Trolebús Elevado, Mexico City

Document prepared by Mercado Ambiental AP

Name of the project	*Trolebús Elevado, Mexico City*
Project proponent	*Mercado Ambiental AP S.C.*
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Project participants	*Environment Secretariat (SEDEMA)* *Mercado Ambiental AP S.C.* *Electric Transport Service of Mexico City*
Version	*1.0*
Date	*14/02/2024*
Project type	*Transport*
Grouped project	*Is a grouped project*

Applied Methodology	*ACM0016: Mass Rapid Transit Projects --- Version 5.0*
Project location (City, Region, Country)	*Mexico City, Mexico*
Starting date	29/10/2022
Quantification period of GHG emissions reduction	29/10/2022 to 28/10/2032
Estimated total and average annual GHG emission reduction amount	253,067 tCO_2e during 14-year period Average 16,871 tCO_2e per year
Sustainable Development Goals	*SDG – Good Health and Well-Being* *SDG 9 – Industry, Innovation and Infrastructure* *SDG 11 – Sustainable Cities and Communities* *SDG 13 – Climate Action*
Special category, related to co-benefits	*NA*

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1 Project type and eligibility

1.1 Scope in the BCR Standard

The scope of the BCR Standard is limited to:	
The following greenhouse gases, included in the Kyoto Protocol: Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O).	**X**
Greenhouse Gases (GHG) projects using a methodology developed or approved by BioCarbon, applicable to GHG removal activities and REDD+ activities (AFOLU Sector).	
Quantifiable GHG emission reductions and/or removals generated by the implementation of GHG removal activities and/or REDD+ activities (AFOLU Sector).	
GHG projects using a methodology developed or approved by BioCarbon, applicable to activities in the energy, transportation and waste sectors.	**X**
Quantifiable GHG emission reductions generated by the implementation of activities in the energy, transportation and waste sectors.	**X**

The project is eligible under the scope of the BCR Standard approved methodology, the Large-scale Methodology ACM0016: Mass Rapid Transit Projects, version 5.0. This methodology allows for the registration of projects that involve the implementation of mass rapid transit (MRT) systems, which aligns with the objectives of the project on Eje 8. The project will count activities initiated from 29/10/202 onwards, in accordance with the BCR Standard, which includes a start date within five (5) years prior to the start of validation. The project on Eje 8 involves the construction and operation of an Trolebús Elevado system, aimed at improving public transportation efficiency, reducing traffic congestion, and mitigating greenhouse gas emissions.

1.2 Project type

Activities in the AFOLU sector, other than REDD+	

REDD+ Activities	
Activities in the energy sector	
Activities in the transportation sector	**X**
Activities related to Handling and disposing of waste	

1.3 Project scale

Small scale (Less than 60 $ktCO_2e$/year reduced according to the definition of Clean Development Mechanism)

2 General description of the project

The Metropolitan Area of the Valley of Mexico faces significant urban mobility and environmental challenges due to rapid urbanization. Currently, inefficient transportation, high reliance on private vehicles, and insufficient road infrastructure lead to congestion, accidents, and high pollution levels. The introduction of next-generation trolleybuses fully electric service, is expected to improve public transportation efficiency, reduce dependence on private vehicles, and decrease CO_2 emissions. The project is estimated to increase service supply by 44%, reduce waiting times by 50%.

The project is proposed under the sustainable development category, meeting criteria for energy efficiency, GHG emission reduction, and urban mobility improvement. It aligns with comprehensive strategies to promote a high-capacity, efficient, and low-polluting public transportation system. The project will significantly contribute to SDGs by improving health and well-being (SDG 3) through reduced air pollution, promoting sustainable cities (SDG 9) and communities (SDG 11) by improving urban mobility and accessibility, and taking action on climate change (SDG 13) through GHG emission reductions.

The implementation of the trolleybus system is estimated (ex-ante) to reduce on average 16,871 tonnes of carbon dioxide equivalent (tCO_2e) per year, significantly improving air quality and contributing to climate change mitigation efforts. The estimated emissions reduction over the 14-year period from 2022 to 2036 is approximately 253,067 tCO_2e.

2.1 GHG project name

Trolebús Elevado, Mexico City

2.2 Objectives

General Objective:

- Enhance the sustainability and efficiency of urban mobility in Mexico City through the deployment of an Trolebús Elevado system, aiming to minimize GHG emissions from the transportation sector, improve air quality, and ensure accessible and efficient public transportation for city residents.

Specific Objectives:

- Reduce GHG Emissions: Achieve a significant reduction in GHG emissions by transitioning from fossil fuel-dependent vehicles to low-emission trolleybus systems.
- Improve Urban Mobility: Increase the capacity and efficiency of public transportation in Mexico City by implementing the Trolebús Elevado system, which is designed to reduce congestion, lower travel times, and increase the reliability of public transit.
- Promote Sustainable Urban Development: Integrate the Trolebús Elevado system into the broader urban planning strategy of Mexico City, aiming to create a more sustainable, livable, and well-connected city.
- Enhance Access to Public Transportation: Make public transportation more accessible and inclusive for all city residents, including vulnerable and marginalized communities, by providing a safe, comfortable, and affordable means of transport.
- Stimulate the Development of Green Infrastructure: Encourage the adoption of green technologies and practices in the transportation sector, including the development of infrastructure that supports the operation and maintenance of the Trolebús Elevado system.

2.3 Project activities

The project activities for the Trolebús Elevado initiative in Mexico City involve the deployment of advanced electric bus technologies, trolleybuses, across the Eje 8 Sur corridor. The project includes the acquisition and deployment of new Yutong generation trolleybuses equipped with advanced features designed to enhance the urban mobility

experience in Mexico City. These trolleybuses feature lithium iron phosphate batteries, offering a range of 75 km on a single charge, and are fully accessible with low floors, ramps for wheelchairs, and designated spaces for passengers with disabilities. The project aims to increase service offer by 44%, improve passenger capacity, and significantly reduce waiting times and GHG emissions. The project incorporates:

- Fleet Modernization: Replacement of older, diesel-powered buses with new generation Trolleybuses.

- Operational Efficiency: Implementation of smart transportation management systems to optimize routes, schedules, and energy use, further reducing the carbon footprint of public transportation services.

These activities align with the goal of transitioning to a low-carbon public transportation system, leveraging clean energy technologies to achieve significant reductions in GHG emissions.

2.4 Project location

The project is located in Mexico, specifically in Mexico City as shown in Figure 1. It encompasses the Trolebús Elevado line running along Eje 8 Ermita-Iztapalapa, from Constitución de 1917 to the Universidad Autónoma de la Ciudad de México (UACM). This route targets significant urban and suburban areas, aiming to enhance public transportation infrastructure and connectivity in one of the city's key corridors.

Figure 1. Geographical location of the project: Mexico City, Mexico

3 Quantification of GHG emissions reduction

3.1 Quantification methodology

Reference methodology Clean Development Mechanism (CDM): ACM0016. Mass Rapid Transit Projects. Large-scale Methodology. Version 5.0. Valid from 27 May 21 onwards.

3.1.1 Applicability conditions of the methodology

Table 1 shows the disaggregation of each concept of applicability and the correlation with the project concept.

Table 1. Applicability of the project to the conditions set by the methodology

Concept of methodology	**Project Concept**
Establishment and operation of new rail-based or bus-based mass rapid transit systems (MRTS) in urban or suburban regions for passenger transport by replacing a traditional urban public transport system. For buses, typical projects involve the replacement, extension of bus lanes or expansion of existing BRT systems (adding new routes and lines). For trains, typical projects involve the extension of existing rail line or expansion of existing rail infra-structure (e.g. new rail lines).	Establishment and operation of new bus-based mass rapid transit system in an urban region (Mexico City) for passenger transport by replacing a traditional urban public transport system.
The methodology is applicable for the implementation of Mass Rapid Transit Systems, such as segregated Bus Rapid Transits (BRT) bus lanes or rail-based lines, that replaces existing bus routes operating under mixed traffic conditions.	Implementation of MRT such as segregated Bus Rapid Transits (BRT) bus lanes, that replaces existing bus routes operating under mixed traffic conditions.
The project may involve one or more of the measures listed below: (a) The construction of a new rail-based infrastructure (e.g. new rail lines); (b) The expansion of an existing rail infrastructure (e.g. extension of an existing rail line);	The project involves: (c) The construction of new segregated BRT bus lanes

(c) The construction of new segregated BRT bus lanes; (d) The extension of bus lanes of existing BRT systems or expansions of existing BRT systems (i.e. adding new routes and lines).	
For projects involving BRTs, the following specific provisions apply: (a) Only BRT systems without feeder route are eligible under this methodology. (b) The buses used in the routes that were replaced by the project MRTS can be retired or relocated to another part of the network; (c) The project activity may be based on existing road infrastructure, but the bus lanes shall be separated physically from mixed traffic.	The project includes: (a) BRT system without feeder routes (b) The buses used in the routes that were replaced by the project MRT were retired (c) The project is separated physically from mixed traffic
Fuels including (liquified) gaseous fuels or biofuel blends, as well as electricity can be used in the baseline or project case. The following conditions apply in case of biofuels: (a) The project buses shall use the same biofuel blend (same percentage of biofuel) as commonly used by conventional comparable urban buses in the country i.e. the methodology is not applicable if project buses use higher or lower blends of biofuels than those used by conventional buses; (b) The project buses shall not use a significantly higher biofuel blend than cars and taxis.	Project buses use electricity. The baseline buses use fossil fuels commonly diesel.
The methodology is applicable for urban or suburban trips. It is not applicable for interurban transport.	The trips of the project are urban
In addition, the applicability conditions included in the tools referred to below shall apply.	All the conditions included in the tools referred to below apply

The methodology is applicable if the most plausible baseline scenario is the continuation of the use of current modes of transport.	The most plausible baseline scenario is the continuation of the use of current modes of transport
The methodology is not applicable for: (a) Operational improvements (e.g. new or larger buses) of an already existing and operating bus lane or rail-based MRTS; (b) Bus lanes replacing an existing rail-based system i.e. the existing urban or suburban rail infrastructure shall remain fully (in its full length) operational; (c) The implementation of air- or water-based transport systems.	The project does not involve: (a) Operational improvements (b) Bus lanes replacing an existing rail-based system. (c) The implementation of air- or water-based transport systems

3.2 Project boundaries, sources and GHGs

3.2.1 Spatial limits of the project

The spatial extent of the project boundary encompasses the passenger trips completed on the Trolebús Elevado system within the Mexico City in which the project takes place. It is based on the origins and destinations of passengers using the project system. As the project cannot control the trip origins or destinations of passengers, the spatial area of the project is the entire larger urban zone of Mexico City in which the project operates.

Figure 2 shows the geographical location of the route that 10 stations through the Alcaldía Iaztapalapa in Mexico City while table 2 presents the GHG that the present project covers.

Figure 2. Geographical location of the project: Eje 8 Ermita-Iztapalapa, Mexico City, Mexico. Source: Mexico City Government

3.2.2 Carbon reservoirs and GHG sources

Table 2. Sources and GHG included for baseline emissions and project emissions reductions quantification

Source	GHG	Included (Yes/No)	Justification
Mobile source emissions of different modes of transport used on the baseline	CO_2	Yes	Major emission source
	CH_4	Yes	Included only if gaseous fuels are used and excluded for liquid fuels. CH_4 emissions are a minor emission source of the total CO_2e emissions in diesel/gasoline vehicles Neglecting these emissions in baseline as well as project emissions is conservative as fuel consumption and thus also CH_4 emissions are reduced through the project
	N_2O	No	N_2O emissions are a minor source of the total CO_2e emissions. Neglecting these emissions in baseline as well as project emissions is conservative as

			fuel consumption and thus also N2O emissions are reduced through the project
Direct emissions from the operation of the project MRT	CO_2	Yes	Major emission source
	CH_4	No	Gaseous fuels not used within the project
	N_2O	No	N_2O emissions are a minor source of the total CO_2e emissions.
Indirect emissions from the different modes of transport used by the passengers of the MRTS, from their point of origin to the MRTS entry station, and from the MRTS exit station to their final destination	CO_2	Yes	Major emission source
	CH_4	Yes	Included only if gaseous fuels are used and excluded for liquid fuels.
	N_2O	No	N_2O emissions are a minor source of the total CO_2e emissions.

3.2.3 Time limits and analysis periods

The first quantification period of the project will cover fourteen years according to section 10.5 of BCR standard version 3.3, with the possibility of renewing three times. Time frameworks comprise from 29/10/2022 to 28/10/2036.

According to the past Mexico City government chief, the lifespan of the Trolebús Elevado project is 50 years (El Universal, 2020), which allows the maximum crediting period of 42 years for non-AFOLU projects.

3.2.3.1 Project start date

The project start date is when the activities that result in actual reductions of GHG emissions begin.

In this case, the GHG emission reductions start on the day of the inauguration and putting into service the Trolebús Elevado, which was October 29th, 2022.

3.2.3.2 Quantification period of GHG emission reductions

Time frameworks comprise since 29/10/2022 to 28/10/2036. This first crediting period of the project will cover fourteen years with the possibility to renew tree times.

3.2.3.3 *Monitoring periods*

The project's first monitoring period covers from 29/10/2022 to 28/10/2036, with the possibility to renew three times until 2064.

The monitoring specifications are defined in section 16 of this document. Reporting periods will last approximately three to five years and proceed to verify emissions reductions.

3.3 Identification and description of the baseline or reference scenario

In conformity with methodology ACM0016 ver 5.0, if the project is deemed to be additional, then the baseline scenario is assumed to be the continuation of the use of usual modes of transport, when the transport system before the project (possibly expanded using additional vehicles) would be able to meet the transportation demand that will be met by the project system.

As is explained in section 3.4, the project is considered additional.

The baseline, according to Cities Finance Facility (CCF) study on the Cost-Benefit Analysis of Eje 8 Sur corridor, until 350 buses were registered on the baseline scenario. For the entire corridor on a maximum-demand hour the inflow is 14,630 passengers per hour at a speed lower than 12km/h. Similarly, Mexico City Government carried out a study in 2020 related to the offer and demand of Eje 8 Sur, concluding that the total offer was higher than the demand in strategic stations of the corridor. The result was an average of 210,407 slots available versus 84,009 passengers daily per station of demand, concluding that the first section of Trolebús Elevado project will cover between 33% and 48% of the baseline offer.

CCF also studied the possibility of covering demand and potentially increasing the transport capacity of diesel-based buses in business-as-usual scenarios. This approach consists of changing concessioned microbuses for Euro IV or Euro IV buses to comply with the national regulations.

This study modelled the cover of the demand through 47 articulated buses with a capacity of 140 passengers. Additionally, CFF assessed economic viability, comparing diesel buses as a business as a business-as-usual scenario vs investing in the Trolebús Elevado corridor. The business, as usual, is more financially attractive with a lower total cost of ownership (CCF), but this represents more emissions.

Under this setup, diesel-based buses are the most feasible scenario, and it could cover the demand by 47 articulated buses. Nevertheless, Trolebús Elevado, with more investment, would carry another benefit, including less GHG emissions.

3.4 Additionality

Consistent with the ACM0016 methodology version 5.0, additionality demonstration section 5.2, for projects not implemented in least-developed countries and projects that do not face first-of-its kind barrier, the procedure is illustrated in figure x.

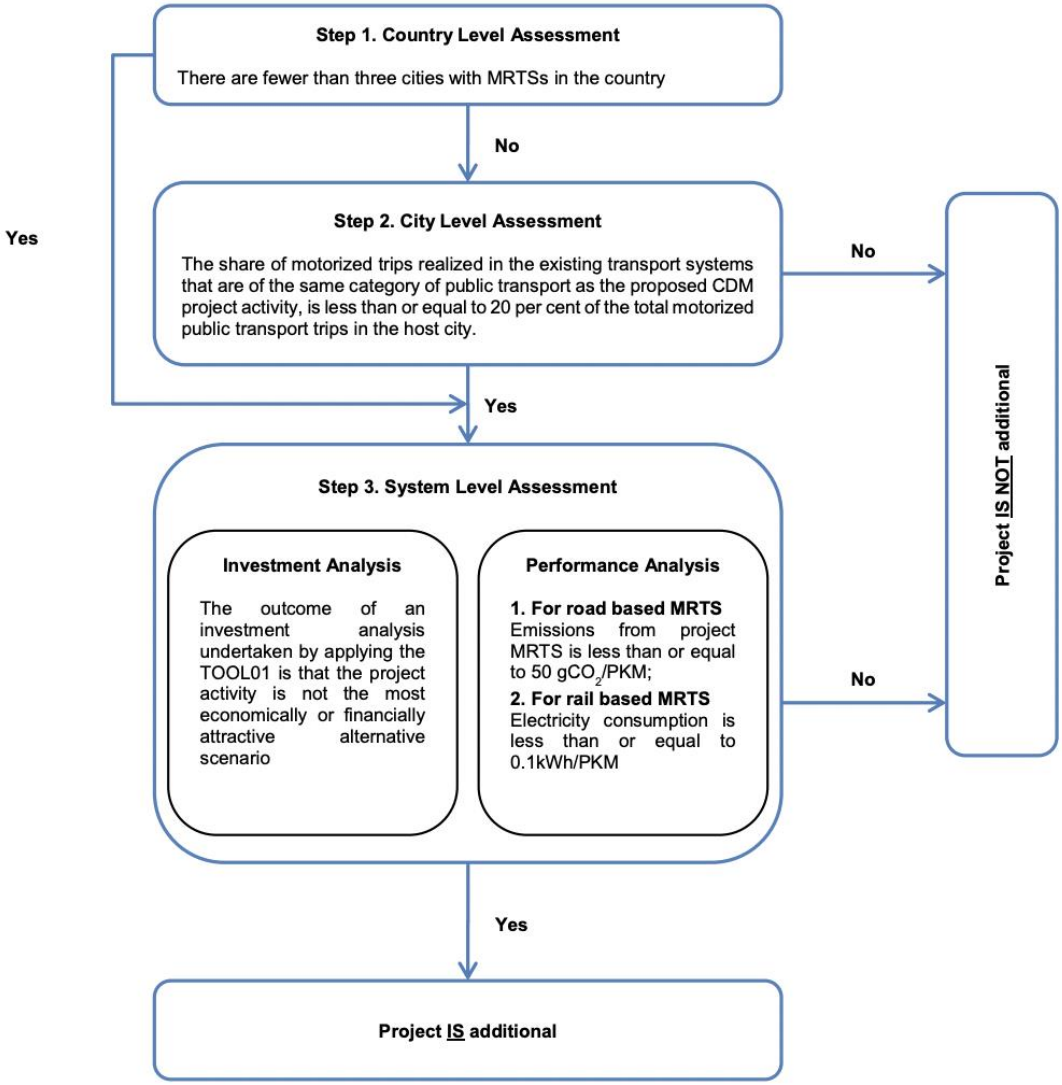

Figure X. Additionality demonstration procedure for Trolebús Elevado project. Source: Methodology ACM 0016

Following the steps of the procedure shown before:

Step 1. Country-level assessment. There are **more than three cities** in the country with MRT systems.

In the words of applicable methodology, the Mass Rapid Transit Systems (MRTs) are collective urban or suburban passenger services operating at high levels of performance, especially regarding travel times and passenger carrying capacity and can be based on elevated, surface level or underground roads or rail systems. MRTS can be rail-based systems such as subways/metros, light rail transit (LRTs) systems, trams, suburban heavy-duty rail systems, or road-based bus systems. For the purpose of this methodology, road-based MRTS are bus systems using bus lanes, which can also be called BRT systems.

MRT systems in Mexico that have started commercial operation prior to the start date of Trolebús Elevado are listed below:

- Mexico City Subway – Mexico City
- Tren ligero – Mexico City
- Guadalajara Electric Train - Guadalajara
- Metrorrey - Monterrey
- Optibus - León
- Metrobús – Mexico City
- Mi Macro - Guadalajara
- Mexibús – State of Mexico
- Bowi - Chihuahua
- RUTA – Puebla
- Juarez Bus – Juarez City
- Ecovía – Monterrey
- Tuzobús - Pachuca
- SITT – Tijuana
- ACABUS – Acapulco
- Qrobús – Querétaro

Step 2. City Level Assessment. The share of motorized trips realized in the existing transport systems that are of the same category of public transport as the proposed project activity is less than or equal to 20% of the total motorized public transport trips in the host city.

As stated by the *Instituto Nacional de Estadística y Geografía* (INEGI) in the Urban Passenger Transport database, in 2021, only 4.15% of the passengers transported in Mexico City were transported by the Trolebús as an MRT electric bus category. The other

motorized public transport systems include the *Red de Transporte de Pasajeros (RTP), Sistema de Transporte Colectivo Metro, Tren Ligero*- light rail, *Metrobús* and *Cablebús.*

Likewise, from January to September 2022, before the implementation of Trolebús Elevado system in October 2022, this share corresponds to 4.08%. Table X. shows the correlation between passengers transported per category of transport in Mexico City (INEGI) from January to September 2022.

Table X. Share of passengers transported in Mexico City before project implementation

Transport	**Category**	**Passengers transported**	**Percentage of total trips**
Cablebús	Cablecar	*28,359,977*	2.35%
Metrobús	BRT bus-diesel-based	*269,312,742*	22.29%
Red de Transporte de Pasajeros	Conventional bus system	*91,043,370*	7.53%
Sistema de transporte colectivo Metro	Metro rail-based subway	*753,201,355*	62.33%
Tren ligero	Ligth rail	*17,175,737*	1.42%
Trolebús	MRT electricity bus-based	*49,359,108*	4.08%

Thus, step **two is fulfilled by the present project with less than 20% of the total motorized public transport trips in Mexico City.**

Step 3. System level assessment. For this project, the option of conducting a performance analysis was chosen.

The procedure indicates that the MRT project shall demonstrate that for road-based systems, forecasted emissions from the project is less than or equal to 50 gCO_2/pkm and,

forecasted electricity consumption of the rail-based systems is less than or equal to 0.1 kWh/pkm, to demonstrate that the project is additional.

As the project is currently in operation, the annual estimation on project emissions and electricity consumption data from January to February 2023 will be used.

To calculate the emission factor per passenger-kilometer for electricity-based vehicle tool 18 of CDM was used, specifically equation 2.

$$EF_{PKM} = \frac{TE_{EL}}{P_{EL} * D_{EL}} * 10^6$$

EF_{PKM}= Emission factor per passenger-kilometer for electricity-based vehicle during the period (gCO_2/PKM)

TE_{EL} = Total emissions from electricity-based vehicle during the period (tCO_2)

P_{EL}= Total number of passengers transported by electricity-based vehicle during the period (passengers)

D_{EL}= Average trip distance travelled by passengers using electricity-based vehicle category during the period (km)

$$TE_{EL} = EF_{SE} * EC_{EL}$$

EF_{SE} = Emission factor of national grid in 2023 (tCO_2e/MWh)

EC_{EL}= Energy consumption of the project during the period (WMh)

$$EC_{EL} = EC_T * D_T$$

EC_T = Energy consumption factor for electricity-based vehicle Trolebús Elevado (kWh/km)

D_T= Total distance driven by the Trolebús Elevado project during the period (km)

$$EC_{EL} = EC_T * D_T = 0.8 \frac{\text{kWh}}{\text{km}} * 519{,}760km * \frac{1MWh}{1000kWh} = 415.80\ MWh$$

$$TE_{EL} = EF_{SE} * EC_{EL} = 0.438 \frac{tCO_2e}{MWh} = 415.80\ MWh = 182.12\ tCO_2e$$

$$EF_{PKM} = \frac{TE_{EL}}{P_{EL} * D_{EL}} = \frac{182.12\ tCO_2e}{3{,}660{,}384\ passengers * 4.635\ km} * \frac{10^6 gCO_2e}{1tCO_2e} = \mathbf{10.734}\,\boldsymbol{\frac{gCO_2e}{pkm}}$$

Equally, to calculate both performance indicators, taking into account that Trolebús Elevado is an electricity-bus-based project, substitute from the last estimation, total emissions for electricity consumption.

$$EF_{PKM} = \frac{EC_{EL}}{P_{EL} * D_{EL}} = \frac{415.80\ MWh}{3{,}660{,}384\ passengers * 4.635\ km} * \frac{1000\ kWh}{1MWh} = \mathbf{0.024}\,\boldsymbol{\frac{kWh}{pkm}}$$

Under the values obtained, less than 50 gCO_2/pkm and less than 0.1 kWh/pkm, it is demonstrated that the project is **considered additional.**

3.5 Uncertainty management

The present project uses local and national data to reduce uncertainty. When using default values, to follow conservative principle, traditional values of setting will be used by the use, for example, the lower limit of the range of data as long as it corresponds to the most conservative assumption.

As the project makes references to external documents susceptible to updates, the project will use the most recent version of the documents.

3.6 Leakage and non-permanence

Project emissions due to the leakage result from:

a. Changes in occupancy of the baseline transport system, that is, the project may potentially increase or decrease the occupancy rate of the baseline vehicles (i.e. buses and taxis)
b. Reduced congestion in remaining roads (because passengers shifted from cars and motorcycles to the MRT project, resulting in a higher average speed of baseline vehicles), plus a rebound effect.
c. Upstream emissions of gaseous fuels if the project vehicles consume more gaseous fuels than baseline vehicles.

The project calculation will include leakage, if applicable.

Regarding non-permanence, in concordance with the BCR tool of risk and permeance, the project will monitor project activities and, through verifications, shall evaluate the permanence of activities. Likewise, BCR Standard considers the validity of emission

reduction certified expire three years after the end of the quantification period of the GHG project.

3.7 Mitigation results

3.7.1 GHG emissions reduction/removal in the baseline scenario

Baseline GHG emissions must be calculated based on the last version of Tool 18 Baseline emissions for modal shift measures in urban passenger transport. This tool indicates the use of surveys conducted in year 1 and year 4 of the crediting period (Adapted to the project to year 2 and 5), taking into account the emissions that would have happened due to the transportation of the passengers who use the project activity to travel between the point of origin to the final destination, had the project activity not been implemented.

Surveys will be conducted in year 2 for the present project once the validation process has been concluded.

To estimate baseline GHG emissions before the surveys it will be used buses that were displaced by the project. According to the Analysis of electric buses for the zero emissions corridor Eje 8 Sur (Cities Finance Facility, 2018) and Mexico City integrated update of the climate change environmental program 2019-2021, there were 47 concessioned buses with 140 passengers' capacity.

The study of Cities Finance Facility indicates a daily mileage per working day of 250km for the baseline buses, and a total annual mileage of 73,000km per bus. According to the latest Emissions Inventory of the Metropolitan Area of the Valley of Mexico (2020) the emission factor for concessioned diesel-based buses in Mexico City is 1,063.74 gCO_2/km.

Therefore, the baseline estimation of GHG emissions for buses displacement is:

$$BE_{pre\ estimation} = DDz,s,x * N_{Z,s,x} * Buses\ emission\ factor$$

$DD_{z,s,x}$ = Total distance driven per bus in year x

$N_{Z,s,x}$ = Number of baseline buses that were displaced

$$BE_{pre\ estimation} = 200\,\frac{km}{bus\ day} * 365\,\frac{days}{year} * 250\ bus * \ 1{,}062.63\,\frac{\mathrm{gCO_2}}{\mathrm{km}} = \mathbf{19{,}392.9\ tCO_2}$$

3.7.2 GHG emissions reduction/removal in the project scenario

In order to estimate direct ex-ante project emissions, the ACM 0016 methodology provide an alternative to calculate emissions due to electricity consumption and distance data.

$$EC_{PJ} = SEC * DD * 10^3$$

EC_{PJ} = Electricity consumed by the project vehicles from the electricity consumption source in year y (MWh)

EC_T = Specific electricity consumed by the project vehicles from the electricity consumption source in year y (kWh/km)

DD = Total distance driven by vehicles in year y (km)

During 2022, from the project start date to December 31st the total distance driven was 590,723km equivalent to 3,481,620 passengers transported.

With a projection of passengers anticipated by the Transport Secretariat, and the emission factor of trolleybuses, the GHG project emissions could be:

Table X. Potential GHG direct project emissions based on expected distance driven

Year	Passengers	Total distance [km]	Electricity consumption [MWh]	GHG emissions
2022	3,481,620	590,723	473	206
2023	23,985,161	4,069,538	3,256	1,426
2024	24,225,013	4,110,234	3,288	1,440
2025	24,467,263	4,151,336	3,321	1,455
2026	24,711,935	4,192,849	3,354	1,469
2027	24,959,055	4,234,778	3,388	1,484
2028	25,208,645	4,277,126	3,422	1,499
2029	25,449,261	4,317,951	3,454	1,513
2030	25,693,953	4,359,467	3,488	1,528
2031	25,938,645	4,400,984	3,521	1,542
2032	26,183,337	4,442,501	3,554	1,557
2033	26,428,029	4,484,017	3,587	1,571
2034	26,672,721	4,525,534	3,620	1,586
2035	26,917,413	4,567,051	3,654	1,600
2036	27,162,105	4,608,567	3,687	1,615

Indirect project emissions will be determined based on survey answers to identify emissions from user' s point of origin up to the project activity entry station and from the project activity exit station up to the final destination, and calculated on the equation below:

$$IPE_y = P_y * \sum (D_{ind,i,1-4} * EF_{pkm,i,1-4} * 10^{-6})$$

IPE_y = Indirect project emissions in year y (tCO_2)

Py = Total number of passengers transported in year y

$EF_{pkm,i,1-4}$ = Emission factor per passenger-kilometer of mode i in years 1 and 4 of the crediting period (Adapted to the project to year 2 and 5) (gCO_2/pkm)

$D_{ind,i,1-4}$ = Average indirect project trip distance of surveyed passengers using mode i in years 1 and 4 of the crediting period (km)

Project emissions due to the leakage result from:

d. Changes in occupancy of the baseline transport system, that is, the project may potentially increase or decrease the occupancy rate of the baseline vehicles (i.e. buses and taxis)
e. Reduced congestion in remaining roads (because passengers shifted from cars and motorcycles to the MRT project, resulting in higher average speed of baseline vehicles), plus a rebound effect.
f. Upstream emissions of gaseous fuels, if the project vehicles consume more gaseous fuels than baseline vehicles (no applicable to this project)

Leakage due to the change in load factor of buses

The decrease in the occupancy of baseline conventional bus fleet results in a higher CO_2 emission factor per passenger-kilometer. Load factor changes will be monitored in years 1 and 4 of the crediting period for the entire larger urban zone of the city as the potential impact is not necessarily in the proximity of the project MRT (buses can be used in other parts of the larger urban zone of the city).

This leakage source is only included if the load factor of buses has decreased by more than 10% as certain variations in the load factor caused by external circumstances are normal, calculated as:

$$LE_{LF,Z,y} = \max\left[\frac{\left(N_{z,1.4} * AD_z * EF_{km,Z,y} * \left(1 - \frac{ROC_{Z,1-4}}{ROC_{Z,x}}\right)\right)}{10^6}; 0\right]$$

Where:

$LE_{LF,Z,y}$ = Leakage emissions due to change of load factor of buses in year y (tCO_2)

$N_{Z,1-4}$ = Number of buses in years 1 and 4 of the crediting period (buses)

AD_Z = Average annual distance driven by baseline buses (km/bus)

$EF_{km,Z,y}$ = Emission factor per kilometer for baseline buses in year y (gCO_2/km)

$ROC_{Z,1-4}$ = Average occupancy rate relative to the capacity of baseline buses in years 1 and 4 of the crediting period (%)

$ROC_{Z,x}$ = Average occupancy rate relative to the capacity of baseline buses in year x (%)

x = Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the Project Document for validation, whichever is earlier

These parameters will be monitored during the 1 to 4 years of project operation to determine if leakage due to bus occupation are applicable.

The same process to determine if there is a change in taxis lead factor will be monitored.

Determination of emissions due to induced traffic/rebound effect

The concept to capture emissions from induced traffic (or rebound effect, measured for passenger cars and taxis) includes the following conservative assumptions:

(a) The distance driven on the affected roads by all additional cars/taxis is considered as additional trip distance, i.e. it is assumed that formerly used alternative routes are shorter;

(b) All additional cars/taxis on the affected roads are considered to be induced by the project and not by external effects such as general traffic growth.

The monitoring is conducted through measurements of traffic flows and distance driven by passenger cars and taxis on the affected roads in end of years 1 and 4 of the crediting period.

The *affected roads* are identified as:

- Main impacted roads:
  - Ermita-Iztapalapa
  - Calzada Ermita Izapalapa

- Reads identified as alternative paths:
  - Anillo Periférico
  - Av. Luis Méndez
  - Av. De las Torres
  - Av. Samuel Gompers
  - Vista Hermosa
  - Av. Primavera
  - Av. Sta Cruz Meyehualco
  - Combate de Celaya
  - Carlos L. Gracida
  - C. 47
  - C. 17
  - Anillo de Circunvalación
  - Av. Morelos
  - Lázaro Cárdenas
  - C. Ejido
  - Av. De las Palmas
  - C. 39
  - Av Guelatao
  - Filomeno Mata
  - Av. Circunvalación
  - Av. Jalisco
  - C. San Miguel
  - Av. Telecomunicaciones
  - Calzada Ignacio Zaragoza
  - Autopista México-Puebla

- Other adjoining streets to the main road:
  - Lic. David Pastrana
  - Lirio
  - Manto
  - Nardo
  - Pabellón
  - Pensamiento
  - Rocio
  - Tulipán
  - Enrique Camarillo
  - Juan de Dios Peza
  - Amado Nervo
  - R. López Velerade
  - Manuel Acuña
  - A. PI
  - Av Miguel Hidalgo
  - Ignacio Manuel Altamirano
  - Maurillo Mejía
  - Guadalupe Victoria
  - Vicente Guerrero
  - Manuel Cañas
  - Niños Héroes
  - Cuitlahuac
  - And. Benito Juárez

- Emiliano Zapata
- Justo Sierra
- Reforma Política
- Reforma Económica
- Zacapexco
- Cerro de la Estrella
- Reforma Aeronáutica
- Reforma a la Salud
- Perseverancia
- Fresno
- Josefa Ortiz de Dominguez
- Aquiles Serdán
- Av. De las Minas
- Paraíso
- Bodega Aurrera
- Trigo
- Teltlalpa
- Octavio Sentíes
- Cam. A Santiago
- 12 metros
- Benito Juárez
- Miguel Hidalgo
- Moctezuma
- Cuauhtémoc
- Santiago
- Rafael Reyes
- Del Consuelo
- Cda. Niños Héroes
- 5 de febrerp
- Unión
- Zacatepec
- Lázaro Cárdenas
- Del Llano
- Leona Vicario
- Guillermo Prieto
- Av. 2 and C. 61 adjacent
- C. 71
- Av. Genaro Estrada
- Luis Cabrera
- Ing. Vito Alessio
- González Camarena
- Lic. José Cruz Rodríguez
- 2 de abril
- Prof. M, Mariles
- Ignacio Vallarta
- Primo Verdad
- Josafat F. Marquez
- Gregorio Tello

Figure X. shows main roads impacted by the project including alternative routes that Google Maps website provide in private transport between different Trolebús Elevado stantions.

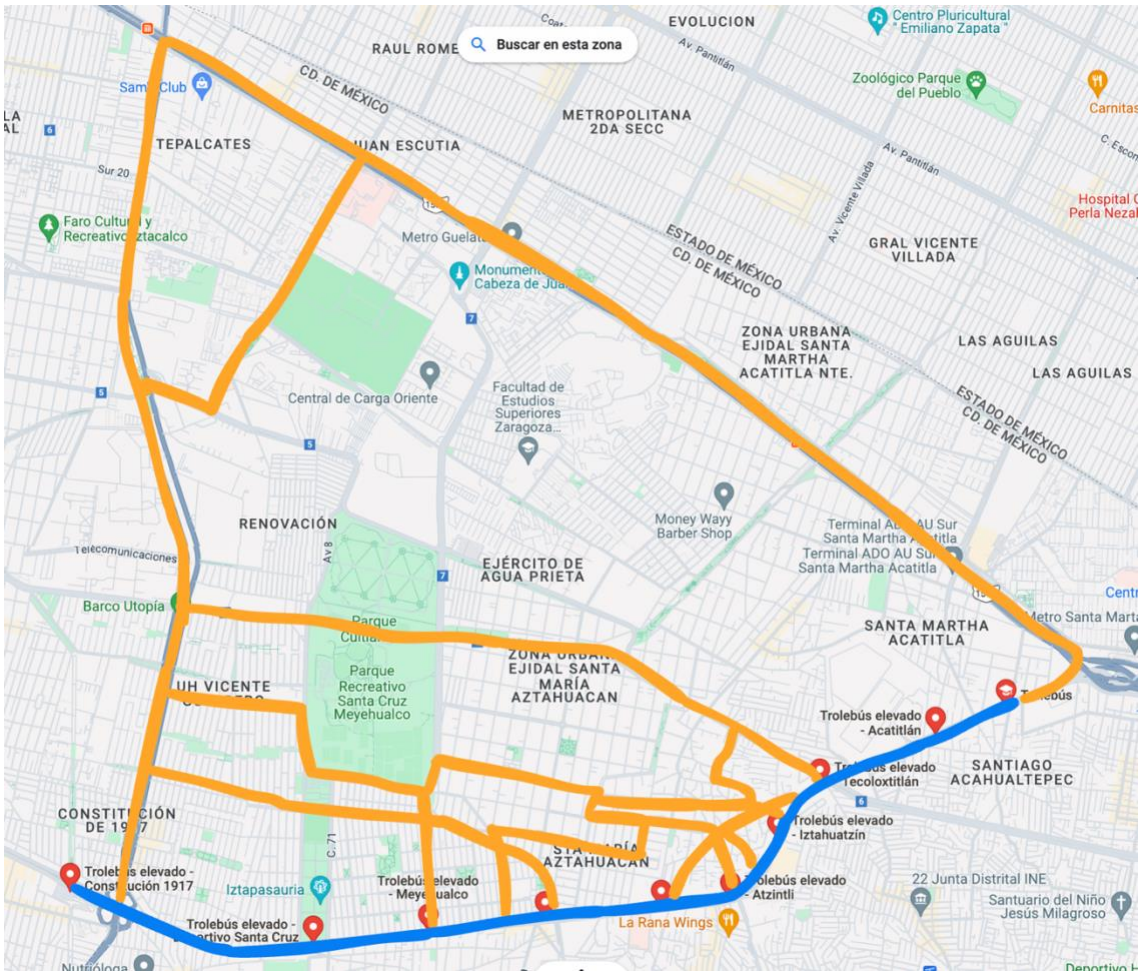

Figure X. Main Road impacted by the project (blue) and alternative paths between different stations (orange)

A negative rebound effect based on additional congestion is expected in this situation. For each affected road the average speed of cars/taxis is monitored and compared with the baseline.

Vehicle speed refers to the average speed, i.e. total distance divided by total time, on the affected road.

The rebound effect for the affected roads is calculated as follows:

$$LE_{REB,y} = \sum \frac{\left[TD_{i,1-4} * EF_{KM,i,1-4} * \left(N_{i,1-4} - N_{i,x} + N_{i,MS,y}\right)\right]}{10^6}$$

Where:

$LE_{REB,y}$ = Leakage emissions due to rebound effect in year y (tCO_2)

$TD_{i,1-4}$ = Average trip distance driven by vehicle category i on the affected roads in years 1 and 4 of the crediting period (km)

$EF_{KM,i,y}$ = Emission factor per kilometer for vehicle category i in years 1 and 4 of the crediting period (gCO_2/km)

$N_{i,1-4}$ = Number of vehicle category i using the affected roads in years 1 and 4 of the crediting period (cars, taxis)

$N_{i,x}$ = Number of vehicle category i per annum using the affected roads in year x (cars, taxis)

$N_{i,MS,y}$ = Number of vehicle category i per annum not used anymore due to mode shift to the MRTS in year y (cars, taxis)

i = Vehicle category: passenger cars (C) and taxis (T)

x = Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whichever is earlier. Data not older than three years.

Emission reductions estimated before surveys and leakage monitoring and assuming same emissions in baseline are shown in table X.

Table X. Ex-ante estimated emission reductions of the Trolebús Elevado project

Year	GHG emission reductions in the baseline scenario (tCO_2e)	GHG emission reductions in the project scenario (tCO_2e)	GHG emissions attributable to leakages (tCO_2e)	Estimated Net GHG Reduction (tCO_2e)
2022	2,801	206	TBC	**2,595**
2023	19,392	1,426	TBC	**17,966**
2024	19,392	1,440	TBC	**17,952**
2025	19,392	1,455	TBC	**17,937**
2026	19,392	1,469	TBC	**17,923**

2027	19,392	1,484	TBC	**17,908**
2028	19,392	1,499	TBC	17,893
2029	19,392	1,513	TBC	**17,879**
2030	19,392	1,528	TBC	17,864
2031	19,392	1,542	TBC	**17,850**
2032	19,392	1,557	TBC	17,835
2033	19,392	1,571	TBC	**17,821**
2034	19,392	1,586	TBC	17,806
2035	19,392	1,600	TBC	**17,792**
2036	19,392	1,346	TBC	18,046
Total	274,289	**21,220**	**TBC**	253,067

TBC: To Be Calculated

Annual average of emission reductions: 16,871 tCO_2e

4 Compliance with applicable legislation

Pendiente

5 Carbon ownership and rights

5.1 Project holder

Table X. Project holder information

Individual or organization	**Mexico City Government, Environment Secretariat (SEDEMA)**
Contact person	Oscar Alejandro Vázquez Martínez
Job position	Climate Change and Sustainable Projects Director
Address	Plaza de la Constitución 1, 3rd floor, Colonia Centro, Alcaldía Cuauhtémoc, zip code 06000, Mexico City

Phone number	55534580oo ext. 1520 ext. 1404
Email	ovazquez.sma@gmail.com

5.2 Other project participants

Table X. Other project participants, project developer: MERCADO AMBIENTAL

Individual or organization	**MERCADO AMBIENTAL AP**
Contact person	Eduardo Piquero
Job position	CEO
Address	Paseo de la Reforma 255, floor 7, Col. Cuauhtémoc 06500, Mexico City, Mexico
Phone number	+52 55 5128 2048
Email	contacto@mexico2.com.mx

Table X. Other project participants

Individual or organization	**Electric Transport Service of Mexico City**
Contact person	José Alberto Guerrero Molina
Job position	Executive Director of Technological Development
Phone number	55 2595 0000 ext. 298
Email	jguerrerom@ste.cdmx.gob.mx

5.3 Agreements related to carbon rights

The declaration of ownership of the Trolebús Elevado project can be found in the Contracts GRM-ADQ-004.2020: Administrative Contract for the Acquisition of a new

articulated trolleybus, and GRM-ADQ-001-2020: Administrative Contract for the Acquisition of a new generation simple trolleybus which indicates de Mexico City government property.

6 Climate change adaptation

In compliance with the BCR Standard, the project must consider any strategic line proposed in national climate change policies.

Mexico's National Determined Contribution was established as an adaptation component, the attention and prevention of negative impact on the population and the territory. Additionally, the national climate change strategy aims to reduce vulnerability and increase social resilience, paying particular attention to the most vulnerable sectors.

In this way, the National atlas of climate change vulnerability (2022) shows that the Trolebús zone is classified as highly vulnerable to flooding. Thus, the project helps, through elevated infrastructure, issues caused by floods on the roads.

The project also works toward develop a restoration of ecosystems...

7 Risk management

Table X shows the potential natural, anthropogenic and social risks and measures to mitigate the risks implemented by Trolebús Elevado project.

> *(d) determine, in the medium and short term, the risks associated with the participation of local communities and stakeholders in the activities proposed by the project owner.*

Table X. Risks that would occur during the operation of the project

	Risk	Measure to mitigate risk
Natural	Technical failures are due to extreme natural disasters such as storms, high wind speeds, and earthquakes.	Trolebús Elevado infrastructure is reinforced with keystones that are capable of resisting an earthquake of 8.5 degrees (Ministry of works and services)

		Likewise, the trolleybuses' technology allows the operation of the buses without electricity feed (in case storms or wind affects electricity) until 70 kilometers because of their batteries. Also, inside Trolebús installations will be advertisements regarding the evacuation routes in case of emergency.
Anthropogenic	Technical failures due to damages occasioned by passengers.	Inside Trolebús installations will be placed advertisements of good practices for the use of the systems. Also, advertisements regarding the evacuation routes in case of emergency.
Financial	Lack of resources for programme follow-up expansion after the change of administration by the Ministry of Environment of Mexico City.	Considering that during 2024, there will be a change of administration due to a change of government in Mexico City, there is a risk that financial resources for monitoring, verifications and inspections will not be available and the expansion of the project as it was projected. The resources collected for the carbon credits will impulse the continuation of the project to cover other costs and ensure carbon project governance in order to transition between government changes.

Participation of local communities	Disconformity of population-related the construction of new stations of Trolebús Elevado (medium term)	Attend to their disconformities and requirements through public consultations before project implementation, as well as the impact caused by compensating actions.

7.1 Reversal Risk

The project holder must demonstrate actions taken to ensure the project is maintained over the time by including clauses or provisions on this objective in the agreements or contracts.

In concordance with the Risk and non-permanence BCR Tool, 10% of the total emissions reductions will be held in a reserve account to cover potential reversal risks in the future.

In case any event occurs and decreases the emission reductions issued and registered in the platform, the project owner will inform and provide a report within a period of no more than a year after the event.

The CAB will report and verify all the risk management.

8 Environmental Aspects

Pendiente

9 Socio-economic aspects

In agreement with the Government of Mexico City, through the Ministry of Economic Development (SEDECO, 2022) estimated that, with the operation of the trolleybus that circulates from Constitución de 1917 to Acahualtepec, in the Iztapalapa, it will generate an economic spillover of 2 thousand 546 million pesos per year for the region.

The head of SEDECO, Fadlala Akabani Hneide, said that attending the demand for mobility, connecting the east with the west of Iztapalapa, will also have a great benefit in economic terms because the work will benefit 11 thousand economic units near the station

10 Consultation with interested parties (stakeholders)

Pendiente

10.1 Summary of comments received

Pendiente

10.2 Consideration of comments received

Pendiente

11 Sustainable Development Goals (SDGs)

To assess the project contribution to the SDGs, the BioCarbon Tool was used to determine the Contributions of GHG Projects to Achieving the Sustainable Development Goals of Standard Version 3.3. In concordance with this tool, the contribution could be covered by four main SDGs, as observed in Table X.

Table X. Assessment of project contribution to SDG

SGD	Target	SDG indicator	Project contribution	KPI
3. Good health and wee-being 	3.9 By 2030, significantly reduce the number of deaths and illnesses caused by hazardous chemicals, air, water and soil pollution and contamination	3.9.1 Mortality rate attributed to household and ambient air pollution	Through the implementation of the project, air pollution from the burning of fossil fuels in means of transport such as diesel buses will be reduced, which is expected to reduce the mortality rate attributed to this factor at the local level	Air quality deaths in Mexico City

9. Industry, innovation, and infrastructure 	9.1 Develop reliable, sustainable, resilient and quality infrastructure, including regional and cross-border infrastructure, to support economic development and human well-being, with particular emphasis on affordable and equitable access for all	9.1.2 Volume of passenger and freight transport	Increase the number of passengers carried by an electric based MRT type of transport	% passengers transported MRT electricity-based
	9.4 By 2030, upgrading infrastructure and retrofitting industries to make them sustainable, using resources more efficiently and promoting the adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	9.4.1 CO_2 emissions per unit of value	Displace the use of conventional buses with electric technologies to reduce the carbon footprint of public transport passengers	gCO2e/pkm

11. Sustainable cities and communities 	11.2 By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all and improve road safety, including through the expansion of public transport, paying particular attention to the needs of persons in vulnerable situations, women, children, persons with disabilities and older persons.	11.2.1 Proportion of the population with convenient access to public transport, disaggregated by sex, age and persons with disabilities	The project aims for a larger part of the population to have greater access to the transport system with inclusive characteristics	Passengers of the project
	11.6 By 2030, the negative per capita environmental impact of cities will be reduced, including by paying particular attention to air quality and the management of municipal and other waste.	11.6.2 Annual average levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population-weighted)	Through the implementation of the project, air pollution from the burning of fossil fuels in transport, such as diesel buses, will be reduced, which is expected to reduce the mortality rate attributed to this factor at the local level	tCO_2e reduced PM contingencies in Mexico City

13. Climate action 	13.2 Incorporate climate change measures into national policies, strategies, and plans.	13.2.2 Total GHG emissions per year	Displace the use of conventional buses with electric technologies to reduce the carbon footprint of public transport passengers and total GHG emissions	gCO2e/pkm

12 Special categories, related to co-benefits

Not applicable to the present project

13 Grouped project

The Trolebús Elevado project is planned to expand 28 kilometers and add 55 new stations up to the Mixcoac place.

New stations will result in the displacement of high-carbon buses and GHG emission reductions during the crediting period that would be included in the future quantification as a grouped project.

14 Other GHG program

The project is not registered or has been registered on another GHG program.

15 Double counting avoidance

Through the BioCarbon platform, the emission reductions generated by the present project will prevent double issuance, use and claiming. In concordance with BioCarbon tool to avoid double counting, the present project shall ensure transparency on the crediting process across:

a. Credits issuance. A third independent party will verify emission reductions - Conformity Assessment Body to demonstrate full compliance with the standard's requirements. Only carbon credits will be requested to the standard once the validation (by a third independent) has concluded.
b. A third independent party will verify emission reductions - Conformity Assessment Body to demonstrate full compliance with the standard's requirements. Only carbon credits will be requested to the standard once the validation (by a third independent) has concluded.
c. Overlapping risk management. There is no evidence in other GHG registry platforms that the project has been registered. Likewise, the project was not put on the record of the national report of mitigation actions: Third Biennial Update Report to the United Nations Framework Convention on Climate Change, consequently, emission reductions have not been accounted for any purpose.
d. Avoid double use of carbon credits. The project holder and other interested parts information are specified in section. Validation, verification, and monitoring reports will be loaded at the registry as well as other documentation-related activities and governance.

A serial number will identify each emission reduction credited by BioCarbon to classify country, holder, sector, project code, vintage, and unique serial number to ensure a single cancellation and its entire traceability through the transactions, if applicable.

16 Monitoring plan

The project will be monitored by daily passengers' register monitored by the electric transport system and Ministry of Environment of Mexico City through the next parameters:

Data used to estimate ex-ante GHG emission reductions

Table X. Information related to the passengers transported by baseline buses parameter

Data/Parameter	**$PBL_{B,x}$**
Data unit	pphd (passengers per hour direction)
Value	6,356
Description	Passengers transported by baseline buses prior to the project starting year x (per day or year)
Source of data	Mexico City Government, Trolebús Elevado Eje 8 Sur Analysis

Measurement procedures	Baseline data, not monitored

Table X. Information related to the total distance driven by baseline buses parameter

Data/Parameter	**$DD_{z,s,x}$**
Data unit	km/year
Value	200
Description	Total distance driven by baseline buses
Source of data	Mexico City Government
Measurement procedures	Baseline data. Monitored if a leakage applicable from official Mexico City Government Reports

Table X. Information related to the total number of passengers transported by the electricity-based project during the period January - February 2023 parameter

Data/Parameter	**P_{EL}**
Data unit	Passengers
Value	3,660,384
Description	Total number of passengers transported by the electricity-based project during the period January - February 2023
Source of data	Electric Transport System of Mexico City
Measurement procedures	Number of entries registered by the system

Table X. Information related to the average trip distance travelled by passengers parameter

Data/Parameter	**D_{EL}**
Data unit	km

Value	4.635
Description	Average trip distance travelled by passengers using electricity-based vehicle category during the period
Source of data	Electric Transport System of Mexico City

Table X. Information related to the emission factor of national grid in 2023 parameter

Data/Parameter	**EF_{SE}**
Data unit	tCO_2e/MWh
Value	0.438
Description	Emission factor of national grid in 2023
Source of data	National emissions registry
Measurement procedures	NA

Table X. Information related to the energy consumption factor parameter

Data/Parameter	**EC_T**
Data unit	kWh/km
Value	0.8
Description	Energy consumption factor for electricity-based vehicle Trolebús Elevado
Source of data	Electric Transport System of Mexico City
Measurement procedures	NA

Table X. Information related to the total distance driven by the Trolebús Elevado project parameter

Data/Parameter	**D_T**

Data unit	km
Value	519,760
Description	Total distance driven by the Trolebús Elevado project during the period
Source of data	Electric Transport System of Mexico City
Measurement procedures	Mileage registered by trolleybuses

Data under review during the project crediting period

Table X. Information related to the total road space available parameter

Data/Parameter	**RSx**
Data unit	km
Description	Total road space available in year x
Source of data	Mexico City Government
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Quality control procedures	Regional data use
Purpose of data	Leakage estimation
Monitoring responsible	SEDEMA

Table X. Information related to the total road space available parameter

Data/Parameter	**RSy**
Data unit	km
Description	Total road space available due to the project activity
Source of data	Mexico City Government

Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each reporting period or official report publication
Quality control procedures	Regional data use
Purpose of data	Leakage estimation
Monitoring responsible	SEDEMA

Table X. Information related to the average annual distance driven parameter

Data/Parameter	**AD_T**
Data unit	km/taxi
Description	Average annual distance driven by taxis
Source of data	Mexico City Government
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each reporting period or official report publication
Quality control procedures	Regional data use
Purpose of data	Leakage estimation
Monitoring responsible	SEDEMA

Table X. Information related to the average annual distance driven parameter

Data/Parameter	**$N_{i,x}$**

Data unit	Number of vehicles
Description	Number of vehicles of vehicle category i per annum using the affected roads in year x
Source of data	Mexico City Government
Measurement procedures	Studies conducted by Mexico City Government
Frequency of measurement and recording	Each reporting period through visual counting on the identified roads. Counting will be based on various parts of the road, if major roads depart from the observed road to ensure average numbers. This includes passenger cars and taxis
Quality control procedures	Contrast the data with other general studies
Purpose of data	Leakage estimation
Monitoring responsible	SEDEMA

Table X. Information related to the average total speed parameter

Data/Parameter	**V_B**
Data unit	km/h
Description	Average total speed and average speed under circulation is measured
Source of data	Mexico City Government
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each reporting period or official report publication
Quality control procedures	Regional data use
Purpose of data	Leakage estimation due to rebound effect.

	Average speed required for calculation of the rebound effect refers to total distance divided by total time on the affected road. Average moving speed required for the calculation of the speed effect refers to the speed under moving conditions i.e. total distance divided by time under movement (total time minus standstill time of vehicle), on the affected road. Only passenger cars and 4-wheel taxis are monitored. The same speed data is taken for both vehicle types. The same method should be applied to determine vehicle project speed thereafter to ensure a consistent approach. Required for monitoring of the rebound effect and the speed effect on affected roads.
Monitoring responsible	SEDEMA

Table X. Information related to the total distance driven by several transport parameter

Data/Parameter	**$TD_{Z,x}$, $TD_{T,x}$, $TD_{C,x}$**
Data unit	km
Description	$TD_{Z,x}$: Total distance driven by public transport buses in year x $TD_{T,x}$: Total distance driven by public transport taxis in year x $TD_{C,x}$: Total distance driven by passenger cars in year x
Source of data	Electric Transport System of Mexico City
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each reporting period or official report publication
Quality control procedures	Regional data use

Purpose of data	Leakage estimation
Monitoring responsible	SEDEMA

Data under review during the project crediting period

Table X. Information related to the emission factor per passenger-kilometer parameter

Data/Parameter	**$EFp_{km,i,1-4}$**
Data unit	tCO_2/pkm
Description	Emission factor per passenger-kilometer of mode i in years 1 and 4 of the crediting period y
Source of data	Calculated based on equations 2 and 3 from the *TOOL18: Baseline emissions for modal shift measures in urban passenger transport*
Measurement procedures	As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport".
Frequency of measurement and recording	Calculated based on the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport", through surveys conducted in the end of years 1 and 4 of the crediting period
Quality control procedures	As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport".
Monitoring responsible	SEDEMA

Table X. Information related to the direct project emissions from electricity consumption parameter

Data/Parameter	**$DPE_{EC,y}$**
Data unit	tCO_2

Description	Direct project emissions from electricity consumption in year y
Source of data	Electric Transport System of Mexico City
Measurement procedures	Electricity consumption
Frequency of measurement and recording	Daily measurement and annually recorded
Quality control procedures	Calibrated equipment used

Table X. Information related to the number of vehicles parameter

Data/Parameter	**$N_{i,1-4}$**
Data unit	Number of vehicles
Description	Number of vehicles category i in years 1 and 4 of the crediting period
Source of data	Mexico City Government
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each reporting period or official report publication during the 1 and 4 of the crediting period. Vehicle categories: buses (B), passenger cars (C), taxis (T)
Quality control procedures	Regional data
Monitoring responsible	SEDEMA

Table X. Information related to the emission factor per kilometer for vehicle parameter

Data/Parameter	**$EF_{km,1-4}$**
Data unit	gCO_2/km

Description	Emission factor per kilometer for vehicle category i in years 1 and 4 of the crediting period (gCO_2/km)
Source of data	Mexico City Government, Emissions Inventory
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each reporting period or official report publication during the 1 and 4 of the crediting period
Quality control procedures	Regional data
Monitoring responsible	SEDEMA

Table X. Information related to the emission factor per kilometer for vehicle parameter

Data/Parameter	**$OC_{i,t}$**
Data unit	Passengers
Description	Average occupancy of vehicle category i in the period of time t
Source of data	Mexico City Government
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each official report publication or reporting period. Based on visual occupancy studies for all vehicle categories. For buses the occupancy rate is based on boarding-alighting studies, electronic smart tickets or on visual occupancy studies with expansion factors for routes served to determine the average occupancy rate along the entire route. As an alternative for buses, the occupancy rate can be based on average trip distance of bus passengers, total passengers and total distance driven of buses. For taxis, the driver should not be counted. Studies/surveys conducted at the end of years 1 and 4of the crediting period.

Quality control procedures	Regional data
Monitoring responsible	SEDEMA

Table X. Information related to the average capacity of vehicle parameter

Data/Parameter	**$OV_{i,t}$**
Data unit	Passengers
Description	Average capacity of vehicle category i in the period of time t
Source of data	Mexico City Government
Measurement procedures	Official statistics or studies conducted by Mexico City Government
Frequency of measurement and recording	Each official report publication or reporting period. Period of time when the parameters are measured: most recent calendar year prior to the start of commercial operation of the project system. Vehicle categories: buses (B), passenger cars (C), taxis (T)
Quality control procedures	Regional data
Monitoring responsible	SEDEMA

Table X. Information related to the number of vehicles displaced parameter

Data/Parameter	**$BSCR_y$**
Data unit	Number of vehicles displaced
Description	Cumulative bus units displaced by the project on the trunk lanes as a result of the project in year y
Source of data	Project proponent – Mexico City Government

Measurement procedures	Official studies conducted by Mexico City Government
Frequency of measurement and recording	Annually
Quality control procedures	NA
Monitoring responsible	SEDEMA

Table X. Information related to the average trip distance driven parameter

Data/Parameter	**$TD_{i,1-4}$**
Data unit	km
Description	Average trip distance driven by vehicle category i on the affected roads in years 1 and 4 of the crediting period (Adapted to the project to year 2 and 5)
Source of data	Project proponent – Mexico City Government
Measurement procedures	Official studies conducted by Mexico City Government through electronic or visual tracking of samples of vehicles entering/exiting the affected roads registering the entry and the exit point and measuring the distance by GPS or other means
Frequency of measurement and recording	Surveys conducted at the end of years 1 and 4 of the crediting period (Adapted to the project to year 2 and 5)
Quality control procedures	NA
Monitoring responsible	SEDEMA

Table X. Information related to the net share of passengers using the Trolebús Elevado project which would have used other mode parameter

Data/Parameter	$MS_{i,1-4}$
Data unit	%
Description	Net share of passengers using the Trolebús Elevado project which would have used mode i in the years 1 and 4 of the crediting period
Source of data	Survey conducted
Measurement procedures	Survey conducted at the end of years 1 and 4 of the crediting period
Frequency of measurement and recording	Years 1 and 4 of the crediting period (Adapted to the project to year 2 and 5)
Quality control procedures	Procedure as ACM0016 indicates
Monitoring responsible	SEDEMA

Table X. Information related to the average speed of cars/taxis on affected roads parameter

Data/Parameter	$VP_{i,1-4}$
Data unit	km/h
Description	Average speed of cars/taxis on affected roads in years 1 and 4 of the crediting period
Source of data	Mexico City Government
Measurement procedures	Official statistics or studies conducted by Mexico City Government.
Frequency of measurement and recording	Once at the end of years 1 and 4 of the crediting period (Adapted to the project to year 2 and 5)
Quality control procedures	On-board measurements determining the total average speed and the average moving speed (when circulating) on the affected road based, e.g. on GPS measuring. Average speed required for calculation of the rebound effect refers to total

	distance divided by total time, on the affected road. Average moving speed required for calculation of the speed effect refers to speed under moving conditions i.e. total distance divided by time under movement (total time minus standstill time of vehicle), on the affected road. Taxis and passenger cars are treated identical. This condition should be monitored for each affected road.
Monitoring responsible	SEDEMA

Table X. Information related to the Contribution to Sustainable Development Goals parameter

Data/Parameter	**SDG**
Description	Contribution to Sustainable Development Goals
Source of data	Mexico City Government studies
Measurement procedures	Official statistics or studies conducted by Mexico City Government.
Frequency of measurement and recording	Each monitoring report
Monitoring responsible	SEDEMA

16.1 Methodological design of surveys

Considering project as aggregate, whenever the MRT is extended, a new survey distribution is realized, and data of the new survey is used for calculating emissions reductions achieved from the moment of the MRT extension.

16.1.1 Survey objective

The survey objective is to determine the input parameters needed to calculate:

(a) The baseline emissions caused by passengers which use the MRTS and in absence of the latter would have used other modes of transport to realize their trip;

(b) The indirect project emissions caused by passengers using the MRTS, which correspond to the emissions caused from the point of origin (O) to the MRTS entry station, and from the MRTS exit station to the final destination (D).

16.1.2 Target population

The target population are all passengers over 12 years of age. Smaller children are excluded due to problems in answering the questions. Also, smaller children, in general, are accompanied by their parents or an adult and thus have the same trip sequence as the adult person.

16.1.3 Sample frame

The sample frame is the passenger flow in selected stations of the MRTS. Data for the passenger frame is obtained from the system manager.

16.1.4 Sample design

Systematic sampling of passengers in selected stations within the selected hours

16.1.5 Geographical coverage

The geographical coverage is the area where the MRTS operates (project boundary) within Mexico City.

16.1.6 Sample frequency

Two surveys shall be conducted during the crediting period: at the end of the 1st and 4th years of the crediting period (Adapted to the present project 2nd and 5th year).

The survey shall take place during an entire week that does not correspond to a public holiday or a holiday season and shall be representative for the average demand for transport services in the considered year.

16.1.7 Selection of stations and evaluation hours

Given that there is a complete list of stations, the selection of stations within the main strata is conducted according to a Simple Random Sampling design.

Similarly, a specific hour interval is selected from within each sub-stratum, that is, the range of hours (e.g. morning peak, evening peak, off peak) by simple random sampling.

16.1.8 Selection of passengers

Given that there is no reference frame or list frame for the identification of MRTS users, the selection of the sample in the last stage will be performed according to a systematic sampling design within each selected hour and considering the following steps:

(a) A random starting point is generated between 1 and n;

(b) Systematic selection of passengers: every n passenger entering the station, starting with the random number. In this way, if the random number is 20, the first passenger selected is the 20th that enters the station, the 2 n+20 and thus successively every nth passenger.

16.1.9 Consideration on information collection

The information will be obtained through the face-to-face application of the questionnaire below.

According to the selected stations and hour intervals, each survey interviewer will carry out the number of established surveys. Given that the selection of people is done randomly in a time range, the start point, that is the person number from which the contact begins, is random and is defined by the appointed pollster supervisor.

The random selection of individuals, as well as the sufficiency in the sample size, enables obtaining dispersion and representation of the study population through the sample. Further, it allows controlling factors that may affect the user type, in terms of use of modes of transport and distance in these travels.

16.1.10 Survey realization

The survey shall be realized through a company with minimum 3 years of experience in comparable surveys in the respective country to ensure a professional survey execution. The following principles are to be followed in the survey realization:

(a) Non-responses should be recorded;

(b) Record and store all original surveys;

(c) Surveys are conducted at MRTS stations when people wait for MRTS-boarding. It should be avoided to realize the survey with people de-boarding the MRTS as latter will not want to invest time in a survey thus potentially giving wrong answers.

16.1.11 Preparation phase

This phase is characterized by the development of all the activities previous to the execution of the field operation and it is divided in:

(a) Drafting of the manual on information collection and basic concepts. The manual on information collection and basic concepts covers in general terms the profile of the field personnel, the questionnaire structure, the instructions and specifications for filling in the questionnaire, the definitions and basic concepts of the study and the instructions and formats used;

(b) Selection and training of field personnel. The selection and training of the field personnel is performed on concepts of filling in of questionnaires, in order to select the most adequate survey interviewers for the development of the field work:

> (i) A pre-test is performed with the aim of familiarizing the supervisors with the instrument of information collection and establishing in general terms the acceptance degree of the population facing the instrument's application. The pre-test is also to assure that respondents understand what the MRTS is as they might not have taken a similar system before, to ensure that all the concepts are clearly defined and the questions are not ambiguously phrased and avoid interviewer errors. Interviewers may misread the question or twist the answers in their own words and thereby introduce bias. The pre-test has to detect and minimize this potential error;
>
> (ii) The results of the pre-test will be documented and will be taken into consideration for the modification of the final instrument and for the preparation of the model of information collection.

16.1.12 Validation process of the information

A supervisor should participate in the field to carry out the field verifications, guaranteeing the validity of the gathered information as well as the attained coverage.

16.1.13 Calculation of trip distance in the survey

Trip distances need to be determined for each surveyed passenger. The following procedures are applied:
(a) For NMT, others and induced traffic this is not required as the applied EF is “0”.
(b) For users of buses either:

(i) The shortest possible geographical distance based on electronic maps or measuring the distance between the two points with GPS or a comparable mean or through distance measurement on maps; or

(ii) Measuring the actual distance from the bus entry station to the bus exit station based on (electronic) route maps of the bus operators with official distances or measuring e.g. with GPS the distances between the involved stations.

(c) For users of passenger cars, taxis, motorcycles, motorized rickshaws and other modes of motorized transport except buses based on the shortest possible geographical distance based on electronic maps or measuring the distance between the two points with GPS or a comparable mean or through distance measurement on maps; (d) For non-project rail systems based on official or GPS distances between the entry and exit station of the rail-systems.

16.1.14 Questionnaire model

Survey ID: ___________________________

Interviewer: __________________________

Date: ________________________________

Time: ________________________________

Station: _______________________________

___Survey was fully completed

___Surveys was fully or partially not responded

Comments/Observations of survey: ____

_ _

Aged of surveyed person:

__12-17 years __18-25 years __26-35 years __36-45 years __46-55 years

__56-65 years __over 65 years

Gender: ___female ___male ___prefer not to say

_ _

Describe the trip you are currently realizing. Your trip origin: _______________ ____

Question 1

Your entry (boarding) Trolebús station lane: ____________________________________

Your exit (deboarding) Trolebús station lane: ____________________________________

Your final trip destination: ____

Question 2

Assuming that the Trolebús you are currently using would not exist: Would you have made the trip you are currently doing anyway, or would you have stayed at home/office/origin?

__I would have made the trip ➔ *Continue with questionnaire*

__I would have stayed at home/office/origin ➔*The questionnaire is terminated*

Question 3

What mode of transport did you use from your trip start to the Trolebús? Please refer to the mode on which you performed the longest stretch if you used various modes.

__Bus (conventional)
__Existing bus lane/BRT (NOT the project)
__Rail
__Taxi
__Passenger car
__Motorcycle
__Motorized taxi tricycle
__Bike or per foot
__Other: _____

Question 4

What mode of transport will you use from the point where you leave the Trolebús lane until your destination? Please refer to the mode on which you will perform the longest stretch if you intend to use various modes.

__Bus (conventional)
__Existing bus lane/BRT (NOT the project)
__Rail
__Taxi
__Passenger car
__Motorcycle
__Motorized taxi tricycle
__Bike or per foot
__Other: _____

Question 5

Have you moved your home or workplace since the start of operations of the MRTS?

__No ➔*continue with next question*

__Yes: Has the availability of the new MRTS been an important factor when choosing the location of your new home or new workplace?
__No ➔ *continue with next question*
__Yes ➔ What was your original/former trip origin and trip destination? (at the time before you moved your home or workplace)
Origin point:.....
Destination point: .....

Question 6
Assuming that the Trolebús elevado you are currently using would not exist: How would you have made the same trip you are doing now?
From Home/Office/Others (.....) to point..... by *.....
From point.....to point .....by *.....
From point.....to point .....by *.....
From point.....to home/office/others (.....) by *.....

__Bus (conventional not bus lane)
__Existing bus lane/BRT (NOT the project)
__Rail
__Taxi ➔ *continue with question 6A*
__Passenger car ➔ *continue with question 6B*
__Motorcycle ➔ *continue with question 6C*
__Motorized taxi tricycle ➔ *continue with question 6D*
__Bike or per foot
__Other: _____

Question 6A
Have you used a taxi in the last 6 months? __Yes __No

Question 6B
Do you or your family own a car or do you have access to a car (e.g. car-sharing) or have you used a passenger car in the last 6 months? __Yes __No

Question 6C
Do you or your family own a motorcycle or do you have access to a motorcycle or have you used a motorcycle in the last 6 months? __Yes __No

Question 6D

Have you used a motorized taxi tricycle in the last 6 months? __Yes __No

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If interviewed persons respond in the questions 6A to 6D with NO they are not included in the final calculation i.e. this specific survey is not included as the response is deemed as non-consistent with the one given in question 6