

CASE STUDY

MEDELLÍN, COLOMBIA

Urban Mobility and the transition to E-Buses



City Profile

As of April 2023



Location map of the department of Antioquia. In red the Metropolitan Area of the Aburrá Valley, and in dark red the city of Medellín.

Source: Wikipedia

Local Government Name

Medellín

Official Name

Medellín

Population

2.427.129 million

Total Area

385 km², Urban and rural area

Municipal Budget

2.427.129 million (2018)

Web address

<https://www.medellin.gov.co/>

Project profile

Local Government Name

TUMI E-Bus Mission City Network

Project start / end date

2021/2023

Scale

Global



Metroplus' Electric Bus in Medellín.

Source: Metro de Medellín

Key Partners

- German Ministry for Economic Cooperation and Development (BMZ)
- German Society for International Cooperation (GIZ)
- C40 Cities
- The International Council on Clean Transportation (ICCT)
- The Institute for Transportation and Development Policy (ITDP)
- ICLEI – Local Governments for Sustainability
- The International Association of Public Transport (UITP)
- World Resources Institute (WRI)

Summary

The adoption of electric buses in the District of Medellín has had momentum since 2015, with the first vehicle introduced into the fleet in 2019. Today, there are 69 electric buses in operation, 1 articulated electric bus, 4 feeder buses belonging to the TPC, 64 electric buses belonging to the BRT system. The current development plan, “Medellín Futuro”, plans to reach 130 electric buses by the end of 2023. In the next two decades, investment will have to double in order to meet the Sustainable Development Goals (SDG) and improve air quality in the District and its metropolitan area.

There are still transportation barriers and challenges associated with replacing diesel vehicles with electric vehicles.

Introduction

Medellín is the capital of the Department of Antioquia and is also the core District of the Aburrá Valley Metropolitan Area (AMVA). Medellín has about 2.42 million inhabitants (2018 census), and the AMVA, with its 10 municipalities, has a population of about 4 million (2018), making it the second largest agglomeration in the country. Also, 94% of these inhabitants live in urban areas. Regarding the percentage distribution of emissions by sector in the AMVA, transportation is the main source of GHG emissions, with an average contribution of 43%.¹

In order to respond to the above-mentioned mobility challenges the District has been working with key players on different fronts, such as active mobility, road safety, infrastructure improvement,

There are still transportation barriers and challenges associated with replacing diesel vehicles with electric vehicles. Some of the challenges are financing, adequate design of a vehicle for the geometry and slopes, integration of the transportation system, information on operating costs and lack of space for the definition of yards, among others. To advance this transition, in 2022, Medellín joined the E-Bus Mission City Network, which is a learning network of cities committed to accelerating the transition to electric bus fleets within public transportation systems.

This case study describes the actors involved, the steps that Medellín has taken so far in this journey towards the adoption of electric buses, the challenges, and the lessons learned.

electric mobility, and the Integrated Transport System of the Aburrá Valley (SITVA), seeking a metropolitan, integrated, and sustainable territory.

SITVA Metropolitan Agreements² intend to define the mass and collective transport policy to improve the quality of the service, whose most visible aspects are:

- Defines the structure of the SITVA
- Division³ of the territory into geographic basins for the operation of SITVA food services
- Defines the conditions for the implementation of new modes of transport.
- Defines the conditions of connectivity to the railway mode, incorporation of new transport technologies to guarantee efficient, safe, accessible, and environmentally sustainable integral mobility through clean fuels.
- Defines operating parameters of the BRT system in Medellín and its Metropolitan Area

¹ <https://www.upb.edu.co/es/central-blogs/divulgacion-cientifica/contaminacion-aire-medellin>

² <https://www.metropol.gov.co/acuerdosmetropolitanos/2017/Acuerdo%20Metropolitano%2005.pdf>

³ Source: <https://www.metropol.gov.co/acuerdosmetropolitanos/2017/Acuerdo%20Metropolitano%2005.pdf>



Getting to know the Medellín transportation system

The Aburrá Valley Metropolitan Area has the SITVA, which is made up of the Metro, Metroplús (BRT), an urban cable system, a feeder and integrated system, and a public bicycle system called EnCicla. Urban and metropolitan collective public transport is a complement to SITVA and operates radially along the main roads towards the center of the District.

In the Metropolitan Area and Medellín as the core District, more than 6 million daily trips are made and the average travel time is 44 min. Work represents 47% of travel reasons, study 15%, and health 8%. Most trips are made using sustainable modes of transport: walking represents 41%, and mass public transport modes (metro, tram, BRT, and traditional buses) represent 23% of the total.⁴ Despite this trend, individual motorization and motor vehicle use rates continue to grow: between 2008 and 2018, annual car and motorcycle registrations increased by 170% and 340%, respectively.

As a result, automobiles and motorcycles have become the main source of GHG emissions (72% of total) and more than 90% of air pollutants, which generates more frequent environmental contingencies throughout the year

Currently, the number of urban buses amounts to 3,262 units, of which 536 feed the Medellín Metro and 2,726 are part of collective public transport (2023 data). About the types of fuel, 87% of the buses run on diesel, 10% on gas, and only 2% are electric.

The lines of action for the transformation and improvement of quality in public transportation are:

- Renewal of fleet and institutional image by area of operation
- Fleet management and control
- Bus stops with route information
- Preferential lane
- Electronic collection
- Public Transport Culture (TPM)

The electric buses are operating within the SITVA, and they do so through the payment system called Cívica⁵ whose boarding and integration rates are defined by the Metropolitan Area as transportation authority. The modes that are physically, fare, institutionally, and operationally integrated are the Metro (public), Metroplús (public), the feeder routes (private), and the “Encicla” public bicycle system (public).



Figure 1. Line 1 of the Medellín Metro buses.
Source: Juan Esteban Martínez consultants, 2023.

⁴ Aburrá Valley Mobility Survey 2022.

⁵ <https://civica.metrodemedellin.gov.co/que-es-civica/tarifas>

Interdisciplinary work team and stakeholder mapping

The planning and preparation of electric mobility has been taking place since 2015 in terms of electric buses. Transportation and environmental problems are the initial triggers for the incorporation of the first and existing 69 electric buses, of which 64 of the 80-passenger) standard buses (autonomy up to 280 km) operate on the BRT System Trunk on its Lines O and 2 called Metroplús and 4 buses of 40 passengers bus type (autonomy up to 220 km) in the feeder system to the BRT in the District of Medellín.

In 2017 approved the Comprehensive Management Plan for Air Quality (PIGECA),⁶ where an inter-institutional work table is created to develop policies and actions that favor the deployment of electrical technologies.

The main players are the environmental authorities, public transport associations, manufacturers, Medellín Metro, energy companies (such as EPM) and other transport actors.

Within the Development Plan 2020–2023, proposed to create a Interinstitutional Unit for Integrated Management for Sustainable Mobility, with a work team in charge of leading the articulation of the actors, will carry out the Public Policy for Vehicle Renewal, the formulation of the renewal project for the different vehicle segments, the generation of business models, property management for recharging spaces and technology.



Figure 2. Medellín e-bus fleet

Source: Juan Esteban Martínez consultants, 2023

⁶ <https://www.metropol.gov.co/ambiental/calidad-del-aire/Paginas/Gestion-integral/PIGECA.aspx>

Goals towards the transition of electric buses

The goals that Medellín has set for itself correspond to:

Goals	Year	Term
Reach 130 electric buses purchased for public transport	2023	short
Acquire only zero emission buses from 2025, signed agreement via C40	2025	medium

Pilot tests

In 2015, the first standard 80-passenger electric bus arrived in the District of Medellín, through a contract between the Clean Air Institute and the Metropolitan Area. Tests were carried out on Metroplús Line 1 and on collective public transport road corridors.

In early 2023, with support from C40 Cities and ICCT through the Zero Emission Bus Rapid-deployment Accelerator (ZEBRA) Program, a pilot of an articulated electric bus was conducted, that operated on the Avenida 33, San Juan and San Antonio routes. A pilot is also being conducted with a TPC electric bus to operate on traditional TPC routes, specifically in two companies, Flota Nueva Villa and Transportes Aranjuez Santa Cruz.

Adjust operational design and charging infrastructure

Considering the increase in demand for mass transportation in the District, the operation of electric buses was incorporated on the BRT corridor, thus improving operational conditions in terms of capacity and service times.

The charging infrastructure to power the 64 Metroplús standard buses is installed in the yard located at the Universidad de Medellín final station on Lines 1 and 2; for the 4 feederbuses it is installed in the concessionaire's own yard; and there is

also the Fatima yard, where there is charging infrastructure for the existing buses. In total, there are 4 chargers at UdeM and 6 at Patio Fatima.

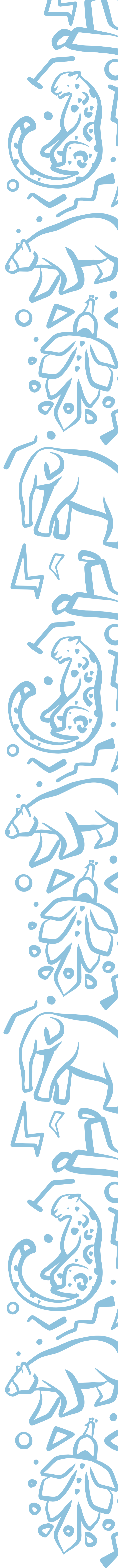
In terms of ITS equipment, the fleets have installed equipment for fleet control, collection system, speed restrictions at 60 km/h, door control, weight sensors, WIFI, USB ports and security cameras.

Regulatory, financial and business model structuring:

The two business models that have been established in the District of Medellín are:

1) Public initiative (fleet supply and operation):

The business model of this adoption of 64 standard electric buses, consisted of the fact that the Municipality of Medellín gave resources to the management entity (Metroplus S.A.) so that through a contracting it could acquire the electric fleet. Once the buses and their charging infrastructure were awarded, Metroplús S.A., through another inter-administrative contract, delivered the buses to the Medellín Metro so that this entity could carry out the operation and maintenance under the corridor selected by the municipality. The chargers were purchased from the same fleet provider, and the energy infrastructure to guarantee charging was carried out by EPM.



2) Vertical integration (fleet supply and operation):

The business model of this adoption of 64 standard electric buses, consisted of the fact that the Municipality of Medellín gave resources to the management entity (Metroplus S.A.) so that through a contracting it could acquire the electric fleet. Once the buses and their charging infrastructure were awarded, Metroplús S.A., through another inter-administrative contract, delivered the buses to the Medellín Metro so that this entity could carry out the operation and maintenance

under the corridor selected by the municipality. The chargers were purchased from the same fleet provider, and the energy infrastructure to guarantee charging was carried out by EPM.

In both cases, when user fee income does not cover operating costs, the deficit must be covered by the Municipality of Medellín. To date, there are no defined alternative financing sources to cover the tariff differential.

From the point of view of regulations, there are the following elements for the promotion and transition of electric mobility in the District of Medellín:

National and local regulatory framework towards the transition of electric buses	
Standard and year	Context
Plan Bio 2011-2030	Structuring systems for the occupation of the territory: Mobility and transport structuring system: Propose an offer of alternatives that reduce greenhouse gas emissions and atmospheric pollutants.
POT Medellín, agreement 48 of 2014	Article 167. Motorized mobility Paragraph 5. The Integral Plan for Sustainable Mobility shall analyze a collective electric transportation system exclusively for passenger mobility in the District center.
Metropolitan Agreement No. 6 of 2014	Regional Mobility Policies established by the Mass Transit Authority for the Implementation of SITVA
Municipal Agreement 44 of 2015	The strategy for the promotion and massification of electric mobility in the municipality of Medellín was approved
Resolution No. 2504 /2016	Promotes the renovation towards cleaner technologies, including electric technology.
Metropolitan Agreement No. 5 of 2017	Modifies the Metropolitan Agreement No. 6 of 2014
Metropolitan Agreement No. 16 of 2017	Comprehensive Air Quality Management Plan (PIGECA) 2017-2030. Transformation towards a low and zero emission mobility system.
Council agreement 021 of 2020	Reduction of emissions: progress will be made in migrating from fossil fuels (such as diesel, gasoline and gas) to means of zero and ultra-low emissions, such as electric mobility and active mobility.
Metropolitan Master Plan 2020-2030	Its strategy is to implement progressive measures for the renewal of the public transportation fleet towards low or zero emission vehicles, and to generate financial incentives to renew freight and intermunicipal public transportation vehicles towards low or zero emission vehicles.



Medellín Municipality
Development Plan 2020-2023

Execution Program and POT commitments (Agreement 48 of 2014) for development and modernization of the Public Transportation System, through spaces for storage and recharging of vehicles with sustainable mobility systems implemented, and fleet of public transport buses renewed with electric buses.

Developed by ICLEI South America

Results

- In 2015, through the Clean Air Institute and the Metropolitan Area, the first standard electric bus was brought to the District, which came by road from Bogotá.
- In 2017, the energy company (EPM) acquired an 8-meter electric bus, which was used to perform operation, stability, reliability, and performance tests.
- In 2018, the Ministry of Mobility of Medellín, the Metropolitan Area of the Aburrá Valley, and EPM acquired a 100% electric articulated bus with capacity for 180 passengers to be operated on BRT Line 1.
- In 2019, 64 electric buses were acquired to operate Line 1 and Line 2 of the BRT.
- In 2020, operation of four 40-passenger electric buses from the BRT feeder concessionaire began on Lines 1 and 2.
- In 2022 and early 2023 Medellín carried out pilot tests with a 50-passenger electric bus on the transport route that connects Medellín with the José María Córdoba Airport and the routes of the company Flota Nueva Villa in the urban area

Lessons Learned

Political will and stakeholder involvement:

For the acquisition of the existing electric fleet, political will and pilot tests were required to obtain data, references, and national and international external experiences that will complement the information, and the decision will be made based on technical analysis.

Normative framework:

There is a lack of regulations and financing schemes that allow promoting the electrification of transport in collective and inter-municipal public transport that operates under operating permits regulated by the Ministry of Mobility and/or Ministry of Transport. It is necessary to regulate the fare stabilization fund (FET) and to have the entire transportation system integrated through an electronic collection system. In the future, bidding processes may be carried

Training:

It is identified that there are many myths and ignorances about electric mobility. Constant training is required for public officials and stakeholders in the transportation industry.

Vehicle typology

Based on the pilot tests carried out, the need for the factory market to design and offer vehicles that adjust to the needs of the market, geometry and topography of Medellín is identified.

Financial:

Lack of information regarding operating costs and investment in infrastructure according to the topographic conditions of the District, high costs of vehicles and their batteries, and availability of spare parts, added to the lack of land or spaces for the definition of patios, among others.

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