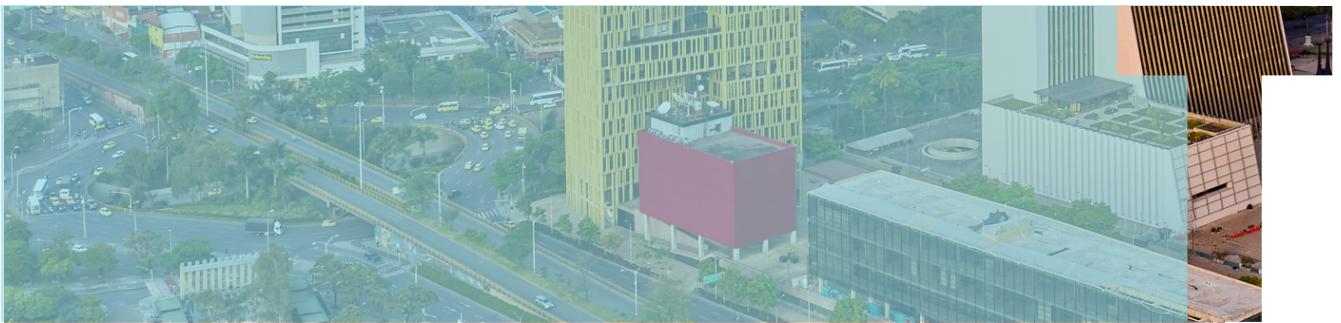
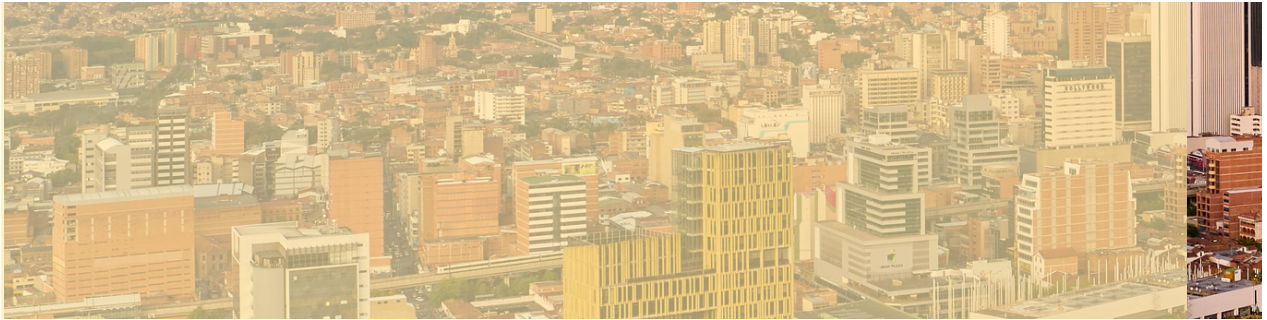
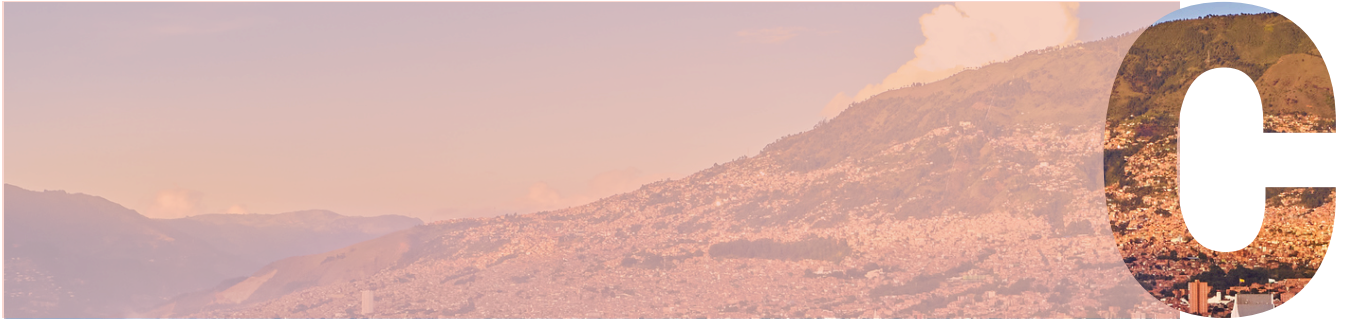


MEDELLÍN, COLOMBIA



CITY FEATURES



Medellín, along with nine other smaller municipalities, comprises the Metropolitan Area of the Aburrá Valley (AMVA), the second-largest urban agglomeration in Colombia (over 3,7 million inhabitants and an urban area of about of 340 km²). The city lies on a narrow and elongated natural valley, and it has grown, following a relatively compact and high-density development along the river. During the second half of the twentieth century, however, accelerated migration from rural areas and an increase in road infrastructure prompted the expansion towards hilly peripheral areas. This in turn, triggered a land use imbalance in service, industrial and commercial areas concentrated along the river, whereas residential use prevails in the outer centre and the periphery.



Population
2,455,072
(2018)



Land area
382 km²



Average temperature
22°C

TRANSPORT FEATURES

Status quo and urban mobility trends¹

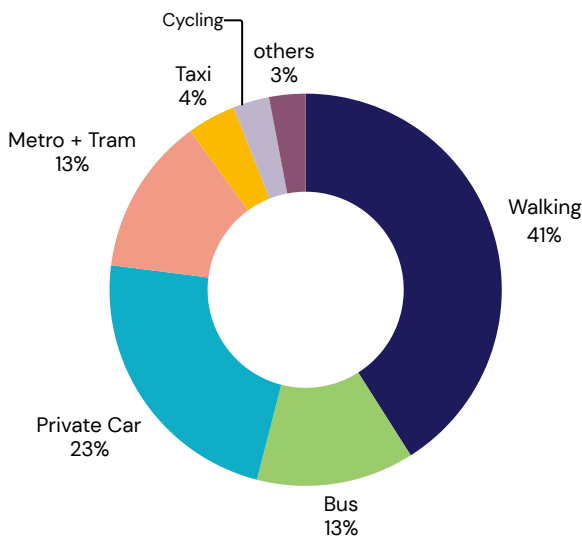
Around 7.5 million daily trips took place in the AMVA with an average travel time of 44 minutes in 2022. Most trips were made using sustainable modes of transport: Walking covered 41% of trips, while public transport (metro, tram, Bus Rapid Transit (BRT), traditional buses and taxis) accounted for 30%. In 2022, approximately a quarter of total daily trips were made using these modes. As a result, cars and motorcycles have become the main source of GHG emissions (72%) and more than 90% of air pollutants, leading to more frequent environmental contingencies throughout the year.



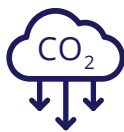
¹ Longitudinal mobility survey of the Metropolitan Area of the Aburrá Valley (AMVA), 2022

TRANSPORT FEATURES

Modal Split¹



GHG Emission Levels



Total GHG emissions²
4,939,288.6 tCO_{2eq}

From road transport³
4,199,400.59 tCO_{2eq}

Air Pollutant Levels⁴



PM 2.5	NO ₂
20.1 µg/m3	49.4 µg/m3
PM 10	SO ₂
53.3.9 µg/m3	23.3 µg/m3

The average air quality level (AQI) in the region is 20.1 µg/m³. The main sources of emissions are trucks, dump trucks, and special service buses, which contribute significantly to pollutants like CO, PM2.5, NOX, and VOCs. Trucks are the leading source overall, while dump trucks and special service buses also play a major role in PM2.5 emissions due to their predominant use of diesel and older vehicle technologies (pre-Euro IV), which lack efficient particulate control. Together, these three vehicle types account for 84% of PM2.5 emissions. Similarly, trucks, cars, and special service buses are responsible for 70% of NOX emissions and 92% of CO emissions, making them the biggest contributors to air pollution in the area.

Bus Trips Features⁵



Number of bus trips

Non-BRT	10,608,095 (2024)
BRT	353,992 (2024)



Average time
53 min



Trips by gender

Women	51.55%
Men	48.45%



Trips by purpose

Return Home	38%
Work	25%
Study	8%
Others	25%
Leisure	4%



Average cost per travel by bus
0,8 €

In 2022, buses used for public passenger transport accounted for 15% of all trips. For many of the most vulnerable residents in urban areas, buses are an essential mode of transportation, providing crucial mobility for daily activities. Compared to men, women rely on buses more frequently and for a greater variety of trips. Additionally, buses serve as the primary means of transport for individuals between 30 and 50 years old. Bus travel follows three key peak periods throughout the day. The morning rush occurs from 5:30 to 8:30 AM, followed by a midday peak at 12:00 noon, and an afternoon surge from 3:30 to 6:00 PM. When looking at travel patterns, most bus trips originate from peripheral neighborhoods on the outskirts of the city. However, the most common destination remains the city center, located in Commune 10 of the District.

1 Longitudinal mobility survey of the Metropolitan Area of the Aburrá Valley (AMVA), 2022.
2 Inventory of atmospheric emissions from mobile sources in the Aburrá Valley, 2022.
3 Study of emissions from industrial sources in the metropolitan area of the Aburrá Valley, 2022.
4 Annual Air Quality Report, Área Metropolitana del Valle de Aburra (AMVA), 2023.
5 Secretariat of Mobility of Medellín and Metropolitan Area of the Aburra Valley (AMVA), 2024.

BUS SYSTEMS OUTLOOK

Fleet and Infrastructure⁵



Number of buses
3,202 part of TPC5 system
513 part of METRO system

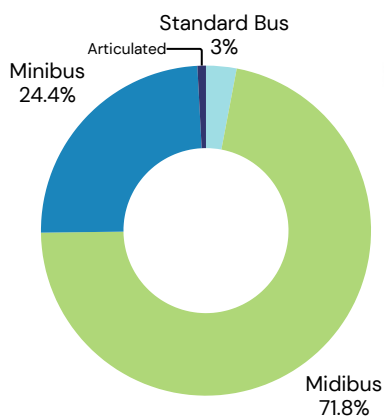


254 Non-BRT routes
2 BRT routes

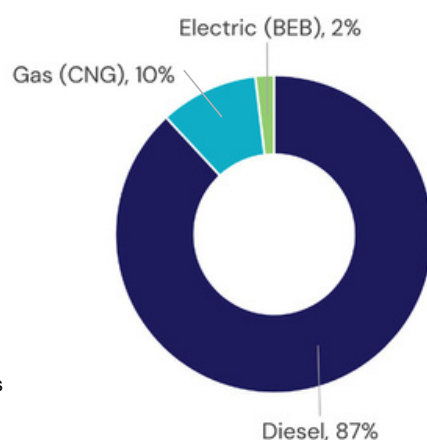


4,231 bus stops⁷
31 bus depots

Buses by fleet type



Buses by fuel type



Medellín's public transport system includes 31 bus depots, with 96,929 m² of effective operational space, leaving a deficit of 203,227 m². The city operates two BRT lines. Line 1 runs 12.5 km with 20 stops, 31 buses (one electric), and a 45-minute travel time at 16 km/h. Line 2 spans 13.5 km with 15 stops, 45 gas and 32 electric buses, taking 52 minutes at 13 km/h. Additionally, Line O (P80) on Avenida 80 runs 8.9 km in mixed traffic, with 14 stops, a 55–60 minute travel time, and a speed of 10 km/h. Each year, 30 million passengers use feeder services, while the BRT system moves 37.6 million. Medellín's BRT plays a key role in urban mobility, offering efficient and accessible transport.

Quality of Service⁵

Most collective public transport routes originate in the city's outskirts and have destinations in the central area, providing direct connections for disadvantaged people and integration with the mass transit system and other modes. Currently, efforts are being made to adjust the transport offer to users' needs. The commercial speed of collective public transport is about 13 km/h, but the lack of dedicated lanes affects its efficiency compared to mass transit. The BRT system includes the Troncal Universidad de Medellín – Aranjuez, with 12.5 km of exclusive lanes, and Medellín also has 72 km of preferential lanes for collective transport. The 2024–2027 Development Plan aims to improve public transport quality through network restructuring, fare integration, and accessibility. 45% of the fleet uses clean technologies, and efforts are underway to reduce the fleet's average age to 10 years, with 70% of vehicles using clean technologies.



⁵ Secretariat of Mobility of Medellín and Metropolitan Area of the Aburra Valley (AMVA), 2024.

Existing Business Model ⁶

A

Model A: Vertically integrated, private operator in BRT/integrated system

B

Model B: Divided responsibilities in BRT/integrated system

C

Model C: Large, more formal, private operator in traditional service

D

Model D: Small, informal, private operator in traditional service

E

Model E: Government-run system

C

(Model C) variation implemented to operate bus feeder lines of Medellín's mass transport system (BRT, metro, and aerial cable) through concessions. Compared with permits, concessions to private operators are subject to higher standards. Fare collection is electronic based on allowing integration, and fleets need to comply with higher emission requirements, meaning most buses are EURO VI. Due to the local government's tariff stabilization fund, private operators secure revenues regardless of the number of passenger variations on each route.

C-D

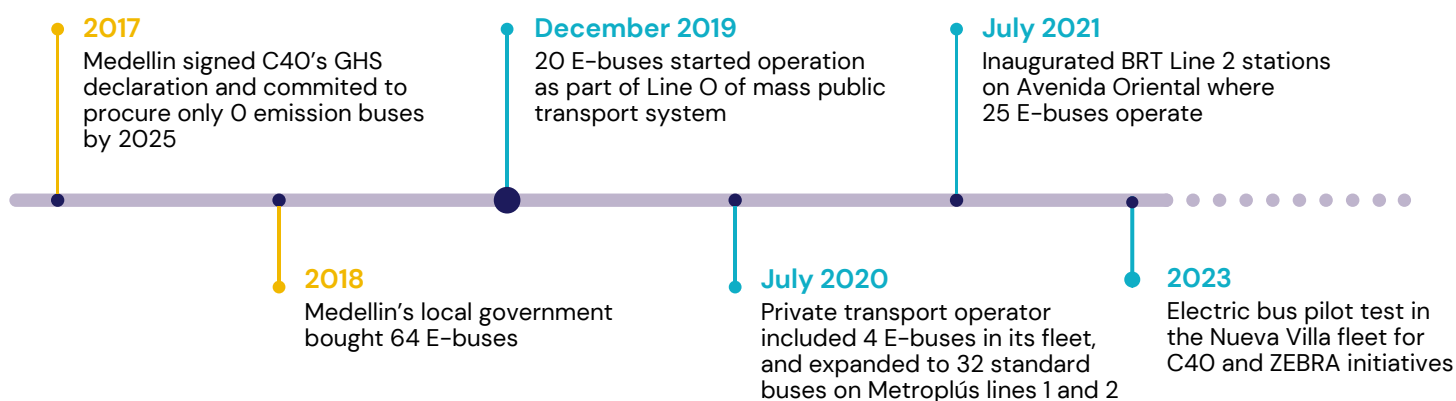
Private operators not only run the system but also own and maintain the fleet. The type and size of private operators vary widely: from large companies to individuals/small groups (e.g., family businesses) associated with cooperatives. Payment systems mostly remain cash-based. Route permits are awarded by the Medellín and AMVA's mobility departments with no end date. Both authorities also define fare cost, which is adjusted yearly.

E

Consortium of government institutions, Metro de Medellín (public TPO – Transport Public Operator), and some of AMVA's municipal governments to operate Metroplús, the metropolitan BRT system. Metro de Medellín and municipalities own buses and other assets, whereas operation was granted to Metro de Medellín exclusively.









E-BUS ADOPTION APPROACH



⁶ Based on Accelerating a market transition in Latin America: New business models for electric bus deployment, P4G, Zebra and Dalberg, 2020

E-Bus Fleet Technical Features

	Model/Brand				Number of buses with this Technology		
	Type A BYD-2912TZ-XY-A BYD	Type B LCK6780EVG Zhongtong	Type C BYD 18(KF1) BYD		64 Type A	4 Type B	1 Type C
	Passenger capacity				Charging System		
	Type A 80 Pax	Type B 40 Pax	Type C 160 Pax		Type A In depot 6.4 buses per charger	Type A In depot 2 buses per charger	Type A In depot One charger per bus
	Battery features				Price		
	Type A Capacity 348 kWh Range 242 km/charge	Type B 168 kWh 168 km/charge	Type C 450 kWh 288 km/charge		Type A \$ 1200,000,000 COP	Type A \$ 800,000,000 COP	Type A \$ 630,000 USD

E-Bus Business Model

The bus operators are the ones who own and operate the system and charge the fee. The municipality is responsible for maintaining the infrastructure (stops, streets), regulating and supervising the system. It also offers subsidies such as tax exemption on spare parts, rolling stock and fuel subsidies. The main problem is the lack of common funds at the district level and among the operators, along with the presence of informal transport. That deficit is not covered by any institution or fund. There is still missing a regulatory framework to close these gaps for advancing the adoption of electric buses.

Opportunities and Challenges to Scaling E-Bus Fleets



Opportunities

- Reduce environmental impacts related to CO2 and PM2.5 (particulate matter), improving air quality in the city.
- Modernize the current bus fleet operating the Collective Public Transport (TPC).
- Increase passengers in TPC and Metroplús by ensuring buses offer higher comfort, operational safety, availability, and a better user experience with smoother driving.
- Break technological barriers for the 38 transport companies in Medellín by encouraging the adoption of new vehicle types and clean technologies.



Challenges

- Bus design considerations: Buses must be maneuverable on city roads, which feature steep slopes (10–45%), tight turns, narrow roads (TPC width: 3.25 meters), and on-street parking. This requires buses with good handling and attention to front and rear overhangs to avoid damage due to slopes when carrying passengers.
- Change transporters' mindset about buses having enough power to climb the steep routes in the city.

OVERALL FRAMEWORK

Policy

Entities involved in Medellín's sustainable mobility and bus electrification include the state, academia, AMVA, EPM, Metro de Medellín, and UPB. These entities manage resources, lead technical discussions, and ensure legal compliance and proper fleet operation. Key policies include Agreement 44 of 2015, promoting electric mobility through education and incentives, and Decree 1221 of 2016, which supports electric public transport. Medellín's Climate Action Plan (2020–2050) focuses on transitioning public and private vehicles to electric, promoting low-emission technologies. Additionally, strategies are being developed to improve pedestrian and cycling mobility, encouraging sustainable transport choices.

Financing

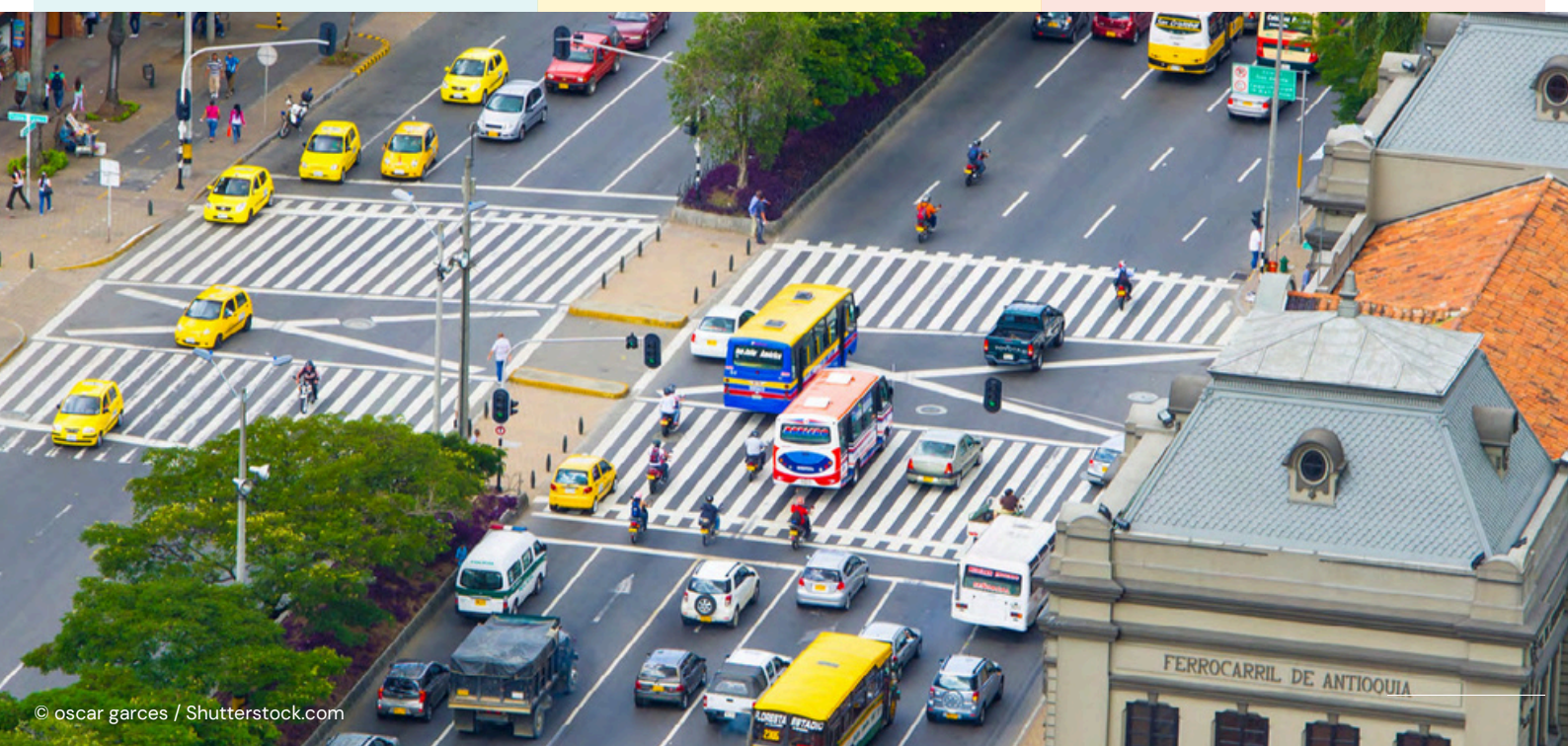
In Medellín, sustainable mobility is a priority, with various financing schemes for electric vehicles.

Key mechanisms include:

- District's own funds: Medellín purchased 64 electric buses for the Metroplus system, reducing fossil fuel dependence.
- Public-private investment: Five entities co-financed an electric articulated bus for a pilot project, promoting energy efficiency and reducing emissions.
- Private financing: Masivo de Occidente acquired four electric buses through discounted credit, although post-pandemic financial challenges slowed fleet modernization.

Impact

Medellín's Climate Action Plan 2020–2050 focuses on sustainable transport, aiming to ensure public transport continuity and resilience during extreme weather events. Key actions include developing safe, inclusive infrastructure, reducing fossil fuel vehicle trips, and transitioning to electric vehicles. The city targets a 15% reduction in GHG emissions by 2030 and 28% by 2050. Notable projects include EnCicla, a public bike-sharing system, and efforts to integrate electric buses and trams. The MetroCable and subsidized public transport programs enhance accessibility for vulnerable communities. Medellín also fosters citizen participation in mobility planning, ensuring inclusive and sustainable solutions.



TUMI E-bus Mission City Network – Profile

MEDELLÍN, COLOMBIA



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About the TUMI E-Bus Mission

Funded by the German Ministry for Economic Cooperation and Development (BMZ), a core group of organizations supports cities in their transition toward electric bus deployment.

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