of the possibility of external support (Federal, State, and other stakeholders)										
Transition in 5 % of the fleet										
Satisfaction survey (1)										
Transition in 15 % of the fleet										
Satisfaction survey (2)										
Transition in 25 % of the fleet										
Satisfaction survey (3)										
Transition in 40 % of the fleet										
Satisfaction survey (4)										
Evaluate the achievement of the established goals										
Review business model for the rest of the transition										

Source: Own elaboration.

5.2 MONITORING

As discussed in the previous item, a pilot project to finance electric buses inserts itself in the context of the beginning of the transition from a city towards Electromobility. In this sense, it is crucial throughout the operation of the new vehicles to monitor the efficiency of the new technology regarding its social, environmental, and economic objectives.

An electric bus pilot project is the main tool for evaluating the implementation and operation of the new technology in the context of a municipality. Through a pilot, it is possible to obtain an estimate of how electric buses will behave in the local context and whether they will be able to meet the needs and expectations of the city, considering its public transport challenges.

The data collected during a pilot project are fundamental and will determine whether the observed performance reaches expectations for the buses. Thus, the pilot project must be conducted in a feedback manner so that, after the beginning of data collection and based on the evidence produced, the planning and operation of the vehicles can be revisited, as well as the chosen business model itself.

So that the results obtained through the pilot project allow the evaluation and reflection on the insertion of the new technology, all data and information must be collected and monitored for the two types of technology: the electrical technology tested and the previous technology that will continue in operation in the rest of the transport system, in this case, diesel buses.

The monitoring of the pilot project of electric buses should consider several groups of information to be collected and compared, based on data from the equipment vehicles and economic-financial model, and user perception surveys.

The following table presents compiled indicators that can be used to evaluate the pilot project of electric buses and their objectives within the monitoring process.

Table 29 – Indicators that can be used for the evaluation of the pilot project of electric buses

Type of information	Objectives	Possible indicators
Characteristics of vehicles	Comparison between similar vehicles, diesel and electric.	• Model. • Weight. • Dimensions. • Passenger capacity. • Battery capacity, among others.
Capital costs	Comparison of initial investments for each technology.	• Cost of the vehicle. • Cost of charging infrastructure.

Type of information	Objectives	Possible indicators
Operating conditions	Lays down the boundary conditions of the operation to allow comparison between vehicles with similar operations	• Topographic conditions. • Weather conditions of the city or test site • Extension traveled with road priority in the planned route. • Number of pick-up and drop-up points
Operation of vehicles	Evaluation of the performance of vehicles and batteries	• Daily mileage traveled per vehicle. • Average daily route. • Average speed per trip. • Vehicle availability. • Energy consumption per trip. • Passengers transported by journey. • Passenger rate per km.
Charging	Comparison of energy consumption of each technology and associated costs	• Electricity tariff. • Energy consumed by recharge. • Charging status per vehicle. • Average charging time per vehicle. • Cost of diesel. • Diesel consumption per kilometer traveled.
Maintenance of vehicles and infrastructure	Comparison of maintenance demand and possible failures reported between technologies	• Reason and duration of maintenance stops • Average mileage between failures • Failure rate per month • Qualitative perception of the challenges of maintenance and satisfaction of the professionals responsible for this function
Environmental benefits	Verification of avoided emissions with the inclusion of electrical technology	• Energy saving • Avoided greenhouse gas emissions • Avoided emission of local pollutants • Noise emission reduction
Perception of users and drivers	Comparison of the level of comfort and satisfaction reported by users for each of the types of vehicles	• Qualitative perception of the satisfaction of users and drivers. - Internal noise level. - Internal vibration level. - Conservation status. - Places of pîck-up and drop-off. - Drivers' performance (for users). • General satisfaction with the experience.

Source: Own elaboration, based on the records of the Tumi E-bus Mission and ITDP (2021)

As indicated in the table, some information is important for establishing the boundary conditions of the comparison of indicators between the two technologies in use in the municipality. Among them, highlights the topographic conditions of the route in which the vehicles operate, the distribution and number of stops and the climatic conditions. For example,

routes that run through steeper topographies usually have higher energy expenditure for both technologies. In contrast, routes with a higher number of stops may present a lower energy expenditure in electrical technology due to the existing mechanisms of energy regeneration[5] at times of stop, which does not happen in conventional diesel vehicles. In addition, the need to record climatic conditions is highlighted since the local temperature can directly affect energy consumption.

It is recommended to establish an information recording routine be established for each new electric vehicle that should also be performed in those diesel vehicles that present the operating conditions closest to the conditions to which electric vehicles will be subjected. The records should be daily, also considering the periods of permanence of vehicles in garages or terminals and the trips made outside the operation with passengers.

The evaluation and comparison of indicators should be performed more frequently at the beginning of the pilot project operation since this is when technical failures or the need for operational adjustments will be more likely. In addition, the evaluation of indicators should be used to identify the most sensitive points of the new operation, which may be subject to immediate adjustments as they are identified.

To conduct satisfaction surveys with users and drivers, it is recommended to apply them after the stabilization of the operation of new vehicles to avoid the natural challenges of starting the operation of the new technology do not generate negative perception results contrary to the continuity of the pilot project. Conducting satisfaction surveys from the moment the initial challenges have already been overcome can bring a better perception of the opinion of users and drivers about the new technology with diesel technology.

5.3 INITIAL TRAINING

It is essential to consider that the pilot project in question deals with introducing a new technology in public transport operation in the city, which represents the emergence of new peculiarities to the operation in relation to the technology currently used. These include new procedures for drivers and staff responsible for maintaining the new fleet.

Given this change, the teams involved in the operation of the new vehicles should go through a training cycle before the start of the operation. Such training is essential for disseminating knowledge concerning new vehicles currently centered among their manufacturers, already used to the new technology and procedures related to their use and maintenance.

5 Energy regeneration mechanisms in electric vehicles allow the conversion of the vehicle's kinetic energy into electric energy. Thus, at specific moments of the mechanical cycle, energy storage is transformed for use in the vehicle itself, reducing the use of batteries. The conversion of kinetic energy into electric energy happens when the vehicle reduces its speed, such as in obstacles, curves and at stations and stop points.

Thus, the knowledge transfer from manufacturers/suppliers to the operations' responsible agents of the vehicles must be effective and occur soon after their acquisition, before the preparation of the operation.

For the transfer of knowledge to be effective and contribute to the implementation of the pilot project in the city, manufacturers and equipment suppliers must be involved in the project soon after acquiring the assets. This involvement must occur during the negotiations of the purchase for the conclusion of the contracts, so the city can receive all the necessary support for training its local staff.The training must then be provided directly by manufacturers and suppliers to those responsible for operating new vehicles and equipment, i.e., drivers and maintenance technicians.

The table below lists the minimum training expected for a successful operation of the new technology.

Table 30 – Recommended training for new vehicle operator teams

Topic	Target public	Content	Objective
Operation of electric fleets	Operator's team responsible for the design of the operation	• Operation of electric vehicles • Procedures and charging times • Maintenance procedures and periodicity • Energy expenditure optimization practices • Practices for maximizing battery useful life and electrical components	Capacitate operators to introducing new technology to their operating schemes to ensure effective and efficient use of assets
Driving electric vehicles	Drivers of new electric vehicles	• Characteristics and devices of vehicles • Good driving practices • Safety equipment • Good security practices • Emergency protocols • Basics of mechanics	Motivate safe and professional driving practices and facilitate a disciplined operation of the acquired vehicle fleet.
Formation of trainers for the driving electric vehicles	Selected team of operators for future trainings	• Characteristics and devices of vehicles • Good driving practices • Safety equipment • Good security practices • Emergency protocols • Basics of mechanics	Capacitate operators' team to provide training to future drivers

Topic	Target public	Content	Objective
Vehicle maintenance	Responsible maintenance team	• Characteristics and components of vehicles • Mechanics of electric vehicles • Electrical components and battery maintenance • Component check and replacement routines	Enter recommended maintenance practices for maximizing the useful life of vehicles and components
Formation of trainers for the driving electric vehicles	Selected team of operators for future trainings	• Characteristics and components of vehicles • Mechanics of electric vehicles • Electrical components and battery maintenance • Component check and replacement routines	Capacitate operator team to provide training to future maintenance technicians
Charging of vehicles and chargers	Team responsible for charging and maintenance of equipment	• Characteristics and components of vehicles and equipment • Safety procedures when charging • Electrical components and equipment maintenance	Insert the best practices for charging vehicles and maintaining equipment, as well as ensuring the necessary safety procedures
Formation of trainers for the driving electric vehicles	Selected team of operators for future trainings	• Characteristics and components of vehicles and equipment • Safety procedures when charging • Electrical components and equipment maintenance	Capacitate operators' staff to provide training to future technicians

Source: Own elaboration

As shown in the table, the training scheme agreed with the manufacturer and suppliers must consider that there should be continuity in the transfer of knowledge during the pilot project's operation. This happens because the renewal of the staff responsible requires the repetition of training as new drivers or maintenance technicians enter the operation of electric vehicles. Thus, it is also important to train professionals within the responsible teams who can provide the same training in the future, with the necessary adjustments as the operators' knowledge about the new technology develops.

Another possibility to ensure good maintenance and operation of the new vehicles is to agree directly with the manufacturer and suppliers to supervise maintenance at the time of acquisition of the assets. This supervision can happen only in the initial periods of the operation of the pilot project, as it can also extend for a long term, ensuring a better transition of knowledge about the assets and contributing to the rapid solution and any problems or failures that may occur.

6.

FINANCING PILOT PROJECT

This last chapter discusses the financing strategy for the solution chosen by the stakeholders consulted. The implementation steps are presented in the following items, from the consolidation of public definitions to the request for financing.

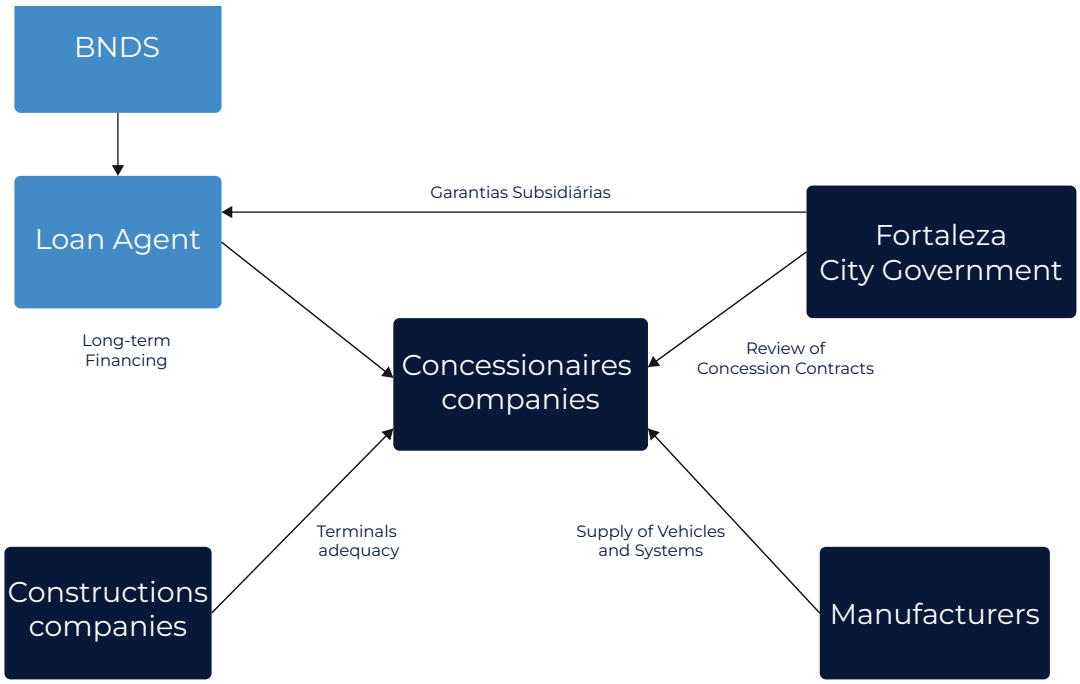
6.1 FINANCING STRATEGY

The Financing Pilot Project is a financial structure proposition demonstrating the sustainability of contracting resources to make long-term investments in the public transport system. Among the various alternatives evaluated together with agents from the Municipality of Fortaleza, the Ministry of Regional Development, the World Bank, and other agents involved in the design of the best-proposed solution, it was understood that the main guidelines would be:

- Business Model: attribution of investments in vehicles, charging systems, and civil constructions by the concessionaires of the Public Transport System of Fortaleza
- Agent to be funded: Concessionaires companies
- Funding agent: BNDES

The following synthesized solution was constructed on these premises, where the main agents and contractual relationships that will bind them are presented.

Figure 44 – Agents and contractual relationships



Source: Own elaboration.

In this model, the Government negotiates and reviews the contractual economic-financial rebalance with the concessionaires of the public transport system of Fortaleza, which are appointed responsible for the implementation and operation of the defined electric vehicles. Once this agreement is concluded, it is up to the Concessionaires to raise investment debt.

For this model, concessionaire companies can count on two sources of financing, the National Bank for Economic and Social Development, BNDES, or the World Bank, via the International Financial Corporation. Together with BNDES, the available financing lines will be:

- **BNDES Urban Mobility Climate Fund**
    - Financing up to 50% CAPEX of the project or program for which the applicant requires resources, limited to R$ 80 million per beneficiary per year.
    - Interest Rate: fixed 3% per year as funding cost, added to a BNDES Remuneration rate of 1.3% per year, added to a risk spread and financial agent transfer limited to 3% per year.
    - Maximum term of 20 years of financing, with a maximum of 3 years of grace.
- **BNDES Climate Fund Efficient Machinery and Equipment**
    - Financing up to 50% CAPEX of the project or program for which the applicant requires resources, limited to R$ 80 million per beneficiary per year.

- Interest Rate: fixed 3% per year as funding cost, added to a BNDES Remuneration rate of 1.3% per year, added to a risk spread and financial agent transfer limited to 3% per year.

- Maximum term of 20 years of financing, with a maximum of 3 years of a grace period.

- **BNDES FINAME (only for complementation, if necessary, of equipment not categorized into the other categories)**

  - 50% do valor de CAPEX

  - Interest Rate: TLP (IPCA + 5.0% per year) as funding cost, added to a BNDES Remuneration rate of 1.45% per year, added to a risk spread and transfer of financial agent to be defined.

  - Maximum term of 15 years of financing, with a maximum of 1 year of grace.

Transfer agents are necessary regardless of the financing line triggered since it is a small operation. In this case, it is recommended to use the commercial bank with a closer relationship with the concessionaires. The following form summarizes the registration for framing the operation.

Table 31 – Registry overview for the operating framework

Borrowing Agent	Fortaleza Concessionaire Company
Transfer Agent	BNB Banco do Brasil Caixa Econômica Federal
Investment Value	R$ 25.575.000,00
Loan Value	R$ 25.575.000,00
Objects: Vehicles, Systems, and Civil Works	15 Padron vehicles, high floor, with bus body shell up to 13.2 m and battery of 324 kWh. 20 chargers “slow” AC, with 2 plugs of 40kW each. Installation of chargers and adequacy of electrical installations in garages and 5 in Antonio Bezerra Terminal
Guarantees	Linking receivables from the marketing of travel rights Corporate guarantees Additional guarantees provided by the Municipality of Fortaleza, such as linking a fraction of the Municipal Participation Fund
Disbursement Schedule	Single disbursement upon presentation of invoice and local survey
Convenants	Compliance rules Maintenance of balance sheet indicators Fiduciary disposal of vehicles

Source: Own elaboration.

If the option is to contract financing by the Municipality, the operation may be planned with the World Bank, and the Flexible Loan or Rapid Disbursement Loan lines can be used. The Rapid Disbursement Loan lines have more than 60% of their releases made in less than 2 years, which would certainly be the case for a Pilot Project. In this case, the loan limit would follow the needs of the Municipality and its CAPAG index. Currently, Fortaleza has CAPAG Note "C," which makes it necessary to evaluate the possibility of opening space for credit in R$ 25 million.

The lines are characterized by high flexibility to customize forms of amortization, grace periods, and even maximum payment terms, limited to 35 years, with a maximum duration of 20 years. For these lines, the estimated base rates are the Secured Overnight Financing Rate, SOFR, added to a spread of 1.07% per year. The base fees add up to the front fee corresponding to 0.25% of the amount financed and a commitment fee of 0.25% per year, paid every six months, on undisbursed balances. It should be made that there is a certain possibility of converting all conditions to pre-fixed rates in Reais. In this case, the pre-framing form of the project will be.

Table 32 – Project pre-framing sheet

Borrowing Agent	Fortaleza Municipal Government
Transfer Agent	Only for structuring multi-municipality financing lines.
Investment Value	R$ 25.575.000,00
Loan Value	R$ 25.575.000,00
Objects: Vehicles, Systems, and Civil Works	15 Padron vehicles, high floor, with bus body shell up to 13.2 m and battery of 324 kWh. 20 chargers "slow" AC, with 2 plugs of 40kW each. Installation of chargers and adequacy of electrical installations in garages and 5 in Antonio Bezerra Terminal
Guarantees	Guarantees provided by the Fortaleza Municipal Government Government Endorsement (COFIEX approval / Senate Foreign Relations)
Disbursement Schedule	Single disbursement upon presentation of invoice and local survey
Convenants	Ex post monitoring of the objectives of the financing program and other conditions negotiated with the World Bank

Source: Own elaboration.

6.2 IMPLEMENTATION STEPS

For the implementation of the project under the proposed conditions, the main steps are summarized in the following figure.

Figure 45 – Steps for the implementation of the pilot project

Source: Own elaboration.

Step 1: Consolidation of Public Definitions

At this stage, the Government transfers and reviews the topics developed throughout this Report, presenting adjustments and updates regarding the set of lines, vehicle number and mileage of vehicles replaced by electric vehicles. The vehicles' operators are identified in this sense, and the charging points are defined.Finally, the conditions that the assets should remain over the rental period will be defined.

Step 2: Negotiation/signing of the Contractual Amendment Term

Once the municipality's stages have been completed, the next step involves the negotiation on values of revision of the contractual balance, consolidating the increased and avoided costs, with the acquisition of vehicles and variable costs, in search of a contract that results in minimal impact on the financial balance of the system

Step 3: Basic Project of Terminal Engineering

In parallel to the negotiations and accurate definition of the charging locations, the dimensioning of charges, comparison to current capacity, and calculation of needs for new investments in transmission and distribution systems should be carried out. After this dimensioning, the project of the adequacy of civil constructions with the respective budgeting will be elaborated.

Step 4: Funding Request

Once the previous steps have been fulfilled, it will be entirely feasible for the Concessionaire company to enter the Proposal Letter Protocol with the desired funding agent. To do so, you must forward the loan taker's documents, engineering, environment, and other specific project conditions, as requested by each funding agent.

In the implementation process detailed above, one of the most critical points to be evaluated is the impact of the Pilot Project on the economic and financial balance of the Public Transport System of Fortaleza. On this theme, it is important to highlight that the financial management

of concession contracts signed for the system's operation is not done by the cash flow methodology but by the tariff sheet. Every period of contractual balance adjustment or review updates the tariff sheet. It represents a metric to establish the amount of operators' compensation. This remuneration can come only from the tariff charged to users, such as in the original conception of contracts, or a combination of the users' tariffs with additional subsidy from the Fortaleza Municipal Government and the Government of Ceará.

As developed in Section 3.2 of this Report, the planned budget replacement model for the Municipality of Fortaleza means that the exchange of fifteen Padron vehicles by combustion for electric vehicles of the same characteristic will increase R$ 1,519,040.07 in the annual costs of the system. The last updated sheet published by ETUFOR, which constituted the basis of parameters used, points to an annual cost of R$ 591,164,012.64. Therefore, the technological replacement of vehicles will result in an increase of 0.26% in the system's total cost. This represents the value of reviewing the contractual balance required for implementing the Pilot Project.

If the selected option is to not pass on this increase to the tariff paid by users, it is possible to marginally adjust the amount of the subsidy granted by the Fortaleza Municipal Government with the Government of the State of Ceará. As a result, the subsidy of R$ 72,000,000.00 planned for 2022 would be increased by 2.11% to R$ 73,519,040.07. In both solutions, the system's cost increase is rebalanced due to the Pilot Project for The Transition to Electromobility implementation.

7.

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Transição para a Eletromobilidade
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Executor

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