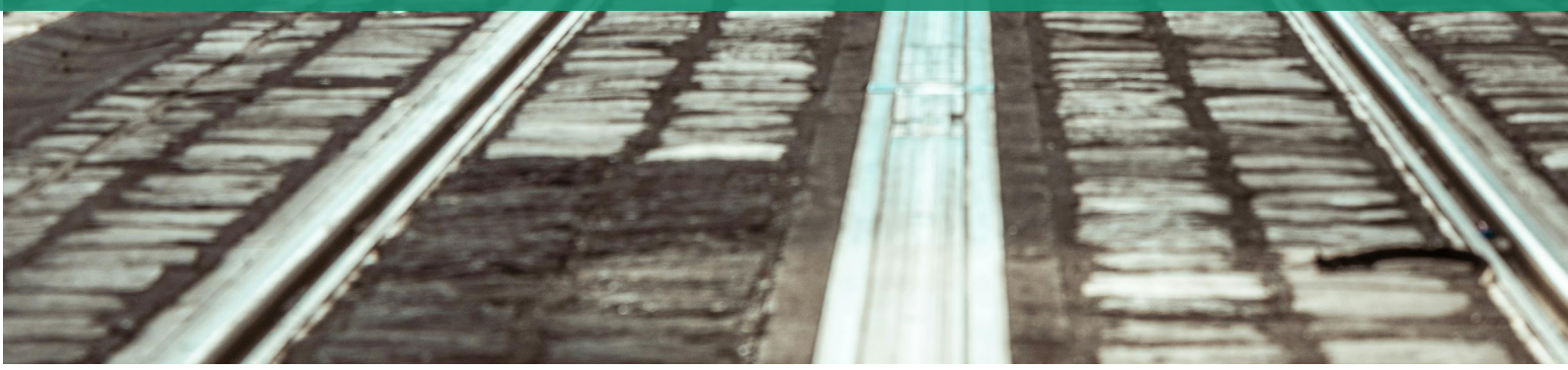
CITY ROADMAP FOR E-MOBILITY:
LAST MILE DELIVERY WITH LIGHT ELECTRIC VEHICLES IN CUENCA, ECUADOR



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PROJECT PARTNERS

ABOUT

To provide an input for Departmental Governments in planning the transition to low carbon urban mobility by developing electric vehicles as a scalable solution to reduce emissions in public transport and urban logistics

TITLE

City Roadmap for E-mobility: Last mile delivery with light electric vehicles in Cuenca, Ecuador

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All the pictures are provided by the SOL+ partners

June, 2024

City Roadmap for E-mobility: Last mile delivery with light electric vehicles in Cuenca, Ecuador

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Executive Summary

As the third urban conglomerate in Ecuador and home to more than 700,000 inhabitants, Cuenca has experienced exponential population growth since 1950, driven by the economic potential of productivity and manufacturing. In the Azuay province, Cuenca is one of the most developed areas, offering service equity covering water and energy to more than 93% of its citizens. According to the municipality, 85% of the rural population work and study in the urban area of Cuenca (Municipio de Cuenca, 2015).

As the state and city progress, challenges in urban mobility become apparent. Public transport users are growing, and the city road network is reaching its maximum capacity. In response, the municipality with the support of various institutions addresses those problems, with sustainable mobility initiatives emerging as a trending solution globally. The municipality has developed a plan for public transport integration and fleet modernization.

The Sustainable Mobility Plan initially focuses on optimizing routes, introducing a modern tramline, and exploring alternatives to zero-emission technologies through e-Cuenca electromobility plan. Urban freight is included in this policy development e-plan, playing a pivotal role in the city's economic development. Through projects like SOLUTIONPlus and other research from local universities and international organizations, the city collaborates with multiple stakeholders and seeks better solutions for moving goods, particularly in the highly demanded city center.

Cuenca has historically shown the potential of its industry and the acceleration of adopting novel systems for city administration. With the alignment of the national government's National Determined Contribution (NDC), the city is on the path to reducing CO2 emissions and understanding the importance of competence at the national and regional levels.

Cuenca bases its development on five main milestones that frame the policy by suggesting a better understanding of emission reduction and a paradigm shift towards zero-emission transport for both persons and freight:

- 2023 – Cuenca's Low Emissions City Centre - KFW
- 2023 - “e-Cuenca” Plan de Electromovilidad de Cuenca (e-Cuenca Electromobility Plan for Cuenca)
- 2021 - La Estrategia Nacional de Electromovilidad para Ecuador (National Electromobility Strategy for Ecuador)
- 2019 - Primera contribución determinada a nivel nacional para el acuerdo de París bajo la Convención Marco de Naciones Unidas sobre Cambio Climático. Quito: República del Ecuador – (First nationally determined contribution for the Paris Agreement under the United Nations Framework Convention on Climate Change. Quito: Republic of Ecuador)
- 2019 - Electromovilidad: Panorama Actual en América Latina y el Caribe – (Electromobility: Current Landscape in Latin America and the Caribbean)

- 2018 - Memorias del 1er Foro Internacional de Electromovilidad y Propuesta de Hoja de Ruta para la Eelectromovilidad en Ecuador (Proceedings of the 1st International Electromobility Forum & Proposal for a Roadmap for Electromobility in Ecuador)

Cuenca is not behind other major cities, including Quito, Montevideo, Bogota, Buenos Aires, among others. It is actively building knowledge and experience to introduce novel solutions and methods for creating a responsible future and a green recovery.

Policy instruments have been identified in the city as an acceptable effort to ensure transparency, allowing citizens and third parties to follow different actions in the Local Government. The Transparency Platform (EMOV, 2024) offers a view of budget exploitation and contracts, enabling the understanding of the city's aims and the ability to follow the status of master plans established in previous years.

The roadmap for adopting light electric vehicles (LEV) in urban freight complements previous publications and policy frameworks related to sustainable mobility and low emission technology adoption. It provides valuable insights for decision-makers in Cuenca and peer cities, aiding their understanding of the necessary stages and requirements for integrating and promoting intelligent solutions for the last mile in their urban logistics.

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List of Abbreviations

BID: Banco Interamericano de Desarrollo. Inter-American Development Bank

DGM: Dirección General de Medicamentos, Insumos y Drogas. General Directorate of Medicines, Supplies and Drugs

EV: Electric vehicles

GAD: Gobierno Autonómono Descentralizado. Decentralised autonomous government.

GDP: Gross Domestic Product.

GHG: Greenhouse gas

INEC: Instituto Nacional de Estadística y Censos. National Institute of Statistics and Censuses

LEV: Light Electric Vehicle

NAMA: Acciones de Mitigación Nacionalmente Apropiadas. National Appropriate Mitigation Actions.

PLANEE: Plan Nacional de Eficiencia Energética 2016-2035. National Plan for Electric Mobility and Energy Efficiency

PME: Plan Maestro de Electricidad. Ecuador Electricity Master Plan 2016-2025

PNMUS: Política Nacional de Movilidad Urbana Sostenible. National Sustainable Urban Mobility Policy.

UEMI: Urban Electric Mobility Initiative

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Purpose	To provide an input for Departmental Governments in planning the transition to low-carbon urban mobility by developing electric vehicles as a scalable solution to reduce emissions in public transport and urban logistics.
Coordination	WI and ICLEI
SOLUTIONSplus partners	- ICLEI - Local Governments for Sustainability: A global network of more than 2500 local and regional governments committed to sustainable urban development. Active in 125+ countries, we influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development. - Wuppertal Institute (WI): German research center that aims to design transformation processes towards a climate friendly world by promoting sustainable use of resources. - The Urban Electric Mobility Initiative (UEMI): Platform launched by UN-Habitat to contribute to limiting global warming by reducing urban CO2 emissions through the incorporation of e-mobility.
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1. Background – Where are we now?

The SOLUTIONSplus project aims to enable transformational change towards sustainable urban mobility through innovative and integrated electric mobility solutions. It is funded under the European Union's Horizon 2020 research and innovation programme and was implemented from January 2020 to December 2023. The project encompasses city-level demonstrations to test different types of innovative and integrated e-mobility solutions, complemented by a comprehensive toolbox, capacity development, and replication activities. In Latin American cities, the SOLUTIONSplus demonstration action supports electric mobility for last-mile passenger connectivity and logistics. Promoting light electric vehicles (LEV) focuses on producing e-cargo bikes and e- 3&4-wheelers locally.

Ecuador advances in the conceptualisation and implementation of zero-emissions mobility with national and local institutional and legal frameworks, financing schemes, technological conditions, and technical capacities that align with a collective effort to replace fossil fuel-based technologies, which are emission-causing, with cleaner technologies that can minimise oil dependency (Ministerio de Transporte y obras Públicas, 2023).

With a population of 16,938,986 inhabitants, according to the last census from the National Institute of Statistics (INEC) in 2022 - 2023, where 51.3% are women, and the average age is 29 years. The country's ethnic diversity is reflected in 7.7% indigenous groups, 7.7% montubia and 4.8% afroecuatorian (Instituto Nacional de Estadística y Censos, 2023).

Despite the 0,15% country's contribution to global greenhouse gas (GHG) emissions, it maintains a development model that entails increased resource and energy consumption based on petrol. In 2010, emissions from the energy sector, which includes transportation as a primary source, became the leading source of GHG emissions at the national level, accounting for 44.5% of the total emissions (MAE, 2016:6). By 2015, land transportation consumed 87% of the total energy in the subsector, with heavy-duty freight transportation accounting for 44% of the land transportation energy consumption.

Regarding the country's energy situation, it is evident that the transportation sector remains the largest energy consumer, accounting for 46% of its annual consumption. Considering energy consumption by source, 31% corresponds to diesel oil and 27% to gasoline (MEER, 2018). By 2015, land transportation consumed 87% of the total energy in the subsector, with heavy-duty cargo transportation accounting for 44%. On the other hand, according to the National GHG Inventory in 2012, the energy sector is responsible for 46.3% of emissions. Within this sector, transportation covers 45.16%, with a total of 16,977.02 GgCO2-eq, corresponding to 21% of national emissions (MAE, 2017). The National Plan for Electric Mobility and Energy Efficiency (PLANEE) aims to enhance the transportation sector, with one of its action lines focusing on new and clean technologies.

The transportation sector contributes 7% to the national Gross Domestic Product (GDP) (BCE, 2018) and generates 6% of total employment in the country (INEC, 2017). However, this sector is also the largest consumer of energy and the second-largest emitter of greenhouse gases (GHG), contributing to global climate change.

At the national level, the 2016-2025 Master Electricity Plan, Progress, states that incorporating 2,263 electric vehicles (EVs) into the country's electrical system represents less than 0.068% of the expected demand for 2020. This national policy presents an annual economic benefit of up to USD 435.01 from fuel savings (gasoline) when replacing an internal combustion private vehicle with an electric one (B4future, MTOP, GIZ Ecuador, 2018).

1.1. Urban mobility context in Cuenca

Cuenca has been the administrative and trade center for goods and services in the south-central regional context of Ecuador. The limited agricultural capacity of the territory and the imposing presence of environmentally susceptible areas have contributed to industrial and service development, essential components within the economic structure. This situation has led to Cuenca concentrating around 97% of provincial economic activity, with a significant number of companies in the fields of commerce, transportation, services, manufacturing industry, personal services, and construction, Figure 1 shows the evolution of the urban area and limits between rural and urban sector. Cuenca's Historic Center was declared a UNESCO World Cultural Heritage site in 1999 and the present century.

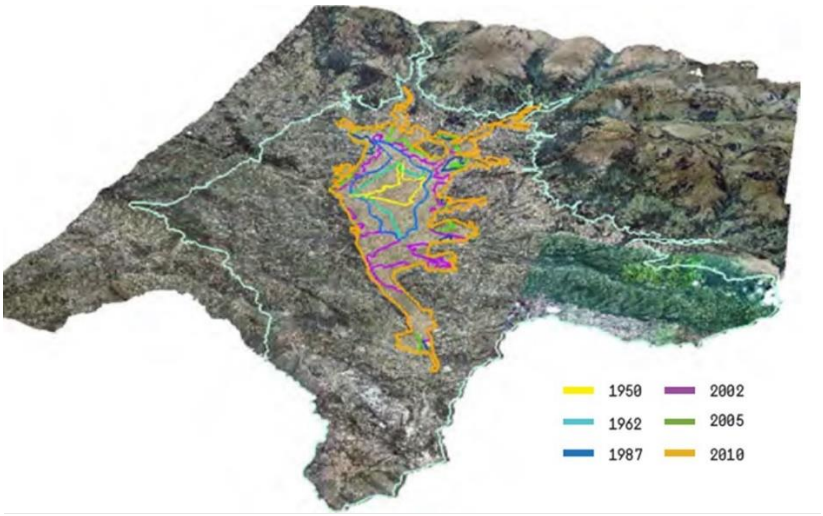

Figure 1 - Urban expansion of Cuenca. Source: (BID, 2014)

In Ecuador, Cuenca is the third most densely populated urban area. The INEC provides information on urban and rural populations from 2010-2020 (INEC, 2016b). According to the latest census in 2023, 63.1% of the population resides in urban areas. Figure 2 shows the density and distribution of population in the city.

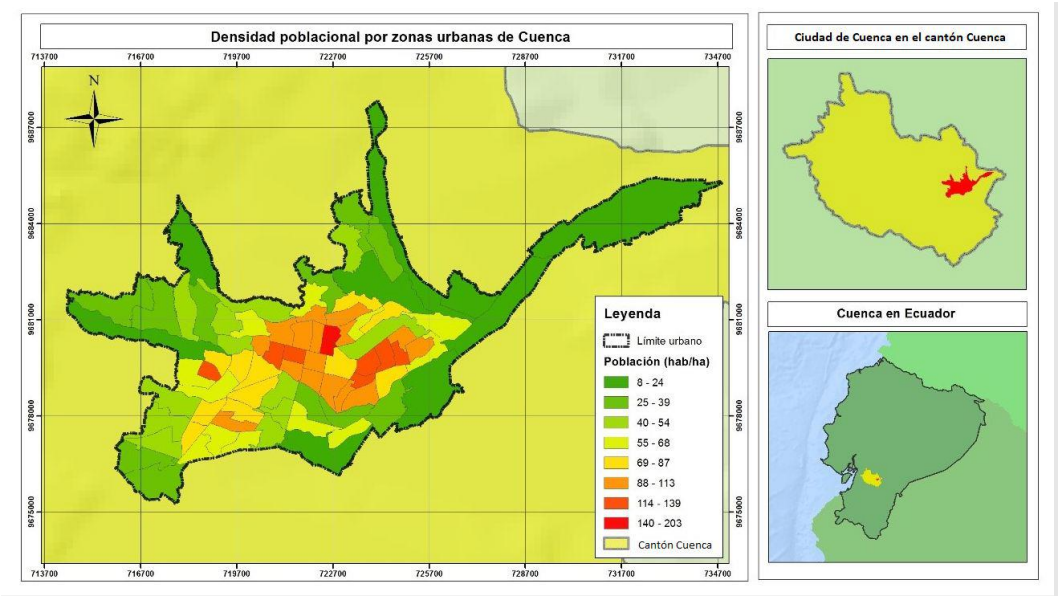

Figure 2 - Densidad poblacional por zonas urbanas. Source: (Barragan E, 2018)

The Inter-American Development Bank (BID, 2014) establishes that Cuenca has ideal coverage in the provision of essential services such as water, sanitation, solid waste management, or electricity (greater than 80%). On the other hand, there is evidence of continuous growth in the vehicle fleet, causing traffic conflicts and air pollution problems. There is a horizontal expansion of the city that, besides increasing mobility, can lead to difficulties in providing services such as water, sewerage, or energy). (BID, 2014).

Cuenca use of fossil fuels generated 89,200 tons of polluting emissions (NOx, CO, VOC, SO2, PM)[1] in 2014. Meanwhile, CO2 emissions were 1,372,434 tons in the same year. According to available information from the emissions inventory 2017 (EMOV EP, 2015; Jaramillo, 2017). The transportation sector has the highest representativity in the emission of atmospheric pollutants. Private transit users are the major emitters of CO2 and N2O, accounting for 58% and 79%, respectively. The industry also significantly contributes to CO2 emissions (27%) (EMOV EP, 2015) (BID, 2016).

Its status as an intermediate city allows for promoting actions to manage its resources with energy value. In 2007 an Energy Plan for Cuenca was developed, covering both urban and rural areas (Cuenca Environmental Management Commission, CGA Cuenca, 2007). In this plan Cuenca seeks to transform its

[1] **Air pollutants**
CO: Carbon Monoxide
CO2: Carbon Dioxide
NOx Nitrogen Oxides
N2O: Nitrous Oxide
PM: Particulate Matter
SO2: Sulfur Dioxide
VOC: Volatile Organic Compounds

energy matrix, where, according to its City Master Plan, diesel constitutes 29.05%, Liquefied Petroleum Gas (LPG) 14.81%, fuel oil 8.04%, and Natural Gas (GN) 2.19%, while electricity contributes 10%, and others around the 36% (Barragan E, 2018). This structure is similar to the country's consumption pattern (Ministry Coordinator of Strategic Sectors, MICSE, 2015).

Cuenca is aware of the need to reduce the negative impact on the environment and climate caused by GHG emissions from the transportation sector. Among the goals of the latest electric mobility plan is to transform Cuenca into a healthier, modern, and livable city where combustion vehicles give way to pedestrians and entirely sustainable means of transportation on public roads (e-Cuenca, 2023). Furthermore, the objective is to ensure that everyone can access zero-emission mobility services. The introduction of electric vehicles in Cuenca is a substantial advancement and demonstrates a firm political dedication to expedite the adoption of electric mobility within the city.

Current mobility patterns in large and medium-sized cities in Ecuador are characterised by dispersed and low-density urban growth. This model demands longer trips and prioritises using private vehicles over public transportation and other low-carbon or non-polluting modes of transport. In Cuenca, 32% of the population travels by private vehicles, 31% on foot or bus, 4.3% by taxi, 1.4% by other means, 0.7% by motorcycle, and 0.2% by bicycle, resulting in 69% of motorised transport and 31% non-motorised transport. Most journeys are related to work (33%), followed by studies (18%), shopping (17%), and personal errands (16%). The demand for urban public transportation is estimated at 410,000 trips per day in 2015, according to calculations made in that year. A reverse planning strategy has been implemented using the mobility pyramid, which redefines road sections to prioritise public transport, bicycle use, and pedestrian (B4future, MTOP, GIZ Ecuador, 2018).

1.2. Current Policy Framework and Market Readiness for deployment of e-mobility

Status of e-mobility support

Global experiences acknowledge integrating national and local policies to adopt new technologies. Through business opportunity analyses and improvements in public policies, stakeholders have shown increased interest in zero-emission technologies (B4future, MTOP, GIZ Ecuador, 2018). This collaborative approach helps overcome obstacles, such as the lack of regulation on vehicle energy efficiency, fuel subsidies, or poor electrical distribution. Such challenges were considered when establishing a national electromobility strategy in 2021. In Ecuador, there is emerging regulation on energy efficiency in the automotive market, which is necessary to create competitiveness for electric vehicles compared to conventional ones and has been crucial in bridging the cost gap between the two technologies (López, G. 2016:9).

Ecuador has three significant advantages for introducing electromobility: relatively short geographical distances, an energy matrix dominated by renewable energy sources, and an overall national electricity coverage of 98.8%. Over the past years, various public and private stakeholders in the country have initiated the debate on electromobility as a realistic solution for more efficient and sustainable transport. Despite the lack of a national framework, some cities have led the adoption of electric vehicles (GIZ, 2019). Policies in the country promote electric bikes, taxis, and buses, among other initiatives. Furthermore,

according to the Inter-American Development Bank (BID, 2019), in 2018, Ecuador was the third Latin American country, after Mexico and Brazil, with higher market penetration of hybrid vehicles.

In the regulatory field, actions are underway from the Ministry of Electricity and Renewable Energy for the construction of the first Energy Efficiency (EE) Law published in 2019 (Asamblea Nacional República del Ecuador, 2019) through the Interinstitutional EE Committee, a National Energy Efficiency Plan (PLANEE), and technical regulations that include tariff and tax preferences for efficient equipment, including electric vehicles. A tariff scheme for introducing electric vehicles is also being developed (see Table 1) (B4future, MTOP, GIZ Ecuador, 2018).

The country aligns itself with international peers to adopt Ecuador's National Appropriate Mitigation Actions (NAMA), voluntary interventions by developing countries to reduce greenhouse gas emissions. The NAMA has been developed in the Subsector of Freight and Passenger Transportation. Among the areas of action in this proposal is the improvement of technologies and fleet renewal, considering the identified issue of many vehicles being over 10 years old, accounting for 54% of heavy-duty vehicles and 48% of light-duty vehicles (B4future, MTOP, GIZ Ecuador, 2018).

After signing the Paris Agreement in 2016, Ecuador became a member of the Nationally Determined Contributions (NDC) Partnership in 2018. In March 2019, Ecuador issued its first Nationally Determined Contribution (NDC). In the mitigation chapter, a 9% reduction in GHG emissions from the Energy, Industry, Agriculture, and Waste sectors is defined in the unconditional scenario, with an estimated reduction of up to 20% in the conditional scenario. Additionally, action lines in the energy sector include strengthening energy efficiency, shifting consumption behaviour, and promoting sustainable urban mobility (República del Ecuador, 2019).

Regarding policy and regulation, Figure 3 shows the energy consumption in Cuenca per economic sector, pointing to transportation as the one that drowns more of the region's generated energy (Barragan E, 2018).

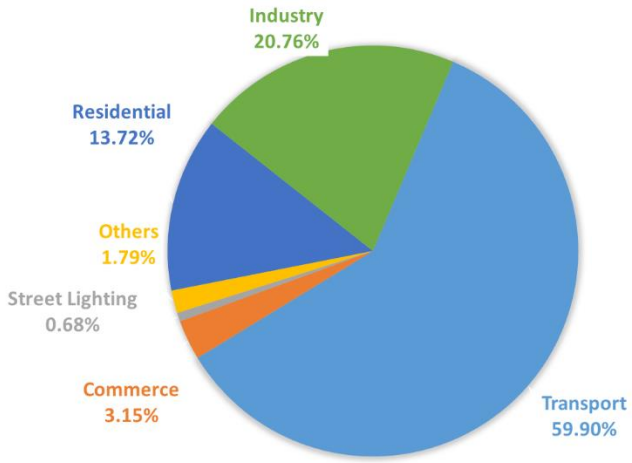

Figure 3 - Participation in energy consumption, Source: Developed with information from Centrosur et al. (2017)

The data related to the consumption of fossil fuels was provided by the Hydrocarbon Regulation and Control Agency (ARCH-Azuay, 2017). The sectors supplied with fuels include residential, commercial, industrial, transportation, and others, totaling 2454.62 kBEP, see Figure 4. The average growth rate for each sector indicates a significant variation in the commercial sector, followed by residential, industrial, transportation, and others. The total rate of increase compared to electric energy is very similar (Barragan E, 2018).

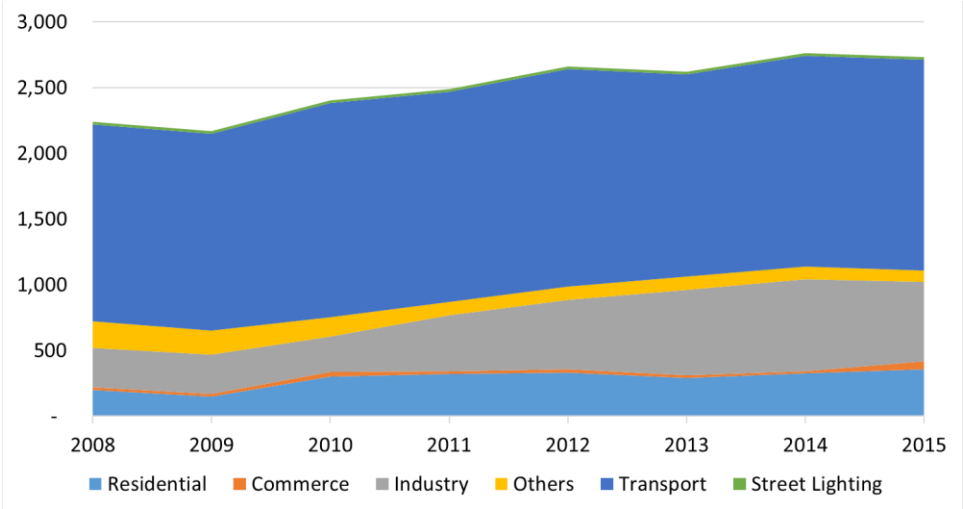

Figure 4 - Demand for fuels in urban Cuenca Source: Developed according to the information from ARCH-Azuay (2017)

Status of e-mobility regulatory framework

Various institutions in Ecuador, including local and regional clusters, are actively working to enhance NDC environmental targets. They are implementing numerous laws and rules to adopt the most suitable technology for various sectors. Table 1 lists initiatives and their implementation status or absence in the

country. This overview outlines the scope of action for the city and delineates how far it can go without national intervention. However, national policies often take the lead and support initiatives in local contexts.

Table 1 - Existing and missing regulations related to electric mobility in Ecuador - Source: (GIZ-AFD, 2019) & (B4future, MTOP, GIZ Ecuador, 2018), updated by SOLUTIONSplus, 2023.

Group of initiatives	Existing	Partially / in progress	Gap
Public policy instruments / strategic framework targeting e-mobility			
Constitution of the Republic (Articles 14, 15, 395, 413, and 414)	X		
The 2021 Reform to the Organic Law on Land Transport, Transit and Road Safety (Art. 12, 74, 75 & 76) includes guidelines on electric mobility. In Article 214b, the responsibility of implementing incentives for electric mobility and zero emissions is appointed to the Decentralized Autonomous Governments (GAD). This reform establishes that electric vehicles will be exempt from the measures to restrict vehicle circulation in any of the modalities available, that these will also have free use of paid public parking spaces within the jurisdiction of the GAD, and that for these public entities and commercial establishments that offer parking spaces to the public must allocate a minimum percentage of 2% of the total number of parking spaces enabled.	X		
National Development Plan 2017-2021 (Objective 5, Policy 5.7)	X		
Executive Decree No. 371 from April 19, 2018 (National Agreement of Ecuador 2030, ODS 7, 7.3). It aims to unite the public and private sectors with civil society and international organisations to develop norms, policies, and plans on relevant national interest areas under the SDGs' framework.	X		
Electricity Regulation and Control Agency (ARCONEL): resolution ARCONEL-038-15 defines tariffs with differentiated hourly demand for recharging medium and high voltage electric vehicles.	X		
Ministry of Industries and Productivity (MIPRO): development of the Ecuadorian Technical Regulation Project 162 "Charging Accessories for Electric Vehicles," which is in the approval process and includes aspects such as home charging mode, charging connectors, power outlets, charging cables, batteries, and other components. Safety considerations for users and vehicles are considered.		x	
The Energy Efficiency Law issued in March 2019 was created to guarantee energy sovereignty using environmentally clean technologies and non-polluting and low-impact alternative energies. It includes projects for identifying end uses of energy in the residential, commercial, and public sectors, a program for replacing equipment in the industrial and residential sectors, and Cogeneration in the industry. For this purpose, Article 14 addresses energy efficiency in the transport sector.	x		
Ministry of Electricity and Renewable Energy (MEER): construction of the Energy Efficiency Law, implementation of the National Energy Efficiency Plan (PLANEE), and technical regulations with tariff and tax preferences for efficient equipment, including electric vehicles.			
National Electromobility Strategy (ENEM) was developed with the support of the IDB. It identifies the country's advantage due to its clean energy generation matrix, which adds to the national government's interest in developing electric mobility.	x		
Local electric mobility strategies (or Sustainable Urban Mobility Plans with a strong focus on e-mobility)		x	

Group of initiatives	Existing	Partially / in progress	Gap
Regulation governing the conditions for improving the quality of public passenger bus transportation services in the Cuenca canton and its renovation plan. (Cuenca CAD Municipal, 2018)		x	
Plans to integrate e-mobility in the NDC update phase			x
Ministry of the Environment (MAE): development of the NAMA (E-mobility NAMA) for the Cargo and Passenger Transport Subsector, which includes areas of action such as technology improvement and fleet renewal, and the process of defining the NDC5 until mid-2019. Actions for reducing GHG emissions in cargo and passenger transport in Quito, Guayaquil, and Cuenca.			x
Energy Efficiency Law and Safety regulations for charging points		x	
Incentives for the purchase of electric vehicles or clean vehicles			
VAT & Property tax & Environmental taxes rebate/exemption	x		
Development and promotion of an Energy Management Companies (ESCOs) market.			
Import duty rebate/exemption Foreign Trade Committee (COMEX): Exemption in 2015 from all types of levies on importing manufacturing kits and electric vehicles, elimination of quotas for importing vehicles valued at up to $40,000.	x		
Internal Revenue Service (SRI): exoneration in 2015 of VAT on hybrid or electric vehicles with a taxable base of up to USD 35,000.	x		
Vehicle conversion premiums			x
Waiver on tolls and parking	x		
Waiver on driving restrictions	x		
Differentiated electricity tariffs	x		
Regulation			
Regulation of charging stations			x
Regulation to facilitate the development of cargo service businesses, promoting pilot projects, and establishing vehicle energy efficiency labelling.		x	
Formulation of installation standards and permitting protocols for EV charging point installation			x
Integration of charging system requirements with the local building codes and regulations			x
Clarification and formulation of mechanisms and regulations on charging operations and setting rates			x
Introduction of industry requirements on the adoption of EVs			x
Development of a government procurement program on EVs			x
Restrictions/limitations of the use of internal combustion engines / polluting vehicles			
Vehicular norms with high environmental standards (like EURO V, VI, etc…)	x		
GHG emission/energy efficiency standards for vehicles:			
RTE INEN 017	x		
NTE INEN 2204	x		
Vehicle labelling regarding their environmental standard	x		
Mandatory vehicle inspection regarding emissions	x		
Driving restrictions for polluting vehicles			x

Group of initiatives	Existing	Partially / in progress	Gap
Energy Efficiency Regulations (ISO 50001)	x		
Incentives and instruments for scrapping			
Legal obligation to eliminate vehicles (buses, taxis, trucks) after certain age of operation	x		
Presence of official dismantling/recycling centres; accreditation to manage car wrecks	x		
Structured industrial sector for scrapping/dismantling / recycling vehicles		x	
Public programs for vehicle fleet substitution	x		
Financial mechanisms incentivising scrapping/recycling (incl. scrapping premiums)	x		
Mechanism to recycle batteries of e-vehicles			x

Ecuador published the National Sustainable Urban Mobility Policy (PNMUS) (Ministerio de Transporte y obras Públicas, 2023), a comprehensive framework applicable to all Decentralized Autonomous Governments (GAD). This policy aims to empower local authorities with strategies and the implementation of sustainable urban mobility solutions. Simultaneously, there is progress in a Global Environment Facility (GEF) readiness project focused on facilitating E-mobility adoption, including a policy brief with recommendations to promote E-mobility and establishing a formal inter-institutional group on sustainable mobility. This group will be linked to the existing Interinstitutional Committee for Climate Change. As part of this initiative the PNMUS is include a leadership structure led by the Ministry of Transport, providing coordination and support for effectively implementing the national policy.

The initiatives mentioned above provide valuable support for those at the local level who have recently taken on the responsibility of managing urban mobility in Ecuador. With a robust methodology following the PNMUS, private companies lacking of economic incentives to transition to electric buses under their current operational framework will be able to adopt and transform to a more sustainable management including zero emissions, and universal accessible technologies.

Despite greater opportunities in freight transport, logistics is often overlooked in urban mobility planning. Identifying these barriers at the local government level is essential for developing more responsive initiatives. A list of limitations and barriers provides a better understanding of forward action.

i. Limited government coordination on electric mobility, with unclear distribution of competencies.
   a) Insufficient capacities to facilitate the transition to electric mobility.
   b) Lack of social acceptance for changes affecting transport costs.
ii. Limited knowledge of the potential of electric mobility.
   a) Lack of trust among private and public fleet owners.
   b) Lack of data and information to support decision-making in electric mobility.
iii. Nascent market and limited regulation for electric vehicles (EVs).
   a) Incomplete regulatory framework favouring current models.
   b) Limited availability of EV models, infrastructure, and services.
   c) Lack of business models and an adequate legal framework to facilitate the adoption of electric mobility.

iv. Insufficient development of end-of-life vehicle management systems.
    a) Unregulated end-of-life vehicle management.
    b) Lack of capacity to undertake the environmental management of EVs and their batteries.

In the operation of electric mobility for the public, three barriers are identified:

i. Economic barriers:
    a. Promote innovative business models.
    b. Conduct cost-benefit studies for the implementation of electric vehicles.
ii. Operational barriers:
    a. Lack of successful demonstrative experiences related to electromobility.
    b. Promote implementing MRV[2] systems in electromobility projects to quantify environmental and economic benefits.
iii. Barriers for end-users:
    a. Lack of knowledge about the benefits of electromobility.
    b. Limited initiatives to communicate benefits.
    c. Conduct test drives and traffic education with electric vehicles.

Recognizing the barriers and opportunities, Cuenca gathered interested parties in sustainable development for the adoption of zero-emission technologies in the city. e-Cuenca is an example of overcoming identified barriers and bringing stakeholders together to align goals for a coherent adoption of policies. The vision of e-Cuenca is the city's Electromobility Plan, which is complemented by the LEV roadmap to decarbonise mobility by 2030, transforming the city into a pollution-free environment.

Standards

Decentralised Autonomous Governments (GAD) directly impact the improvement of the quality of life for their residents in Ecuador. They are responsible for monitoring air quality, ensuring compliance with vehicle technical inspections, and adhering to regulations outlined in traffic, land transportation, and road safety laws, among others. They align with the national government in the distribution of energy and fuels. The GADs have institutional, technical, and financial capacity and have taken on the responsibilities of Transportation, Traffic, and Road Safety, along with the necessary financial resources for managing and planning transportation within their jurisdictions.

In this context, considering the relationship between 1) energy consumption, GHG emissions, and climate change, and 2) the increasing mobility and transportation of goods and people in cities, it is necessary to develop technological alternatives that enhance air quality and energy efficiency in transportation systems based on renewable energy sources, linked to sustainable mobility policies. Ecuador has made progress in effective control and is working on updating various standards (see **Error! Reference source not found.**).

Table 2 - Existing regulations related to LEV and electric mobility in Ecuador. Source: (SOLUTIONSplus, 2022)

[2] MRV systems refer to Monitoring, Reporting, and Verification systems.

Standard Number	Title	Scope
NTE INEN 2656:2012	Vehicle classification standard	This standard applies to all vehicles designed for land circulation (motor vehicles and cargo units).
RTE INEN 034	Minimum safety elements in motor vehicles	This Ecuadorian technical regulation applies to all vehicles entering the park, including Ecuadorian automotive vehicles, whether imported, assembled, or manufactured in the country.
RTE INEN 136 (1R)	Technical Requirements for Motorcycles	This technical regulation applies to all motorcycles and tricycles imported, assembled, and commercialised in Ecuador.
NTE INEN 2558	Braking system	Product requirement
RTE INEN 011	Tires (including emergency tires, if any)	
NTE INEN 2556	Mirrors	
NTE INEN 2559	Suspension system	
NTE INEN 2557	Direction system	
NTE INEN 2560	Lighting	
RTE INEN 048	Three-wheeled motor vehicle for passenger transport and freight transport	This regulation applies to all three-wheeled passenger and freight transport vehicles, whether imported, assembled, or manufactured and commercialised in the country.
RTE INEN 017	Control of pollution emissions of road movable sources	This technical regulation applies to both imported and motorised vehicles locally manufactured.
RTE INEN 162	Charging accessories for electric vehicles	Draft regulation that establishes the technical and safety characteristics that connectors, chargers, wiring and batteries must meet for charging electric vehicles.
Ministerial Agreement No. MAATE-2021-034	Extended producer responsibility (REP) in the management of used lead Acid batteries regulation	Art. 1d. Prepare and present the Comprehensive Management Plan (PGI) for used lead acid batteries, following the provisions of these instructions, before the environmental national authority for your approval.

The e-Cuenca electromobility plan supports the primary standard in Cuenca, which will develop the decarbonisation component of urban mobility within Cuenca's Sustainable Urban Mobility Plan. Therefore, its objectives, scope, and implementation framework are aligned with this strategic document. Its goal is to reduce the negative impact on the environment and climate of GHG emissions produced by the transportation sector and make the city a healthier, more modern, and livable place, where combustion vehicles give way on public roads to pedestrians and 100% sustainable means of transportation. This will be achieved by universalising access to 100% sustainable mobility services in Cuenca (e-Cuenca, 2023).

The city has a clear political will to accelerate the adoption of electromobility and position Cuenca as an international benchmark in promoting the decarbonisation of transportation. There are already guidelines and commitments in public policy, which e-Cuenca adds, thus establishing a solid framework for developing sustainable mobility and replacing combustion vehicles, such as the Sustainable Urban Mobility Plan or the Low-Emission Historical Center project financed by the German Development Bank – KfW following the National Policy for Urban Mobility (Ministerio de Transporte y obras Públicas, 2023).

Other challenges to overcome include a lack of support and incentives from the local government and public administrations to promote electromobility. The electrification of public transportation might require the support and involvement of the private sector and financial entities. The lack of charging

infrastructure in public spaces hinders the adoption of electromobility. Additionally, the limited awareness of some benefits of using electric mobility is an obstacle. It is necessary to enhance public understanding about sustainable mobility in Cuenca.

Baseline information on electric transport modes available in the city; demand assessment and market size across segments

In 2012, responsibilities for planning, regulating, traffic management, road transport, and road safety were transferred to the decentralised autonomous government (GAD) Municipalities. Ecuador's main progress around e-mobility has focused on policy development. Quito and Guayaquil lead the adoption of electric mobility for public transport. Joining these cities after 2014, the Mobility and Public Spaces Plan of Cuenca was developed for the implementation of electric vehicle charging stations, operational cost analyses of public transportation, studies on the demand for mass and collective public transportation, an ordinance for the universalisation of smart card payments, and a resolution for improving urban passenger transportation in the Cuenca canton were conducted. The first tram line, in Figure 5, is one of the primary outcomes of Cuenca's new vision.

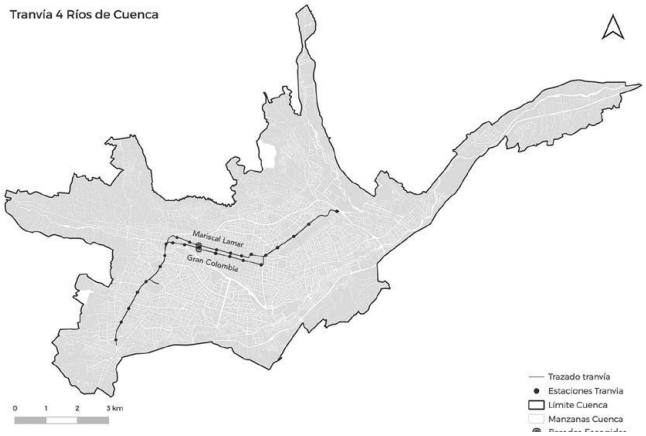

Figure 5 - Tram route in Cuenca, Ecuador Source: (Fernández de Córdova, Pauta, & Hermida, 2023) Data obtained from the Tram Executive Unit)

As the mass transit system in Cuenca started operating in 2020, a tram moved around 20,000 trips daily, while the expected demand was 50,000. In 2017, the Municipality of Cuenca, BYD, and the University of Cuenca expressed their interest and collaborated on creating a work plan. This plan included technical feasibility assessments, the implementation of necessary infrastructure, staff training, route planning, and preliminary field tests. In January 2018, a Cooperation Agreement was formalised among these three institutions, and testing commenced. In April 2018, a technical report was completed, and the Agreement closing statement was signed (B4future, MTOP, GIZ Ecuador, 2018).

In the initial analysis phase, the behavior and autonomy of the vehicles were evaluated, considering an average of 6 daily trips over 22 days, with an average distance of 15.9 km per trip. Six fixed stops were established during each journey. This study served to understand the legal framework from the national to the local level, identify the target population, and analyse the effects on the modal transportation

distribution in Cuenca. The target population included the university population of Cuenca, representing 7% of the total inhabitants and distributed across the University of Cuenca, the University of Azuay, the Salesian Polytechnic University, and the Catholic University of Cuenca. The study area included multiple campuses in the city, intramodality nodes, and pedestrian zones (B4future, MTOP, GIZ Ecuador, 2018).

Regarding passenger transportation, an estimated reduction of 132.86 tons of CO, 10.585 tons of HC[3], and 160.24 tons of NOx was determined. Among the challenges and recommendations, it is essential to understand the modal distribution within each university community, adopt a comprehensive approach, establish partnerships, coordinate with the Transportation Chamber, and raise awareness among the population (B4future, MTOP, GIZ Ecuador, 2018).

Regarding light electric vehicles, there is only data regarding motorcycles. Nationwide, there are a total of 744 electric motorcycles. The provinces with the highest circulation of this type of electric vehicle are Pichincha, Guayas, Santo Domingo, Santa Elena, and Manabí (VARUS, 2022). There is no available data on scooters, Segways, and other light electric vehicles such as tricycles, quadricycles, and e-vans. As the annual budget discloses, Cuenca plans to acquire electric vehicles, corresponding to the e-Cuenca master plan, starting in 2023. (EMOV, 2023). In addition to the mobility actions, the energy sector outlines the following lines of action (República de Ecuador, 2019):

- Incorporate, reformulate, and update regulations that promote the use of sustainable energy and energy efficiency inclusively in each of the subsectors.
- Develop and implement safe and sustainable transportation.
- Promote the use and development of renewable energy, ensuring full accessibility.
- Encourage the use and development of energy efficiency and changes in consumption behavior.
- Promote research for the implementation of energy solutions, reducing the gender gap.

2. Demo project – Last-Mile delivery project with LEV's in Cuenca

The project aims to deliver supplies to pharmacies in Cuenca's historic centre, using electric tricycles to replace the heavy diesel trucks. Farmasol has 12 pharmacies in the urban centre of Cuenca, and seven of them will be supplied within the framework of this pilot project. The selected pharmacies are (#4, #10, #11, #35), and three others are adjacent (#2, #25, #44) as shown in Figure 6. Pharmacy #44 is a

cross-docking spot to unload and distribute supplies transported from the company's central warehouse at Farmasol "27 de Febrero".

[3] HC: Hydrocarbon

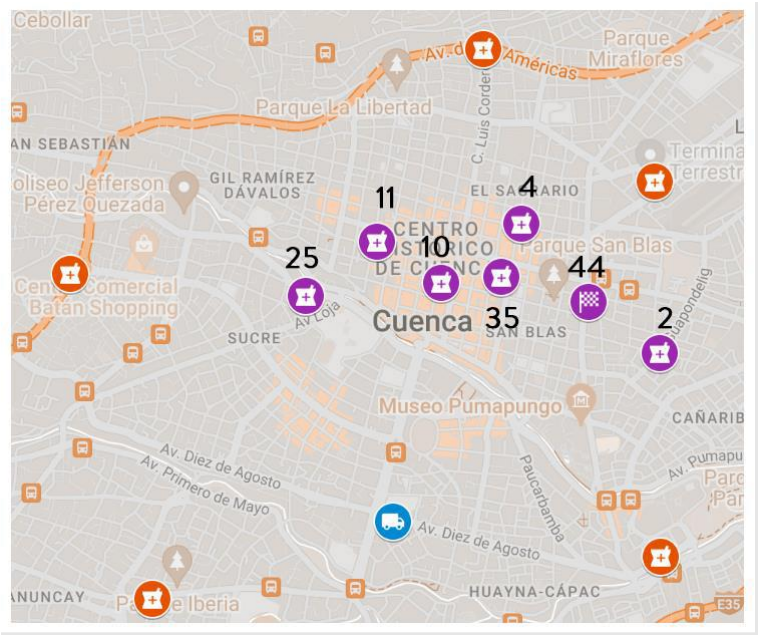

Figure 6 - Location of the project's pharmacies, with the pharmacies that could be extended in the future highlighted in orange. Source: (Google my maps 2023)

Key stakeholders for this project are:

- **Kradac:** Promoter
- **Farmasol EP:** Implementing partner
- **TUMI (GIZ):** co-financiers
- **Dirección general de movilidad de Cuenca (DGM) - Mobility office:** Facilitating partner
- **CITIES FORUM:** Main technical partner
- **Centro de transporte y Logística** (Universidad Andrés Bello): technical partner
- **Universidad del Azuay (UDA):** Technical assistance

Figure 7 - Stakeholders of the project.

Farmasol currently operates 53 pharmacies in Ecuador, with 24 located in urban areas of Cuenca and 15 additional in rural regions. The remaining pharmacies are situated in nearby cities such as Azogues, Quito, and Loja. This distribution seems to have a good potential for scaling up novel ideas to be tested in this pilot.

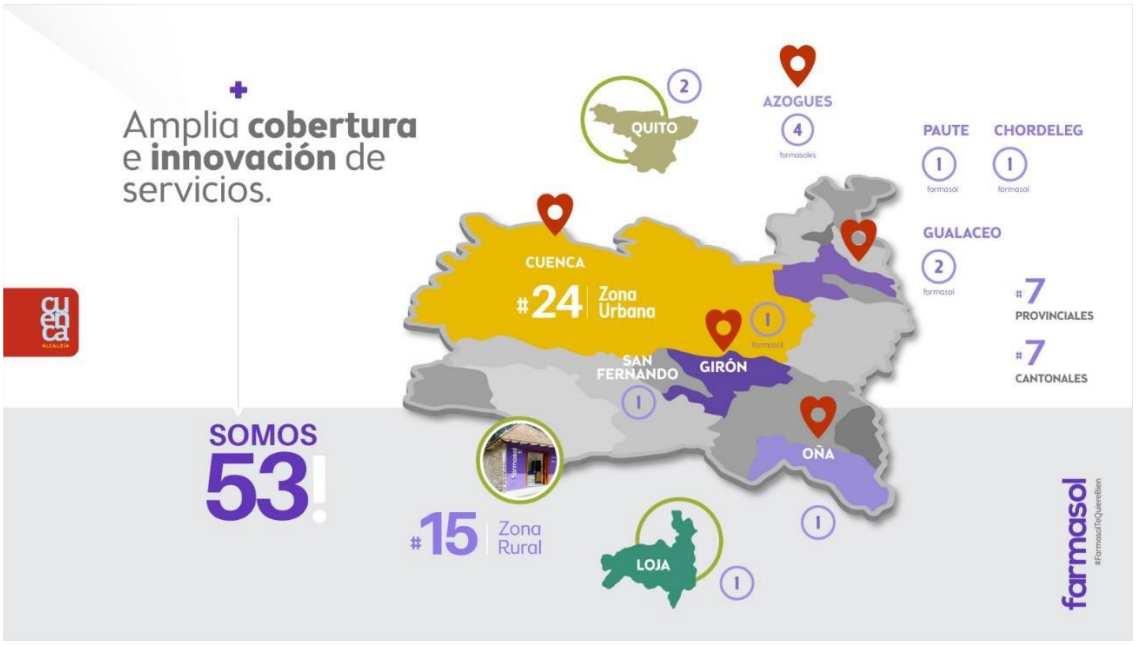

Figure 8 - Distribution of pharmacies served by Farmasol in Ecuador.

In the initial plan, the distribution warehouse for the pilot operation was intended to be outside Cuenca's historic centre. Both the loading process and parcel distribution to the seven pharmacies within the historic centre were planned to occur at this external location. The project's preparation coincided with a detailed operational characterisation, and during this period, municipal elections took place in the city.

The election results brought a new political party to the municipality, led by Mayor Cristian Eduardo Zamora and new directors for the General Directorate of Medicines, Supplies and Drugs (DGM) and FARMASOL. To mitigate risks, meetings were held with the new decision-makers to explain the project's characteristics, progress, and goals. Subsequently, the project received strong support from the previous administration, which has been renewed and confirmed by the new one. Minor adjustments have been introduced to fine-tune the operation and work plan in line with the needs and expectations of the new administration.

A notable change is the suggestion from DGM and Farmasol to avoid the LEVs driving in and out of the borders of Cuenca's historic centre. Instead, they propose establishing a cross-docking location inside the historic centre, specifically at the HUAYNA CAPAC pharmacy. In broad terms, this adjustment will reduce the distance covered by the tricycles during the week, improving the agility and efficiency of Farmasol's operation. Consequently, the lorry supplying the cross-docking pharmacy will cover 2.88 km on the outward trip (lasting 8 minutes) and 3.4 km on the return trip (also lasting 8 minutes).

Proposed indicators

The indicators in Table 3 validate the indicators to measure during the demonstration project.

Table 3 - Demonstration project indicators.

Indicator	Unit	Description
Operational		
A. **kg of goods delivered by time:**	Kg/h	Rate of goods delivery measured in kilograms per hour
B. **Kg of goods delivered per km**	Kg/Km	Efficiency of goods delivery measured in kilograms per kilometer
B. **Number of deliveries per hour:**	# deliveries/h	Frequency of deliveries completed within one hour
C. **Distance traveled per hour:**	Km/h	Total distance covered by the vehicle within one hour
D. **Operating time of vehicle:**	h	Total duration the vehicle is actively in use
E. **Route speed**	Km/h	Average speed maintained along the delivery route
F. **Emissions per Kg transported**	g CO2-eq/Kg	Environmental emissions produced per kilogram of goods transported
G. **Emissions per delivery**	g CO2-eq/ delivery	Environmental emissions produced per delivery
H. **Energy consumption per Km**	KWh/Km	Average if energy consumed per kilometer traveled
I. **Energy consumption per delivery**	KWh/delivery	Average of energy consumed per delivery

Technical characteristics vehicles

The chosen LEV is the TAURUS model by the Colombian manufacturer ECOTRICICLOS. The project plan is to acquire 2 of these tricycles for USD 4,300 each and an additional USD 1,000 for replacement parts for preventive maintenance and on-site training provided by ECOTRICICLOS. The manufacturing and delivery time is estimated at 50 days following payment, and the importation costs are less than USD 4,300.

Figure 9 - LEV model Taurus Three-wheeler vehicle

Technical specifications are detailed in *Table* 4

Table 4 - Cargo bike technical specifications

Characteristic	Description
Structure	Structural round and square Cold Rolled pipe
Floor	20-gauge sheet
Doors	Two side leaves in a 22-gauge sheet
Bearings	Industrial ball bearings
Tires	17 x 250 for motorbikes and load-bearing spokes.
Suspension	Front-type Zoom Oversize
Axle	Solid 1" steel
Brake	Front and rear disc-type bicycle brake. Accessory for parking brake.
Mirrors	Included rear-view mirrors
Canopy	Front in summer waterproof canvas
Mudguards	Metallic
Pedals	In aluminium / or joint (depending on stock)
Ratio	In aluminium 28,38,48 teeth and 20, 22, 24 pinion tensioner.
Van measurements	1.20 m long X 1.20 m wide x 1.20 m high (measurements according to requirement 1.00, 1.20, 150 high and long x 1.00, 1.20 wide)
Internal trays	2 interior trays in grilles (grill type)
Total measurements	2.36 m long X 1.92 m high X 1.04 m wide approx.
Seat	Tufted
Paint	Electrostatic
Load capacity	300 kilos

Characteristic	Description
Weight	70 kg approx.

2.1 Pilot results

In the company management, the adoption of a well-defined business strategy, initiated from head management, is essential to successfully implement any structural change in Farmasol EP's management and operations model. This strategy should focus on logistics optimization as a primary step for reducing emissions, highlighting that there is always room for improvement in how logistics activities are currently operated.

The incorporation of different types of vehicles adapted to the various needs of the logistics chain, such as trucks, vans and bicycles, plays an essential role in this process. These changes not only contribute to the reduction of operating costs proportionally, but also primarily of vehicle emissions, in addition to strengthening Farmasol EP's corporate social image, aligning with sustainability and corporate social responsibility policies, consistent with the company's social turn.

In addition, the transition to more efficient and less polluting vehicles can significantly improve customer satisfaction. The implementation of these vehicles allows greater availability and speed in the delivery of products, which improves the perception of quality and flexibility of the service offered by Farmasol EP. This comprehensive approach not only benefits the environment, but also generates sustainable competitive advantages for the company

With these changes, Farmasol EP could logistically serve 46% of its demand on a daily basis instead of 5% or 74% with visits at least 3 times a week. This would be possible with an investment of $138,000 and an increase of $15,000 in annual operating costs, while saving close to 80% of greenhouse gas emissions through this strategy.

Improvements to be implemented identified through the pilot at Farmasol's logistics:

2.1.1 Clusters of pharmacies

In the case of logistics study, a cluster is a set of geographically close entities, grouped with common characteristics or functionalities that can generate competitive and cooperative advantages. In the context of Farmasol EP's supply chain optimization, clustering refers to the configuration of pharmacies in groups, based mainly on geographical proximity. In this area, clusters can facilitate operational efficiency and improve response to local demand.

In contrast, routes refer to the path or itinerary followed to reach one or more specific points, usually optimized to reduce travel times or costs. While routes are dynamic and can vary depending on logistical need, clusters are static in terms of member composition and geographic location.

Grouping pharmacies into clusters based on geographical proximity allows you to reduce costs and delivery times, improve inventory management, as well as foster cooperation and support among those involved.

2.1.2 Decentralized warehouses

It is possible to use a next strategy based on points in the territory where they could store a greater number of products, not only for internal supply, but as a priority location for the assignment of orders to different pharmacies. These premises would serve as a proximity, decentralized warehouse and, along with other strategies, it would be possible to serve nearby pharmacies more frequently without the need for supply on the scheduled routes two to three times a week.

2.1.3 Nearby orders

The next strategy to improve customer service times and logistics optimization is the prioritization of proximity orders, where pharmacies when placing an order must prioritize pharmacies within a pre-established proximity cluster. These orders, if they are close enough and if there are no special requirements for transport, can be done on foot in the first instance, but ideally, they should be carried out by a light vehicle with load capacity within its cluster.

When within a cluster, the criteria for searching for any items that are not in the pharmacy's inventory should prioritize searching by distance, at the nearest pharmacy. In case it does not exist, the second closest, the third and so on until you find it. If it is found, once registered within the system, the shipment can occur within the same day, within a few hours. In the case of pharmacies within the same cluster, priority should be given to pharmacies that are within the same route and prior to shipment, so that same-day shipment is also possible if there is availability.

If none of the criteria are met, the traditional order can be placed from any pharmacy with the return to the central warehouse. In this case, it may take one to two days for the order to arrive, reflecting poorer product availability and customer service.

In conjunction with having pharmacies with greater inventory, or as decentralized warehouses, the forecast is that the number of traditional order requirements can be significantly reduced while improving response times within the logistics chain. With this, the expectation is that half of the 17 tons of orders can be supplied through the light vehicle for local orders, which is equivalent to a reduction of 76% from that recorded in the 2023 baseline.

2.2 Results of the adoption of electric tricycles

The pilot determined that delivery by means of electric tricycles as logistics support vehicles significantly contributes to making the delivery of goods more efficient for the Farmasol company. The benefits are even greater when the operation is carried out in central areas with high vehicular volume and narrow streets, such as the historic center of Cuenca, where the velocities of the vehicular flow do not reach 40 km/h. The operation of electric tricycles in these prevalent conditions compared to the truck resulted in:

- Tricycles can be more flexible in the conditions of the historic center of Cuenca, adapting better due to their smaller size. This allowed it to have greater fluidity in traffic and to find parking spaces faster. This has an impact on delivery times for goods and reduces emissions.

- Within the road safety component, tricycles, given their conditions, are vehicles that are better adapted to the mobility conditions of the center compared to trucks. Tricycles generate more favorable conditions in terms of safety for pedestrians who are in this area of the city
- The tricycles did not present any problems in transporting weights of up to 230 kg. However, there are goods that are of high volume such as diapers that have restrictions with the size of the crate. One option is to install grills to do a top load on the box.

The table below presents the overall results of the pilot, comparing between the diesel truck and the electric tricycle:

Table 5 – Results of the pilot

Indicator	Unit	Tricycle	Truck	Variation
A. **kg of goods delivered by time:**	Kg/h	326.58	455.43	39%
B. **Kg of goods delivered per km**	Kg/Km	24.23	30.43	26%
B. **Number of deliveries per hour:**	# deliveries/h	10.05	14.01	39%
C. **Distance traveled per hour:**	Km/h	13.48	14.96	11%
D. **Operating time of vehicle:**	h	0.20	0.14	-28%
E. **Route speed**	Km/h	13.33	14.71	10%
F. **Emissions per Kg transported**	g CO2-eq/Kg	0.64	12.60	1856%
G. **Emissions per delivery**	g CO2-eq/ delivery	20.94	409.50	1856%
H. **Energy consumption per Km**	KWh/Km	0.08	1.54	1925%
I. **Energy consumption per delivery**	KWh/delivery	0.10	1.65	1512%

The results show that in general, the operation with electric tricycles is beneficial in logistical and environmental terms. In addition, the operation with women of the tricycles in the pilot proved to be inclusive. This means that the pilot showed the capacity of the integration of women in a force labor field that is dominated by men as the logistics.

3. Approach – Methodology

The methodology for developing the roadmap includes reviewing and analysing studies and technical reports, focusing on urban mobility and zero-emission technologies for Cuenca, including the most recent policy roadmap, e-Cuenca, for transforming mobility in the city. National laws and other recommendations were also considered see Table 1.

Technical reports and studies conducted by local institutions are relevant to understanding the actual context and outlook of zero-emissions mobility and the urban logistics sector. Input documents for this paper are:

- 2023 - e-Cuenca Plan de Electromovilidad de Cuenca (Ecuenca Electromobility Plan for Cuenca)
- 2023 – Política Nacional de Movilidad Urbana sostenible PNMUS (National Policy for Sustainable Urban Mobility)
- 2019 - Primera contribución determinada a nivel nacional para el acuerdo de parís bajo la Convención Marco de Naciones Unidas sobre Cambio Climático. Quito: República del Ecuador – (First nationally determined contribution for the Paris Agreement under the United Nations Framework Convention on Climate Change. Quito: Republic of Ecuador)
- 2019 – Ley Orgánica de Eficiencia Energética (Organic Law on Energy Efficiency)
- 2019 - Electromovilidad: Panorama Actual en Aamérica Latina y el Caribe – (Electromobility: Current Landscape in Latin America and the Caribbean)
- 2018 - Memorias del 1er Foro Internacional de Electromovilidad y Propuesta de Hoja de Ruta para la Electromovilidad en Ecuador (Proceedings of the 1st International Electromobility Forum & Proposal for a Roadmap for Electromobility in Ecuador)
- 2014 – Cuenca Ciudad Sostenible – Plan de Acción (Cuenca Sustainable City - Action Plan)

This document seeks to build based on the diagnosis made by experts on urban logistics and the lines of action and objectives proposed by the government of Cuenca, with a particular focus on electrification and the adoption of zero-emission vehicles (Alcaldía de Cuenca, 2022). In this way, this work is intended to be a valuable input for the interested stakeholders and not a marginal element detached from the local context and ongoing initiatives.

Furthermore, this roadmap contains information and contents arising from the different activities related to the SOLUTIONSplus Regional Training for Latin America carried out during 2021 and 2022, in which organisations from Europe, Latin America and the Caribbean presented on LEV for urban logistics, regulatory frameworks for e-vehicles and charging infrastructure for e-mobility.

The content and outcomes of other courses and capacity-building activities in the framework of the SOLUTIONSplus project were also taken as sources for this work. The roadmap for the uptake of LEVs in urban areas of Uruguay and the Scale-up concept note for Buenos Aires and Cuenca (SOLUTIONSplus deliverables related to electric mobility and urban logistics) are relevant resources for this paper.

With all this, the following work aims to analyse the actual scenario and conditions in Cuenca for the uptake and deployment of electric vehicles for urban logistics, define and structure a roadmap, and create an implementation plan. Finally, this work finishes with some conclusions and next steps. For the implementation plan: The individual actions proposed by Cuenca were grouped under 5 Focus Areas – FA:

- FA1: Urban Planning
- FA2: Regulatory Measures
- FA3: Economic and financial measures
- FA4: Charging infrastructure
- FA5: Partnerships and public awareness

4. The roadmap – Where are we going?

The roadmap provides a comprehensive plan with specific actions, budgets, timeframes, and outputs to achieve the set goals by ranking these actions based on Cuenca's context, needs, and insights from previous experiences. The process includes potential GHG emissions reduction, costs, project implementation time, external resource availability, and social and economic benefits.

The primary criteria help identify potential obstacles to project progress, while secondary criteria ensure alignment with project objectives, local programs, and stakeholder acceptance. This forward-looking and systematic approach aims to facilitate efficient, resilient, and sustainable urban freight movement. The roadmaps for urban freight focus on influencing policymakers by defining a vision and specific goals and implementing measures and policies in the following areas:

1 Infrastructure management
2 Parking/Loading area management
3 Vehicle-related strategies
4 Traffic management
5 Pricing, incentives, and taxation
6 Logistical management
7 Freight demand/Land use management
8 Stakeholder engagement

4.1 Vision

Aligned with e-Cuenca's vision for the adoption of zero-emission technologies (e-Cuenca, 2023), the SOLUTIONSplus plan focuses on transportation areas, such as urban freight, aiming to transform Cuenca into a vibrant and sustainable city by the year 2030. It aims to achieve emission-free mobility, engage citizens in climate change, and ensure efficient travel options without emissions in public transport, commercial endeavours, and shared mobility services. These transport alternatives offer greater benefits than combustion vehicles, supported by deploying suitable infrastructures and developing regulations and public policies promoting emission-free mobility. These initiatives are backed by public, private, and academic efforts to educate and raise awareness about decarbonising urban mobility among Cuenca's population and businesses.

4.2 Objectives

SOLUTIONPlus aligns with e-Cuenca by joining efforts toward better adaptation and approaching more robust, sustainable, and zero-emission mobility solutions.

- Accelerate and incentivise the replacement and acquisition of combustion fleets with zero-emission technologies.
- Establish recharging infrastructure using zero-emission energy sources.
- Develop public policies and guidelines for adopting zero-emission technologies.
- Attract external financing.
- Inform and raise awareness among citizens and stakeholders about the benefits of zero-emission mobility.
- Develop local capacities for the development and operation of zero-emission technologies.
- Reduce the number of fatalities and injuries resulting from road accidents.

Specific objectives can be established and aligned with the electromobility plan, such as:

- Install charging stations to encourage the use of private and commercial electric vehicles.
- Reduce emissions related to transportation, including buses, public and private fleets, and commercial vehicles.
- Implement incentives to drive electromobility in Cuenca.
- Promote electromobility training for officials, transportation operators, the private sector, and academia.
- Strengthen actor ecosystems and governance models to drive the development of electromobility and zero-emission technologies.
- Replace combustion fleets with zero-emission fleets in municipal corporations and the private sector.
- Ensure the operational efficiency of Cuenca's zero-emission networks and public street charging stations.
- Improve access to multilateral funding sources to drive electromobility projects in Cuenca.
- Regulate and drive electromobility and zero-emission technology through local regulatory frameworks.
- Execute pilot projects aiding decision-making to promote electromobility.
- Boost last-mile logistics and micro-mobility using electric vehicles.
- Empower women and diverse communities in decision-making on electromobility and zero-emission technologies.
- Inform and educate Cuenca's population about electromobility and zero-emission technologies and their benefits.
- Mobilise the population, businesses, and various stakeholders to support the transition to zero-emission mobility and project the city's international image.
- Train and develop a new generation of drivers, conscious of sustainable zero-emission mobility across all transport-related sectors, including urban logistics, public transportation, and vehicle owners.

Within the framework of e-Cuenca and the new sustainable mobility agenda for the city, the scope of four sustainable development goals can be identified in the areas of health and well-being, industry, infrastructure and innovation, sustainable cities and communities, and climate action see Table 6.

Table 6 - ODS for Cuenca Roadmap

ODS	Goal	Description
(3) Health and Well-being	No. 3.9 Environmental Health	The advancement of zero-emission technologies will contribute to the reduction of pollutant emissions and an improvement in air quality in Cuenca.
(9) Industry, Innovation, and Infrastructure	No. 9.5 Scientific Research, Technological Capacity	The adoption of zero-emission mobility will lead to increased investment in research in Cuenca, especially in the field of electric vehicles, led by the four universities participating in the plan.
(11) Sustainable Cities and Communities	No. 11.5 Mitigation of Climate Change	With these plans, Cuenca aims to implement public policies to reduce the long-term effects of climate change.
	No. 11.6 Reduce Negative Environmental Impact	The measures in the plan will help reduce the current negative impact on air quality caused by transportation in Cuenca.
(13) Climate Action	No. 13.2 Policies, Strategies, and Plans on Climate Change	Cuenca has set specific goals for reducing emissions from the automotive fleet in its efforts against climate change.
	No. 13.3 Education and Awareness of Climate Change	The plan promotes education and awareness about the effects of pollution on climate change and the benefits of zero-emission mobility.

4.3 Timeline

The roadmap action plan can align with the goals and measures of e-Cuenca. Firstly, short-term measures achievable within the first year of this publication are considered "Quick wins" (high positive impact and low cost). These actions motivate the population, companies, and other stakeholders to seek funding and aim to strengthen the local ecosystem.

Medium-term implementation measures are scheduled for the second year and could extend over two years. Depending on the execution of short-term measures, they involve infrastructure deployment. Securing a budget for this phase might be challenging; hence, the expectation is that short-term measures will have budget allocations.

Finally, long-term measures commence in the third or fourth year and may last two to five years for completion. They depend on various factors with high levels of uncertainty, including economic and political risks. Additionally, they require a high level of maturity in technological and political terms and investment management flows with complex technological developments. Table 7 displays the timeline for implementing the roadmap for Cuenca.

Table 7 - The Cuenca Roadmap timeline includes demonstration, scale up and mainstream initiatives for the city.

Phase	Demonstration	Scale-Up	Mainstream
Timeline	**2022-2023**	**2024-2029**	**2030 onwards**
Target/ Focus area	**Elaboration and implementation of Communication Campaigns about zero emissions mobility.**	**Generate a perspective on the demand for clean energy distribution to develop infrastructure that fosters the adoption of zero emissions mobility.**	**Reduction of greenhouse gas (GHG) emissions following the adoption of zero-emission technologies in the transportation sector.**
Finance	*Grants*	*Grants*	*Grants*
Actions	– Create workshops, meetings, and promotional activities on the advantages of zero-emission mobility with the public sector, private sector, academia and other interested parties. – Measure the number of communication workshops created annually. – Measure the number of promotional activities created annually. – Establish technical vehicle electrification and electromobility training programs. – Provide training to municipal servants and interested actors on last-mile logistics and micromobility in Cuenca. – Develop and publish a web platform on data of interest regarding electromobility in Cuenca.	– Design of an EV charging network in Cuenca. – Develop infrastructures to boost electric micromobility. – Deploy a minimum of 10 semi-rapid charging points in public spaces by 2025, and 25 points by 2028. – Deploy 8 electric charging points for public and commercial transport fleets by 2028. – Generate an energy outlook of the demand of electric power distribution.	– Reduce 5% of GHG produced by the automotive fleet by 2030 and achieve a proportion of 5% electric vehicles. – Measure the percentage reduction of GHG produced by the automotive fleet. – Measure the percentage of electric vehicles circulating in Cuenca by 2030. – Develop the ordinance Project to regulate and incentivize electromobility in the canton of Cuenca.
Target / Focus area	**Design and approve the electromobility ordinance by 2024.**	**Create a regulation that ensures an incentive for public and commercial transport operators to acquire electric fleets by 2025.**	**Technical and economic feasibility study for the integration of electric bikes into the public bike-sharing system.**
Finance	*Grants*	*Grants*	*Grants*

Phase	Demonstration	Scale-Up	Mainstream
Timeline	**2022-2023**	**2024-2029**	**2030 onwards**
Actions	– Establish a dialogue table with stakeholders and investors for the financing of electric buses and cargo vehicles.. – Establish a working group with the transporter's chamber and freight transport companies. – Seek governmental economic support for financing the purchase of electric buses and freight transport.	– Develop the ordinance project to regulate and incentivize zero-emission mobility in the canton of Cuenca. – Generate financing alternatives for zero-emission technologies for public, commercial and last-mile transportation. Through the management of national and international banking to obtain funding resources. – Conduct a study to determine the location of a low-emission urban logistics centre for the historic downtown area.	– Achieve that 30% of BICICUENCA bikes are assisted by 2030. – Seek partial financing for public electric bikes. – Partially finance the purchase of public assisted bikes.
Target/ Focus area	**Strengthen public-private collaboration agreements and those with academia to drive sector development and the creation of Research, Development and Innovation projects.**	**Reach 30 private electric car users charging on public roads by 2025, and 120 by 2028. Reach 10 companies charging their fleets on public roads by 2025 and 40 by 2028.**	**Secure USD $50 million in financing through loans and non-repayable credits for electromobility projects and launch 10 projects by 2030.**
Finance		*Grants*	*Commercial banks*
Actions	– Minimum of 4 collaboration agreements signed. – Minimum of 4 research, development and innovation projects driven. – Internationally publicize Cuenca's electromobility plan. – Conduct a study to assess the current automotive fleet situation in Cuenca.	– Achieve a 5% share of electric vehicles in the municipal fleet by 2025, 10% by 2028 and 20% by 30%, with 40% of public municipal staff not using combustion vehicles to commute to work. – Implement a plan for the acquisition of electric vehicles within the Municipal Government of Cuenca (Municipal GAD).	– By 20230, have 30 companies conducting their logistics operations in Cuenca's historic centre with electric vehicles. – Implement 4 pilot or demonstrative electromobility projects by 2026. – Conduct a study to implement low-emission and zero-emission zones

Phase	Demonstration	Scale-Up	Mainstream
Timeline	**2022-2023**	**2024-2029**	**2030 onwards**
	– Measure, evaluate and analyse the GHG emissions.	– Ensure that 25% of the population is aware of electromobility and its benefits by 2026.	in Cuenca to promote electromobility. – Generate financing alternatives for electric public transport, commercial, and micromobility.
Target/ Focus area	**Women have 50% participation in forums, initiatives and decision-making processes related to electromobility by 2030.**	**By 2025, 80% of driving licences applicants receive training on the benefits of electric mobility in driving schools.**	
Finance		*Concessional loans*	
Actions	Conduct a study analysing initiatives aimed at social inclusion in zero-emission mobility (women, vulnerable groups, or similar)	– KPI: 19% of driving license applicants who regularly receive training on the benefits of electric mobility in driving schools. – Develop a scheme for temporary vehicle leases to driving schools for practical lessons.	

The above initiatives encompass various scopes of application and imply the engagement of several interested parties. However, the Municipal Government of Cuenca is a key stakeholder in promoting and facilitating the majority of them; thus, it could be considered primarily responsible for successfully implementing the aforementioned initiatives.

5. Implementation plan – How do we get there?

5.1 Focus area 1: Urban planning

The city center of Cuenca will begin a transformation towards a more sustainable and accessible environment, prioritizing active mobility and public transport, thus transforming the paradigm of thinking and planning in Cuenca. This change opens the door to new commercial concepts, such as the adoption of new technologies to address urban freight and last-mile logistics issues, including the operation of micro-hubs and consolidation centers. This transformation will also involve new specifications for vehicles and the introduction of new actors on the streets.

Farmasol and the pilot project enable us to observe primarily outputs on zero emission vehicles, and operation of a consolidation centre. They underscore the importance of combining, mobility solutions

with urban design adaptation in consolidated contexts, such as historic centres, where competition for the usage of public space is frequent.

The transition towards a more sustainable last-mile distribution, such as the use of low-emission vehicles (LEV) in Cuenca, increases demands regarding circulation lanes for these types of vehicles, loading and unloading zones, and designated routes. This necessitates public space adaptation and adequate infrastructure. Thus, it is essential that the required infrastructure for operation is seamlessly integrated into the historic city centre's layout to avoid disruptions to traffic flow and preserve the city's aesthetics while ensuring efficient operation.

On the other hand, Farmasol's pilot also demonstrated that implementing strategies such as clustering pharmacies based on geographical proximity, establishing decentralized warehouses in relation to these clusters, and prioritizing nearby orders results in operational efficiency improvements, cost reductions, inventory management enhancements, and fostering cooperation among stakeholders.

4.2 Focus Area 2: Regulatory measures

In terms of governance, the city aims to create agreements with stakeholders to implement policies for reducing greenhouse gas (GHG) emissions. This involves establishing working groups with transport associations and freight transport companies. These groups facilitate coordinating projects with Cuenca-based companies to encourage the transition of their operational fleets to zero-emission technologies and encourage discussions with investors to fund electric buses and vehicles.

Regarding public policy, e-Cuenca proposes drafting an ordinance that regulates and encourages the development of zero-emission mobility. Simultaneously, the plan involves designing a mobility-as-a-service system that integrates various electric and zero-emission modes of transport, such as trams, buses, and other electric mobility systems. The plan also outlines initiatives for procuring electric vehicles within the Municipal Decentralized Autonomous Government (GAD) of Cuenca and an arrangement for temporarily assigning electric vehicles to driving schools. These policy and governance actions will be monitored and assessed through a mobility plan management system, which includes a zero-emission mobility observatory comprised of city stakeholders.

4.3 Focus Area 3: Economic and financial measures

The economic incentives support the transition from combustion fleets, promoting the acquisition of electric taxis and other public and commercial transport technologies. Additionally, incentives are designed for public and private workers who opt for clean last-mile mobility systems, such as bicycle usage. Encouraging the switch from combustion vehicles to zero-emission ones, these incentives align with the promotion of zero-emission technologies in electric public transport and freight, facilitated by restrictions on private vehicle access.

Farmasol and the pilot demonstrate that incorporating various types of vehicles adapted to different needs within the logistics chain plays a significant role and yields benefits both logistically and environmentally, given that such vehicles offer flexibility, adaptability, and contribute to reducing GHG emissions.

The proposed funding programs aim to provide alternatives for acquiring new fleets in public transport, commercial transport, and micro-mobility. Management seeks to secure funds for technology acquisition, development, and research in the overall transportation sector through national and international banking.

4.4 Focus Area 4: Charging infrastructure

The technical and infrastructural conditions for e-Cuenca involve the development of studies and technical projects related to integrating electric buses in Cuenca. This encompasses the technical and economic feasibility of incorporating electric bicycles into BICICUENCA, the city's public transport system, and the generation of an energy demand forecast for electric power distribution. It also involves updating the technical fare for public transportation and assessing the environmental and health impact of integrating electric buses.

Implementing low and zero-emission zones in Cuenca to promote zero-emission mobility and updating the current vehicle census in the city are also part of this process. These technical capabilities will help define the network of public and private charging stations, allowing for recharging public transport and privately owned vehicles for transporting goods and people. This analysis and implementation drive collaboration between energy companies and stakeholders in using public spaces to promote electromobility and other zero-emission technologies.

4.5 Focus area 5: Partnerships and public awareness

Stakeholders play a critical role in the creation of societies. Through demonstration projects and research, the abilities to operate electric buses in Cuenca are being assessed, alongside their impact on greenhouse gas emissions. Additionally, a project has been integrated into the logistics sector, characterising an urban logistics centre utilising electric vehicles in the historic downtown area.

Effective dissemination and stakeholder communication is crucial for adopting zero-emission mobility in Cuenca. The SOLUTIONPLUS roadmap complements e-Cuenca with a focus on social inclusion and gender, foreseeing the development of initiatives tailored towards women, vulnerable groups, and diverse individuals. However, the Municipal Government of Cuenca is a key stakeholder in promoting and facilitating the initiatives in zero-emission mobility and could be considered primarily responsible for their success.

Consequently, there’s a proposal to update training, education, and research capabilities. Boosting research and development projects on zero-emission mobility and establishing vehicle technical training programs for municipal staff and other stakeholders engaged in last-mile logistics and micro-mobility.

Community and citizen communication is envisaged through educational campaigns on zero-emission mobility, events, and gatherings to promote the advantages of micro-mobility and create exchange platforms like open-data forums. These initiatives will facilitate sharing local and national experiences in zero-emission mobility adoption within Cuenca and Ecuador.

Electric vehicles and other zero-emission vehicles are seen as an opportunity to incorporate them into driving schools, update technological terms, and enhance road safety indicators for citizens, particularly those drivers with higher accident risks, through demonstrative activities.

6. Conclusion and next steps – what do we need?

This roadmap has presented an overview of knowledge related to sustainable mobility, electric mobility, micromobility, and light electric vehicles (LEV) deployment in Cuenca. It provides a timeline and focuses on areas to achieve the overall goal of increasing the successful uptake of LEVs in non-micromobility users (e.g., cars, trucks) while preserving the mode share of public transport, cycling, and strengthening the regulatory conditions for safe deployment of those vehicles. This roadmap aligns with national policies and other master plans, such as the new tramline and E-cuenca operation.

Cuenca should establish an instrument that can support the roadmap implementation and its follow-up from the private and public sectors, as several universities, NGOs, or other non-government organisations have shown enthusiasm to be involved in different roadmap stages. Funding must also be secured to begin implementing activities, at least in salaries and core expenses, for an implementation team to continue the work that has begun in other initiatives and has been integrated and expanded into this roadmap.

The Farmasol pilot component is important in modifying freight operations in the city centre and improving behaviours on last-mile logistics. The pilot underscores the critical role of strategic planning, vehicle adaptation, customer satisfaction, logistical efficiency, GHG emissions reduction, and inclusivity in Farmasol's management and operational model. These findings offer valuable insights into optimizing logistics, mitigating environmental impact, and fostering social responsibility within the company.

Incorporating vehicles adapted to the needs within the logistics chain results in not only the reduction of operational costs and emissions, but also enhances the social image of the company and customer's satisfaction, as well as indicated the potential for diversification and inclusivity in the workforce.

SolutionPlus and partners in Cuenca show that the ecosystem can be improved in which the local manufacturers of LEVs could be profitable, expanding the dialogue with last-mile delivery companies and presenting successful cases of the use of these LEVs in this area to convince them to incorporate locally manufactured vehicles in their fleets. It was also noted that having a dense network of bicycle lanes is essential to encourage the use of LEVs, both commercially and privately.

The roadmap is intended to be an input to help departmental governments transition to e-mobility, so five focus areas were developed, and some of the most important topics on e-mobility were widely presented. These topics are education and training, charging ecosystem, regulatory measures, urban planning and EV battery management.

In Cuenca, training and education in e-mobility have been developed with four universities; however, training can be expanded to the existing offer, developing an educational system that covers all sectors and levels. To have qualified technicians to solve all kinds of problems related to e-mobility, from technicians who repair EVs to decision-makers who make policies for the adoption of EVs.

The charging ecosystem in Ecuador has ambitious projects to develop the charging network throughout the main cities. In particular, for the clean energy production in the country and the significant cover story among the urban areas.

Cuenca has an emerging regulatory framework for e-mobility that, according to the government's objectives, will be strengthened in the coming years with the boosting of e-cuenca and other instruments signalised before. The national and local governments are making a considerable effort to show the economic benefits of adopting EVs and subsidies for purchasing zero-emissions vehicles. Further efforts are made to progress in regulating EV batteries, creating non-economic incentives, regulating the charging ecosystem, and homologating retrofitted vehicles.

In terms of urban planning, the development of the use of LEVs, and the importance of having exclusive circulation lanes for this type of vehicle, it was noted that this was necessary to guarantee their safe and efficient circulation.

In the short term, it is recommended to prioritise technology adoption and infrastructure by developing a comprehensive network of bike lanes and pedestrian paths and providing safe and secure bike parking facilities at key destinations. It is also suggested to continue investing in modern, low-emission buses and trams, improving the frequency and coverage in rural–urban sectors, reliability, accessibility of services, and integrating different modes of transport. These measures will promote walking, cycling, and public transportation as safe, convenient, and attractive options for all residents and help reduce the number of personal cars on the road.

In the medium term, it is recommended to promote the uptake of low-emission modes of transport, including electric vehicles, by investing in charging infrastructure, offering incentives for purchasing and using these vehicles, and creating public awareness campaigns highlighting the benefits of clean transportation. It is also suggested that urban planning and infrastructure be improved by prioritising the needs of pedestrians, cyclists, and public transport users in all new development projects and promoting mixed-use development that supports compact and walkable neighbourhoods.

In the long term, developing a city-wide transportation plan that integrates all modes of transport and addresses the challenges of urban logistics and last-mile delivery is recommended. It also suggests promoting sustainable freight transport options, such as electric delivery vans and cargo bikes, and encouraging urban freight movement consolidation and optimisation.

Throughout the implementation, many administrations will certainly face and overcome typical barriers like administration rotation, limited financial resources, and political and social resistance. It is necessary to strengthen stakeholder engagement, engage in meaningful consultation and collaboration with residents, businesses, and other stakeholders, and develop a communication strategy highlighting the benefits of a sustainable transportation system.

In closing, city authorities, residents, businesses, and other stakeholders are called to work together towards implementing the policies, programs, and projects outlined in this policy paper. By doing so, it would be possible to create a healthy, sustainable, and equitable city that serves as a model for other cities in the region and beyond.

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