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Zero Carbon Mobility

CITY OF CANOAS | RS

Executive Summary

Revision 2 - June 2021

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Revision: 02
Published: June 2021

Executive Summary – Canoas Mobility Zero Carbon Project

Purpose

This executive summary provides an overview of the content of the term of reference for the Canoas Mobility Zero Carbon Project (original title: "Projeto Canoas Mobilidade Zero Carbono"), a study carried out by the Aerom Sistemas de Transporte S.A. team, with the support of multidisciplinary specialists. The study aims to present the main parameters of an urban mobility system for the municipality of Canoas in the context of global trends.

In January 2021, the municipality of Canoas requested a review of the Aeromovel project, as a means to optimize the efficiency of mobility in the city. The study explores references and macrotrends of cities that stand out worldwide for their focus on human development and for the manner in which they face today's climate and urban challenges. Moreover, it assesses new technologies and operational and economic concepts for the public transit industry, considering contemporary methods such as DOT (Transit-Oriented Development) and the carbon economy.

Within the scope of reassessing and restructuring the Aeromovel project pursuant to the updated global parameters of the subject of mobility, the company has relied on experts from different areas; monitored and gathered data from international events and conferences on climate, mobility, and the green economy; conducted interviews; and sought benchmarks from related entities, such as ICLEI, CAF, ABIFER, ANPTRILHOS, and WRI. The study revisited the Aeromovel projects and studies in the city of Canoas, recorded since 1992. The core vision of this study is to place Canoas on the global scenario of inclusive, sustainable and smart cities.

The term of reference has been organized into chapters, with the following structure:

1. Inclusive, Smart and Sustainable Cities;
2. The Aeromovel Technology;
3. The Current Context of Mobility in Canoas;
4. Zero Carbon Mobility – City of Canoas – RS;
5. Economic and Financial Preliminary Study;
6. Financing Sources;
7. Deployment Plan;
8. Conclusions and Recommendations.

The New Age of Cities and Macrotrends

Since the beginning of the process of sedentarization of humanity, which took place roughly 12,500 years ago, cities and towns have become important centers for trade and socialization, often emerging as major the economic centers of ancient civilizations. In 2018, for the first time in history, most people will be living in urban areas, and cities are expected to serve as protagonists in the search for solutions for a more sustainable and efficient way of life.

Inclusive, sustainable and smart cities make up the new global agenda. The construction of alternatives that lead to a healthier way of life and enable cities to become more suitable and pleasant places to live – thereby attracting investments and people – is one of the major challenges of the 21st century.

Figure 1 – Inclusive, sustainable and smart cities

The United Nations (UN) has prioritized sustainable development since 1972, when it hosted the first global climate conference. The 1997 Kyoto Protocol and the 2015 Paris Accord were key milestones in this process. The Leaders' Summit on Climate, hosted by U.S. President Joe Biden, and COP 26, to be held in Glasgow in November this year, confirm that 2021 will be a benchmark for climate agendas, demonstrating the vigor that the agenda should take from now on.

Figure 2 – Acceleration of the global climate policy in 2021

President of France François Hollande during the COP21 conference

U.S. President Joe Biden during a speech at the Summit on Climate

COP 26
GLASGOW

Currently, other elements must be considered. Following the developments caused by the COVID-19 pandemic, the persistent crisis of public transit in Brazil has been dramatically accentuated, requiring, more than ever, new solutions, new models, and new technologies for mobility.

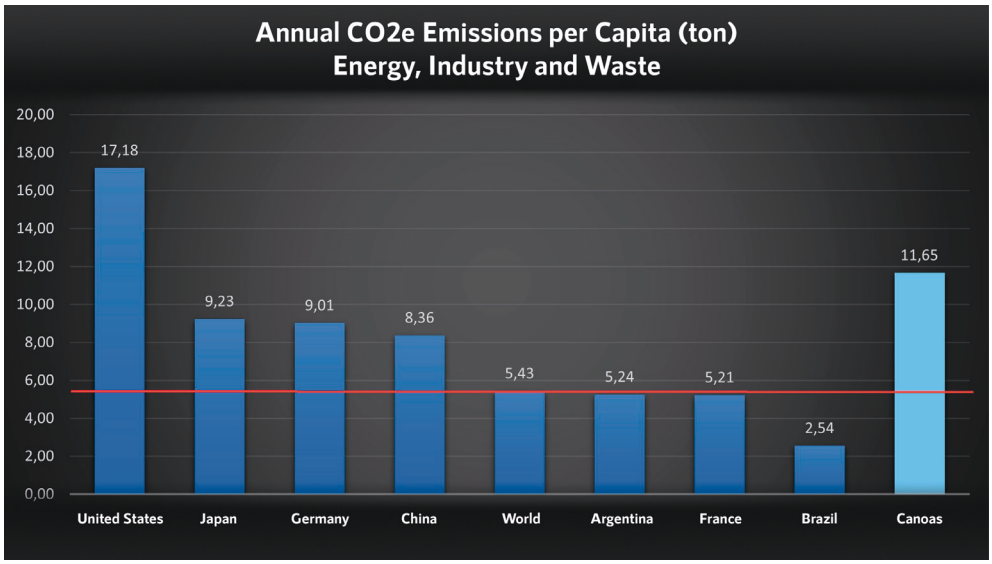
Similarly, the global automobile industry is adapting to new times – electric or hybrid cars are already a reality, in addition to new ways of using cars, such as carpooling, integration with other modes, and MaaS (Mobility as a Service). In addition to the trend towards electric mobility, cities have rethought micromobility, focusing on bicycles, scooters, and the appreciation of pedestrians and walking. One key example of this is city of Paris and the 15-minute city concept.

In addition, carbon neutrality and emission control policies are global targets for countries and cities. This year, the United States pledged to reaching zero pollution levels in the energy sector by 2035 and to make the economy neutral by 2050.

While global carbon neutrality targets are set for 2060, the boldest cities are already seeking to achieve this goal by 2025. In addition to combating climate effects, these policies induce and stimulate new sectors of the industry and economy.

In this aspect, Canoas is a city with critical indicators, with per capita carbon emissions about four times higher than the country's average. Located in one of the largest metropolitan areas in Brazil, with over 4 million inhabitants, it is a quintessentially urban city, impacted by emissions from industry and transport. Furthermore, it is crossed by three federal highways, with BR-116 being one of the busiest across the country.

Figure 3 – Canoas' ranking in terms of annual CO_2 emissions



Sources:

- Canoas – 1st Greenhouse Gas Emissions Inventory – ICLEI (2018)
- Countries: www.climatewatchdata.org (Climate Analysis Indicator Tool – CAIT (2018). Does not include agricultural and forestry emissions

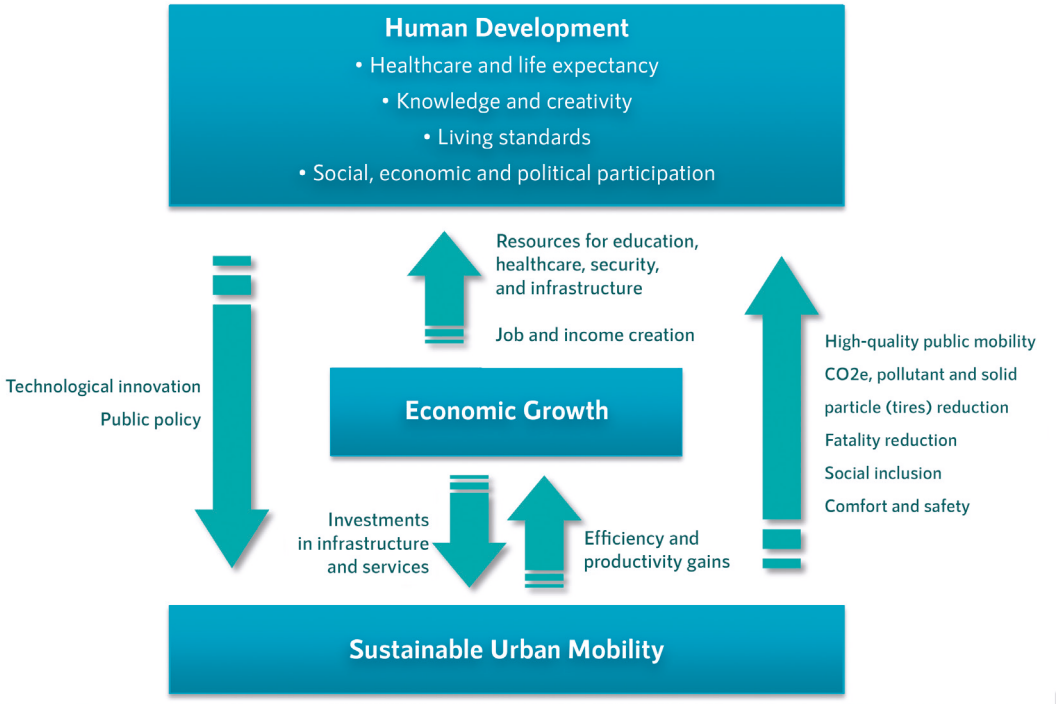
The term of reference indicates alternatives for a public transit system that effectively improves the lives of people, thereby improving the city's efficiency and reducing carbon emissions.

The Economic Cycle of Cities

Modern cities are extremely dynamic structures, in which a number of vectors interact and complement each other. Behavioral, economic, political, cultural and technological issues, among others, make up a web that ultimately defines a city.

The mobility system is considered by many to be the backbone of a municipality's economy. A transit system that provides comfort, safety and efficiency is deeply connected to the operation and competitiveness of the urban organization.

Figure 4 – Economic and social relationship of sustainable mobility



Source: AEROM, adapted from UNDP 2001

The Aeromovel Technology

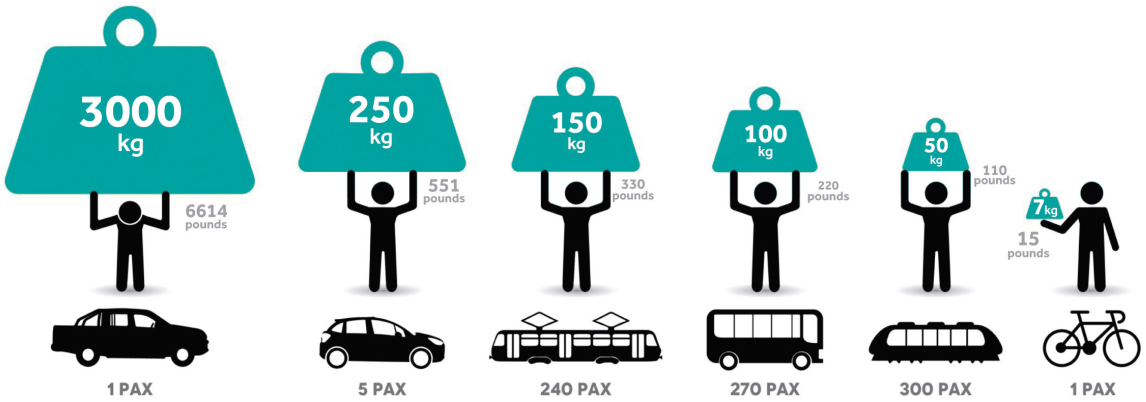
The Aeromovel has been studied as an alternative to address the issues related to urban mobility in the city of Canoas since 1992. Because it is an elevated railway mode, this technology provides an effective and economical solution to the historical problem of mobility integration in the city, as well as offering access to opportunities – for work, study, healthcare, and leisure – for all citizens.

The Aeromovel is an APM/AGT (automated people mover/automated guideway transit) system that uses pneumatic energy to propel vehicles. This energy is generated by stationary centrifugal fans, which pressurize the air in a duct incorporated into the elevated railway, over which the vehicles are guided by conventional light railroad tracks. Despite its disruptive and innovative character, the maturity of the system is proven by over 200 studies, reports and technical certifications produced in cooperation with renowned institutions, dozens of patents worldwide, and nine lines built since its conception in the 1970s. There are experimental lines, the most important being the Gasômetro line, in Porto Alegre, Brazil, which established the basis for urban use of the technology (300 passengers, concrete beam), demonstration lines and commercial lines – such as Taman Mini, in Jakarta, Indonesia, and the Salgado Filho International Airport, in Porto Alegre.

Figure 5 – Salgado Filho International Airport – Porto Alegre, Brazil (2013)

The vehicle's lightness is one of the key differentiators of the Aeromovel System, which does not carry engines or any other traction-related equipment on board. The wheels are thus not used for traction, being free and independent from each other. Pneumatic propulsion and the use of free wheels allow vehicles to take turns with a radius of 25 meters and climb ramps of up to 12%. The use of special steel wheels on the railway tracks also ensures comfort and extreme energy efficiency when compared to more conventional systems that use rubber tires – one of the main factors responsible for releasing microplastics into the environment.

Figure 6 – Excellent deadweight-to-payload ratio of the Aeromovel system



Features of the Aeromovel Technology:

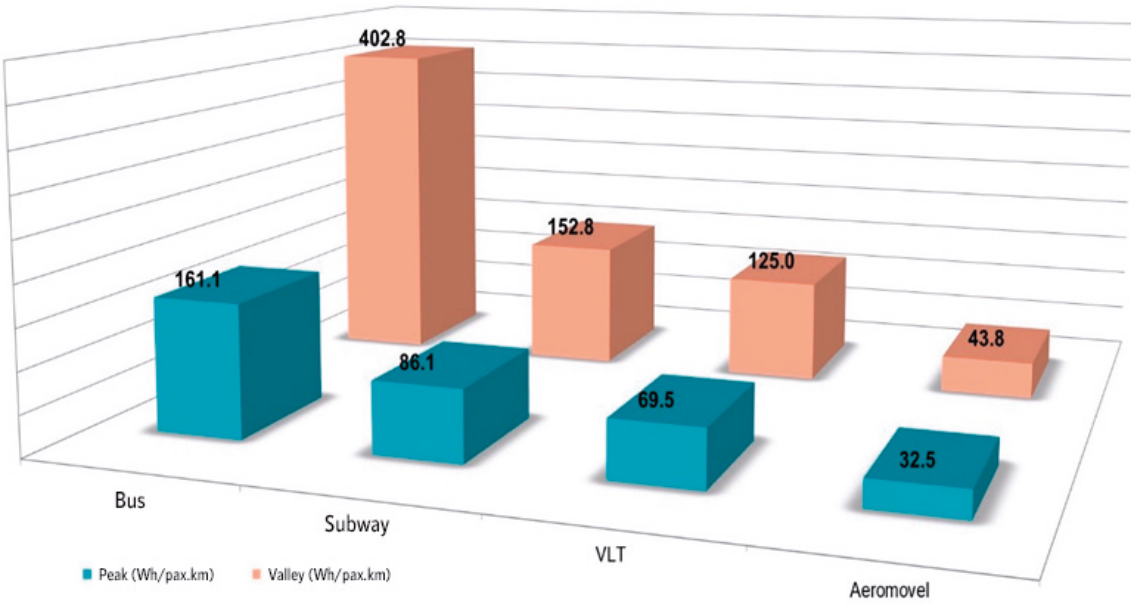
- Exclusive and segregated elevated railway;
- Medium Capacity – up to 24,000 pphpd;
- Pneumatic propulsion with stationary engines;
- Fully automated operation;
- Redundancy in all subsystems;
- Constructive flexibility, curves from a radius of 25m and slopes of up to 12%;
- Maximum speed of 80 km/h;
- Intrinsic anti-collision and anti-derailment security;
- Dual braking system;
- Steel wheels designed for 1.2 million km;
- Steel rails for 30 years of operation without replacement;
- Universal accessibility;
- Compliance with earthquake codes;
- Compliance with the international standards system for APM/AGT

Advantages of the System:

- 100% electric;
- Lightweight vehicle and slender supporting structures;
- Zero emissions and zero tire waste;
- Low noise emission;
- No risk of collision;
- Low land use;

- Low deployment cost;
- Low operating cost;
- Low energy consumption;
- Easy integration with the urban environment and multimodal systems;
- Easy access to stations;
- Smooth acceleration and deceleration;
- Air-conditioned vehicles;
- Synchronized platform doors;
- Onboard entertainment;
- Reduced waiting and travel times;
- Biosafety-oriented design;
- Nationalization index above 95%.

Figure 7 – Energy efficiency comparison between BRT, subway, VLT, and Aeromovel



The Context of Mobility in Canoas

At the 21st United Nations Conference on Climate Change (COP21), in 2015, held in Paris, the signatory countries undertook to reduce their Greenhouse Gas (GHG) emissions, specifying how they would achieve their goals. In Brazil, these goals were internalized in Federal Decree No. 9,073/2017, which constituted Brazil's commitment to the Global Climate Change Agenda. Following this decree, the municipality of Canoas adopted a series of measures to meet the goals and align with the guidelines established by the Federal Government.

In 2017, the city joined the ICLEI Network (Local Governments for Sustainability) and, in the following year, in joined the Global Covenant of Mayors for Climate and Energy. Launched six months after the Paris Climate Conference, the pact represents a powerful reaction by local leaders to urgent climate change and aims to promote the transition, at the municipal level, to a sustainable economy with low emissions of polluting gases.

In November 2020, Canoas launched the 1st Greenhouse Gas (GHG) Emissions Inventory. The study encompassed multidisciplinary aspects, involving a number of areas, such as Healthcare, Education, Transport, Waste, Sanitation, Energy, and Water Resources, acting in a cross-sectional way in the public and private sectors.

According to the Inventory:

> The city of Canoas has a very peculiar profile of GHG emissions, with the main contribution being made by the stationary energy sector (...). When discounting this source of emissions, the transport sector plays a leading role, particularly the consumption of diesel fuel and gasoline. (...). It is important to emphasize that the inventory is one of the initial steps in terms of the climate action. It is crucial to promote updates and revisions according to the period established by the city, as well as to carry out the constant improvement of the process and continuous articulation with the working group and relevant local stakeholders. Following the commitments signed with the Global Compact of Mayors, Canoas is expected to move forward in the implementation of the climate agenda, with the preparation of a Risk and Vulnerability Analysis to determine the nature and extent of the climate hazards faced by the city, culminating in the development of a Climate Action Plan, which sets out targets for reducing GHG emissions and mitigating actions and adapting to climate change. Based on the subsequent assessments to be developed and coordinated by the city, it is expected that various stakeholders from the private sector, local universities and civil society will be involved in initiatives that have the aim of mitigating GHG based on the results of the First Inventory. By observing good practices in cities associated with ICLEI South America, we encourage the city to explore the following alternatives:

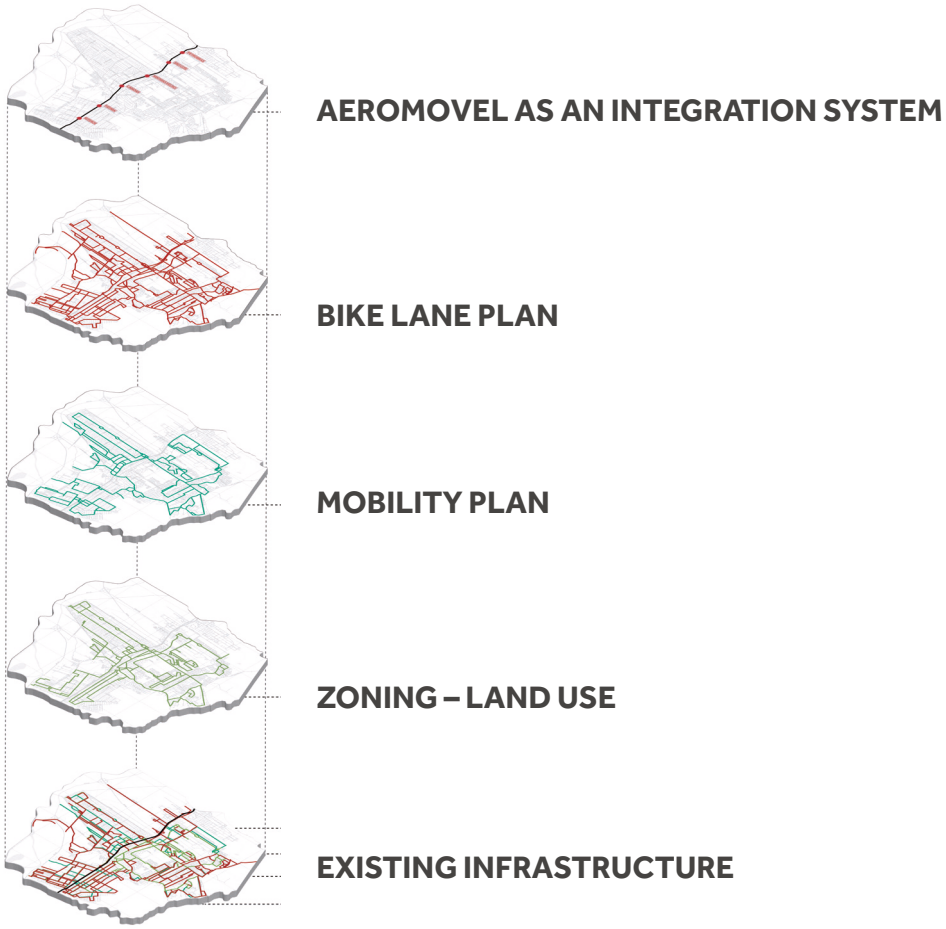
- Low-carbon transport and mobility: developing a transport strategy that favors the rational use of individual vehicles and improves the quality of public transit, in addition to promoting active mobility within the city's borders;
- Promotion of the use of renewable sources and energy efficiency: encouraging the generation and use of renewable energy sources, such as solar, stimulating new energy consumption patterns in buildings and introducing good practices for the use of energy in domestic, commercial and public enterprises.[1]

[1] CTG BRASIL. Greenhouse Gas Emissions Inventory. Base Year 2019 – Rio Canoas Energia. 2020. Available at: https://www.ctgbr.com.br/wp-content/uploads/2020/11/Rio_Canoas_Relatorio_do_Inventario_de_Emissoes_de_GEE_Ano_Base_2019.pdf. Retrieved: May 8, 2021. p. 21.

City Planning:

The compatibility between the Master Plan, the Mobility Plan and the Bike Lane Plan is vital for the implementation of the Zero Carbon Mobility project, which has the Aeromovel as its structural axis.

Figure 8 – Urban planning for Canoas



City planning provides for universal access through the promotion of non--motorized mobility, infrastructure for motorized and non-motorized circulation of people and goods, efficiency in the circulation of non-motorized and motorized modes, equity in the use of public space for circulation, sustainable development of the city in terms of socioeconomic and environmental dimensions, and equity in citizens' access to public transit, through the integration of urban transport modes and services, bicycles, and pedestrians.

The Aeromovel Project is perfectly compatible with the city's plans, as it reduces the number of buses and private vehicles in circulation, resulting in greater fluidity, as well as a reduction in traffic congestion. The deployment of the system leads to a reduction of up to 75% in the time spent on transport and, as it operates on an elevated railway, gives the streets back to citizens, and integrates the city, making the urban mobility system in Canoas more efficient and accessible.

The Aeromovel and the City of Canoas

The city's structural barriers – in particular BR-116 and Trensurb – demand an integration solution on an elevated railway. A demonstration that the Aeromovel is a natural solution for Canoas is the history of six deployment studies prior to the 2016 Concession Notice. The studies, initiated in 1992, were carried out by different administrations.

Figure 9 – History of Aeromovel studies and projects in Canoas

Project	Year	Applicant / Executor	Connection	Relation to the Current Layout
Connecting Canoas to the Future	1992	Municipality of Canoas / Aeromovel	Mathias Velho - Guajuviras	Similar
Ring Connection	1997	Municipality of Canoas / Aeromovel	City Center – Districts	Alternate
Circular Line on the ULBRA Campus	2001	ULBRA/Aeromovel	ULBRA Circular	Complementary
ULBRA Connection to TRENSURB	2002	ULBRA/Aeromovel	ULBRA – TRENSURB Connection	Alternat
Canoas Aeromovel – East/West Axis	2012	Municipality of Canoas / TRENSURB	Mathias Velho - Guajuviras - City Center	Similar
Deployment of the AMP System in Canoas	2013	TRENSURB	Mathias Velho - TRENSURB	Similar
Preliminary Project for the Guajuviras Lina	2014	Municipality of Canoas/ Ministry of Cities/ Aeromovel	Guajuviras/ TRENSURB	-
Technical Studies Mathias – Centro Line	2014	Municipality of Canoas/ Ministry of Cities/ Aeromovel	Mathias Velho - Guajuviras/ ULBRA - Centro	-
Deployment of the Guajuviras Line	2015	Municipality of Canoas/ Ministry of Cities/ Aeromovel	Guajuviras/ TRENSURB	-

The choice of the Aeromovel technology as the main axis of the mobility system in Canoas was made according to technical and economic criteria. The first level of this choice was related to the mode, based on the assumption of the exclusive and segregated railway. The segregated railway allows for greater efficiency and full automation of the system and can be implemented from an underground railway, a ground-level railway isolated by physical fencing (fence or wall), or an elevated railway. The underground subway system was discarded due to its high deployment cost. Ground-level solutions – whether VLT, BRT, or a similar one – present the following technical and economic impediments:

1) High cost and architectural difficulty to overcome the physical barriers imposed by the BR-116 highway and by the Trensurb line;

2) Difficulty in segregating the railway with the imposition of new physical barriers in the urban environment;

3) Impossibility of expanding the existing road template.

The characteristics and parameters used resulted in the choice for the electrical and automated system on elevated railway. Considering the existing alternatives in the international market, as well as the available technology and production chains in Brazil, the deployment and operation costs resulted in the choice of Aeromovel technology as the only adequate solution for the Canoas system. Furthermore, other technical factors were considered in this analysis, such as the unique low weight of its vehicles and structures, in addition to the unique ability to perform curves up to 25 meters in radius and slopes of up to 6%, which are required for the operation of the defined route without the need for expropriations or modifications to the road template.

Figures 10 – Comparative Chart for Canoas – Transport Modes (2014)

Modes	Estimate (R$ Million/km)	Analysis for Canoas
BRT	15 a 90	Unfeasible due to the need to expand the road template
VLT	75 a 150	Unfeasible due to the need to expand the road template
SUBWAY	150 a 900	Economically unfeasible
MONORAIL	150 a 735	Economically unfeasible
AEROMOVEL	35 a 64	Feasible

Source: TPC Guide – Guidelines for Selection of Technologies and Implementation of Public transit Projects. Ministry of Cities of Brazil, Brazilian Development Bank (BNDES), Financial Cooperation of Germany through the German Development Bank (KfW). 2017, pages 121, 126 and 127.

Note: The reference cost ranges (BRL MILLION/KM) are based on the year 2008, as per item 1.6 General Table of TPC Systems of the TPC Guide – Guidelines for Selection of Technologies and Implementation of Public Transit Projects, page 126.

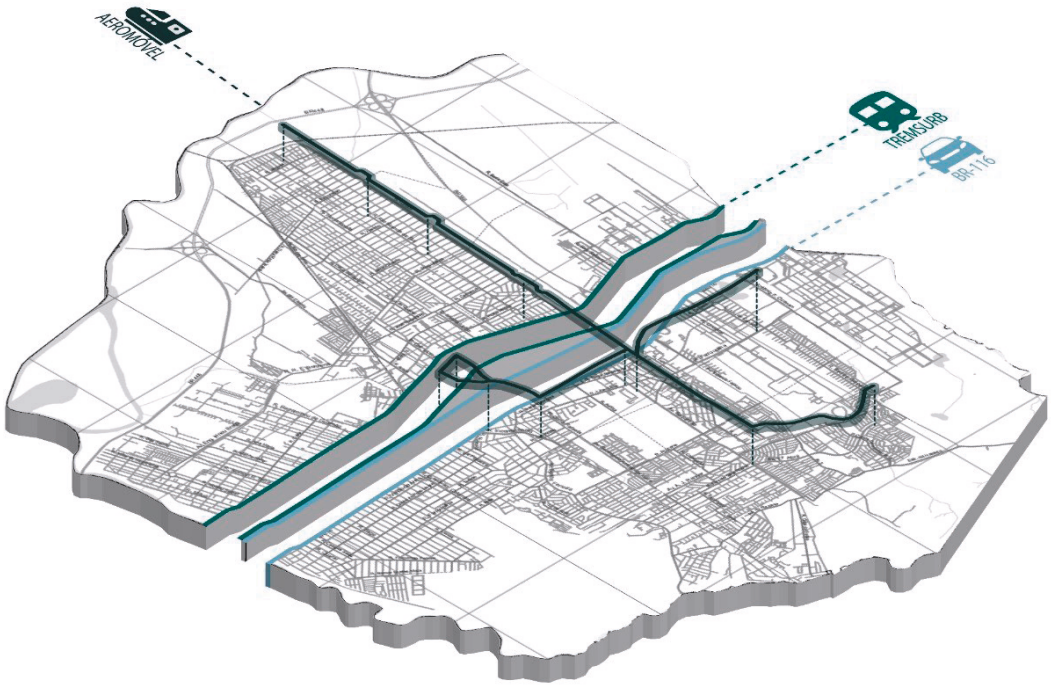
Zero Carbon Mobility – City of Canoas

The Zero Carbon Mobility study has been prepared under several aspects, aiming at an integrated and balanced proposal. Chapter Four of the term of reference details the project with the following structure:

1. Conceptual Emissions Model in Canoas
2. Conceptual Urban Model
3. Integrated Mobility System

4. Stations as a strategic point of the zero zone
5. Biosafety
6. Future expansions with the Aeromovel in the City of Canoas
7. Suggested Action Plans
8. Synergistic Actions and Programs

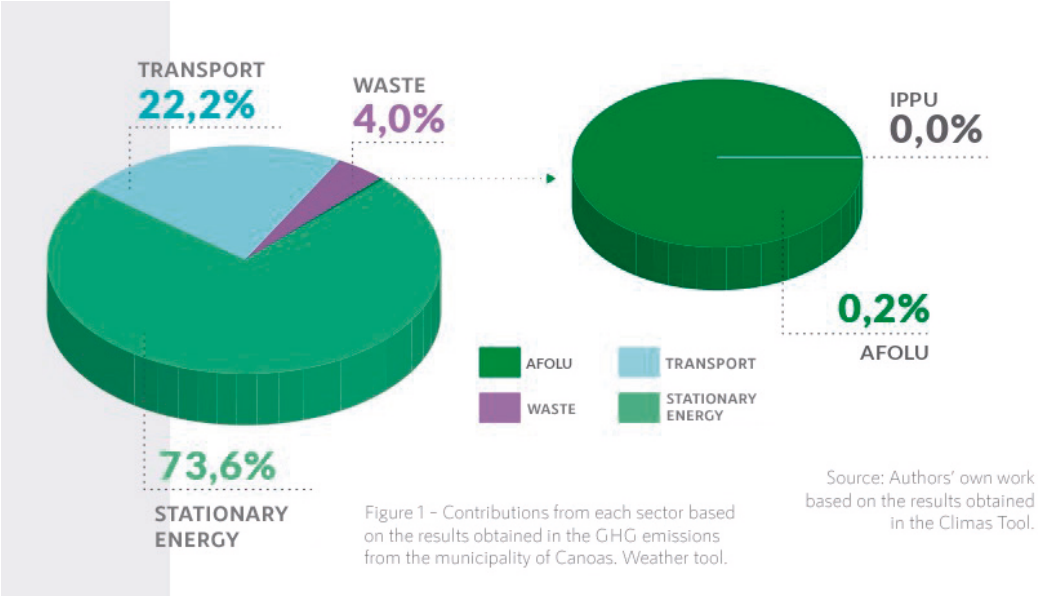
Figure 11 – Physical barriers in the City of Canoas



Canoas Emissions Profile

The emission profile of the city of Canoas differs from that of other Brazilian cities, with emission rates higher than the country's average. Stationary Energy, Transport and Waste are the main emitters of greenhouse gases in the city, and the oil refining activity can be considered its main source, contributing with 52.8% of the total amount.

Figure 12 – Profile of GHG emissions in Canoas



Source: 1st Canoas Greenhouse Gas Emissions Inventory, 2018.

This comparative basis reinforces the importance of the propositions presented in the conclusions of the 1st Greenhouse Gas Emissions Inventory of Canoas, encouraging the city to develop programs and initiatives that are guided by the following guidelines:

- Development of a low-carbon transport and mobility strategy;
- Encouraging the generation and use of renewable energy sources;
- Development of strategies that promote the non-generation of waste and encourage the recycling and composting of organics, in addition to energy recovery of biogas in landfills;
- Innovation in the strategies for the city's territorial development, introducing climate criteria, in a cross-sectional way, in municipal policies, such as the adoption of climate criteria in the master plan and favoring new forms of land use, as well as new standards for construction and establishment of green areas and biodiversity.

The challenging scenario can be seen as a broad horizon of opportunities for transformation. The Canoas Zero Carbon Mobility Project is a strategic vector for the redefinition of the energy matrix and local transport, with ample capacity to reduce emissions and improve quality of life and local and regional economic development indices.

Análise das Emissões e Atuais Impactos na Cidade de Canoas

The profile of emissions from road transport in Canoas, according to the 1st Greenhouse Gas (GHG) Emissions Inventory, indicates that 73% of emissions originate from the consumption of diesel fuel, 26% from gasoline, and 2% from compressed natural gas (CNG). The top-down methodology employed by ICLEI is the most widely adopted thanks to the ease of using fuel sales data to estimate GHG emissions. Fuel sales data by municipalities is accurately collected by domestic energy agencies, such as the National Agency for Petroleum, Natural Gas, and Biofuels (ANP). This accuracy provided by ANP ensures a degree of consistency and availability of data on an annual basis while providing an up-to-date inventory. Nevertheless, the major disadvantage of this approach is that this type of data does not allow segregating individual causes and sources of GHG emissions, for the purpose of developing targeted mitigation strategies, nor does it provide accurate data regarding the areas covered by the emissions.

In Canoas, over 650,000 metric tons of CO2e (carbon dioxide equivalent) are the result of diesel fuel burning. This is a reflection of the intense cargo transport activity on the BR-116, BR-386 and BR-448 highways. For comparison purposes, according to ANP, in 2018, in the municipality of Canoas, the volume accounted for in the sale of diesel fuel was 267 million sq. m. In turn, in Porto Alegre, which has a population four times greater, the volume sold of the same fuel was 148 million sq. m.

Another key aspect to be analyzed is the measurement of emissions of local air pollutants, such as particulate matter (PM), carbon monoxide (CO), nitrogen oxide (NOx), and non-methane hydrocarbons (NMHC). Table 1 shows the main impacts of these pollutants. Canoas must pay attention to NOx and PM emissions, which are the main pollutants resulting from the combustion process of diesel-powered vehicles, such as trucks and buses. According to data from the Pan American Health Organization (PAHO), air pollution is responsible, each year, for 51,000 deaths in Brazil. As of 2018, deaths from air pollution exceeded the number of traffic deaths, which totaled 32,000, according to data from DataSUS.

Figure 13 – Impact of air pollutants

Pollutant	Impact
CO	Acts on the blood, reducing oxygenation, and may cause death after a certain period of exposure
NMHC	Unburned or partially burned fuels make up smog and carcinogens. It is an ozone precursor
NOx	Formation of nitrogen dioxide and photochemical smog and acid rain. It is an ozone precursor
MP	Can penetrate the body's defenses, reach the pulmonary alveoli and cause irritation, asthma, bronchitis, and lung cancer. Causes dirt and degradation of properties near transport corridors

Another major source of air pollution resulting from transport activities is the resuspension of material deposited on the roads. This pollutant, referred to as brake wear particulate matter, originates from the wearing of tires, brakes, and pavements. Both the particulate matter from combustion and from wear tend to be concentrated in the vicinity of the road. For Canoas, which is surrounded by highways, the need to mitigate these risks is evident.

Figure 14 – Per capita transport emissions (SEEG) of a number of cities in the Metropolitan Region of Porto Alegre

City	tCO_2e	Population	tCO_2e/capita
Canoas	788,334	348000	2.27
Novo Hamburgo	250,000	247000	1.01
Porto Alegre	1,431,098	1488252	0.96
Gravataí	260,000	284000	0.92
Cachoeirinha	102,190	131240	0.78
São Leopoldo	170,333	238648	0.71
Sapucaia	100,145	141808	0.71

[2] PAHO (Pan American Health Organization). 2018b. Don't pollute my future! The impact of the environment on children's health. License: CC BY-NC-SA 3.0 IGO. Brasília, DF, Brazil, 2018. https://iris.paho.org/handle/10665.2/49123

Figure 15 – Total tCO2e emissions per year for study scenarios

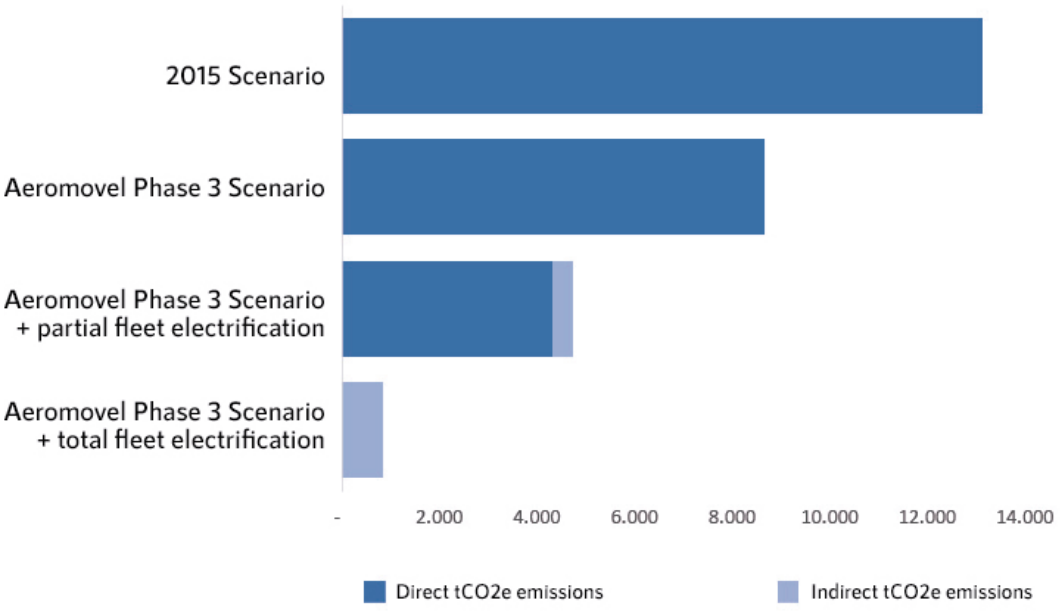


Figure 16 – Transport projects with certified carbon market reductions

Project	Country	Average annual tCO2e reduction	Total length (km)
TransMilenio Bogota - Phase II-IV	Colombia	578,918	169
BRT Transmetro Barranquilla	Colombia	55,828	28
MIO Cali	Colombia	242,187	44
BRT Metroplus Medellin	Colombia	123,479	18
MEGABUS Pereira	Colombia	33,956	30
Cable Cars - Medellin	Colombia	17,290	14
BRT in Guatemala City	Guatemala	536,148	47
BRT EDOMEX - Lines 1-5	Mexico	145,863	101
BRT Metrobus Insurgentes	Mexico	46,544	20
BRT Macrobus Guadalajara	Mexico	54,365	185
BRT Metrobus 2-13	Mexico	134,601	215

Currently, carbon credits are on the rise in Europe, and the trend is that these credits will be highly valued by 2030. In Brazil, discussions regarding the pricing of emissions have advanced. The political and economic instruments that aim to regulate the amount of GHG are under discussion through the PMR (Partnership for Market Readiness) and PMI (Partnership for Market Implementation).

An alternative for trading carbon credits is the voluntary carbon market. Credits arising from registered projects are referred to as Verified Emissions (VER) and are audited by an independent entity, not linked to the UN.

In addition to reductions thanks to the implementation of the Aeromovel system, the project, as an axis for inducing zero carbon mobility, has the potential for reduction through sustainable development-oriented transport (DOTS). Urban planning driven by the Aeromovel system has the potential to reduce car dependency through actions that combine urban planning and mobility. The benefits of DOTS include improved air quality, pedestrian-friendly environments, increased travel and public transit revenue, and the reorientation of urban development patterns around public transit stations and terminals.

In Colombia, a DOTS project submitted to the NAMA Facility climate fund seeks to reduce GHG emissions from private vehicles by creating compact urban environments that offer alternatives to car travel. By changing land use and travel patterns, the goal is to reduce the growth rate of motorized trips by 25-35%, improve air quality, and reduce annual GHG emissions by 15-22% over the next 25 years. The proposal also contemplates a 25% reduction in

CO2 emissions per kilometer, in view of the potential for improvements in energy efficiency for all classes of vehicles.

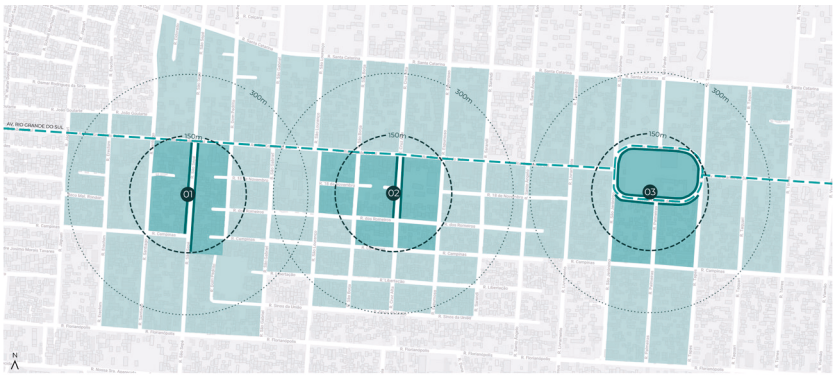
Technologies for heavy vehicles are also developing and becoming increasingly popular, and the trend is that electric trucks should also a competitive alternative. The European Automobile Manufacturers Association (ACEA), for example, expects 200,000 electric trucks to be on the roads by 2030, while in the United States, 54,000 heavy electric trucks are projected to be on the roads by 2025.

Another offsetting strategy is carbon taxation. Currently, over 40 countries adopt the "green" tax in an attempt to reduce GHG emissions. The tax is used to tax polluting activities based on the amount of CO2 emitted. In Brazil, carbon taxation is one of the government's tax reform proposals. There is also a movement by companies that seek to become certified in relation to the ESG (Environmental, Social, and Governance) criteria as a sustainability strategy

Urban Conceptual Model

Transport-Oriented Development (TOD) seeks to balance the structural investments in transport with urban planning and development. Zoning is a strategy for urban requalification based on specific zones, using the cities of London, Medellin and Barcelona as benchmarks. The area surrounding the Aeromovel stations are ideal places to stimulate commerce in safe, clean and healthy areas, with easy access to work, education, services, and recreation. The multimodal integration guideline, with priority given to pedestrians and cycling, promotes the use of public transit by all social classes, providing more egalitarian communities.

Figure 17 – Areas of influence and urbanity corridor

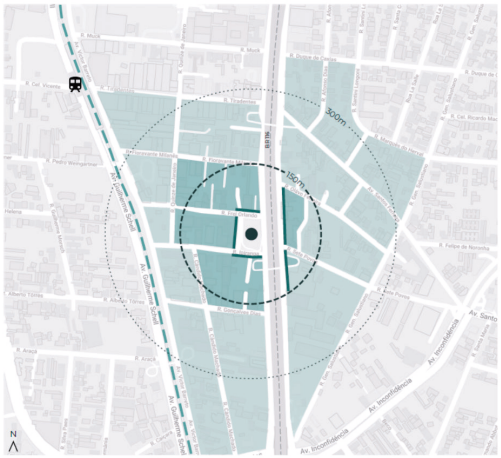


HIGH-INFLUENCE BLOCKS
MEDIUM-INFLUENCE BLOCKS
HIGH-INFLUENCE RADIUS (150m)
MEDIUM-INFLUENCE RADIUS (300m)
ADJACENT BLOCKS FRONTAGE
AV. RIO GRANDE DO SUL
01 STATION 01 (AEROMOVEL)
02 THIAGO WÜRTH STATION (AEROMOVEL)
03 STATION 03 (AEROMOVEL)

Figure 18 – Areas of influence and city center requalification

Land Use
Area of Influence

CITY CENTER URBAN REQUALIFICATION (ground zero)



HIGH-INFLUENCE BLOCKS
MEDIUM-INFLUENCE BLOCKS
HIGH-INFLUENCE RADIUS (150m)
MEDIUM-INFLUENCE RADIUS (300m)
ADJACENT BLOCKS FRONTAGE
GUARDRAIL (BR-116)
TRENSURB RAILWAYS
CITY CENTER STATION (AEROMOVEL)
CANOAS STATION (TRENSURB)

Triple Zero

Aeromovel brings relevant advantages, as the system proves to be efficient, equitable, safe, and sustainable. The main purpose of deploying the technology in the city of Canoas is to set up a carbon-neutral mode of transport that helps to promote the reduction of environmental impacts and social and economic inequity. The Triple Zero proposal aims to combat the emissions of poisonous and polluting gases, accidents and inequality in the region where the system is to be deployed.

Regarding the mobility and intermodal transport bias, the following elements of fundamental application are presented:

a) Reduced impacts from road use;

b) Reduced impacts of traffic on air quality and climate change;

c) Reduced impacts of traffic on water quality, vegetation, and trees and land use;

d) Promotion of better access to employment areas;

e) Stimulating transport infrastructure and support to public transit services that promote sustainable economic growth;

f) Mitigating traffic congestion hours;

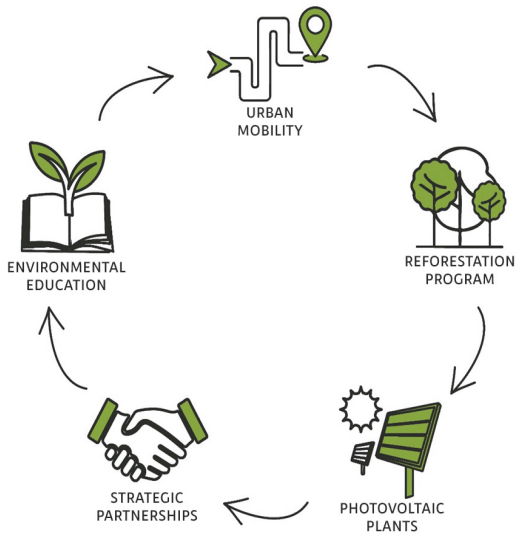
g) Influence and management of the demand and supply of all modes of transport.

Figure 19 – Triple zero urban development concept

Synergistic Programs

The vision of a city that aims at carbon neutrality involves a series of measures, from fundamental actions, such as environmental education, waste and mobility policy, and energy strategies, to policies for offsetting emissions. The following is a suggestion for synergistic programs:

Figure 20 – Synergistic programs



Financing Sources

According to data from the International Finance Corporation (IFC) for 2018, the investment opportunities scenario is estimated at $29.4 trillion in cities in developing countries by 2030. Most of these opportunities – $24.7 trillion – are intended for sustainable housing areas, the so-called green buildings, and existing modernized constructions. Opportunities of around trillions of dollars are also provided by the International Finance Corporation, in infrastructure for public transit, electric vehicles, water management, renewable energy, and waste treatment.

The current scenario offers different approaches and innovative models, with the formation of arrangements and partnerships that cities can implement to narrow the financing gap for smart climate investments, including Public-Private Partnerships, real estate value capture mechanisms and green bonds, for example. Cities are at the forefront of climate impact and sustainable infrastructure.

Multilateral Development Banks are the main stakeholders in international financial cooperation for development. In addition, other institutions are involved, such as bilateral cooperation agencies, government agencies, United Nations organizations, and private foundations, each with distinct characteristics of governance and performance.

The most traditional multilateral banks are

- World Bank:
  https://www.worldbank.org/en/home
- Inter-American Development Bank
  https://www.iadb.org/en/about-us/overview

- Development Bank of Latin America (CAF)
  https://www.caf.com/en/
- European Investment Bank
  https://www.eib.org/
- European Bank for Reconstruction and Development:
  https://www.ebrd.com/

Bancarização e Fontes de Valor

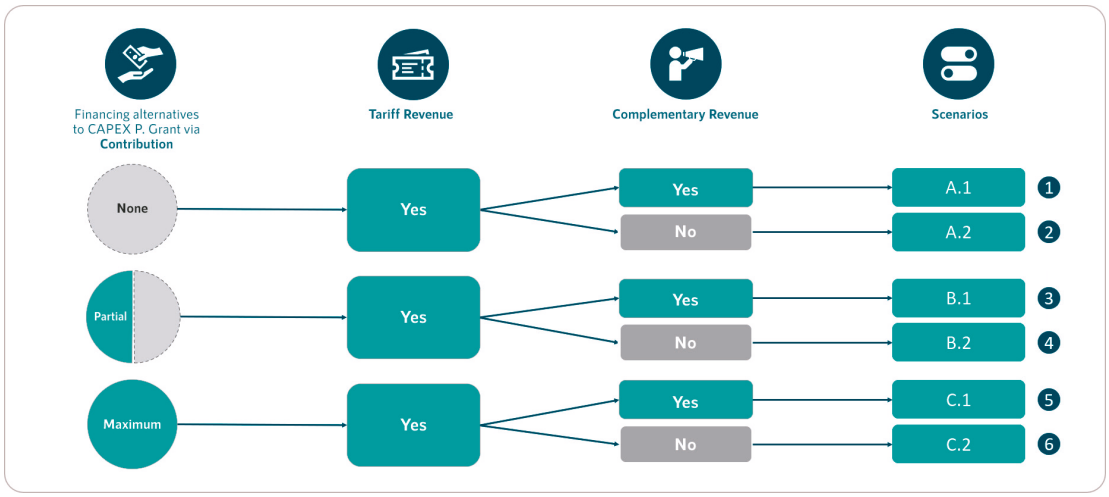
In addition to offering high-quality public services, cities must break free from the recurring emergency financial assistance demanded by transport operators, whether public or private.

Concession projects – or PPP (Public-Private Partnerships) – must follow bankarization rules, that is, parameters that facilitate the performance of the financial system in projects, particularly in the assessment and mitigation of risks. Bankarization is applied from the conception of investments to the form of collection, including fees.

The Aeromovel Project encompasses a number of businesses that are connected under a concession, in the context of PPP, remaining in line with energy transition, resilience, and climate impacts. The financial architecture that supports it addresses the challenges inherent in innovative projects and requires the articulation of four components: equity, debt, risk mitigation, and investment. This articulation makes it possible to achieve three key objectives – sustainability of the project, affordable rates, and minimal spending of the municipality's finances.

The transforming nature of the project requires the participation of development-financing entities and multilateral organizations and becomes crucial to the sustainability and credibility of the Aeromovel Project.

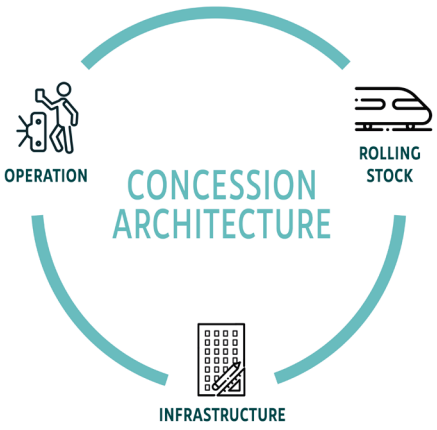
Figure 21 – Base case of the economic-financial pre-feasibility study



Financial Architecture

The economic and financial modeling carried out on the 2016 parameters projected what was referred to as the base case. Given the base case, the transport concession was divided into three levels – infrastructure, rolling stock, and operation – whose best contractual combination has yet to be defined by the granting authority. The term of reference seeks to provide a set of contemporary parameters for the financial architecture and the system's implementation strategy. In addition to conventional elements – the tariff, private investment, and the counterpart in public contribution – other parameters have been explored, such as carbon credits and offsets, TOD and a real estate and commercial development strategy, in addition to the use of long-term bonds associated with the urban and sustainable development of the city.

Figure 22 – Concession architecture and value generation



VALUE GENERATION

- TARIFFS AND TARIFF PLANS
- ADVERTISING AND OTHER ANCILLARY REVENUES
- DEMAND GUARANTEE POLICY
- SERVICES, COMMERCE, BLUE AREA, AND PRIVATE PARKING LOTS
- CARBON CREDITS AND ENVIRONMENTAL OFFSETS (REGULATORY OR VOLUNTARY)
- URBAN DEVELOPMENT PROJECTS (TOD) AND AREA OF INFLUENCE
- EXPLOITATION OF SERVICES ON THE ELEVATED RAILWAY (DATA, ENERGY, LIGHTING)
- COMPENSATION FOR NEGATIVE EXTERNALITIES OF PRIVATE CARS AND OTHER SYSTEMS FOR TRANSPORT OF PASSENGERS OR CARGO
- GREEN BONDS AND CARBON ANCHOR INVESTMENTS
- PUBLIC CONTRIBUTION AND GRANTS

Recommended Actions

Based on surveys and interviews conducted with experts, this pre-feasibility study has identified several promising mechanisms for the economic and financial structuring of the Zero Carbon Mobility project in Canoas. The global moment, heavily impacted by the pandemic and climate policies, is absolutely opportune and favorable to the immediate articulation of these mechanisms. There is a clear receptivity in the investment market and a degree of enthusiasm regarding this project model and the concepts developed in it.

The recommended actions aim to consolidate the parameters for the preparation of the system's concession notice or PPP. Considering the current scenario of opportunities and investments in green infrastructure, which offer innovations in public transit and urban mobility management models, the formulation of a strategic mobility plan for the city is strongly recommended, which includes a tariff study and definitive economic-financial modeling of the

concession, providing a sustainable alternative that allows the city not only to face current challenges, but also to convert the related opportunities into economic development and quality of life for the inhabitants of Canoas.

Integrated Strategy for Mobility, Urbanism and Economic Development

The world is mobilizing for the resumption of development and investments – a favorable moment for the formulation of new solutions for the viability of public transit in the medium and long term. Outstanding government, institutional and private leaders are engaged to implement innovative, inclusive and sustainable projects for the transformation of the urban structure, aiming at better quality of life, jobs, and income for its citizens. The implementation of structuring and transforming projects is necessary to attract new investments and prosperity cycles for cities.

The term of reference for the Zero Carbon Mobility project of the City of Canoas aims to provide a guideline for the transformation of the municipality's mobility and economic and social dynamics. Key recommended actions are related to an integrated mobility and urbanism strategy, aimed at human development, inducing economic development and attracting investments.

Integrated Development Strategy

1. Strategic planning for city mobility
    - Study of tariffs
    - Definitive economic-financial modeling
    - Concession model (infrastructure, fleet, and operation)
    - Physical deployment schedule and regulations
    - Preparation of the concession notice
2. Details and deployment of a strategy to reduce and offset GHG emissions in the municipality
3. Details of the areas of influence in the central area and around the stations
4. Details of economic and regulatory alternatives

The time to implement changes, new technologies and biosafety processes is limited. By having a ready-made and structured project, Canoas has the opportunity to become an inclusive and sustainable mobility laboratory and a leader among medium-sized cities around the world.

Conference on Mobility and Development of the City of Canoas, held on June 21, 2021, in Canoas, RS

Event Schedule

- **Perspectives for mobility**
  Rodrigo Tortoriello
  https://www.youtube.com/watch?v=k8sjALvCMiQ
- **Zero Carbon Mobility – WRI**
  Cristina Albuquerque
  https://www.youtube.com/watch?v=SgtWZx1fjI8
- **The Mobility Plan of Canoas and its main guidelines – PMC**
  Eng. Tânia Batistela
  https://www.youtube.com/watch?v=4kkjLuba5mk
- **Studies, projects and works carried out for a new transport system – PMC**
  Eng. Maurício da Rocha
  https://www.youtube.com/watch?v=E32GYIN1beM
- **Carbon emissions in Canoas – ICLEI**
  Rodrigo Perpétuo
  https://www.youtube.com/watch?v=IOrQ-wFEyHA
- **Zero Carbon Mobility Project**
  Marcus Coster
  https://www.youtube.com/watch?v=ByA1ns-B77M
- **Closing**
  Mayor Jairo Jorge
  https://www.youtube.com/watch?v=GVQpoWLJOtM

Conference on Mobility and Development of the City of Canoas, held on June 21, 2021, in Canoas, RS

Visit of Mayor Jairo Jorge at the 6th Generation Aeromovel Vehicle, on June 21, 2021, in Canoas, RS

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