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Country Diagnostic Colombia

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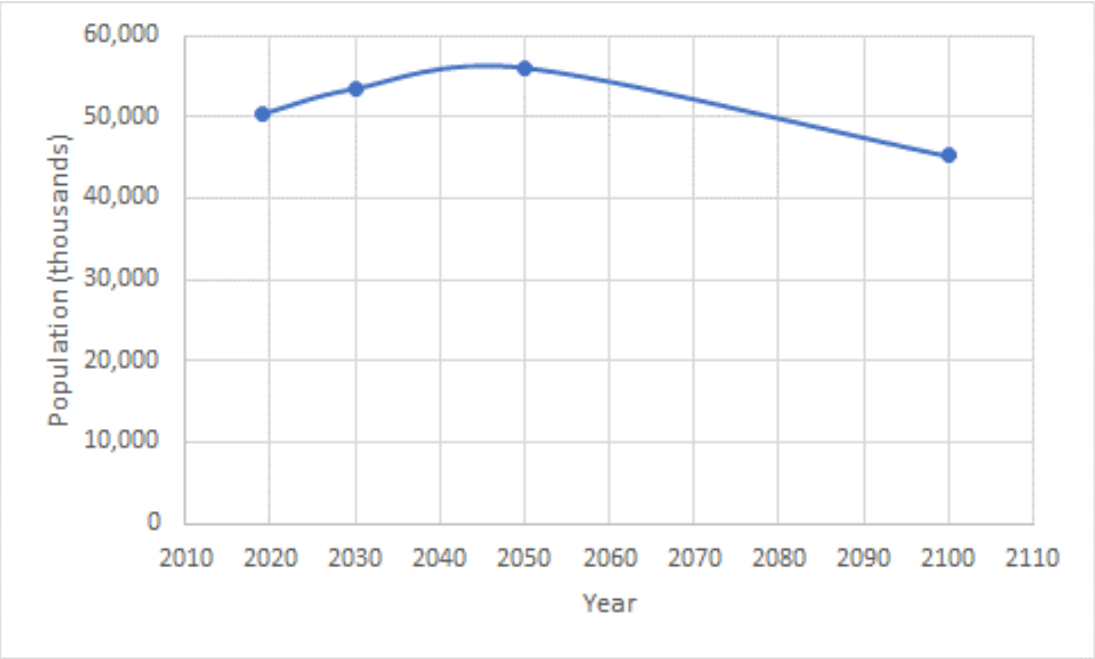
Acronyms

AEROCIVIL	Special Administrative Unit of Civil Aeronautics
LET'S GO	National Association for Sustainable Mobility
ANDI	National Businessmen's Association of Colombia
ANI	National Infrastructure Agency
ANSV	National Road Safety Agency
APP	Public-Private Partnership
BAU	Business as usual
BEV	Battery Electric Vehicle
BRT	Bus Rapid Transit
UNFCCC	United Nations Framework Convention on Climate Change
CNPV	National Population and Housing Census
CONPES	National Council for Economic and Social Policy
COP	Colombian peso
CREG	Energy and Gas Regulatory Commission
DANE	National Department of Statistics
DNP	National Planning Department
ENME	National Strategy for Electric Mobility
FDN	National Development Finance
GEI	Greenhouse Gases
IDEAM	Institute of Hydrology, Meteorology and Environmental Studies (Instituto de Hidrología, Meteorología y Estudios Ambientales).
INVIAS	National Roads Institute
MinAmbiente	Ministry of Environment and Sustainable Development
MinEnergía	Ministry of Energy
MHCP	Ministry of Finance and Public Credit
MinTransporte	Ministry of Transportation
NAMA	Nationally Appropriate Mitigation Actions
NDC	National Determined Contribution
PBN	Performance Based Navigation
PEN	National Energy Plan
PHEV	Plug-in Hybrid Electric Vehicle
UNDP	United Nations Development Programme
PROURE	Program for the Rational and Efficient Use of Energy and Other Non-Conventional Forms of Energy
MDO	Western Massive
RUNT	Single National Traffic Registry
SETP	Strategic Public Transportation System
SITM	Integrated Mass Transit System
SITP	Bogota's Integrated Transportation System
SMMED	Secretary of Mobility of Medellín
SUPERTRANSPORT	Superintendence of Transportation
UPME	Mining and Energy Planning Unit
V2G	Vehicle to grid
VE	Electric Vehicles
VSL	Statistical Value of a Life
ZEBRA	Zero Emission Bus Rapid-deployment Accelerator

1. Context

Colombia has a land surface area of 1,141,748 km2 (Instituto Geográfico Agustín Codazzi, 2021) and is the second most biodiverse country in the world. (Ministerio de Medio Ambiente y Desarrollo Sostenible, 2019). In 2019 its population reached 50,339,000 inhabitants, putting it in the 29th most populated country and is expected to reach a population of 53,417,000 inhabitants in 2030 according to **Error! Reference source not found.** (United Nations, Department of Economic and Social Affairs, Population Division, 2019).

Figure 1: Population projection for Colombia



Fuente: (United Nations, Department of Economic and Social Affairs, Population Division, 2019)

According to the World Bank, GDP per capita in constant 2010 prices for 2019 was US$ 7,838 (Grupo Banco Mundial, 2020).

According to the National Census of Population and Housing - CNPV - 2018 (Departamento Administrativo Nacional de Estadística – DANE, 2019) reported 4 cities with more than one million inhabitants according to **Error! Reference source not found.**.

Table 1: Colombian cities with more than one million inhabitants

City	Population
Bogotá D.C.	7,412,566
Medellín	2,427,129
Cali	2,227,642
Barranquilla	1,206,319

Source: (Departamento Administrativo Nacional de Estadística – DANE, 2019)

2. Policy Framework Relevant to Electric Mobility

2.1. Introduction

Colombia has recognized the importance of the electrification of the transportation sector and its importance in reducing environmental impacts. The national government has published a set of laws,

strategies and mechanisms that seek to promote electromobility in the country. The local governments have joined this effort and have shown their interest by joining different initiatives. Colombia has a broad policy framework for electric vehicles. However, in order to strengthen it, especially in public transportation systems, different government departments are working on policies, regulations and financing schemes. The results of these commitments will be evidenced in the coming years.

2.2. Climate Change and Environmental Policies

In accordance with the commitments made by Colombia in the United Nations Framework Convention on Climate Change (UNFCCC), the inventory of greenhouse gases (INGEI) is carried out, the total emissions for the last five years reported are shown in **Error! Reference source not found.**. The *Second Biennial Update Report of Colombia to the United Nations Framework Convention on Climate Change (UNFCCC)* for which the information for the period 1990-2014 was analysed and concluded that, within the subcategory of transport, land transportation is the mode that contributes the most emissions. The average value is 92% and, therefore, fuel consumption has maintained a growing trend of 34% from 2006 to 2014, with an increase of 24% in GHG emissions (IDEAM; PNUD; MADS; DNP; CANCILLERIA, 2018)

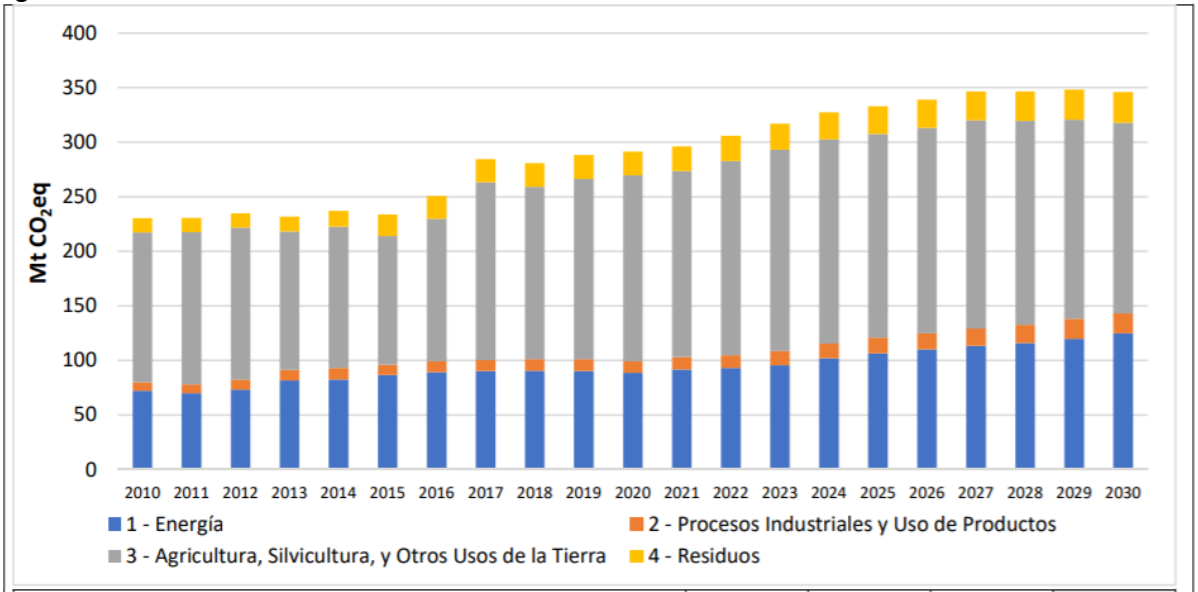
Table 2: Greenhouse gas emissions for Colombia

Sector	GHG Emissions (Gg CO_2 equivalent)				
	2010	**2011**	**2012**	**2013**	**2014**
1 Energy	72,337	69,912	73,369	81,819	82,510
1A Fuel combustion	65,250	62,027	65,380	73,630	74,443
1A3 Transportation	24,461	26,161	27,040	27,681	29,319
2 Industrial processes and product use	7,693	8,288	9,155	9,616	10,538
3 Agriculture, forestry and other land use	137,262	139,448	139,158	126,600	129,512
4 Waste	13,069	12,926	13,135	13,742	14,414
Total	230,361	230,575	234,817	231,777	236,973

Source: (IDEAM; PNUD; MADS; DNP; CANCILLERIA, 2018)

Colombia's Nationally Determined Contribution (NDC) Update estimates that according to the reference scenario for 2030 emissions would reach a value of 346 Mton CO_{2eq}, as shown in Figure 2.

Figure 2: Estimated GHG emissions under the BAU scenario



IPCC nivel 1	2015	2020	2025	2030
i{1} Energía	86,67	88,60	106,47	124,80
i{2} Procesos Industriales y Uso de Productos	9,42	10,66	14,54	18,41
i{3} AFOLU (Agricultura, Silvicultura y otros usos del Suelo)	117,94	170,44	186,45	174,50
i{4} Residuos	19,55	21,60	25,24	28,09
Total (Mt CO_2 eq)	**233,58**	**291,30**	**332,70**	**345,80**

Source: (Gobierno de Colombia, 2020)

Within the mitigation goals for Greenhouse Gases (GHG), Colombia commits through this document to emit a maximum of 169 Mt CO_2 equivalent in 2030 (equivalent to a 51% reduction of emissions), for which in the transportation sector it contemplates the following goals: (i) achieve 600,000 electric vehicles registered in the *Registro Único Nacional de Tránsito (RUNT)* of the categories cab, passenger vehicles (bus[1], buseta, microbus, padrón[2], articulated and bi-articulated), light vehicles, light trucks and official vehicles; (ii) achieve the use of the Performance Based Navigation (PBN) system in 100% of the country's airports and flights; (iii) renew 57,000 cargo vehicles of more than 10.5 tons gross vehicle weight and more than 20 years old between 2015 and 2030; (iv) achieve the transport of 8 million tons of cargo annually by the Magdalena River by switching from road to river transport; (v) increase the modal share of bicycles by 5.5% in the cities targeted by the TANDEM NAMA; (vi) decrease the use of vehicles such as cars, cabs, buses and motorcycles by replacing them with shorter trips that can be made by walking or non-motorized means; (vii) achieve the transport of 4.2 million tons of cargo per year through the rail corridor La Dorada - Chiriguaná - Santa Marta (Gobierno de Colombia, 2020).

The actions covered by the electric mobility component registered in the NDC include: (i) policy development; (ii) policy, technical and regulatory development with technical standards for vehicles and charging infrastructure; (iii) building the technical and market environment for electric power supply; (iv) defining penetration targets, vehicle labelling and (v) developing two specific and applicable financial instruments until parity with traditional technologies is achieved (Government of Colombia, 2020). In order to implement some of these actions, the MoVE NAMA has been developed. This was approved by the NAMA Facility on 12 October 2018 and initiated a detailed design phase of

[1] Bus is a public transport vehicle with a capacity of 40 passengers
[2] "Padrón" is a bus with a capacity of 80 passengers

the project, focused on the generation of two funding mechanisms, with a duration of 18 months and a budget of EUR 337,900. This initiative involves the Ministry of Transport (MINTRANSPORTE), the National Planning Department (DNP), the Ministry of Environment and Sustainable Development (MADS), the Territorial Development Bank FINDETER and the World-Wide Fund for Nature (WWF), which is in charge of its implementation (IDEAM; PNUD; MADS; DNP; CANCILLERIA, 2018)

The *Green Growth Policy* approved through document CONPES 3934, contemplates as a structural axis the efficient use of natural capital and energy in the productive sectors; as a strategy the development of a national program of electrification for transportation whose indicator to 2030 is to reach the goal of 600,000 electric vehicles which represents 6.96% of the national vehicle fleet in 2030 (without motorcycle segment) (Departamento Nacional de Planeación, 2019).

2.3 Energy Policies

Regarding the use of energy for the transportation sector, the national government has wanted to decisively address the use of electricity and sanctioned Law 1964 on July 11, 2019, "Whereby the *use of electric vehicles in Colombia is promoted and other provisions are enacted*", which is known as the *Electric Mobility Law*. It establishes as goals to guarantee in 2022 at least 5 fast charging stations[3] in operation in special category municipalities[4], with the exception of Bogotá D.C. which must have 20 stations. The municipalities are in charge of its installation and the energy company that provides the service in the municipality is in charge of its operation, for which the Public Private Partnership (PPP) scheme may be used. In addition to the regulation by the Ministry of Housing and City and Territory, in conjunction with the authorities of the municipalities of special category, 0, 1, 2 and 3, of the guidelines for the builders of new residential and commercial buildings to provide an electricity connection for charging or refuelling of electric vehicles. (Congreso de Colombia, 2019).

As a complement to the Law, the National Government has also developed the *National Strategy for Electric Mobility* (ENME), which aims to promote the electrification of the transportation sector. Among its actions are the definition of minimum energy efficiency standards for vehicle technologies; the regulation of both electricity tariffs and infrastructure for vehicle charging, according to their interaction with the *vehicle to grid (V2G)* network and the promotion of charging infrastructure to guarantee the supply of energy to electric vehicles. These goals are projected for 2022 (Minambiente; Ministerio de Minas; Ministerio de Transporte; UPME, 2020)

The *Program for the Rational and Efficient Use of Energy and other Non-Conventional Forms of Energy* 2017 - 2022 (PROURE) is aimed at contributing to energy security, as well as compliance with international commitments on environmental issues. The PROURE establishes the energy savings goal for 2022 in the transportation sector at 424,408 TJ (5.49%). Actions to achieve this goal include the replacement of 0.15% of the total national vehicle fleet by 2021, according to **Error! Reference source not found.**. In addition, the measures include the establishment of energy efficiency standards in the sector and labelling for vehicles. (Ministerio de Minas; UPME, 2016)

[3] Fast charging station: system that provides energy for fast charging of electric vehicle batteries and has a power output greater than 50 kilowatts. (Congreso de Colombia, 2019).

[4] Special category: all those districts or municipalities with a population of more than 500,001 inhabitants and whose annual current revenues exceed 400,000 legal monthly minimum wages. (Congreso de Colombia, 2000).

Table 3: Replacement or entry scheme for new EVs in Colombia by 2022

Measure	No. of vehicles	Share of national total	Energy savings (TJ)
Replacement of the official sector's combustion fleet with electric and hybrid vehicles by 2022	3,700	0.030%	154,704
Replacement of the cab fleet in the country's main cities (Bogota, Medellin, Cali, Barranquilla) with electric vehicles by 2022	12,480	0.090%	2,147
Entry of new electric motorcycles nationwide by 2022	2,189	0.016%	36
New electric car entry nationwide by 2022	2,082	0.015%	148
Entry of electric and hybrid vehicles in public passenger transport in the country's main cities by 2022	706	0.005%	2,074

Source: (Ministerio de Minas; UPME, 2016)

On the other hand, and in addition to the above, the *National Energy Plan* (PEN) 2020-2050 presents projections for the incorporation of electric vehicles, under the scenario of meeting the GHG reduction commitments (20% by 2030), which are summarized in the following table (UPME, 2019).

Table 4: EV projection to 2030 under compliance with GHG reduction commitments

Segment	EVs projected to 2030
Urban freight	20,000
Bus	34,000
Cabs	40,000
Light vehicles	370,000
Motorcycles	630,000

Includes for light vehicles electric and hybrid vehicles

Source: (UPME, 2019)

2.4. Transportation Policies

The National Urban and Regional Mobility Policy (CONPES 3991) seeks to "guide transport authorities in the planning and implementation of mobility and territorial transformation projects in accordance with the particularities of each territory". This policy has approaches such as financial sustainability and the definition of the fare structure of public transport systems, participation, monitoring and technical assistance by the Nation to regional urban transport projects, among others (National Council for Economic and Social Policy, 2020).

The *Electric Mobility Law* has managed to provide for measures in public transportation services such as compliance with a minimum quota of 30% of electric vehicles in new acquisitions or contracts, taking into account the commercial offer in Colombia. According to the same law, the goals for the incorporation of electric vehicles in the acquisition of the fleet of zero-emission mass transportation systems must follow the scheme of minimum proportions of 10% in 2025, 20% in 2027, 40% in 2029, 60% in 2031, 80% in 2033 and 100% in 2035 (Congreso de Colombia, 2019).

On the other hand, the ENME proposes a roadmap to be followed in different time periods to achieve a low-emission vehicle fleet, which contemplates for passenger transportation in buses in the short term (2022): the generation of a fleet renewal incentive, the national public transportation electric policy, equipment recycling processes and incentives for the acquisition of hybrid and electric vehicles, and for individual cab transportation services, the intervention in the replacement processes. In the long term (2050) for both segments, it proposes to require low-emission technologies in the cities. (Minambiente; Ministerio de Minas; Ministerio de Transporte; UPME, 2020)

Efforts from the national government have reinforced electrification initiatives that have originated in cities such as Medellin, in which the 2016-2019 administration declared the intention to be the Capital of Electric Mobility in Latin America, focusing its efforts on the electrification of bus-based mass systems and the expansion of the multimodal transportation network with electric modes.

2.5. Others

Regarding economic incentives, Decrees 116 of 2017 and 2051 of 2019 exempted electric chargers until 2027 and vehicles with electric motors, respectively, from the tariff levy. Law 1819 of 2016 establishes that, legal entities that directly make investments in control, conservation and improvement of the environment, will be entitled to deduct from their income tax payable 25% of the investments they have made in the respective taxable year, upon accreditation made by the respective environmental authority, in which the direct environmental benefits associated with such investments must be taken into account.

Law 1964 of 2019 seeks to complement the stimuli, which are: the maximum value of the tax on motor vehicles, which may not exceed 1% of the commercial value of the vehicle; the 10% discount on the premiums of the Compulsory Traffic Accident Insurance (SOAT) of electric vehicles; the exemption of the measures of restriction to vehicular circulation in any of its modalities that the local traffic authority provides; the minimum proportion (2% of the total) of parking spaces enabled for preferential use of electric vehicles in mayors' offices, governors' offices and commercial establishments with parking lots for the public of special category municipalities and those of first and second category (Congreso de Colombia, 2019). In the case of Bogota, the tax on public service electric motor vehicles was limited to 0.5%. (Secretaría Distrital de Hacienda, 2019)

2.6. Summary

The set of strategies and policies in Colombia have demonstrated the national interest in promoting electromobility in different segments. The following table summarizes the most relevant policies.

Table 5: Relevant policies for electromobility by December 2020

Policy	Main components
NDC updated to 2020	Establishes as a goal the incorporation of 600,000 electric vehicles registered in the RUNT by 2030.
PROURE 2017-2022	Sets a target of 21,157 electric vehicles by 2022
PEN 2020-2050	Estimates the projection of electric vehicles to 2030; 20,000 in urban freight; 40,000 cabs; 370,000 light vehicles (including hybrids) and 630,000 motorcycles
Law 1964 of 2019	It compiles incentives for electromobility such as tax exemptions, traffic restriction measures, insurance discounts, parking spaces, public infrastructure for minimum recharging, gradual proportion of electric vehicles in mass transportation systems
Decree 2051 of 2019	Exempts electric vehicles from the tariff levy (with respect to the 15% average for passenger and cargo vehicles).
Decree 116 of 2017	Exempts electric chargers from tariff levy until 2027
Law 1819 of 2016	Regulates the 25% income tax discount for persons who directly invest in environmental control, conservation and improvement.

3. Macroeconomic Impacts of Electric Vehicles

Law 105 of 1993 dictates guidelines for the replacement of the fleet of public passenger and/or mixed service vehicles and sets a maximum of 20 years of service life of land vehicles of collective public passenger and/or mixed service, leaving the Ministry of Transportation in charge of the requirement

for the replacement of the fleet. The Ministry of Environment and Sustainable Development has made efforts focused on vehicle disintegration and the proper disposal of waste derived from it, the guidelines for this process are set forth in the *Environmental Guide for the treatment of end-of-life vehicles (VFTVU) or vehicle disintegration* (Dirección de Asuntos Ambientales Sectorial y Urbana, 2015) Within the framework of the *Policy for the modernization of the automotive cargo transportation sector*, the *Promotion Program for the replacement and renewal of the cargo vehicle fleet* 2013-2018 has been developed, which achieved the disintegration of 19,818 cargo vehicles with a gross vehicle weight over 10.5 tons of an average age of 21.3 years (Consejo Nacional de Política Económica y Social, 2019).

Colombia has an automotive industry dedicated mainly to vehicle assembly, auto parts production and motorcycle assembly. In 2019 it achieved a production of 127,000 vehicles, occupying the fourth position in manufacturers in the region and its share in industrial GDP is 6.2%. (PROCOLOMBIA, 2020). According to the National Association of Colombian Businessmen and women (ANDI), the sector generates 25,000 direct jobs; however, the DANE estimated that in 2019, 535,359 people were employed in the activities of trade, maintenance and repair of motor vehicles and motorcycles. (Departamento Nacional de Estadística (DANE), 2020). The four most representative vehicle assemblers in the sector are GM Colmotores, Sofasa Renault, Hino Motors and Foton; in auto parts production, Bonem, Cofre, Gabriel de Colombia, Imal and Incolbest stand out (Rico, 2019).

Busscar is a bodywork manufacturing company with two plants located in Pereira. It is participating as a partner of the firm BYD for the assembly of 596 electric buses acquired for the operation of the Integrated Transport System (SITP) of Bogota and are expected to be operational by October 2021. The assembly of each bus takes an average of 11 days, and about 25 units will be completed each week (Busscar de Colombia, 2021). This company also collaborated as an assembler in the supply of 483 electric buses for the SITP manufactured by Yutong in 2020 (Busscar de Colombia, 2020). Superpolo will also contribute to BYD in the assembly of electric buses for the SITP in Bogotá, by supplying the bodywork (VEC Magazine, 2021). In addition, Superpolo has expressed interest in the production of electric buses of all types, including bi-articulated buses (Taborelli, 2020). Mountain assembler Kenworth also collaborated with Yutong, supplying the bodywork for the provision of 13 electric buses for Transmilenio operator ETIB (Transmilenio, 2020a). They are also involved in the spare parts supply chain, as operation and maintenance will be carried out by Colombian technical staff trained by the alliance (Martínez, 2020).

At the national level, no specific policies have been defined for the electric vehicle industry. However, the country is driving processes forward within the framework of the ENME, where the Ministry of Transportation must define the minimum homologation parameters for the import, assembly or manufacturing processes of electric vehicles and the Ministry of Commerce will establish the guidelines to provide guarantees for electric vehicles, as well as promote after-sales service programs with importers of electric vehicles. The results of these initiatives should be felt in 2021 (Minambiente; Ministerio de Minas; Ministerio de Transporte; UPME, 2020)

In 2014, the World Bank developed an estimate of health costs due to air pollution, based on the identification of pollutants and the determination of their concentrations, the population exposed to them and the calculation on health impacts to finally estimate the value or cost in health of air pollution. The value of mortality was obtained through the methodology of Statistical Value of a Life (VSL), with an estimated cost of COP $5,708 billion (1,578 MUSD) (International Bank for Reconstruction and Development / The World Bank, 2014).

4. Transportation Sector

4.1. Actors Relevant to E-mobility

National Planning Department (DNP)

It is an entity of the National Government that coordinates, articulates and supports the short-, medium- and long-term planning of the country. It also guides the public policy cycle and the prioritization of investment resources. (Departamento Nacional de Planeación (DNP), 2020). The Infrastructure and Sustainable Energy Directorate -DIES- supports the work of the DNP, advancing the actions required for the development of roads and transportation, telecommunications, mines and hydrocarbons and energy sectors, in coordination with the relevant agencies and entities. (Departamento Nacional de Planeación (DNP), 2020).

Ministry of Transportation (MinTransporte)

It is an administrative organization responsible for ordering the activities of infrastructure, transportation and transit in the country. This ministry is responsible for the transportation sector and for promoting plans and strategies to improve mobility and sustainable development in the country. The following specialized entities are attached to MinTransporte: Instituto Nacional de Vías (INVIAS), Agencia Nacional de Infraestructura (ANI), Unidad Administrativa Especial de Aeronáutica Civil (AEROCIVIL), Superintendencia de Transporte (SUPERTRANSPORTE) and the Agencia Nacional de Seguridad Vial (ANSV). These institutions together design, execute, manage and maintain the policies and strategies related to national transportation; whether road, maritime, river, rail and air of the country. (Ministerio de Transporte, 2011).

Ministry of Energy (MinEnergía)

It is the entity in charge of directing national policy regarding mining, hydrocarbons and energy infrastructure. Its mission is to "formulate and adopt policies aimed at the sustainable use of mining and energy resources to contribute to the economic and social development of the country." (Ministerio de Minas y Energía, 2021). The UPME is a Special Administrative Unit of the National order, of a technical nature, attached to the Ministry of Mines and Energy. Its purpose is to plan in an integral, indicative, permanent and coordinated manner with the agents of the mining and energy sector, the development and use of mining and energy resources; to produce and disseminate the information required for policy formulation and decision making; and to support the Ministry of Mines and Energy in the achievement of its objectives and goals. (UPME, 2021).

Energy and Gas Regulatory Commission (CREG)

The CREG is the commission that has the function of regulating monopolies in the provision of public services, when competition is not, in fact, possible; and, in other cases, to promote competition among those who provide public services, so that the operations of monopolists or competitors are economically efficient, do not involve abuse of a dominant position and produce quality services (CREG, 2017). It is in charge of regulating the electric power, natural gas, liquefied petroleum gas and liquid fuels sectors. (CREG, 2017). It has generated projection studies of electromobility penetration in the country, mainly based on the worldwide penetration generated by the Paris agreement, in addition to monitoring indicators for penetration studies of these vehicles conducted by the UPME and the DNP.

Ministry of Environment and Sustainable Development (MinAmbiente)

It is the governing body for the management of the environment and renewable resources, in charge of defining the policies that will be subject to the recovery, conservation and protection of the nation's environment; it has lines of work in extramural, intramural, noise and electromagnetic radiation pollution in order to ensure sustainable development and public health care. Its main interest related to the transportation sector are the GHG emissions and particulate matter for which the sector is responsible, so it has a clear inclination to bet on sustainable mobility, more specifically in electric mobility. (MinAmbiente, 2018). In addition, it develops topics such as Nationally Appropriate Mitigation Actions (NAMA), which are policies, regulations, programs or other types of actions that reduce GHG emissions from their trend levels or *business as usual* and that, in turn, contribute to achieving the sustainable development objectives for the country. (Mendieta, 2013).

Ministry of Finance and Public Credit (MHCP)

The MHCP is the public entity that coordinates macroeconomic policy; defines, formulates and executes the country's fiscal policy, influences the economic, governmental and political sectors, and manages the Nation's public resources from a budgetary and financial perspective; in order to promote the conditions for sustainable economic growth, stability and soundness of the economy and the financial system; in favour of strengthening institutions, supporting decentralization and the social welfare of citizens. (Función Pública, 2021).

National Development Finance (FDN)

It is a development bank specialized in the financing, management, bidding and structuring of infrastructure projects, it also participates by attracting different key actors to achieve an integral contribution to make the large infrastructure projects that the country requires a reality. (Financiera de Desarrollo Nacional, 2021). FDN finances projects up to 70% through financial products:

- senior debt: which is a long-term bank debt (between 20 and 30 years), taking into account the revenues, costs and risks of each of the project's phases.
- funding in pesos: a long-term line of credit in local currency, destined to international financial entities (commercial banks, multilateral entities), under flexible terms and conditions, to be used to finance infrastructure projects in the country.
- mini-perm debt: medium-term *Project Finance* type credit (between 5 and 8 years) with the idea of covering the construction period and the beginning of the project's operation. (Financiera de Desarrollo Nacional, 2021).

Bancoldex

It is a development bank that promotes business growth and foreign trade in Colombia. It offers different financial and non-financial solutions to promote business development. Its management focuses on promoting exports, supporting productivity and competitiveness with emphasis on *MSMEs*, contributing to the defence of the environment, mitigating climate change, and acting as an instrument for the restoration of business in areas of disaster or deterioration of economic conditions. (Bancoldex, 2021). In relation to the transportation sector and in conjunction with the national government, the bank has enabled several lines of credit to support electric mobility.

FINDETER

It is a development bank that offers comprehensive solutions through planning, structuring and technical assistance. It carries out activities such as rediscounting loans to public entities, private law entities and autonomous patrimonies for infrastructure and environmental projects; capturing internal savings by issuing securities and signing other documents, and entering into internal credit contracts; receiving deposits from public entities, fixed-term or immediately available; external credit operations; administration of securities issues, among others. As direct support to the country's SITM, the entity has an exclusive line of credit, called "Commitment integrated mass transport systems", aimed at financing the operation of these systems. It is also the entity in charge of implementing the MovE NAMA in conjunction with WWF.

Municipal Authorities

This refers to the mobility, transportation or transit secretary, which plan, regulate and control aspects related to land transportation (passengers and cargo), pedestrian and vehicular traffic, in accordance with the social and economic development model of their cities, providing services that meet the needs of users and promoting a culture of road safety and a healthy environment.

Transport Companies and Managers

In order to improve public transport services in Colombia, the national government has stipulated the implementation of Integrated Mass Transit Systems (SITM). Within this framework, companies or managers of these systems have been set up in the main cities, responsible for contracting and control. Such is the case of Transmilenio in Bogotá, Metro Cali, Metroplús in Medellín, Transcaribe in Cartagena, among others. These companies are public, however, with some exceptions, the companies providing transport services are private.

Coordination mechanisms

In general, in order to develop policy instruments, ministries come together with a particular objective in mind. The entity in charge of policy articulation is the DNP. Currently, there is an Inter-institutional Roundtable on Sustainable Transport, with the participation of the Ministry of Environment and Sustainable Development, Ministry of Energy, Ministry of Transport, UPME and DNP. This roundtable is in charge of monitoring the initiatives, lines of action and public policies regarding sustainable transport in Colombia. At this moment the technical secretariat is in charge of DNP.

National Association for Sustainable Mobility (ANDEMOS)

It is the association that represents and watches over the interests of the national assemblers and exporters of automotive vehicles in the country. It is responsible for transmitting these interests to the national government and other related institutions. Its mission is to contribute to the growth of the automotive sector in Colombia based on good practices that facilitate the development of the associates' business (Asociación Nacional de Movilidad Sostenible, 2019)

National Association of Colombian Businessmen (ANDI)

It is the most important business association in Colombia. It is made up of a significant percentage of companies belonging to sectors such as industrial, financial, agro-industrial, food, commercial and services, among others. It also plays a fundamental role in the promotion of good mobility, promoting

good practices at the time of negotiation between the parties involved in the transportation sector. (Asociación Nacional de Empresarios de Colombia, 2019)

Delivery Companies

Delivery companies have shown interest in electromobility. DHL Express has had Renault Kangoo ZE electric vehicles in the country since 2015 and incorporated 5 more units in 2018, operating in Pereira, Barranquilla, Medellin and Bogota (DHL, 2018). TCC added a fleet of electric vehicles to its operations. These vehicles are part of the acquisition of a more sustainable fleet, including 12 electric vans (TCC, 2020b, 2020a). Recently, Servientrega joined forces to innovate with its fast (last mile) delivery fleet called Green Car, which consists of 40 light vehicles and 20 electric bicycles. The light vehicles are officially motorbikes, however, they can easily replace a small truck with a two-ton capacity (El Tiempo, 2018; Servientrega, 2020).

Energy Companies

Energy companies have been involved in electromobility, providing not only energy, but also charging infrastructure and even the purchase of electric vehicles. Enel, a marketer in Bogotá and Cundinamarca, includes within the portfolio of its Enel X business line, the installation of electric chargers for EVs; acquisition of motorbikes, scooters and electric bicycles, both for individuals, companies or public administration and recharging at public access charging stations (Enel X, 2020a). Celsia, a marketer in Valle del Cauca, Tolima and Chocó, offers the sale of bicycles, scooters and electric motorbikes. In addition, as a power generation and transmission company with a vocation for renewable energies, it has a strong interest in energy storage, and therefore in the use of second life batteries (Celsia, 2019). Celsia participated in the acquisition of the first electric buses for SITM MIO in Cali, in its charging infrastructure and electricity supply.

4.2. Urban Mobility in Colombia

The National Government sanctioned Law 105 of 1993 and Law 336 of 1996, with the objective of reducing the problem of urban passenger transportation, which was made up of individual operators with a scarce business structure, an obsolete vehicle fleet, deficient regulation, inadequate routes and operations, among others. For this reason, the DNP developed the CONPES 3260 (Departamento Nacional de Planeación, 2003) and CONPES 3167 (Departamento Nacional de Planeación, 2002) in order to implement strategies and recommendations to improve urban public passenger transportation systems.

Among the strategies presented, it was proposed that cities with more than 600,000 inhabitants develop an Integrated Mass Transportation System (SITM) with exclusive corridors served by Bus Rapid Transit (BRT). (Departamento Nacional de Planeación, 2002). For cities with a population between 250,000 and 600,000 inhabitants, Strategic Public Transportation Systems (SETP) are proposed to meet 100% of the demand for urban public transportation. (Gobierno de Colombia, 2009). Law 310 of 1996 established that the financing of the systems by the Nation must be a minimum of 40% and a maximum of 70% of the cost of the debt service of the project; the remaining value is assumed by the local government (Colombian Congress, 1996). The financing scheme proposed for these systems is shown in the following table.

Table 6: Source of funding for Urban Transport Systems in Colombia

Component	Public Source	Private Source	Mixed Source
Infrastructure	X		
Equipment – Buses	X	X	
Equipment - Control Centre	X		X
Equipment - Collection System	X		X
Operation	X	X	
Road Infrastructure Maintenance	X		
Operational Infrastructure Maintenance	X	X	

Source: **(FDN, 2019)**

The following table summarizes the characteristics of the SITMs in operation. According to the *Urban Passenger Transport Survey* (ETUP), the distribution of trips is 46% for the traditional system and 53% for the SITMs (Departamento Nacional de Estadística, 2020). The approximate composition of the vehicle fleet of the traditional system is shown below.

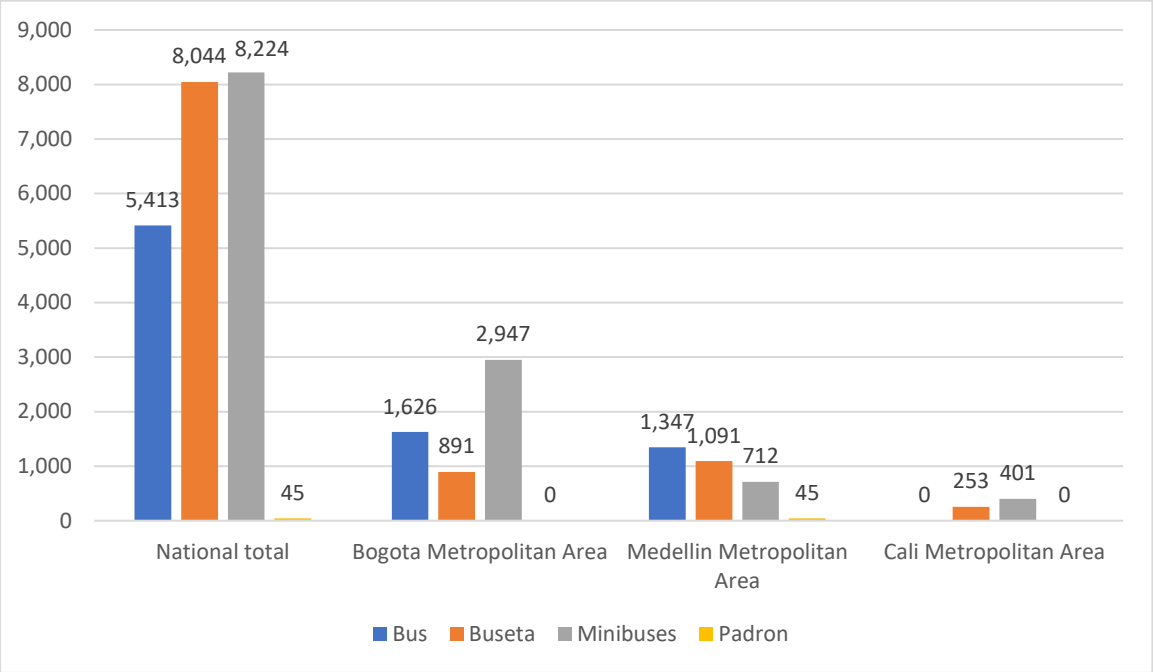
Table 7: Characteristics of the SITMs in operation in Colombia

City	Vehicle fleet		Passengers transported per day[5]
Bogotá - Transmilenio	Articulated	763	2,500,000
	Bi-articulated	1,329	
	Dual standard	261	
	Padron[6]	782	
	Buseton[7]		
Bogotá - SITP	Padron	1,742	1,700,000
	Buseton	2,774	
	Bus	931	
	Minibus	287	
Medellín - Metroplús	Articulated	31	162,000
	Register	47	
	Bus	302	
	Minibus	65	
Cali - MetroCali MIO	Articulated	199	485,000
	Padron	288	
	Dual	26	
	Buseton	88	
Barranquilla - Transmetro	Articulated	92	131,000
	Padron	85	
	Buseton	107	
Cartagena - Transcaribe	Articulated	54	106,000
	Padron	147	
	Buseton	115	
Bucaramanga - Metrolínea	Articulated	27	118,000
	Padron	102	
	Buseton	106	
Pereira - AMCO	Articulated	47	121,000
	Buseton	42	
	Bus	705	

Source: (Transmilenio, 2020); (AMVA, 2020); (MetroCali, 2020); (TRANSMETRO, 2019); (TransCaribe, 2020); (Metrolínea, 2019); (Área Metropolitana Centro Occidente, 2020)

[5] Data for operation before COVID-19. The variation in demand estimated by some managing bodies due to the health contingency has been close to 40% (Transmilenio S.A., 2021).
[6] Padron is a public transport vehicle with a capacity of 80 passengers
[7] Buseton is a public transport vehicle with a capacity of 50 passengers

Figure 3: Traditional urban transport vehicles in service by 2019



Source: (Departamento Nacional de Estadística, 2020)

Table 1: Characteristics of the public transportation fleet in Colombia[8]

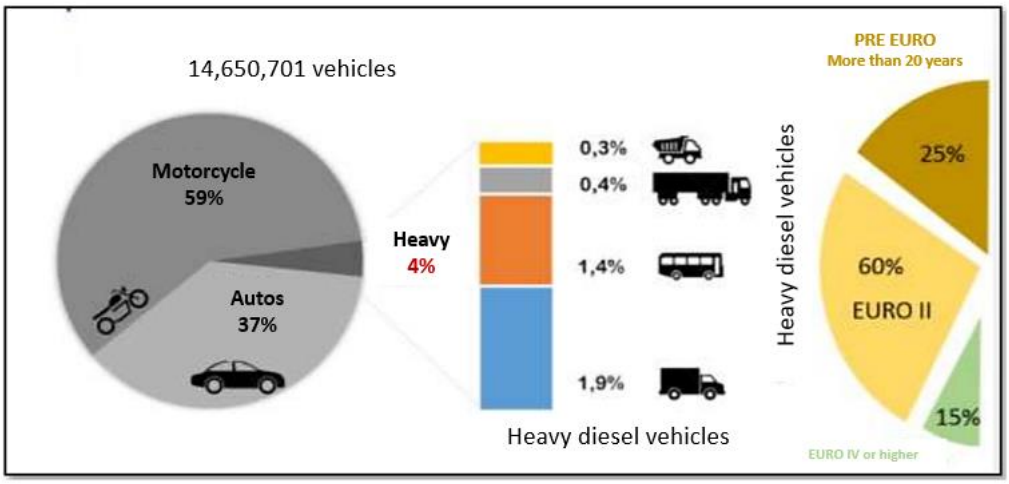
Parameter	Minibus	Bus	Buseton	Register	Dual Standard	Articulated	Bi-articulated
Length (m)	7	9	10	12.3	12.3	18.3	27.2
Passenger capacity	19	40	50	80	80	160	242
CAPEX (USD)	34,000	53,000	70,000	284,000	-	400,000	500,000
Technology	From Pre-Euro to Euro IV	From Pre-Euro to Euro IV	From Pre-Euro to Euro IV	Euro III/IV/V/VI	Euro V/VI	Euro III/IV/V/VI	Euro V/VI
Daily mileage	163	163	163	179	179	239	239
Average life (years)	20	20	20	15	15	19	19

Source: (Transmilenio, 2016); (Diesel Andino, 2020; Diesel Andino, 2020; MetroCali, 2018; Potkány, Hlatká, Debnár, & Hanzl, 2018; Suárez Montoya, 2016); (Transmilenio, 2020)

The participation of the different technologies in the national fleet is shown in the Figure 4, where 25% of the heavy diesel vehicles are pre-euro technology, 60% are Euro II and only the 15% is Euro IV or superior.

[8] These data seek to characterise the national fleet, so SITM and traditional services have been taken into account.

Figure 4: Colombian automotive fleet composition by technologies

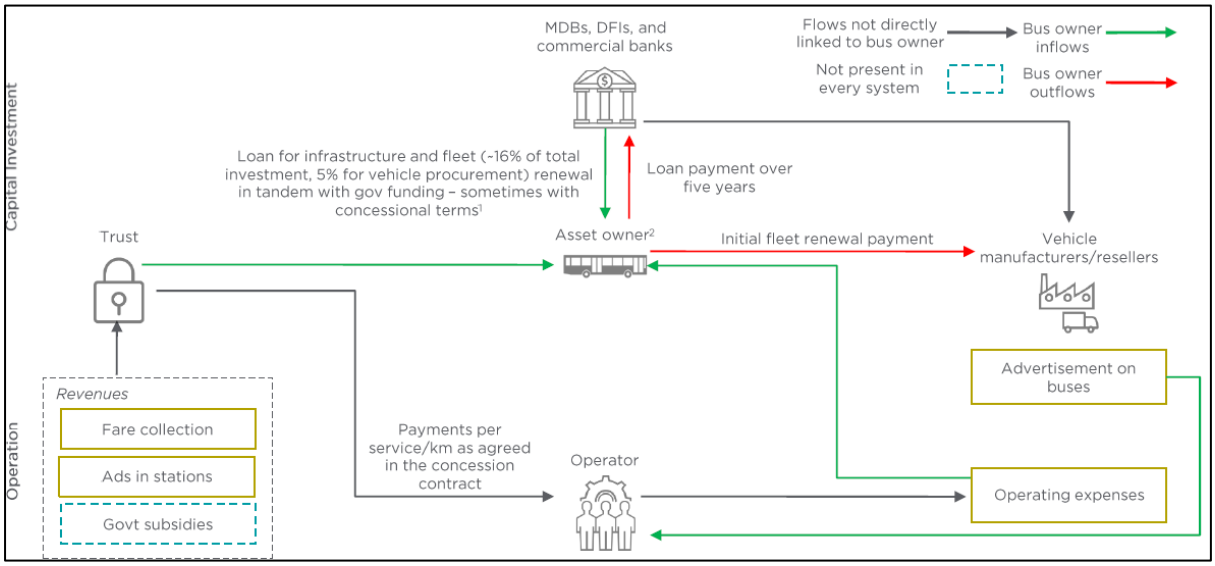


Source: (MinEnvironment & MinEnergy, 2019)

In the operation of these systems, the figure of a fund fed by resources from local authorities to cover the differential costs between the system's technical fare and the resources received for the public fare is common, thus guaranteeing the remuneration to concessionaires. This is the case of the Transmilenio system in Bogotá, MetroCali in Cali and Metroplús, which, being a public entity, does not have the figure of a fund but does have the resources for the compensation of the fare differential. (SMMED, 2020).

Regarding the structuring of concessions, the models have evolved, the reference is Transmilenio, for being the pioneer SITM in the country. Initially, the concession for the provision and operation of the fleet was granted to the same actor. However, this model has migrated to a scheme of separation of ownership and operation, which allows guaranteeing the availability of the fleet, regardless of the continuation of the operator. The duration of the concessions is 10 years for diesel buses and 15 years for electric vehicles in both components. The remuneration is differential, in the case of fleet provision it is in $/bus and depends on the type and technology of the vehicle, in the operation the payment is divided into two components, one expressed in $/km travelled per vehicle and in turn depends on the type and technology of the bus; and the other expressed in $/bus and associated to the operational cost of the vehicle by type and technology. (FDN & TMSA, 2017) The fleet will be active during the term of the concession contract; once the contract is terminated, the operator must deliver the buses to Transmilenio for their respective scrapping by the fleet supplier. The financing scheme used in Transmilenio is summarized below.

Figure 5: Financing Scheme for Transmilenio



Source: (Dalberg, 2020)

Colombia has demonstrated its interest in the inclusion of electromobility in this segment, participating in initiatives such as *Zero Emission Bus Rapid-deployment Accelerator* (ZEBRA), which is an alliance led by the C40 Cities network and the International Council on Clean Transportation, ICCT, with funding from P4G (*Partnering for Green Growth and the Global Goals 2030*), with the objective of promoting the expansion of zero-emission bus fleets for public transportation. The progress of this initiative has been a study of business models in Latin America, among which the model used by Transmilenio stood out. BYD, Creatti EV/Zhongtong, Foton, Sunwin and Yutong committed to commercialize a zero-emission bus model in Medellín within 12 months and to guarantee the commercial availability of a model throughout the country within a maximum of 18 months **Invalid source specified.**. Zebra seeks to bring together the interests of different actors, including investors, but does not guarantee access to resources.

In Bogotá, in 2013 the Technological Upgrade Plan for the integrated Transmilenio system was adopted and structured, with the objective of improving air quality and reducing impacts on public health due to atmospheric pollution, through the implementation of zero or low emission technologies on route in the SITP (Transmilenio, 2013). Within the framework of this plan, the Mayor's Office of Bogotá and Transmilenio granted several contracts for the purchase of 1,485 electric buses, 740 type "Padrón" of 80 passengers and 745 type “Busetón” of 50 passengers (SITP, 2020). The value of the latest acquisition of 596 buses was worth MUSD 502.3 ($1.82 billion pesos) (SITP, 2020). This latest purchase positions the city as the capital of electromobility in Colombia and a reference in Latin America. As of January 2021, 133 electric buses have arrived and are operating. Regarding charging stations, 483 SITP electric buses will be able to travel thanks to the 223 charging points that will be set up in the Suba, Airport, Refugio and Usme yards that Enel X, Enel-Codensa's business line, is building in Bogota. (Enel, 2020). The construction of the charging stations and their electrical infrastructure is progressing with the first UFO 2 yard in Fontibón to be delivered in December 2020 (Alcaldía de Bogotá, 2020) and the remaining ones to be delivered before the end of the first quarter of 2021. (Enel, 2020).

Figure 6: Electric bus in the recharging yard operating in the SITP in Bogota

Source: (Alcaldía de Bogotá, 2020)

Currently, Medellín has 68 electric buses: Metroplús has 64 electric buses which were financed by the local government and Metroplús with its own resources (Buitrago, 2020). Masivo de Occidente (MDO) has 4 electric buses that were financed by the concessionaire through equity and debt in an 80-20 ratio (Montoya, Campiño, & Muñoz, 2020). The 64 electric buses are BYD brand and the fleet has 16 chargers that are distributed in several charging points: Patio-Taller UdeM, Estación Industriales and/or a new Logistics Transportation Center. (Metroplus, 2020). These buses run on Line O, which is a line operated entirely with electric buses. (Buitrago, 2020).

On the other hand, there is MDO, one of the operators of the feeder routes, in charge of Basin 3. In 2017, MDO started planning for the acquisition of 12 electric buses that will operate in the routes they have in operation. On July 16, 2020, they started the operation of the pilot test with 4 Zhongtong brand electric buses, which are 7.8 m buses with a capacity of 18 passengers and currently they have 8 buses approved, but they are waiting for an increase in passenger demand (Montoya, Campiño, & Muñoz, 2020). Regarding the recharging infrastructure for these buses, MDO built the electrical infrastructure in its own yards and financed the project with its own capital and debt. As of January 2021, they have three 60 kW chargers and installed a 400 kVA transformer that allows them to charge up to 25 electric buses. (Montoya, Campiño, & Muñoz, 2020).

Another city that has electric units is Cali, which by 2020 had 35 electric buses, 26 buses operated by Blanco y Negro Masivo and 9 operated by GIT Masivo, both MIO operators. The energy company Celsia plays an important role as a partner of the company "Blanco y Negro Masivo S.A.", providing the city with electric buses,[9] recharging infrastructure and electricity for this fleet. (Cando, 2020). Another partner of this concessionaire is EMCALI, who adapted a high voltage line in the transport company's yard-workshop, which will allow the construction of the recharging bays for the new buses. These electric buses have a travel range of 280 kilometers and a capacity for 56 passengers; 19 seated and 37 standing, they also have air conditioning, *WIFI* network, USB ports that offer cell phone charging, monitoring camera, and more space for passenger comfort, among other aspects. (MetroCali, 2019).

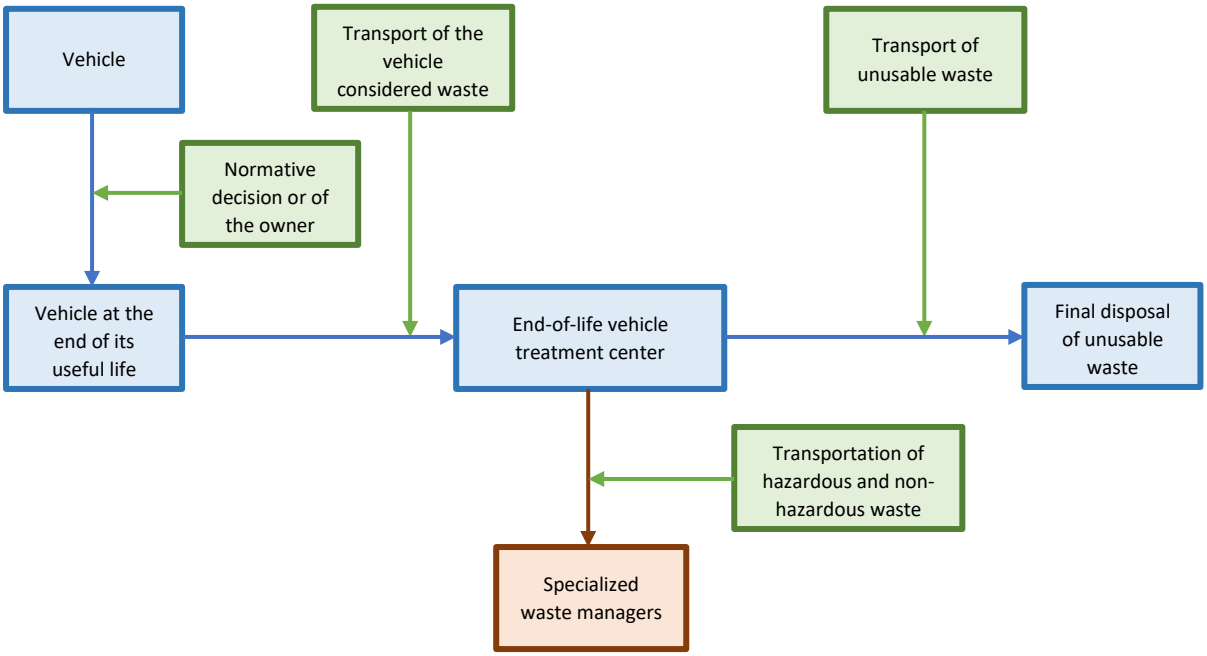
[9] On this occasion, due to the financial problems of the operator “Blanco y Negro Masivo S.A.”, Celsia decided to finance the buses.

The nine buses acquired by GIT Masivo, which arrived in Colombia in November 2020 have batteries with a range of 320 kilometers and capacity for 50 passengers. To recharge the batteries, the dealership will install chargers that will recharge each battery in two hours to 100% power (Alcaldía de Cali, 2020).

About the traditional public transport systems, it is regulated under the Decree 170 of 2001 (MinTransport, 2001). This decree was in turn compiled by the Single Decree 1079 of 2015 (MinTransporte, 2015). On it establishes the rules for the addition of a new collective public transport bus operator, the assignment of routes and their respective obligations, as well as the requirement to use an operation card to circulate and their respective requirements to obtain it. The local authority grants permits to the Public Transport Companies to operate the routes and these, in turn, affiliate the required vehicles, without exercising further control during the provision of the service and are paid according to the number of affiliates. The owners of these affiliated vehicles receive a fixed income from the drivers, who earn per passenger collected. Because this system was considered inefficient, urban transport systems in Colombia are being restructured according to CONPES 3260, based on the number of inhabitants in the cities (Departamento Nacional de Planeación, 2003).

Regarding scrap, Colombia has the *"Environmental Guide for the treatment of vehicles at the end of their useful life or vehicle disintegration"* (Ministry of Environment, 2015). This document issued by the government in 2015, presents a complete breakdown of the process and considerations necessary for the scrapping of vehicles that have finished their useful life cycle or have suffered damages equivalent to the totalization of their functional capacity.

Figure 7: Comprehensive end-of-life vehicle management process



Source: (MADS, 2015)

Law 105 of 1993 establishes guidelines for the replacement of the passenger and/or mixed public service vehicle fleet and sets the maximum useful life of public passenger and/or mixed public service land vehicles at 20 years and leaves it at the head of the Ministry of Transport the requirement for the replacement of the vehicle fleet, in such a way that the replacement of vehicles that have completed their useful life cycle is made by new vehicles; likewise, it assigns responsibilities to the competent

territorial authorities in terms of incentives for vehicle replacement (Colombian Congress, 1993). Law 336 of 1996 obliges the operating companies of the public transport service to have replacement programs in all modalities, considering that *"replacement implies the entry of a new vehicle to replace another that permanently leaves the service and that he will be subjected to a process of total physical disintegration, for which his registration will be cancelled"* (Colombian Congress, 1996).

In numerals 6, 7 and 8 of article 16 of Resolution 12739 of December 20, 2012 (MinTransporte, 2012a), the procedure and requirements for cancelling vehicle registration are established in cases involving disintegration, destruction, or total loss of the vehicle. If the registration cancellation request originates from the owner's voluntary decision to disintegrate his vehicle, the certification issued by the disintegrating entity must be presented, which must be duly authorized by the Ministry of Transportation, together with the certification of the technical review. This is complemented by Chapter IV of the Resolution 646 of March 18, 2014 (MinTransporte, 2014), which establishes the procedure that must be followed to advance the vehicle disintegration procedure, among other aspects.

4.3 Individual Transportation Services

In Colombia, Decree 172 of 2001 (MinTransporte, 2001) regulates the individual passenger transportation service in cab vehicles. This decree was in turn compiled by the Single Decree 1079 of 2015 (MinTransporte, 2015) and this establishes that the competent transport authorities are the Ministry of Transport and the Mobility secretary of the Municipality under the Municipal or District Mayor's Office. In order for a company to provide the individual motorized land transportation service of passengers in cab vehicles, they must request and obtain a permit to operate. This permit must be requested before the competent transportation authority of the municipality or district, once a duly constituted company has the authorization to provide the service, the permit has an indefinite duration. Once authorized to provide the service, cabs must have contractual and extra-contractual civil liability policies.

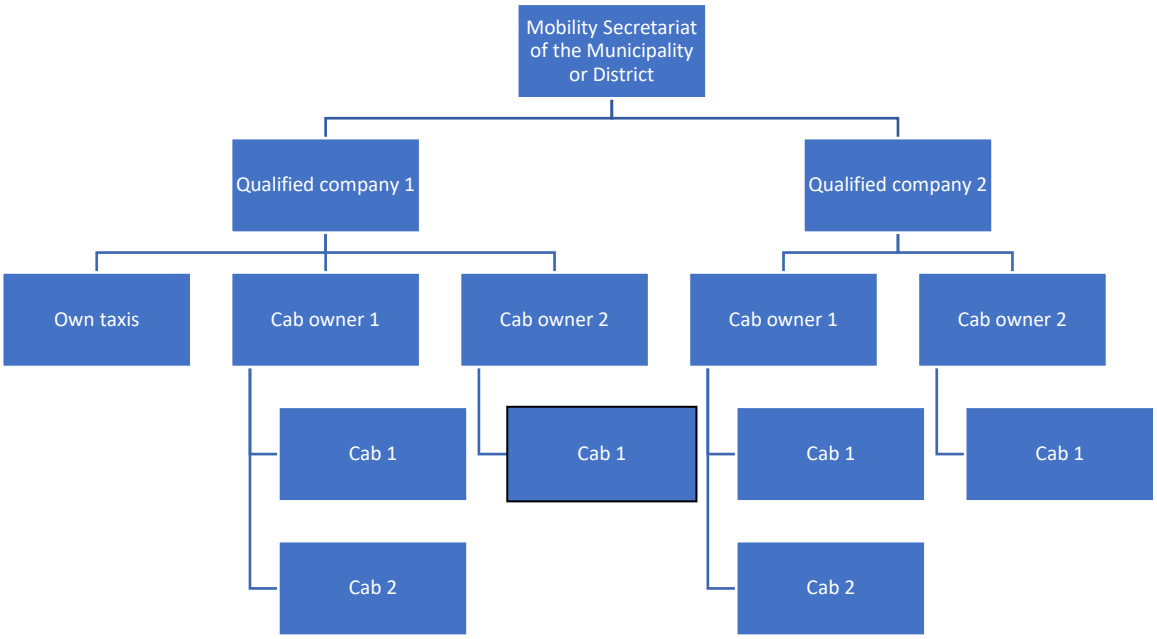
A vehicle is linked to a public transportation company when it joins the fleet of said company once it has been granted authorization by the competent transportation authority. It is formalized with the execution of the respective contract between the owner of the vehicle and the company, and is made official with the issuance of the operation card by the competent transportation authority, which duration is one year. Vehicles may be added to the fleet in two ways: (i) by increase, when the taxi addition implies an increase in the number of vehicles of that modality operating in the respective locality, or (ii) by replacement, where the adding occurs by replacing another vehicle that is registered in the public service. The entry of replacement vehicles (ii) is commonly referred to as "quota", which is the right to replace a cab type vehicle and has no cost. However, this "quota" being limited by the Mobility secretary or transit authority of each municipality, took a commercial value among the owners of cabs. This means that if a new person wants to buy a taxi, he/she will have to buy the "quota" from another taxi driver, as the number of permits issued by the authority remains constant over time. In 2018 it was between USD 27,000 – 32,000 (MCOP[10] $100 and $115) for the city of Bogotá, however, currently has been devalued due to the high supply of transportation offered by technology platforms such as Uber, Cabify or Didi to name a few, so that the cost of the "quota" is currently between USD 10,000 – 11,000 (MCOP $38 and $40) (Sánchez R. , 2021).

Cab owners may drive their vehicles or have drivers, generally under a 2-shift daily operation scheme. According to the Fenalco Bogotá study, 24% drive their own cab, 67% of drivers drive someone else's

[10] Million Colombian pesos

cab and 9% work under contract. (Fenalco Bogotá, 2016). This means that many of the drivers do not own the cabs and that there are entrepreneurs/companies and/or individuals who have fleets of cabs and affiliate them to any of the companies that are authorized by the competent transport authority. The following figure shows the scheme or structure of cab operations in a summarized form.

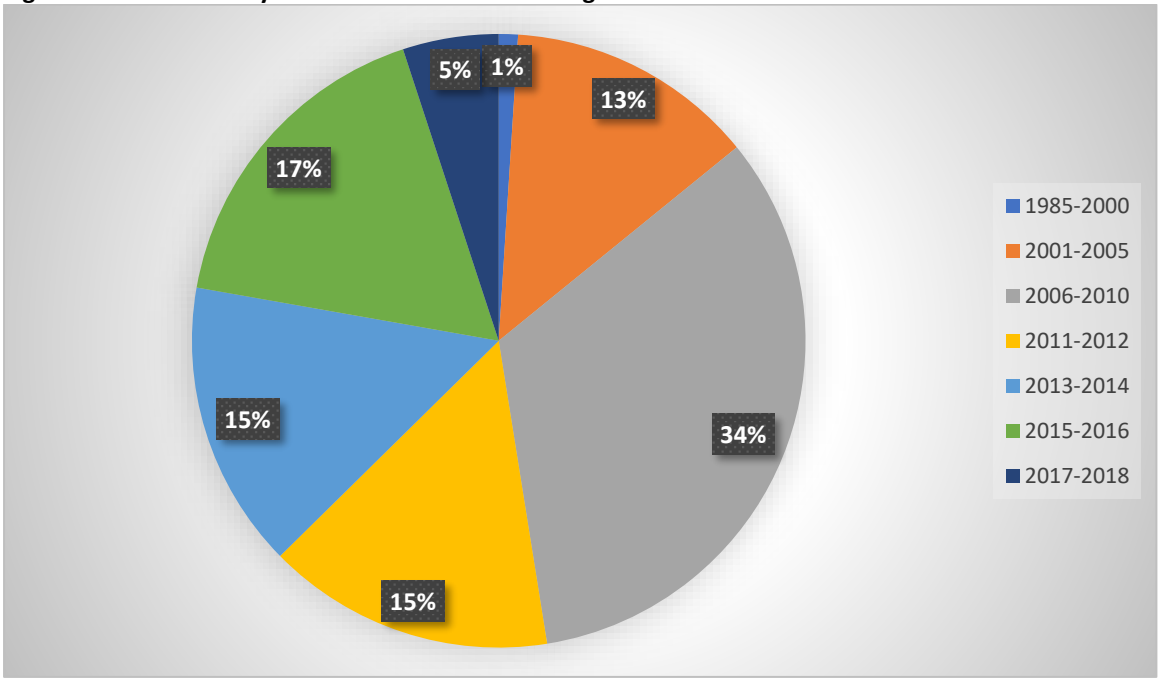
Figure 8: Organizational scheme of the cab service



Source: Own elaboration

Regarding the fare charged to users for cab service, this is regulated and is under the responsibility of the Mobility Secretary or transit authorities. For this purpose, each vehicle makes use of a taximeter that follows the defined charging parameters. Bogotá has defined the rate per kilometre at COP $908 (USD 0.25) and Medellín at COP $1,590 (USD 0.44). (Alcaldía de Bogotá, 2021) (Alcaldía de Medellín, 2019). Bogota has a fleet of about 50,000 vehicles affiliated with 54 licensed companies, with about 90,000 drivers in the city. (Bogotá, 2020). According to the following figure, 48% of cabs are close to 10 years old.

Figure 9: Distribution by model of the cab fleet in Bogota for 2017



Source: (Secretaría Distrital de Movilidad, 2017)

According to the ANDEMOS vehicle sales report, the manufacturer with the highest number of sales is KIA, followed by Hyundai and Chevrolet, with the models *KIA Grand EkoTaxi*, *Hyundai Grand Metro Taxi* and *Chevrolet Chevytaxi Plus.* (Andemos, 2020). The average characteristics of these vehicles are listed below.

Table 8: Average characteristics of the cab fleet operating in Colombia

Parameter	**Value**		
Fuel	Gasoline	CNG new	Conversion from gasoline to CNG
CAPEX	14,000 USD	20,000 USD	800 USD
Daily mileage	220 km	200 km	200 km
Average lifespan as taxis	7 years	10 years	10 years

Source: (Sánchez R. , 2021); (Fenalco Bogotá, 2016); (Kia Motors Colombia, 2021; Auto Koreana, 2021; Chevrolet, 2021)

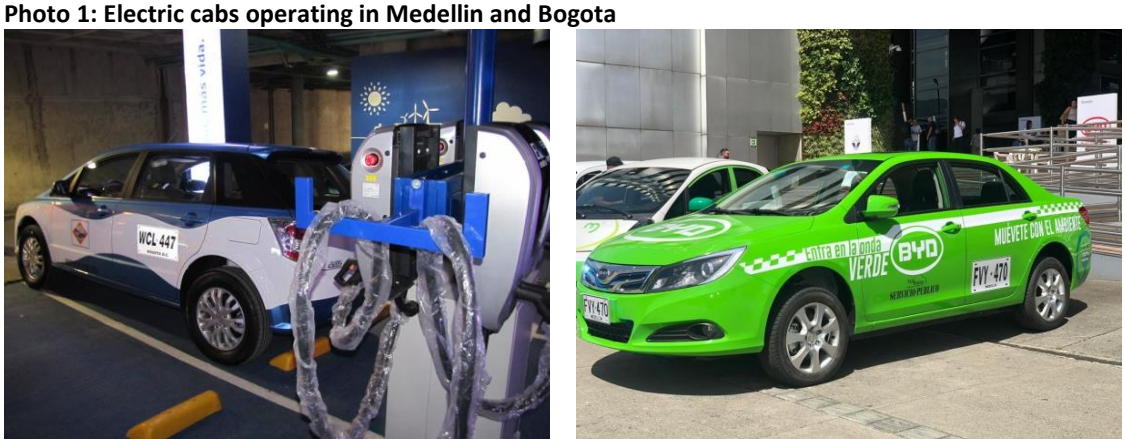
Once the vehicle has completed its lifespan, it can be sold in the second-hand market as a private vehicle or if the owner desires, the vehicle can be scrapped.

Currently the different digital mobility companies are in one of two situations; 1) adapted to national regulations and registered as a company providing transportation services, such as Cabify or MiÁguila, or providing a leasing style service, where the application operates as an intermediary for the user to hire the vehicle with its driver for a period of time or for a defined distance. MinTransport considers that the platforms operating under the leasing modality are illegal and should not be allowed to operate, however it has lost in court since the companies of this court have shown that by not owning vehicles to their registration do not fall into the category of transportation companies. Although individual processes are advanced for each company, legal inconsistencies are many, which is why it strongly promotes the creation of frameworks for new technologies that allow situations like Uber, but in the government, there are still many crossed opinions which prevents them from achieving efficient progress with these regulatory frameworks. (Revista Dinero, 2020).

Currently, only two cities have implemented pilot projects for the deployment of electric cabs in the country; Bogota and Medellin. By means of Art. 3 of Decree 677 of 2011 (Alcaldía de Bogotá, 2011) a pilot plan was established to provide 50 electric cabs and this pilot plan has an initial period of 3 years from the date the decree came into action, later the pilot plan was extended to 10 years taking into account the return on investment. Once the pilot plan was completed, the vehicles could continue to provide cab service, as long as another internal combustion vehicle was withdrawn. The vehicles were purchased from BYD and assigned to drivers after a bidding process. Although initially 50 vehicles were viewed, only 45 entered into operation. The vehicles were assigned to the interested based on a raffle, the chosen drivers had to look for the financing through banks and they are the owners of the vehicle.

This program revealed some barriers to electromobility, such as the difficulty for operators to acquire credits, the lack of promotion of electromobility, the system and the pilot's entry into operation, the need for functional recharging infrastructure, among others. Currently, these vehicles have been incorporated into operation at the International Airport, but due to their different colour scheme and lack of user awareness, they were not used in the same proportion as traditional vehicles. This represents a regulatory gap (Sánchez R. , 2021).

Photo 1: Electric cabs operating in Medellin and Bogota



Source: (Secretaría Distrital de Ambiente, 2020); (Secretaría de Movilidad de Medellín, 2019).

The Mayor's Office of Medellín through Decree 1221 of 2016 (Alcaldía de Medellín, 2016) establishes in Art. 6 that, through the competent entities and the support of EPM, a pilot project of 100% electric taxi-type individual public transport shall be developed, which started in 2019 (Sánchez L. A., 2021). This pilot project of electric cabs was a project led by the Mayor's Office of Medellín and Empresas Públicas de Medellín E.S.P. (EPM) that sought to introduce 1,500 electric cabs in the following three years (500 each year (Montoya G. , 2021)), through the replacement of conventional gasoline and diesel cabs with 100% electric cabs. (Sánchez L. A., 2021). EPM offered 200 quotas to receive an economic incentive to those who were selected under certain criteria[11] to replace their conventional gasoline or diesel cabs with electric cabs. This incentive amounted to COP $18,300,000 (USD 5,050), however, COP $1,300,000 (USD 360) had to be deducted for taxes, leaving COP $17,000,000 (USD 4,690) to the beneficiary cab driver, who could finance part of the cost of the replacement (Sánchez L. A., 2021). This would allow him to finance part of the electric cab, which had an average cost of COP $95,000,000 (USD 26,200) (El Espectador, 2019). Initially, the call was intended to deliver 100 quotas

[11] Vehicle older than or equal to 5 years, operating with gasoline or diesel, operation card in force during the five years prior to the moment of registration, not presenting sanctions of suspension or cancellation of driving license during the 2 years prior to the moment of registration; vehicle free of limitations to the domain and encumbrances, except pledge; it must also be registered in the Secretary of Mobility of Medellin and linked to one of the companies legally authorized by this Transit Authority to operate in the city of Medellin.

for electric cabs – however, only 50 interested parties applied and only 6 were awarded one of these quotas (Sánchez L. A., 2021). The causes of the low participation and assignment rate of the program were recognized as the low advertisement of the call, the lack of knowledge of the technology, the search for financing in commercial banks by the cab driver, among others. The pilot project was terminated in that first call due to the low participation of Medellín cab drivers (Sánchez L. A., 2021). Currently, SMMED is working on a new call for proposals with new strategies for a new pilot project of 50 electric cabs, where the requirements to qualify for the program would be changed (SMMED, 2020) so that more people can participate, including companies that have cabs. However, this call would not include the subsidy offered by EPM (Sánchez L. A., 2021).

However, this new call is being studied to give the benefit of having two taxis, so the people selected to participate in this new pilot plan could have the electric taxi and the conventional gasoline taxi as well (Sánchez L. A., 2021). This business model closes financially, because it basically has income from two vehicles (Montoya, 2021).

4.4. Urban Cargo Vehicles

As of September 2020, there are 194 registered postal operators in the country, of which 189 are express courier operators, 5 are paid postal service operators and one of the express courier operators is the official postal operator Servicios Postales Nacionales S.A. 4-72. (MinTIC, 2020).

At the end of 2019, there were 3,580 hybrid and electric vehicles registered, it can be seen that there are several classes of electric vehicles, where only 13% correspond to full EVs (Mintransporte, 2021). Renting Colombia, a company belonging to Grupo Bancolombia, is the leading company in the vehicle renting or pay-per-use model. This company is involved in electric fleet supply processes with companies such as TCC, Bavaria, Nutresa, Argos, Bimbo, Grupo Éxito and Tiendas D1 (Renting Colombia, 2021). Renting Colombia has an active fleet of more than 20,000 light and heavy vehicles of different brands and models (Renting Colombia, 2021) including the Stärk E-Cargo 4.0 ton electric truck. By 2022, they expect to deploy 1,000 Stärk E-Cargo 4.0 Ton electric trucks in order to encourage electric mobility in SMEs and large companies in the country (Bancolombia Group, 2019).

In 2015, TCC incorporated to its last mile parcel delivery fleet 5 Renault Kangoo electric vehicles equipped with Renault Z.E engines. In 2019 it incorporated to its fleet 16 electric vehicles; 12 in Medellin and 4 in Bogota (TCC, 2020). These vehicles were incorporated through the Renting model through the company Renting Colombia in order to ensure that they will always have an available fleet and avoid maintenance or repair costs, and by 2020 they renewed their Renting contract, but all electric vehicles were destined to Medellín, where the distances travelled are shorter and therefore the use of EVs is more efficient (Fajardo, 2021). Bavaria expects to reduce CO_2 emissions by 25% throughout its value chain by 2025. To meet that goal, Bavaria in alliance with Renting Colombia, announced in 2019 the commitment to incorporate 200 electric trucks to its distribution fleet by 2021, equivalent to 20% of its fleet. They started with 12 Stärk electric trucks with 4-ton capacity that are used in Bogota and Medellin. (Bavaria, 2019).

In Colombia, DHL has a fleet of 144 vehicles, of which 7 are electric. (DHL, 2019). By 2025, DHL Global wants to operate 70% of first and last mile services with clean pick-up and delivery solutions, such as bicycles and electric vehicles, and in Colombia, the goal is to achieve the goal of 70% of the first and last mile services with clean pick-up and delivery solutions, such as bicycles and electric vehicles. (DHL, 2017). Since 2010 Coca-Cola has started to contribute to electric mobility in Colombia with the first fleet of green trucks with 12 electric vehicles. The vehicles have a range of up to 48 km, a load capacity of 1,360 kg and a towing capacity of 4,500 kg. (Coca-Cola, 2010). Currently Coca-Cola has entered the

Renting Colombia modality (Renting Colombia, 2020). Grupo Exito has a fleet of 30 cars for home deliveries of the Exito and Carulla brands (Grupo Éxito, 2019) in Medellín.

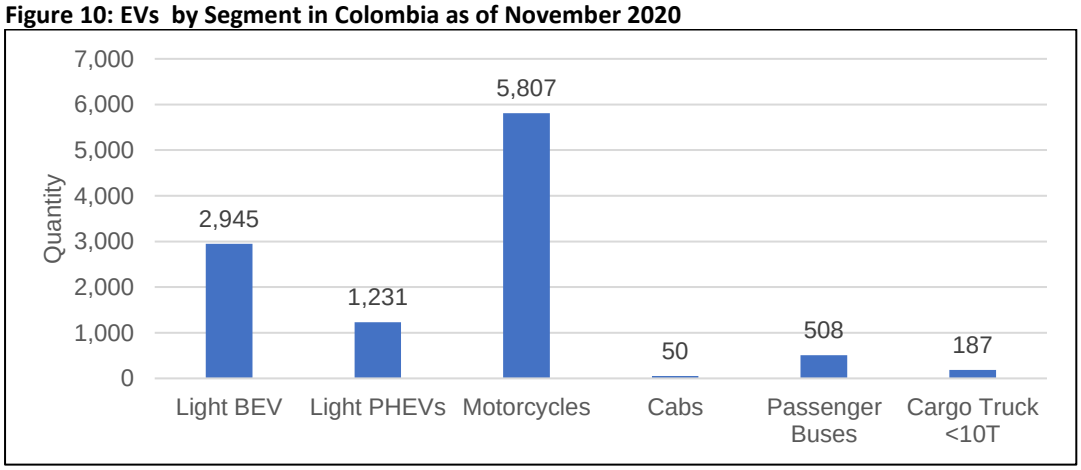
Photo 2: Electric trucks operating under the Renting Colombia scheme

Source: (Renting Colombia, 2020)

5. E-mobility System

Colombia has seen an increase in the EV fleet, both pure hybrids, plug-in hybrids and battery electric vehicles. This increase in the fleet is mainly due to financial incentives from the government, such as tariff exemptions and VAT reductions, favouring the sale of this type of vehicle. This in turn favours the arrival of new electric vehicle manufacturers and the arrival of electric and hybrid vehicles from brands that are already positioned in the country, such as BMW, Mercedes Benz or Renault. As of November 2020, Colombia had an estimated 10,728 EVs including PHEVs (see below).

Figure 10: EVs by Segment in Colombia as of November 2020



Source: (ANDEMOS, 2020)

Electricity grid operators play a key role in the charging station infrastructure. At the national level, EPM, Enel, with emphasis on Bogota, Celsia and companies such as Terpel are also betting on charging stations, although with a more interurban focus. The following table shows the number of EV charging stations segmented by owners and location.

Table 9: EV charging stations by owner

Owner	City	Quantity
Enel Group	Bogotá	60
EPM	AMVA	19
	Quindío	3
	Bucaramanga	2
	Rionegro	1
Celsia	AMVA	8
	Cali	6
	Bogotá	1
	Cartagena	1
	Ibagué	2
Terpel	Bogotá	1
National total		**104**

Source: (Celsia, 2020); (Enel, 2020); (EPM, 2020); (Terpel, 2019)

UPME has developed an estimate of charging infrastructure projections required to meet the market demand taking into account the growth of EVs in Colombia, these projections for the main cities of the country are listed below.

Table 10: Charging infrastructure projection in Colombia's main cities

City	EVs in 2030	Public chargers (1)	Private chargers (2)
Bogotá	279,606	239 – 1,075	251,645
Medellín	100,515	86 – 387	90,464
Cali	79,770	68 – 307	71,793
1 Includes 11 kW, 22 kW and 50 kW chargers 2 Includes Level 1 (3.6 kW) and Level 2 (7.7 kW) chargers			

Source: (UPME; USAENE; SUMATORIA, 2019)

In addition, estimates have been made for 2023 taking into account the expansion plans of the Urban Transportation Systems and the inclusion of electric buses.

Table 11: Projection of chargers and buses for 2023

City	Buses	Chargers
Bogotá	1,690	388
Medellín	2,009	415
Cali	422	113
Pereira	79	15
Ibagué	46	18
Tunja	90	22
National total	**4,336**	**971**

Source: (UPME; USAENE; SUMATORIA, 2019)

The NAMA MovE, which promotes electromobility, is designing two financial instruments, a proposal for instruments for the transfer of funds, a guide for the negotiation and purchase of electric energy for transport and a projection of charging stations to be installed in strategic cities. The results of these products will be available in September 2021 (FINDETER; WWF, 2020) .

Bancoldex facilitated a credit line in 2018 for MUSD 19 (MCOP 70,000), aimed at financing individuals and companies interested in investing in electric mobility. The resources could be used to finance programmes for the purchase of electric vehicles, the import and marketing of electric vehicles, and the development and operation of charging infrastructure. In maximum amounts of MUSD 2.7 (MCOP 10,000), with a term of up to 5 years and a grace period of up to 1 year (Bancoldex, 2018).

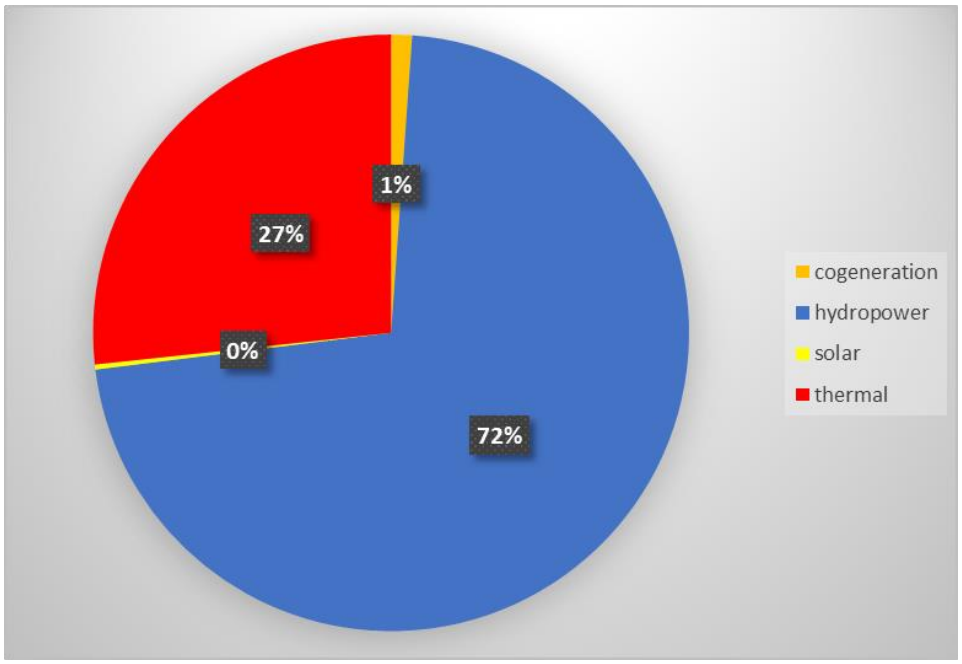
GIZ-TRANSfer contracted Sumatoria as a consultant to assess, plan and design at pre-feasibility level the financial, technical and governance conditions that would apply for the construction, operation, duration and monitoring of a fund to promote the development of electric mobility in Colombia. Especially for the integration of electric buses and the necessary infrastructure for their operation. The consultancy aims to define (at a pre-feasibility level) the conditions that would determine the viability of the fund, and that will allow for the future development of a detailed structuring and implementation of the fund.

6. Power Sector

6.1. Electricity Generation

In 2019 around 70% of the installed power capacity (totalling around 17,000 MW including centrally and non-centrally dispatched) is hydropower and 30% thermal power plants (coal, gas, fuel oil and diesel)[12]. In 2020 the share of renewables in total electricity generated was slightly above 70% (see following figure).

Figure 11: Electricity Generation Colombia 2020

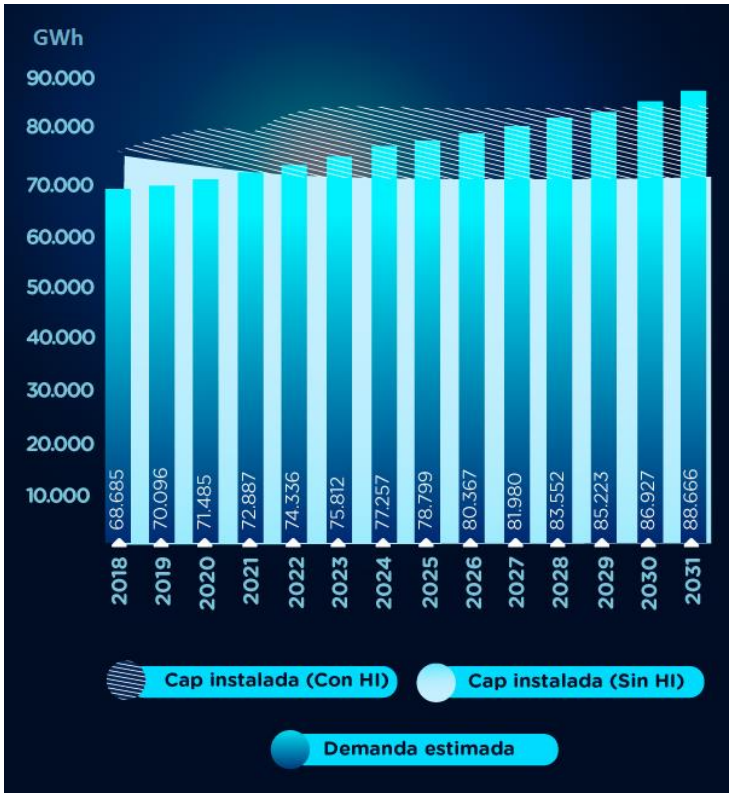


Source: XM (2020), *Generation (kWh) 2020:*
http://portalbissrs.xm.com.co/oferta/Paginas/Historicos/Historicos.aspx

The following figure shows expected demand and supply until 2031. Electricity demand is projected to grow annually by 2%b between 2020 and 2030.

[12] XM. (2020). *Net effective capacity*. Retrieved from XM: https://informeanual.xm.com.co/demo_3/pages/xm/21-capacidad-efectiva-neta.html

Figure 12: Projections Electricity Demand and Generation Colombia to 2031



Source: (Arango, 2019) Retrieved from Grupo Bancolombia: https://www.grupobancolombia.com/wps/portal/empresas/capital-inteligente/especiales/especial-energia-2019/panomara-energetico-colombia

Colombia still has a considerable non-exploited renewable energy capacity in terms of hydroelectric, solar and wind power (Arango, 2019).

6.2. Grid Factor

The carbon emission factor of the grid is calculated based on national data. UPME calculates the carbon emission factor as used for national emission inventories as well as for determination of the carbon footprint [13]. This value is also used for EVs in this report and is for 2019 0.13 $kgCO_{2e}/kWh$ [14].

6.3. Electricity Demand from EVs

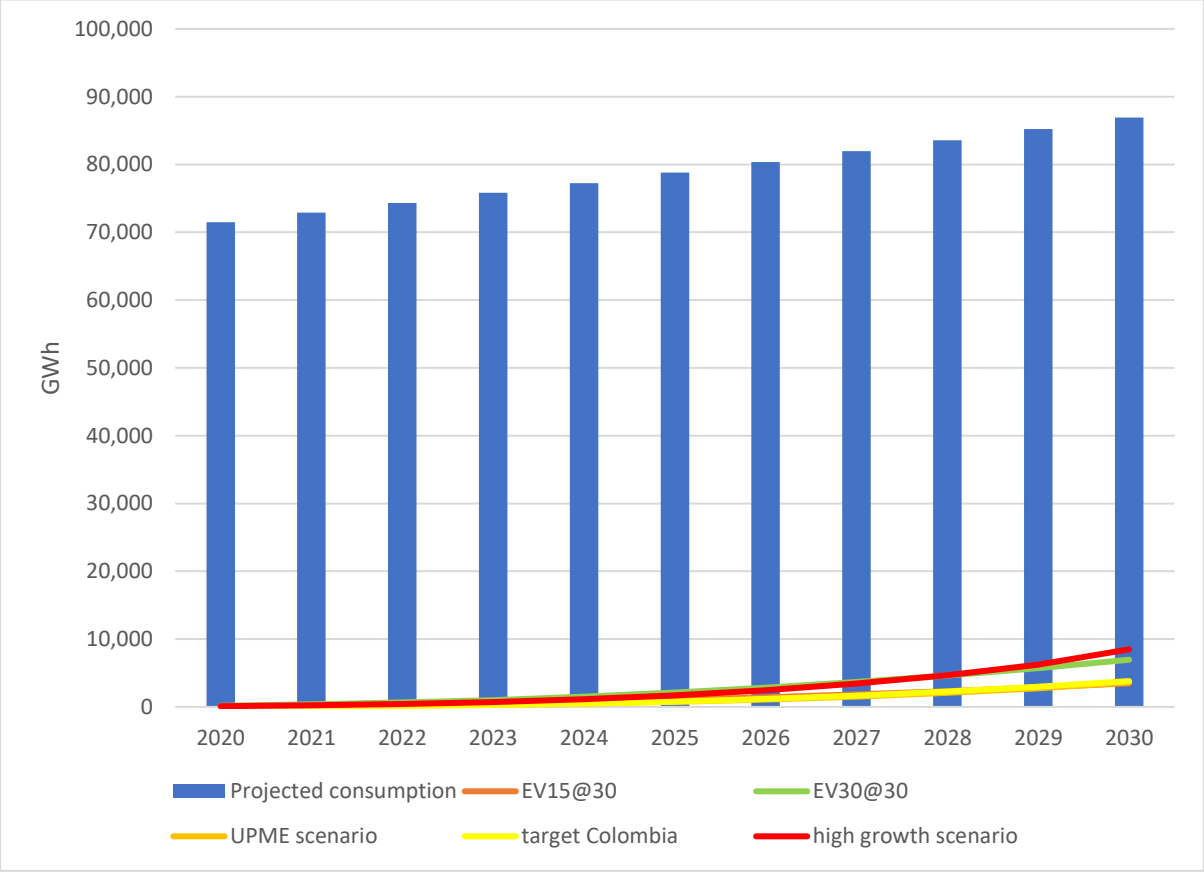
6.3.1. Supply versus Demand

The following figure shows the projected electricity demand from EVs based on the five scenarios (see following chapter for the scenarios) and the projected electricity demand of Colombia.

[13] UPME & XM. (2019). *Emission Factor Calculation of the National Interconnected System.*

[14] The CDM grid factor used for renewable energy projects entered into the CDM was calculated by UPME at 0.38kgCO2e/kWh

Figure 13: EV Electricity Demand vs Total Electricity Consumed Colombia 2020-2030



Source: Grutter Consulting based on EV scenarios and consumption projections based on (Arango, 2019)

The 2030 electricity demand of EVs represents 4% of projected electricity generation for the EV15@30 and the Colombian scenarios (UPME and target), 8% for the EV30@30, and 10% for the high growth scenario. Annual consumption increases excluding EVs in the 2020 to 2030 are 2% or cumulative 22% i.e. the incremental electricity demand from EVs should not meet any difficulties to be met 100% by renewables. Also the demand increase is very gradual and thus leaves enough time to the country to plan a production expansion required however only in a decade from now.

6.3.2. Peak Demand

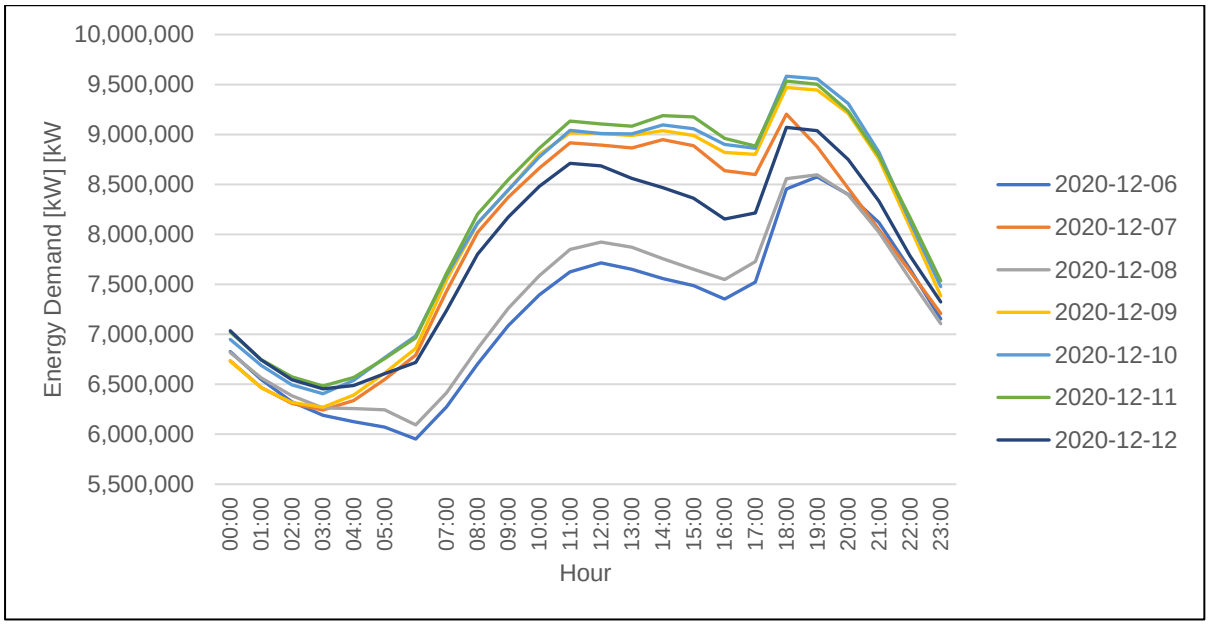
Running 100% EVs not only stresses the grid in terms of electricity production but also in terms of power demand. EV charging can have a sizeable impact on the loads applied to the grid at certain times and locations. The rise in the number of EVs can be accommodated fairly easily by power generation facilities as long as the vehicles are charged off peak. Faster charging during peak demand, however, can have a significant impact [15]. The extent on which EVs will impact the electricity networks will depend highly on technologies and charging modes used with the bulk of charging expected to occur in low-voltage distribution grids in residential or commercial areas (IEA, 2017). The management of the grid is considered critical rather than absolute capacities. Problems which can occur are

[15] Peak demand from a single EV using a top-of-the-range fast charger can be 80 times higher than the expected peak demand of a single typical household. See **Invalid source specified.**

increased peak loads and charging hotspots resulting in local network overloading. EV charging can have a sizeable impact on the loads applied to the grid at certain times and locations.

The following figure shows the typical demand curve during the day in Colombia.

Figure 14: Demand Curve Colombia



Source: XM. (2020h). *Demand_for_OR_2020*. http://portalbissrs.xm.com.co/dmnd/Paginas/Historicos/Historicos.aspx.

The system has a peak in the early evening (from 5-9 PM). Electric buses can avoid using these peaks for charging. This is true for overnight charged buses as well as intermediate or opportunity fast charged buses. Intermediate fast-charged buses are charged 1-2x per day during off-peak transport hours which also coincide with low demand times of the power sector and opportunity charged buses can easily be equipped with large-enough battery sets to run 2-3 hours without charging.

Taxi fast charging could basically be done outside the peak as well and fast chargers could apply significant differential pricing to avoid peak charging. Passenger cars and LCVs are basically charged overnight which minimises the need for incremental electricity generation capacity and investment in distribution infrastructure upgrades. Plugging EVs to the grid too early i.e. before 10PM may however result in this additional demand coinciding with the evening peak electricity demand resulting in a higher risk of overloading of the power distribution network ultimately requiring additional generation capacity and network upgrades. Especially LCVs and passenger cars, but also taxis could be prone to be charged too early as people return home and plug-in their vehicle. This will require smart management involving e.g. controlled charging and using Demand Side Management (DSM) instruments.

6.4. Potential Grid Issues with Commercial EV Charging

This section relates to the connection of charging sites for commercial electric vehicles[16] (EV) to the public electricity grid in urban areas of Colombia, with the main focus on large cities such as the metropolitan area of Bogotá. Commercial EVs will operate rather continuously during day-time and

[16] Commercial vehicles include urban buses, minibuses, taxis, light and medium trucks and public fleet etc.

will be usually charged at sites with many chargers (e.g. depots) and/or by fast chargers with large power ratings. Consequently, the charging sites will require power connections in the range of typically 500 kW to 5 MW. This power range is usually connected directly or indirectly - via a dedicated transformer - to medium voltage (MV) networks. For that reason, this section's focus is on connecting charging sites to MV networks.

Electricity Networks in Colombia

The MV networks in Colombia mainly consist of overhead lines. Only in special cases underground cables are installed[17]. In the large Columbian cities, a distinction is made between 'industrial' and 'non-industrial' MV networks. The most common voltage levels for non-industrial networks are 13.2 kV and 13.8 kV. For industrial networks the most common voltage level is 34.5 kV[18]. It is noted that - dependent on the location and size of the load - also industries could be connected to 13.2 kV networks.

Because of the relatively high voltage level of the 'industrial' MV networks on 34.5 kV, the capacity of the feeders is relatively high. The MV feeders could typically accommodate a total load of 10 to 17 MW[19]. Consequently, charging sites of 500 kW – 5 MW would normally not require dedicated MV feeders, but will likely share the MV feeders with other customers. This may be different for the MV feeders on 13.2 kV or 13.8 kV in 'non-industrial' MV networks. If not already completely loaded, these feeders may be able to facilitate charging sites at the lower end of the 500 kV – 5 MW range. However, larger charging sites may require a dedicated feeder.

It is reported that in the main cities of Colombia, the networks have significant spare capacity to meet future demand. Furthermore, the network operators are in good financial condition to invest in infrastructure and have a high interest in increasing energy sales. In cases like Medellín, the exit from an energy-intensive industry resulted in a lot of unused capacity in the MV networks. Both in Medellín and Bogotá, the networks that are used have excess capacity at night (11 pm-3am).

The medium voltage networks are usually powered from a substation in which High Voltage (HV) is transformed to MV (34.5 kV, 13.8 kV or 13.2 kV). The MV side of these substations typically connects several MV feeders. These feeders are constructed in a so called ring topology and are operated radially. This means that feeders starting from one HV substations may be connected via switching actions to other feeders powered from the same or other HV substations. This has the advantage that in case of a power outage due to a fault in a feeder line or cable or a substation, the power supply can be restored via another route. Consequently, after a fault in a MV feeder or a HV/MV substation, the supply to all customers could be restored within typically a few hours.

In addition to this, MV feeders in Colombia are usually divided into typically three sections by so-called reclosers. In case of a fault in a feeder, these reclosers help to limit the number of customers affected and may limit the duration of the power interruption.

[17] For example where construction regulations prohibit the installation of aerial networks, such as crossings of parks, traffic distributors and parking lots in commercial areas. Also in sectors as underground urban distribution, historical conservation areas, bridges, near heliports or airports (see: https://www.cens.com.co/Portals/2/Documentos/Norma_Actualizada/CAPITULO%203_Redes%20de%20Media%20y%20Baja%20Tensión%20CENS%20-%20Norma%20Técnica%20-%20CNS-NT-03.pdf).

[18] In Antioquia 44 kV

[19] The MV feeders have a capacity of 16 MVA to 27 MVA and are operated up to 70%. Considering an assumed power factor 0.9, the active load per feeder should be in the range of 10 - 17MW.

On average, a customer in Bogotá was in 2018/2019 without power 18 to 20 times per year (=SAIFI). The number of interruptions per customer (SAIFI) for other cities was larger, e.g. customers in Medellín faced almost double the number of power interruptions. The average SAIFI for Colombia was 53 interruptions per year. The average duration of an outage for the customers in Bogotá was in 2018/2019 about 45 minutes (=CAIDI)[20] and was similar to the Colombian average. It is noted that although the duration of a fault is reasonably short, the number of power interruptions is high. The main causes are specific for overhead networks and include lightning, storms and birds. In Bogotá these issues are being mitigated by undergrounding the networks while in Medellín the overhead lines are being isolated.

The Colombian regulation of power quality[21] describes the target voltage quality, including limits for voltage level, flicker, harmonic distortion, and voltage dips in MV networks. The limits in this regulation are in line with internationally applied standards (e.g. IEEE 519 for harmonic distortion) and should be sufficient to connect charging equipment without problems. The regulation adds requirements on monitoring and reporting on these aspects of voltage quality, which are also in line with international standards (e.g. IEC-61000-4-30).

Connecting to the Electricity Network Colombia

The distribution companies are by regulation required to meet the demands of any customer. After a request for a connection, the distribution company carries out a feasibility study. The feasibility studies determines if a direct connection to the existing MV network can be made or if a new MV feeder should be installed.

Summary and Conclusion Considering Commercial EVs and the Power Grid

In summary, the MV networks in the urban areas of Colombia are considered in good shape for accommodating the connection and the load of charging sites for commercial vehicles in the range of 500 kW to 5 MW. Especially for the 'industrial networks' (operated at 34.5 kV), a connection should in general not be of much concern and could be realised pretty quickly. Also in 'non - industrial networks' (operated at 13.2 or 13.8 kV), connections at the lower end of the 500 kW to 5 MW range should usually be realised reasonably fast. The connection of larger charging sites (several MW's) to 'non - industrial networks' may more likely require new feeders, which may take more time to install i.e. sufficiently long lead times in planning are required.

An area of concern is the quality of the electricity networks. Although the duration of an interruption in power supply is on average less than one hour, the number of interruptions per year is high in Bogotá (18-20 per year) and even higher in Medellín (almost 40 interruptions per year). However, black-outs are not generalized in a city i.e. only certain chargers would be affected. A sufficient number of chargers to have system redundancy is thus important.

6.5. Electricity Pricing for EVs

Large transport operators can get negotiated prices below the official tariffs as they are in the non-regulated market. The rates of three of the country's largest traders are presented below. They vary depending on the voltage level and peak and off-peak hours. These are ceiling (maximum) values for

[20] CAIDI is calculated by dividing SAIDI by SAIFI.
[21] D-CREG 032 de 2012 Calidad de la potencia.

the regulated market; however, better prices can be obtained in the unregulated market with significant discounts.

Table 12: Electricity Tariffs in Col. Pesos per kWh as of 2020

Company	Level I		Level II		Level III	
	peak	Off-peak	peak	Off-peak	peak	Off-peak
EPM	563	562	464	463	421	420
CELSIA	549	546	487	484	439	435
Enel	524	523	484	485	417	419
Average in USD	0.15 USD	0.15 USD	0.13 USD	0.13 USD	0.12 USD	0.12 USD

Level I: <1 kV; Level II: 1-30kV; Level III: 30-57.5kV; Peak Level I and II: 9-12 and 18-21; peak level III 6-21:

1 USD = 3,560 Col. Peso

Source: https://www.enel.com.co/content/dam/enel-co/español/personas/1-17-1/2021/Tarifario-enero-2021.pdf;https://www.epm.com.co/site/Portals/2/Documentos/tarifas/Energia_2021/Publicacion_Tarifas_Energia__16_enero_2021.pdf?ver=2021-01-18-153518-887; https://www.celsia.com/wp-content/uploads/2020/09/PUBLICACION-TARIFAS-CELSIA-2020-01-15-ReportePublicacionTarifas.pdf; https://www.enel.com.co/content/dam/enel-co/español/personas/1-17-1/2021/Tarifario-enero-2021.pdf

For urban public fast chargers as used by private EVs the current rate is around 0.26 USD/kWh including electricity and charger cost. For slow chargers the rate is around 0.19 USD/kWh[22]. Residential rates for customers of stratus 4 to 6 which are basically people with financial means to purchase an EV are 015-0.18 USD/kWh.

7. Transport Emissions

7.1. Introduction

2018 around 14 million vehicles were officially listed in the statistics of the Ministry of Transport (Ministerio de Transporte, 2020) - however, based on an analysis of vehicle insurance and annual registration the actual number of operating vehicles is only estimated at around 8.5 million units (UPME, 2015). Many vehicles still in the list of the Ministry of Transport are no longer operational - this is well reflected in the age statistics which shows e.g. more than 1.2 million motorcycles (15% of the fleet) older than 16 years - most of these motorcycles are probably out of operations or only used on a very limited base.

Since 2010 the country has the vehicle emission standard Euro 3 for gasoline cars and motorcycles, Euro 4/IV for diesel powered vehicles[23]. Euro 6 standards are under discussions and shall be introduced 2025 (MinAmbiente, MinMinas, MinTransporte, UPME, 2019). As of 2018 60% of heavy duty vehicles operating in the country comply with Euro II, 15% with Euro IV and 25% with pre-Euro vehicle emission standards (MinAmbiente, MinMinas, MinTransporte, UPME, 2019).

Resolution 90963 of 2014 established a maximum sulfur contents in fuels of 50 ppm. The ethanol share in gasoline is currently 10% and the biodiesel share in diesel also 10% GHG calculations are thus influenced by this biofuel share (MinMinas, 2020).

[22] https://www.epm.com.co/site/home/sala-de-prensa/boletines-estamos-ahi/epm-lanzo-su-servicio-de-carga-para-vehiculos-electricos

[23] Emission Standards: Colombia: On-Road Vehicles and Engines (dieselnet.com)

The following table shows the median age of vehicles per vehicle category and the projected commercial lifespan.

Table 13: Vehicle Average Age in 2018

Vehicle Category	Average age in 2018	Projected commercial lifespan in years
Passenger car	12 years	18 years
Motorcycle	8 years	12 years
Cab	9 years	14 years
Small bus	13 years	20 years
Urban bus	13 years	20 years
LCV	10 years	15 years
Truck	13 years	20 years

Source: Calculation by Grutter Consulting based on data (Ministerio de Transporte, 2020) adjusted for vehicles >16 years; commercial lifespan estimated at 1.5x average age

7.2. Transport Emissions 2018

The following table shows operational vehicles of Colombia in 2018.

Table 14: Operational Vehicles Colombia 2018

Vehicle category	Gasoline	Diesel	CNG	Total operational	Share operational of registered vehicles
Passenger car incl. pick-up	2,912,350	30,982	154,912	3,098,244	80%
Taxi	77,761	0	58,662	136,424	61%
Motorcycle	3,845,058	0	0	3,845,058	48%
small bus	0	66,988	0	66,988	80%
standard urban bus	0	61,416	0	61,416	55%
LCV	894,176	88,435	0	982,611	82%
Truck < 7.5t	0	96,770	0	96,770	73%
Truck 7.5-16t	0	96,770	0	96,770	73%
Truck 16-32t	0	43,220	0	43,220	87%
Truck >32t	0	48,140	0	48,140	87%

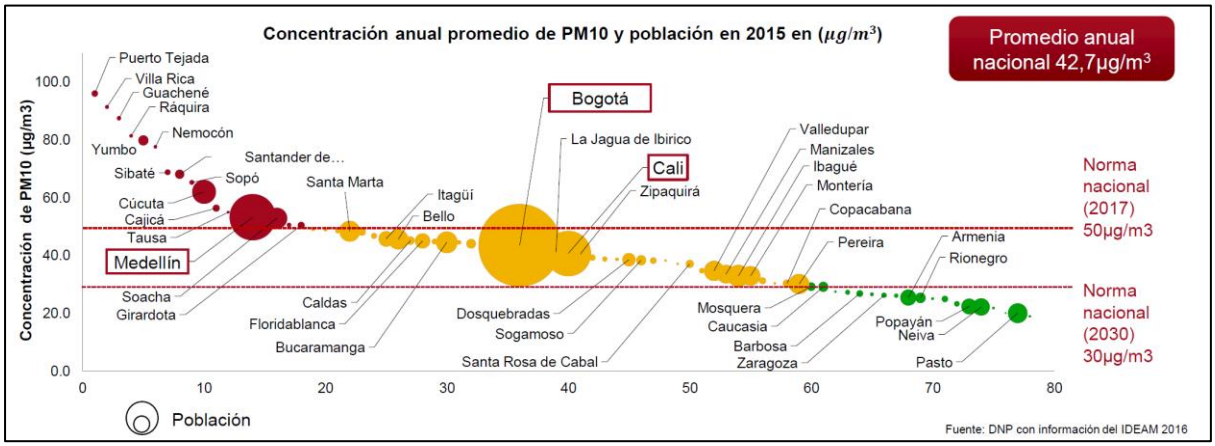
Source: (Ministerio de Transporte, 2020); car includes campero; LCV = camioneta; truck>32t = tractocamion; truck 16-31 = volqueta; camion distributed 50:50 in lowest 2 categories; fuel distribution based on (Andemos, 2020); MOT has registered vehicles- not all of these circulate however - data from (UPME, 2015) shows the share of actually circulating vehicles (with annual licence plus insurance) (see table 2) -a correction factor of 1.2 based on actual sales of SOAT relative to registered vehicles with SOAT has been applied to the UPME data;

No significant number of 3-wheelers operate in the country. Urban buses include basically standard 12m units. However also medium sized buses, articulated and bi-articulated units operate in Colombia.

Air quality Colombia

76% of the municipalities with monitoring of the air quality in Colombia register PM10 levels which surpass the annual norm of 50 μgm^3 (see figure below).

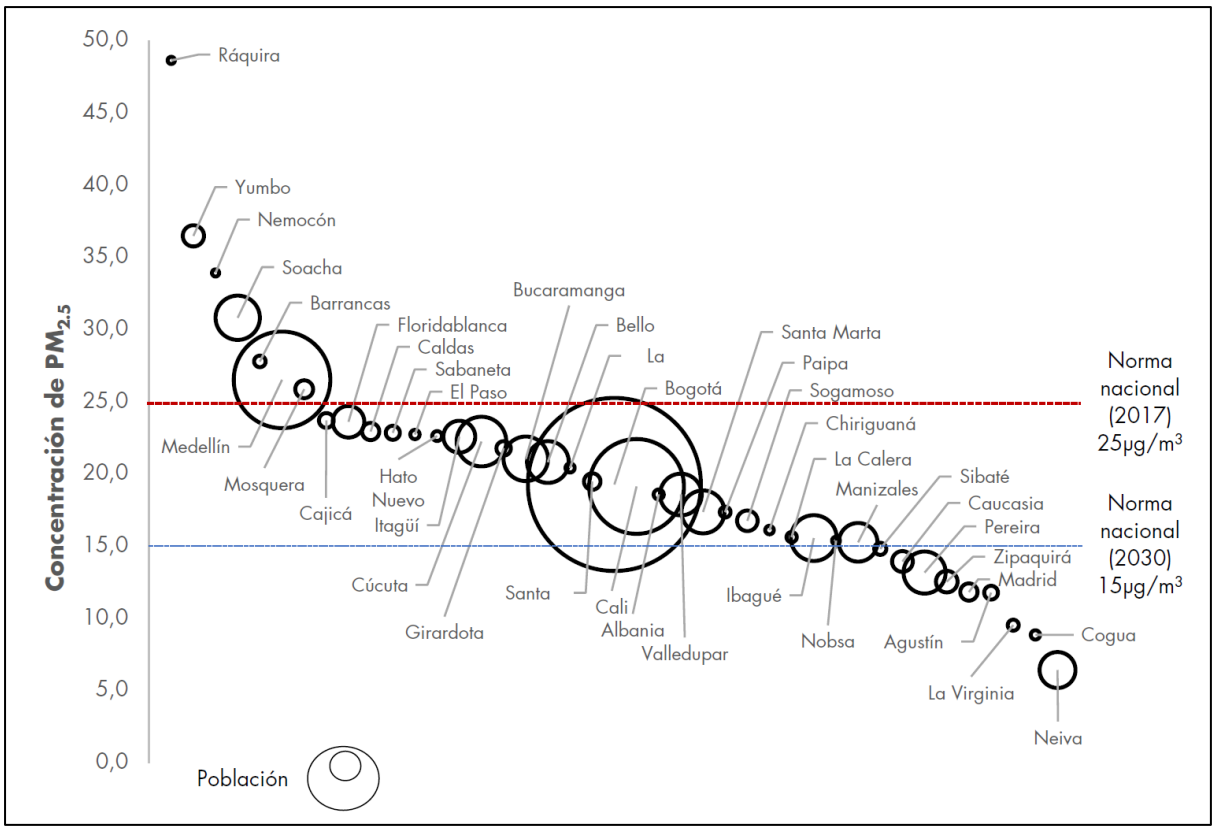
Figure 15: Annual PM_{10} Concentration in Municipalities of Colombia in 2015



Source: DNP with information of IDEAM 2016 cited in F. Mejia, DNP, Calidad del aire: Una prioridad de politica publica en Colombia, 02/2018

For $PM_{2.5}$ the results are slightly better considering the norms of 2017 but based on the norms valid as of 2030 the large majority of urban areas have air pollution levels which are above the future norm (see figure below).

Figure 16: Annual $PM_{2.5}$ Concentration in Municipalities of Colombia in 2016



Source: DNP with information of IDEAM 2018 cited in (CONPES, 2018)

Emission inventories of large cities show that around 80% of particle emissions are due to transport and 20% due to industry. The major sources are buses and trucks with 70-80% of all vehicle emissions (larger share for buses in Bogota and larger share for trucks in Valle de Aburra). Transport is also

responsible for around 60% of NO_x emissions (CONPES, 2018). 2018 results of Bogota show that the new transport system has resulted in emission reductions of buses. The major transport source of PM_{10} emissions are now trucks with 40% followed by cars and light commercial vehicles with 17% each and buses with 12%. For NO_x the major source are buses with 24%, followed by cars with 22% and LCVs with 18% (SDA, 2019)[24].

The bad air quality is also perceived by the population: 51% of the population consider the air quality to be an environmental problem (based on survey realized by DNP, 2017 cited in F. Mejia, DNP, Calidad del aire: Una prioridad de politica publica en Colombia, 02/2018). In 2016 Colombia realized an economic valuation of the costs of air pollution based on the methodology of the World Bank. It was estimated for 2018 that around 8,000 deaths have to be attributed to air pollution. Depending on the methodology chosen, the cost of air pollution is estimated at the equivalent of 0.2 to 1.5% of the GDP of Colombia (lowest figure based on cost of insurances and compensation payments; highest value based on statistical value of life).

The following table summarizes core assumptions on milage and fuel consumption used for calculations[25].

Table 15: Main Parameters Used for Emission Calculations 2018

Vehicle Category	Fuel Used	Specific fuel consumption (l/100km)	Annual mileage (km)
Passenger car	Gasoline	7.6	14,000
	Diesel	6.5	17,000
	CNG	8.8 m^3/100km	17,000
Taxi	Gasoline	7.6	55,000
	Diesel	6.5	55,000
	CNG	8.8 m^3/100km	60,000
Motorcycles	Gasoline	2.7	11,500
small bus	Diesel	18	60,000
standard urban bus	Diesel	47	70,000
LCV	Gasoline	9.4	30,000
	Diesel	9.5	30,000
Truck < 7.5t	Diesel	12	40,000
Truck 7.5-16t	Diesel	18	45,000
Truck 16-32t	Diesel	25	50,000
Truck >32t	Diesel	30	70,000

Source: Distance driven determined based on international averages of operating vehicles with calibration realized to match actual total amount of transport fuels consumed in Colombia; Fuel consumption: Passenger car size small; all fuel consumption values from (EEA, 2020) Tier 2 approach for vehicles > Euro 1/I;

The following table shows estimated 2018 transport emissions for Colombia. The model has been calibrated with actual transport fuel consumed by Colombia in 2019 based on BECO[26] with a difference between top-down actual fuel consumption and the modelled bottom-up consumption of -0.4% for gasoline, +0.3% for diesel and +0.4% for CNG.

[24] See for further air quality details of Colombia Annex 1 report

[25] Fuel consumption is the base for calculation of GHG emissions using for tank-to-wheel (TTW) calculations the fuel consumed, Net Calorific Value and the CO_2 Emissions factor and for well-to-wheel (WTW) calculations an upstream mark-up for fuel extraction, refinery and transport plus the GHG emissions caused by Black Carbon.

[26] BALANCE ENERGETICO COLOMBIANO - BECO (upme.gov.co)

Table 16: Estimated 2018 Transport Emissions

Vehicle category	NO_x	$PM_{2.5}$	CO_2 TTW	CO_2 WTW	Energy in TJ
Passenger car	10,922	121	7,599,822	9,190,312	110,359
Taxi	1,288	13	1,400,686	1,805,081	21,254
Motorcycles	14,017	155	2,714,987	3,265,656	39,177
small bus	3,633	655	1,945,584	2,776,326	26,256
standard urban bus	46,001	946	5,549,483	7,379,165	74,892
LCV	6,565	372	6,441,009	7,929,227	92,312
Truck < 7.5t	13,509	236	1,245,690	1,670,328	16,811
Truck 7.5-16t	23,951	453	2,150,665	2,910,255	29,024
Truck 16-32t	17,093	335	1,445,967	1,974,486	19,514
Truck >32t	31,542	654	2,695,060	3,697,366	36,371
Total	**168,521**	**3,940**	**33,188,951**	**42,598,203**	**465,969**

Source: Grutter Consulting; for details of modelling data see Annex 1

Transport GHG emissions of Colombia TTW in 2018 were 33.2 million tCO_{2e}. Based on fuel sales the emissions are 33.1 million tCO_{2e} i.e. the modelled values reflect well the monitored top-down calculation. WTW GHG emissions are 43 million tCO_{2e} – these reflect the GHG emissions caused directly and indirectly by the transportation sector of Colombia: these emissions occur basically within the country due to fuel extraction, refinery and transport. Taking into account the biofuel usage and assuming no upstream (WTT) emissions of biofuels (highly unrealistic as emissions due to land-use change as well as due to fertilizers used could well result in higher total emissions than of fossil fuels) the GHG emissions TTW as well as WTW would be 10% lower reaching 30 $MtCO_{2e}$ (TTW) respectively 38 $MtCO_{2e}$ (WTW).

Taxis represent in 2019 around 4% of GHG emissions, buses 24% and LCVs 19% i.e. the targeted vehicle sectors result in nearly 50% of transport GHG emissions. Noteworthy is also that the mentioned commercial vehicles represent 50% of $PM_{2.5}$ and 34% of NO_x emissions of the transport sector due to being primarily diesel vehicles whilst passenger cars and motorcycles used by private persons are predominantly gasoline powered.

7.3. Projected 2030 Transport Emissions

For 2030 projections the data of (UPME, 2015) was used. The slightly different vehicle categories as used by UPME were adjusted for this purpose:

- Bus vehicle growth of annually 1.8%
- Passenger car, taxi and motorcycle growth of annually 4.0%
- LCV and truck growth of annually 2.2%

Vehicle growth rates per vehicle category are used to model vehicle numbers for 2030. The mileage of vehicles is kept constant. The following table shows projected 2030 transport emissions of Colombia.

Table 17: Projected 2030 Transport Emissions

Vehicle category	NO_x	$PM_{2.5}$	CO_2 TTW	CO_2 WTW	Energy in TJ
Passenger car	4,697	103	12,140,534	14,646,224	176,296
Taxi	732	14	2,237,562	2,881,207	33,952
Motorcycles	13,704	247	4,337,127	5,216,808	62,585
small bus	25,221	198	2,397,554	3,082,723	32,356
standard urban bus	28,714	245	6,268,774	7,875,806	84,599
LCV	5,104	180	8,383,530	10,127,381	120,152
Truck < 7.5t	8,263	53	1,621,373	2,030,337	21,881
Truck 7.5-16t	15,020	91	2,799,276	3,504,706	37,777
Truck 16-32t	10,773	67	1,882,050	2,360,298	25,399
Truck >32t	20,220	118	3,507,854	4,394,005	47,339
Total	**132,447**	**1,316**	**45,575,633**	**56,119,494**	**642,335**

Source: Grutter Consulting; for details of modelling data see Annex 1

TTW emission from the transport sector are expected to grow under a BAU scenario by nearly 40% reaching 46 million tCO_2 by 2030 (56 million tCO_{2e} with a WTW approach) – considering 0-emissions from biofuels and a continuous 10% share of biofuels the TTW emissions would be 41 $MtCO_{2e}$ and the WTW emissions 51 $MtCO_{2e}$ by 2030.

8. EV Scenarios

5 different EV scenarios have been constructed which are contrasted with the BAU scenario[27]:

- EV30@30: The EV30@30 scenario of IEA has as target that 30% of all vehicles sold in 2030 are electric. The scenario is built on newly purchased vehicles (and not the stock of vehicles) in line with IEA scenarios (IEA, 2019). In addition to the IEA also motorcycles and trucks <7.5t are included with the same EV penetration rates.
- EV15@30: The moderate EV scenario is based on the "EV new policies scenario" which has as target for 2030 15% instead of 30% EV share. The same approach is used as for EV30@30.
- EV scenario based on projections of UPME in Colombia (UPME & MinMinas, 2019).
- EV scenario based on official national targets in Colombia.
- EV "high-growth potential" scenario focusing on the potential for commercial vehicles targeted by the e-mobility fund with an EV target of 100% of new registered vehicles for these categories by 2030. In all other vehicle categories the maximum of the 3 other scenarios has been chosen.

The number of vehicles to be newly registered per annum is the sum of additional vehicles (due to vehicle growth) and replacement vehicles. Scenarios with absolute targets of EVs at a given year (as stock of vehicles) have been translated to annual EV registration data.

EV 15@30 and 30@30 Scenarios

The following table shows the modelled share of EVs as total of new registered vehicles 2019 to 2030.

[27] See for more detailed assumptions: (Grutter Consulting, 2020)

Table 18: EV Rates of Newly registered Vehicles

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EV15@30	3%	3%	4%	5%	7%	9%	10%	11%	12%	14%	15%
EV30@30	5%	6%	8%	11%	14%	18%	20%	22%	24%	27%	30%

Source: Grutter Consulting based on IEA scenarios

Scenario Projections UPME Colombia

The targets are coming from a report by UPME to determine the required charging infrastructure in Colombia. For this purpose projections of EVs per vehicle sector were realized based on percentage of vehicle stock and vehicle number targets for years 2021, 2025 and 2030 and re-calculated to % of annual EV registrations to reach this target.

Table 19: EV Rates of Newly Registered Vehicles EV Scenario Projection UPME

Vehicle Category	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cars	0%	11%	2%	4%	7%	10%	16%	19%	23%	26%	30%
Motorcycles	0%	2%	3%	5%	8%	9%	10%	12%	13%	15%	18%
taxis	0%	1%	5%	10%	20%	40%	15%	15%	15%	15%	20%
Large buses	0%	12%	4%	5%	6%	9%	20%	30%	50%	70%	80%
LCVs	0%	7%	6%	6%	6%	6%	8%	10%	13%	16%	20%

Source: Grutter Consulting based on targets in (UPME & MinMinas, 2019)

Numbers might seem a bit erratic. The problem is, that UPME formulated the targets based on the vehicle stock (see table below), which results in a gradual increase of vehicle numbers. However, this does not take into account stock/vehicle renewal and thus results in not very logic dips in EV registration shares. This illustrates the problematic of making projections based on vehicle stocks instead of vehicle registration units.

Table 20: EV Stock Projection Targets UPME

Vehicle category	Target 2021	Target 2025	Target 2030
Cars	0.1%	2.9%	8.0%
Motorcycles	0.2%	2.9%	5.4%
Taxis	0.1%	8.1%	14.8%
Urban transport (taken as equal to large buses)	0.8%	2.3%	18.7%
Urban freight (taken as equal to LCVs)	0.6%	2.6%	7.9%

Source: (UPME & MinMinas, 2019)

Scenarios are made for illustrative purposes to assess their impact on the EV stock, the electricity sector and the environmental impact. The table below shows an illustrative calculation of the electric passenger cars under this EV scenario reaching the target of 600,000 electric cars in 2030.

Table 21: EV Car Scenario "UPME" Colombia

Passenger cars UPME Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all cars	3,349,820	3,483,167	3,621,822	3,765,997	3,915,911	4,071,793	4,233,880	4,402,420	4,577,668	4,759,893	4,949,371
Replacement cars	178,977	186,101	193,509	201,212	209,222	217,551	226,211	235,216	244,579	254,315	264,438
Additional new cars	128,242	133,347	138,655	144,175	149,914	155,882	162,087	168,539	175,248	182,225	189,479
EV car fleet new	0	34,832	6,643	13,815	25,140	37,343	62,128	76,713	96,560	113,500	136,175
EV car fleet stock	0	34,832	41,475	55,290	80,430	117,773	179,901	256,614	353,175	466,675	602,850
EV fleet as % of stock	0%	1%	1%	1%	2%	3%	4%	6%	8%	10%	12%
GHG reduction WTW in tons	0	88,426	105,291	140,363	204,184	298,986	456,707	651,456	896,589	1,184,727	1,530,429
Electricity demand GWh	0.0	87.8	104.5	139.3	202.7	296.8	453.4	646.7	890.0	1176.0	1519.2

Source: Grutter Consulting

Scenario Colombian National Targets

The national energy plan 2020-2050 (UPME, 2019) for cars, taxis, freight transport urban/interurban (translated into LCVs) and passenger transport urban/interurban (translated into small buses as large bus targets are fixed in law 1964 of 2019). Buses target is taken from the law 1964 which has for cities with mass transit systems targets for new purchased vehicles from 2025 onwards (see table below).

Table 22: Target EV Share of New Registered Public Transport Buses (for cities with mass transport systems)

	2025	2027	2029	2031	2033	2035
Target	10%	20%	40%	60%	80%	100%

Source: Law 1964, 2019, paragraph 3

The table below shows the Colombian national targets translated into vehicle registration shares per annum.

Table 23: EV Rates of Newly Registered Vehicles Colombian National Target

Vehicle Category	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cars	0%	1%	3%	5%	7%	10%	13%	16%	19%	23%	28%
taxis	0%	1%	2%	5%	9%	15%	20%	25%	33%	40%	50%
Large buses	0%	5%	6%	7%	8%	10%	15%	20%	30%	40%	50%
Small buses	0%	5%	25%	40%	60%	80%	100%	100%	100%	100%	100%
LCVs	0%	0%	1%	1%	1%	1%	2%	3%	4%	6%	8%

Source: Grutter Consulting based on targets (UPME, 2019) and law 1964

EV High Growth Potential Scenario

The share of newly registered EVs for the selected vehicle categories in the potential scenario is shown below.

Table 24: Share of EVs of Newly Registered Vehicles "Potential Scenario"

Vehicle Category	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Taxis	0%	1%	1%	4%	8%	14%	22%	32%	45%	61%	100%
Urban Buses	0%	1%	1%	4%	8%	14%	22%	32%	45%	61%	100%
Small buses	0%	1%	1%	4%	8%	14%	22%	32%	45%	61%	100%
LCVs	0%	0%	1%	4%	8%	14%	22%	32%	45%	61%	100%

Source: For urban buses, taxis and LCVs the target is that 100% of new registered buses/taxis/LCVs in 2030 are electric; This takes into consideration that EVs in this segment should be cost-competitive by 2030. No early replacement of vehicles is made i.e. conventional vehicles could still be used until ending their lifespan. The growth builds upon initial experiences which remove barriers cost reductions of vehicles to achieve financial equivalence in the future. For taxis a kick-start with 100 taxis in 2021 is assumed and for other vehicle categories 50 units. The growth curve towards 2030 is based on a power function based on the curve of Norway for the last 10 years. Initial experiences are built and cost structures go down. Barriers are removed and financial equivalence will be achieved.

For other vehicle categories no specific scenario is made but the highest value from the other 3 EV scenarios is taken.

Scenario Results

The following table shows the results in terms of GHG reduction against the BAU scenario of no EVs as well as the additional electricity consumption due to EVs with the different scenarios.

Table 25: Scenario Results

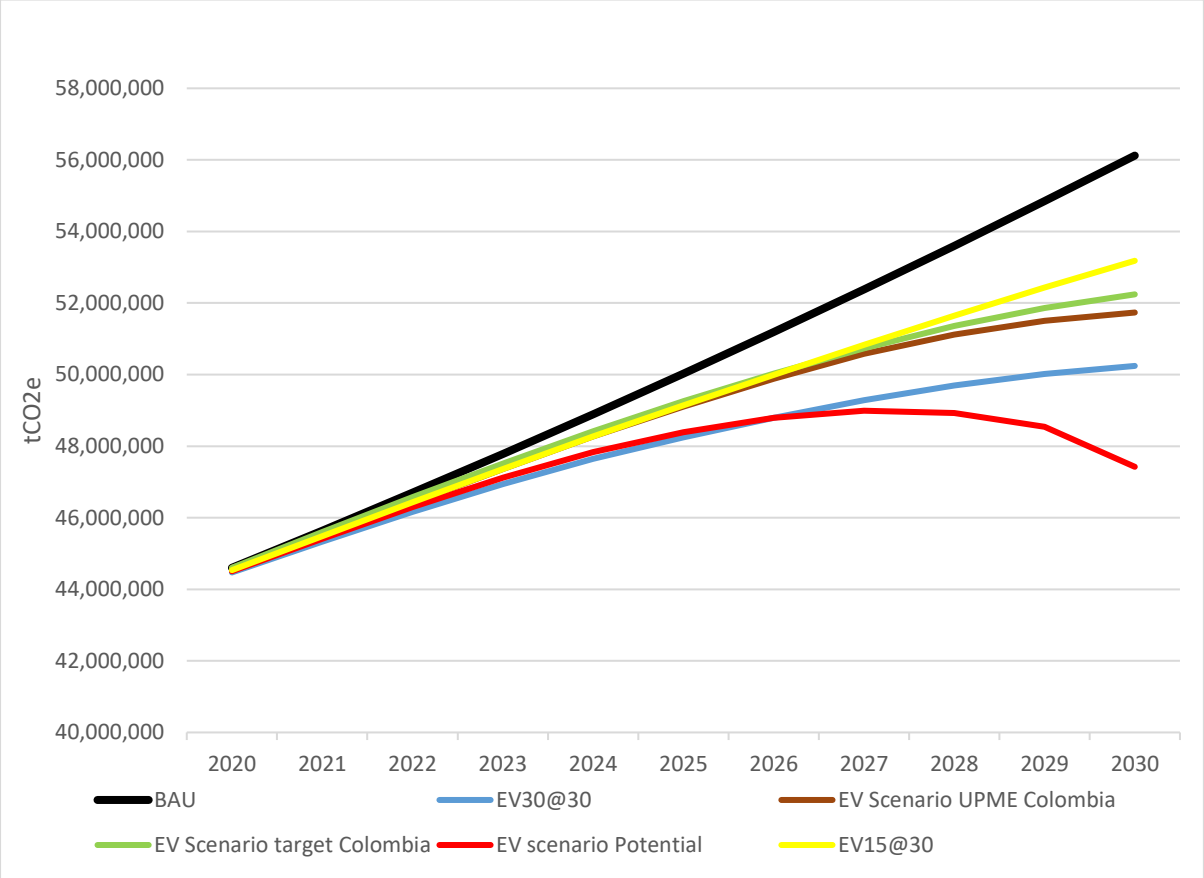
Impact	Scenario	By 2025	By 2030
GHG reduction WTW in tCO_{2e} per annum	IEA 15@30	890,000	2,900,000
	IEA30@30	1,780,000	5,900,000
	UPME projection	920,000	4,400,000
	Colombian target	770,000	3,900,000
	"Potential" scenario	1,640,000	8,700,000
Electricity demand of EVs in GWh per annum	IEA 15@30	1,060	3,500
	IEA30@30	2,130	7,000
	UPME projection	770	3,600
	Colombian target	780	3,800
	"Potential" scenario	1,710	8,500

Source: Grutter Consulting, see Annex for further details

The growth of electricity demand is discussed in chapter 6. The UPME projection and the Colombian targets are situated in-between the IEA 15@30 and 30@30 targets.

The most ambitious scenario (EV potential scenario) would result in a 15% reduction of GHGs relative to the baseline. Only the "high growth potential" scenario result in a trend change in this period and even latter still result in GHG transportation emissions in 2030 being higher than in 2018. This clearly shows (i) the limitations of EV strategies to bring short-term massive GHG reductions (ii) the impact time-lag involved in any technology renewal strategies with the transportation sector (iii) the necessity to act quickly and to have quickly a high vehicle renewal share to achieve medium term large impacts. The figure below shows the slow reaction of GHG emission reductions of the sector due to long permanence of vehicles once purchased. The introduction of EVs takes a long time to reduce in absolute terms GHG emissions of the transport sector as vehicle growth still occurs and as vehicle replacement rates are relatively low i.e. it takes time to achieve a large stock and therefore large impact of EVs. This highlights the importance of early actions. Waiting 5-10 years more until the market has evolved without support will result in a 5-10-year time lag of GHG reductions and thus non-attainment of climate targets.

Figure 17: Projected GHG Transport Emissions Colombia BAU and with EV Scenarios (WTW)



Source: Grutter Consulting

The following tables shows the impacts which are possible to achieve for the targeted vehicle sectors under a "high-growth scenario".

Table 26: Taxis "High-Growth Potential Scenario"

High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all taxis	147,501	153,373	159,478	165,827	172,428	179,292	186,429	193,850	201,566	209,590	217,934
Replacement taxis	10,508	10,926	11,361	11,813	12,283	12,772	13,281	13,810	14,359	14,931	15,525
Additional new taxis	5,647	5,872	6,105	6,348	6,601	6,864	7,137	7,421	7,717	8,024	8,343
EV taxi fleet new	0	100	240	695	1,491	2,721	4,479	6,868	9,998	13,989	23,868
EV taxi fleet stock	0	100	340	1,035	2,526	5,247	9,726	16,594	26,592	40,580	64,449
EV taxi as % of stock	0%	0%	0%	1%	1%	3%	5%	9%	13%	19%	30%
GHG reduction WTW in tons	0	997	3,395	10,322	25,194	52,328	96,996	165,492	265,206	404,718	642,765
Electricity demand GWh	0.0	1.0	3.4	10.2	25.0	51.9	96.3	164.3	263.3	401.7	638.0

Source: Grutter Consulting

Table 27: Small Buses "High-Growth Potential Scenario"

Small Bus High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	69,361	70,579	71,819	73,080	74,363	75,669	76,997	78,349	79,725	81,125	82,550
Replacement vehicles	3,496	3,557	3,619	3,683	3,748	3,813	3,880	3,949	4,018	4,088	4,160
Additional new vehicles	1,197	1,218	1,239	1,261	1,283	1,306	1,329	1,352	1,376	1,400	1,425
EV vehicle fleet new	0	66	67	189	397	709	1,143	1,715	2,443	3,345	5,585
EV vehicle fleet stock	11	77	144	333	730	1,439	2,582	4,297	6,739	10,084	15,669
EV fleet as % of stock	0%	0%	0%	0%	1%	2%	3%	5%	8%	12%	19%
GHG reduction WTW in tons	309	2,157	4,038	9,354	20,524	40,467	72,595	120,807	189,491	283,533	440,561
Electricity demand GWh	0.4	2.6	4.8	11.2	24.5	48.4	86.8	144.4	226.4	338.8	526.5

Source: Grutter Consulting

Table 28: Urban Buses "High-Growth Potential Scenario"

Urban bus High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	63,592	64,709	65,845	67,001	68,178	69,375	70,593	71,833	73,094	74,378	75,684
Replacement vehicles	3,205	3,261	3,318	3,377	3,436	3,496	3,558	3,620	3,684	3,748	3,814
Additional new vehicles	1,097	1,117	1,136	1,156	1,177	1,197	1,218	1,240	1,261	1,284	1,306
EV vehicle fleet new	0	50	61	173	364	650	1,048	1,572	2,240	3,066	5,120
EV vehicle fleet stock	42	92	153	327	691	1,341	2,389	3,961	6,200	9,267	14,387
EV fleet as % of stock	0%	0%	0%	0%	1%	2%	3%	6%	8%	12%	19%
GHG reduction WTW in tons	3,988	8,737	14,560	31,022	65,607	127,360	226,845	376,133	588,811	880,008	1,366,241
Electricity demand GWh	2.9	6.4	10.7	22.9	48.4	93.9	167.2	277.3	434.0	648.7	1007.1

Source: Grutter Consulting

Table 29: LCVs "High-Growth Potential Scenario"

LCV High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	1,026,740	1,049,542	1,072,851	1,096,677	1,121,033	1,145,929	1,171,378	1,197,392	1,223,985	1,251,167	1,278,954
Replacement vehicles	66,962	68,449	69,969	71,523	73,112	74,736	76,395	78,092	79,826	81,599	83,411
Additional new vehicles	22,307	22,802	23,309	23,826	24,355	24,896	25,449	26,014	26,592	27,183	27,786
EV vehicle fleet new	0	50	1,284	3,646	7,696	13,804	22,340	33,677	48,196	66,292	111,197
EV vehicle fleet stock	276	326	1,610	5,257	12,952	26,757	49,097	82,774	130,971	197,262	308,460
EV fleet as % of stock	0%	0%	0%	0%	1%	2%	4%	7%	11%	16%	24%
GHG reduction WTW in tons	1,903	2,248	11,104	36,251	89,325	184,524	338,591	570,841	903,220	1,360,390	2,127,248
Electricity demand GWh	1.7	2.0	9.7	31.5	77.7	160.5	294.6	496.6	785.8	1183.6	1850.8

Source: Grutter Consulting

The following table shows key figures for the potential EV scenario in terms of number of electric vehicles, the GHG impact and the vehicle investment volume.

Table 30: Key Figures Commercial Vehicles EV "High-Growth Potential Scenario"

Parameter	Taxis	Small Buses	Urban Buses	LCVs	Total
EV stock 2025 (% of all vehicles)	5,200 (3%)	1,400 (2%)	1,300 (2%)	27,000 (2%)	35,000
EV Stock 2030 (% of all vehicles)	64,000 (30%	16,000 (19%)	14,000 (19%)	308,000 (24%)	404,000
GHG impact 2025	52,000	40,000	127,000	185,000	388,000
GHG impact 2030	642,000	441,000	1,366,000	2,127,000	4,576,000
$PM_{2.5}$ reduction 2030 (tons)	4	38	47	43	132
NO_x reduction 2030 (tons)	216	4,787	5,459	1,231	11,693
Savings emission costs in 2030 (MUSD)	27	40	82	101	251
Savings in pollutants costs in 2030 (MUSD)	2	23	27	16	68
Vehicle CAPEX 2025 (cumulative) MUSD	335	107	293	602	1,336
Vehicle CAPEX 2030 (cumulative) MUSD	1,310	980	2,770	6,400	11,500

Note: Constant real USD of 2020; vehicle values based on 2020 average values and annual reduction rate for each vehicle category based on market trends; see Annex for further details

Source: Grutter Consulting

By implementing this strategy Colombia would have more than 400,000 commercial EVs by 2030 reducing 4.6 $MtCO_2$ in 2030. Around 50% of the impact by 2030 would be with LCVs followed by urban buses with 30%. The estimated cumulative vehicle investment required by 2025 is around 1.3 billion USD and 11.5 billion USD by 2030. This excludes the investment required for chargers, grid upgrades or other investments e.g. in depot facilities. More than 50% of the required investment would be in LCVs. This is not the incremental investment for EVs relative to the BAU investment for fossil vehicles but the total required vehicle investment. Economic savings due to reduced emissions would reach by

2030 more than 320 MUSD (annual figure) of which nearly 80% is due to savings on reduced GHG emissions.

9. Facilitators and barriers

Facilitators

- **Authorities' interest in electromobility:** the National Government has shown its interest by publishing policies that seek to promote electromobility as well as the incentives stated in the *Electric Mobility Law*. Likewise, major cities such as Bogota, Medellin and Cali have shown their interest incorporating electric vehicle fleets and setting as a goal the expansion of this technology in their systems.
- **Public policy for urban transportation systems:** the policies issued at the national level that structure the SITM and SETP allow to improve the business structures of the operators in the system, which allows having a more robust institutional structure as they are not in charge of individuals. These schemes facilitate the inclusion of electromobility, which requires such capabilities.
- **The automotive industry in the country:** Colombia has an automotive industry that has been strengthened over time mainly made up of assemblers, which allows the production of trucks, buses, cars and motorcycles that can be electric thus reducing costs since these vehicles are currently imported.
- **Structured transport sector:** Since 2001, when the first line of Transmilenio started operating in Bogotá, Colombia initiated a process of change that has allowed for a radical change in the business structure of the public transportation sector. The BRT systems model has allowed to move from a scheme of atomized ownership and the so-called “guerra del centavo” (penny war), to one in which the main cities of the country already have a sector of transportation entrepreneurs that have brought formality to the sector. Despite the fact that some SITM in some cities have presented financial problems, there is a strong institutional framework that allows establishing clear rules between the public and private sectors..

Barriers

- **Initial investment costs:** the differential between the initial investments of the electric vehicle with respect to a conventional vehicle makes the acquisition difficult for most public transport services, considering that they generally require the intervention of local authorities in the financial deficit due to the difference between the technical tariff and the tariff to the public. In addition, this technology incorporates a considerable investment in recharging infrastructure, which requires specialized human talent. This barrier can be mitigated by incorporating non-refundable resources or financing fees with significantly lower rates compared to traditional vehicles.
- **Lack of knowledge of the technology:** although pilot projects have been carried out in the main SITM to learn about the operating conditions of the vehicles, in general, this is a privilege for the most robust systems. However, in medium-sized city systems and individual operators, as taxis, the sector and its operation is unknown. Some issues on which there is no knowledge in batteries are: useful lives, potential reuse and their respective disposal at the end of useful life. In addition, the lack of knowledge on the incidence of variables associated with the operation, such as topography, as in the case of Medellin, where some basins have corridors

with high slopes and yields are still components to be evaluated. As well as, knowledge is limited in the face of technological advances such as fast or ultra-fast charging infrastructure. This barrier can be mitigated by training for entrepreneurs on the technology, as well as the appropriate selection of the type of vehicle according to its operational conditions, knowledge sharing in countries where the technology has been in place for several years, among others.

- **Reinvestment for battery replacement:** since the systems contemplated in the inclusion of electromobility in the transportation systems are made up of vehicles with batteries, considerable reinvestments must be made in year 7 or 8, which requires the owner to have resources or financing that is aware of this flow of resources. Given the conditions of the massive systems in Colombia, which operate in BRT schemes, other types of recharging technologies can be considered, such as opportunity charging stations, which would facilitate the operating conditions by not requiring a complex battery recharging schedule. Thus, comprehensive financing schemes are required that contemplate: a. reinvestments for systems based on battery buses, or b. additional initial investments in CAPEX to acquire opportunity charging systems.
- **Financial conditions of transport systems:** in general, transport systems do not have financial solvency, which increases the investment risk for traditional financiers, who, considering the payment history of previous loans, prefer not to participate in these schemes. This barrier makes evident the need for the active participation of the national and local government in the structuring of new financing schemes that guarantee payment to the financiers, as well as competitive financing conditions to which the systems can have access. Thanks to the COVID -19 crisis, several transportation systems are in a difficult situation that forces them to rethink the various payment mechanisms, as in the Chilean case, where the operator's remuneration varies according not only to the kilometers travelled, but also to the volume of passengers. Discussions are also beginning on possible payment mechanisms based on fleet availability, but more studies and experiences need to be analysed to review the feasibility of these proposals in each city.
- **Institutional capacity:** in general, local transport authorities and transport systems have limited institutional capacity, which hinders the regularization, supervision and adequate control of the systems. Strengthening the technical capacity of existing officials, as well as providing additional vacancies, facilitates the operation of the system, financial control, among others.
- **Low supply of electric vehicles:** the supply of electric vehicles is still limited to a few manufacturers with national presence, so the options for purchasing and obtaining spare parts are expensive. In the case of electric buses, the main manufacturers are Chinese, where the electric bus industry is booming, which increases transportation costs and exceeds the normally estimated budgets.
- **Recharging infrastructure:** is a very important limitation, because in general there is a low level of development in some cities and the implementation of the recharging infrastructure has some complexities, such as having exclusive land, making adjustments to the distribution network due to the high power required to charge the buses, among others.
- **Coordination with local and regional authorities:** although the law 1964 of 2019 establishes a roadmap with the percentage of electric buses that must be included at the time of fleet replacement or fleet addition, this is a national policy that needs to be adapted to the local context. In addition, each municipality must establish a roadmap, allocate resources for this type of projects and have instruments for their implementation, since to date, there are no local policies except for some cities such as Bogota or Medellin. The public policy documents

developed so far have ambitious national goals for electric mobility; however, it is important to be able to articulate them with the territorial entities to ensure their compliance, taking into account the specific realities of the sector at the local level.

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Annex: Detailed Data

Vehicle Data

Operating (not registered) vehicles

Vehicle category	gasoline	diesel	CNG	total	share operational of registered
Passenger car	2,912,350	30,982	154,912	3,098,244	80%
Taxi	77,761	0	58,662	136,424	61%
Motorcycle	3,845,058	0	0	3,845,058	48%
small bus	0	66,988	0	66,988	80%
standard urban bus	0	61,416	0	61,416	55%
LCV	894,176	88,435	0	982,611	82%
Truck < 7.5t	0	96,770	0	96,770	73%
Truck 7.5-16t	0	96,770	0	96,770	73%
Truck 16-32t	0	43,220	0	43,220	87%
Truck >32t	0	48,140	0	48,140	87%
total				8,475,643	

Source: MOT; car includes campero; LCV = camioneta; truck>32t = tractocamion; truck 16-31 = volqueta; camion distributed 50:50 in lowest 2 categories; fuel distribution based on Andemos; MOT has registered vehicles- not all of these ciruclate however; Data from UPME (2015) shows the share of actually circulating vehicles (with annual licence plus insurance); this data has been taken to determine actaully operating vehicles

UPME 2015;see table 2; correction factor 1.2 based on actual sales of SOAT relative to registered vehicles with SOAT

Year of data	2018
GDP growth rate	2.9%
take from country values	
Carbon grid factor	0.130
take from country values	
Growth rate freight transport	2.2%
See below	
Bus, coach growth	1.8%
see below	
Passenger car, MC, taxi growth	4.0%
see below	

Emissions

All data in tons per annum

2018

Vehicle category	NO_x	$PM_{2.5}$	CO_2 TTW	CO_2 WTW	Energy in TJ
Passenger car	10,922	121	7,599,822	9,190,312	110,359
Taxi	1,288	13	1,400,686	1,805,081	21,254
Motorcycles	14,017	155	2,714,987	3,265,656	39,177
small bus	3,633	655	1,945,584	2,776,326	26,256
Urban bus	46,001	946	5,549,483	7,379,165	74,892
LCV	6,565	372	6,441,009	7,929,227	92,312
Truck < 7.5t	13,509	236	1,245,690	1,670,328	16,811
Truck 7.5-16t	23,951	453	2,150,665	2,910,255	29,024
Truck 16-32t	17,093	335	1,445,967	1,974,486	19,514
Truck >32t	31,542	654	2,695,060	3,697,366	36,371
Total	**168,521**	**3,940**	**33,188,951**	**42,598,203**	**465,969**
Total with biofuel			**29,870,056**	**38,338,383**	

2030

Vehicle category	NO_x	$PM_{2.5}$	CO_2 TTW	CO_2 WTW	Energy in MJ
Passenger car	4,697	103	12,140,534	14,646,224	176,296
Taxi	732	14	2,237,562	2,881,207	33,952
Motorcycles	13,704	247	4,337,127	5,216,808	62,585
small bus	25,221	198	2,397,554	3,082,723	32,356
Urban bus	28,714	245	6,268,774	7,875,806	84,599
LCV	5,104	180	8,383,530	10,127,381	120,152
Truck < 7.5t	8,263	53	1,621,373	2,030,337	21,881
Truck 7.5-16t	15,020	91	2,799,276	3,504,706	37,777
Truck 16-32t	10,773	67	1,882,050	2,360,298	25,399
Truck >32t	20,220	118	3,507,854	4,394,005	47,339
Total	**132,447**	**1,316**	**45,575,633**	**56,119,494**	**642,335**
Total with biofuel			**41,018,070**	**50,507,545**	

Emission costs	2018	2030
Pollutants	1,288	714
GHG	1,534	2,020
Total	**2,821**	**2,734**

in MUSD of 2019

Fuel Usage	Modelled	actual	% MofA	modelled
	2018	2018	2018	2030
Gasoline	7,132	7,107	100.4%	10,051
Diesel	5,876	5,893	99.7%	8,038
CNG	387,654	389,201	99.6%	546,297
in million liters for diesel and gasoline and tons for CNG				

GHG BAU	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
GHG	44,601,044	45,637,505	46,698,052	47,783,245	48,893,656	50,029,871	51,192,490	52,382,127	53,599,409	54,844,979	56,119,494

EV Scenarios

Rate of EVs of newly registered vehicles

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
S1 EV 15@30	3%	3%	4%	5%	7%	9%	10%	11%	12%	14%	15%
S2 EV30@30	5%	6%	8%	11%	14%	18%	20%	22%	24%	27%	30%

Colombia projection UPME 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cars	0%	11%	2%	4%	7%	10%	16%	19%	23%	26%	30%
Motorcycles	0%	2%	3%	5%	8%	9%	10%	12%	13%	15%	18%
taxis	0%	1%	5%	10%	20%	40%	15%	15%	15%	15%	20%
Urban buses	0%	12%	4%	5%	6%	9%	20%	30%	50%	70%	80%
LCVs	0%	7%	6%	6%	6%	6%	8%	10%	13%	16%	20%

Source: UPME & MinMinas. (2019). Establecer recomendaciones en materia de infraestructura de recarga para la movilidad eléctrica en Colombia para los diferentes segmentos: buses, motos, taxis, BRT; fixed as percentage of vehicle stock for years 2021 ,2025 and 2030 and re-calculated to % of new registrations; target 2030 600,000 passenger cars fixed

Colombia official targets	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cars	0%	1%	3%	5%	7%	10%	13%	16%	19%	23%	28%
taxis	0%	1%	2%	5%	9%	15%	20%	25%	33%	40%	50%
Large buses	0%	5%	6%	7%	8%	10%	15%	20%	30%	40%	50%
Small buses	0%	5%	25%	40%	60%	80%	100%	100%	100%	100%	100%
LCVs	0%	0%	1%	1%	1%	1%	2%	3%	4%	6%	8%

Plan energetico nacional 2020-2050 for cars, taxis, freight transport urban/inetrurban (translated into LCVs) and passenger transport urban/interurban (translated into small buses as large bus targets are fixed in law 1964) (absolute numbers trandslated into percentages during various years to reach the absolute 2030 target). Buses target is taken from the law 1964 which has for cities with mass transit systems targets for new purchased vehicles from 2025 onwards (see below)

High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Taxis	0%	1%	1%	4%	8%	14%	22%	32%	45%	61%	100%
Urban Buses	0%	1%	1%	4%	8%	14%	22%	32%	45%	61%	100%
Small buses	0%	1%	1%	4%	8%	14%	22%	32%	45%	61%	100%
LCVs	0%	0%	1%	4%	8%	14%	22%	32%	45%	61%	100%

This scenario is only made for the vehicle categories of the program i.e. urban buses, small buses, taxis and LCVs

For urban buses, taxis and LCVs the target is 100% of new registered buses/taxis/LCVs in 2030 are electric; This takes into consideration that Evs in this segment should be cost-competitive by 2030. No early replacement of vehicles is made i.e. conventional vehicles could still be used till ending their lifespan.

The growth curve towards 2030 is based on a power curve with the function y=0.0024*n^2.52 based on the curve of Norway for the last 10 years). Initial experiences are built and cost structures go down. Barriers are removed and financial equivalence will be achieved. The vehicle penetration rates increases then (for new vehicles)

For taxis a kick-start with 100 taxis in 2021 is assumed. The growth rate is then assumed 50% for new registered taxis per annum reaching 100% in 2029
For urban buses a kick-start of 50 units in 2022 is assumed and then a growth of 50% of new registered per year reaching 100% of new registered in 2027
For small buses a kick-start of 50 units in 2022 is assumed and then a growth of 50% of new registered per year reaching 100% of new registered in 2029
For LCVs a kick-start of 50 units in 2022 is assumed and then a growth of 100% of new registered per year reaching 100% of new registered in 2030

Passenger cars S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all cars	3,349,820	3,483,167	3,621,822	3,765,997	3,915,911	4,071,793	4,233,880	4,402,420	4,577,668	4,759,893	4,949,371
Replacement cars	178,977	186,101	193,509	201,212	209,222	217,551	226,211	235,216	244,579	254,315	264,438
Additional new cars	128,242	133,347	138,655	144,175	149,914	155,882	162,087	168,539	175,248	182,225	189,479
EV car fleet new	7,747	10,370	13,881	18,580	24,870	33,289	38,411	44,321	51,140	59,008	68,088
EV car fleet stock	7,747	18,118	31,998	50,578	75,448	108,737	147,148	191,469	242,609	301,617	369,705
EV fleet as % of stock	0%	1%	1%	1%	2%	3%	3%	4%	5%	6%	7%
GHG reduction WTW in tons	19,668	45,994	81,233	128,401	191,537	276,047	373,559	486,074	615,901	765,703	938,554
Electricity demand GWh	19.5	45.7	80.6	127.5	190.1	274.0	370.8	482.5	611.4	760.1	931.7

Passenger cars S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all cars	3,349,820	3,483,167	3,621,822	3,765,997	3,915,911	4,071,793	4,233,880	4,402,420	4,577,668	4,759,893	4,949,371
Replacement cars	178,977	186,101	193,509	201,212	209,222	217,551	226,211	235,216	244,579	254,315	264,438
Additional new cars	128,242	133,347	138,655	144,175	149,914	155,882	162,087	168,539	175,248	182,225	189,479
EV car fleet new	15,495	20,740	27,762	37,160	49,740	66,578	76,822	88,642	102,280	118,017	136,175
EV car fleet stock	15,495	36,235	63,997	101,157	150,896	217,474	294,296	382,938	485,218	603,235	739,410
EV fleet as % of stock	0%	1%	2%	3%	4%	5%	7%	9%	11%	13%	15%
GHG reduction WTW in tons	39,336	91,989	162,466	256,802	383,074	552,093	747,117	972,148	1,231,802	1,531,406	1,877,108
Electricity demand GWh	39.0	91.3	161.3	254.9	380.3	548.0	741.6	965.0	1222.7	1520.2	1863.3

Passenger cars UPME Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all cars	3,349,820	3,483,167	3,621,822	3,765,997	3,915,911	4,071,793	4,233,880	4,402,420	4,577,668	4,759,893	4,949,371
Replacement cars	178,977	186,101	193,509	201,212	209,222	217,551	226,211	235,216	244,579	254,315	264,438
Additional new cars	128,242	133,347	138,655	144,175	149,914	155,882	162,087	168,539	175,248	182,225	189,479
EV car fleet new	0	34,832	6,643	13,815	25,140	37,343	62,128	76,713	96,560	113,500	136,175
EV car fleet stock	0	34,832	41,475	55,290	80,430	117,773	179,901	256,614	353,175	466,675	602,850
EV fleet as % of stock	0%	1%	1%	1%	2%	3%	4%	6%	8%	10%	12%
GHG reduction WTW in tons	0	88,426	105,291	140,363	204,184	298,986	456,707	651,456	896,589	1,184,727	1,530,429
Electricity demand GWh	0.0	87.8	104.5	139.3	202.7	296.8	453.4	646.7	890.0	1176.0	1519.2

Passenger cars official Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all cars	3,349,820	3,483,167	3,621,822	3,765,997	3,915,911	4,071,793	4,233,880	4,402,420	4,577,668	4,759,893	4,949,371
Replacement cars	178,977	186,101	193,509	201,212	209,222	217,551	226,211	235,216	244,579	254,315	264,438
Additional new cars	128,242	133,347	138,655	144,175	149,914	155,882	162,087	168,539	175,248	182,225	189,479
EV car fleet new	0	3,194	9,965	17,269	25,140	37,343	50,479	64,601	79,767	100,404	124,827
EV car fleet stock	0	3,194	13,159	30,429	55,568	92,912	143,390	207,991	287,758	388,162	512,990
EV fleet as % of stock	0%	0%	0%	1%	1%	2%	3%	5%	6%	8%	10%
GHG reduction WTW in tons	0	8,110	33,407	77,248	141,069	235,871	364,019	528,018	730,520	985,411	1,302,304
Electricity demand GWh	0.0	8.1	33.2	76.7	140.0	234.1	361.3	524.1	725.2	978.2	1292.7

Taxis S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all taxis	147,501	153,373	159,478	165,827	172,428	179,292	186,429	193,850	201,566	209,590	217,934
Replacement taxis	10,508	10,926	11,361	11,813	12,283	12,772	13,281	13,810	14,359	14,931	15,525
Additional new taxis	5,647	5,872	6,105	6,348	6,601	6,864	7,137	7,421	7,717	8,024	8,343
EV taxi fleet new	407	545	730	977	1,308	1,750	2,020	2,331	2,689	3,103	3,580
EV taxi fleet stock	407	953	1,683	2,660	3,967	5,718	7,738	10,068	12,757	15,860	19,440
EV taxi as % of stock	0%	1%	1%	2%	2%	3%	4%	5%	6%	8%	9%
GHG reduction WTW in tons	4,063	9,501	16,781	26,525	39,567	57,025	77,169	100,412	127,231	158,177	193,884
Electricity demand GWh	4.0	9.4	16.7	26.3	39.3	56.6	76.6	99.7	126.3	157.0	192.5

Taxis S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all taxis	147,501	153,373	159,478	165,827	172,428	179,292	186,429	193,850	201,566	209,590	217,934
Replacement taxis	10,508	10,926	11,361	11,813	12,283	12,772	13,281	13,810	14,359	14,931	15,525
Additional new taxis	5,647	5,872	6,105	6,348	6,601	6,864	7,137	7,421	7,717	8,024	8,343
EV taxi fleet new	815	1,091	1,460	1,954	2,615	3,501	4,040	4,661	5,378	6,206	7,161
EV taxi fleet stock	815	1,905	3,365	5,319	7,935	11,436	15,475	20,136	25,514	31,720	38,881
EV taxi as % of stock	1%	1%	2%	3%	5%	6%	8%	10%	13%	15%	18%
GHG reduction WTW in tons	8,126	19,003	33,562	53,049	79,134	114,050	154,337	200,823	254,462	316,353	387,768
Electricity demand GWh	8.1	18.9	33.3	52.7	78.6	113.2	153.2	199.3	252.6	314.0	384.9

Taxis UPME Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all taxis	147,501	153,373	159,478	165,827	172,428	179,292	186,429	193,850	201,566	209,590	217,934
Replacement taxis	10,508	10,926	11,361	11,813	12,283	12,772	13,281	13,810	14,359	14,931	15,525
Additional new taxis	5,647	5,872	6,105	6,348	6,601	6,864	7,137	7,421	7,717	8,024	8,343
EV taxi fleet new	0	153	873	1,816	3,777	7,855	3,063	3,185	3,311	3,443	4,774
EV taxi fleet stock	0	153	1,027	2,843	6,620	14,474	17,537	20,722	24,033	27,476	32,250
EV taxi as % of stock	0%	0%	1%	2%	4%	8%	9%	11%	12%	13%	15%
GHG reduction WTW in tons	0	1,530	10,239	28,353	66,021	144,356	174,901	206,662	239,688	274,028	321,637
Electricity demand GWh	0.0	1.5	10.2	28.1	65.5	143.3	173.6	205.1	237.9	272.0	319.3

Taxis official Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all taxis	147,501	153,373	159,478	165,827	172,428	179,292	186,429	193,850	201,566	209,590	217,934
Replacement taxis	10,508	10,926	11,361	11,813	12,283	12,772	13,281	13,810	14,359	14,931	15,525
Additional new taxis	5,647	5,872	6,105	6,348	6,601	6,864	7,137	7,421	7,717	8,024	8,343
EV taxi fleet new	0	168	349	908	1,700	2,945	4,084	5,308	7,285	9,182	11,934
EV taxi fleet stock	0	168	517	1,425	3,125	6,070	10,154	15,462	22,747	31,929	43,863
EV taxi as % of stock	0%	0%	0%	1%	2%	3%	5%	8%	11%	15%	20%
GHG reduction WTW in tons	0	1,675	5,159	14,216	31,166	60,542	101,269	154,204	226,860	318,434	437,457
Electricity demand GWh	0.0	1.7	5.1	14.1	30.9	60.1	100.5	153.1	225.2	316.1	434.2

High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all taxis	147,501	153,373	159,478	165,827	172,428	179,292	186,429	193,850	201,566	209,590	217,934
Replacement taxis	10,508	10,926	11,361	11,813	12,283	12,772	13,281	13,810	14,359	14,931	15,525
Additional new taxis	5,647	5,872	6,105	6,348	6,601	6,864	7,137	7,421	7,717	8,024	8,343
EV taxi fleet new	0	100	240	695	1,491	2,721	4,479	6,868	9,998	13,989	23,868
EV taxi fleet stock	0	100	340	1,035	2,526	5,247	9,726	16,594	26,592	40,580	64,449
EV taxi as % of stock	0%	0%	0%	1%	1%	3%	5%	9%	13%	19%	30%
GHG reduction WTW in tons	0	997	3,395	10,322	25,194	52,328	96,996	165,492	265,206	404,718	642,765
Electricity demand GWh	0.0	1.0	3.4	10.2	25.0	51.9	96.3	164.3	263.3	401.7	638.0

Motorcycle S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all MC	4,157,274	4,322,764	4,494,842	4,673,769	4,859,819	5,053,276	5,254,433	5,463,598	5,681,089	5,907,238	6,142,389
Replacement MC	333,177	346,440	360,230	374,570	389,481	404,985	421,106	437,869	455,300	473,424	492,270
Additional new MC	159,154	165,490	172,078	178,928	186,050	193,456	201,157	209,165	217,491	226,149	235,151
EV MC fleet new	12,416	16,619	22,245	29,775	39,855	53,347	61,555	71,026	81,954	94,564	109,113
EV MC fleet stock	12,416	29,034	51,279	81,054	120,909	174,256	235,811	306,837	388,791	483,355	592,468
EV fleet as % of stock	0%	1%	1%	2%	2%	3%	4%	6%	7%	8%	10%
GHG reduction WTW in tons	10,081	23,574	41,635	65,811	98,170	141,485	191,464	249,132	315,674	392,454	481,047
Electricity demand GWh	3.6	8.3	14.7	23.3	34.8	50.1	67.8	88.2	111.8	139.0	170.3

Motorcycle S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all MC	4,157,274	4,322,764	4,494,842	4,673,769	4,859,819	5,053,276	5,254,433	5,463,598	5,681,089	5,907,238	6,142,389
Replacement MC	333,177	346,440	360,230	374,570	389,481	404,985	421,106	437,869	455,300	473,424	492,270
Additional new MC	159,154	165,490	172,078	178,928	186,050	193,456	201,157	209,165	217,491	226,149	235,151
EV MC fleet new	24,831	33,237	44,489	59,550	79,710	106,694	123,110	142,052	163,908	189,127	218,226
EV MC fleet stock	24,831	58,069	102,558	162,108	241,818	348,512	471,622	613,674	777,582	966,709	1,184,936
EV fleet as % of stock	1%	1%	2%	3%	5%	7%	9%	11%	14%	16%	19%
GHG reduction WTW in tons	20,161	47,148	83,271	131,622	196,341	282,970	382,928	498,265	631,348	784,907	962,094
Electricity demand GWh	7.1	16.7	29.5	46.6	69.5	100.2	135.6	176.4	223.6	277.9	340.7

Motorcycle Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all MC	4,157,274	4,322,764	4,494,842	4,673,769	4,859,819	5,053,276	5,254,433	5,463,598	5,681,089	5,907,238	6,142,389
Replacement MC	333,177	346,440	360,230	374,570	389,481	404,985	421,106	437,869	455,300	473,424	492,270
Additional new MC	159,154	165,490	172,078	178,928	186,050	193,456	201,157	209,165	217,491	226,149	235,151
EV MC fleet new	0	8,646	15,969	27,675	43,165	53,860	62,226	74,409	87,463	104,936	127,299
EV MC fleet stock	0	8,646	24,615	52,290	95,454	149,314	211,541	285,949	373,412	478,348	605,647
EV fleet as % of stock	0%	0%	1%	1%	2%	3%	4%	5%	7%	8%	10%
GHG reduction WTW in tons	0	7,020	19,986	42,456	77,503	121,234	171,758	232,173	303,187	388,389	491,747
Electricity demand GWh	0.0	2.5	7.1	15.0	27.4	42.9	60.8	82.2	107.4	137.5	174.1

Small Bus S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	69,361	70,579	71,819	73,080	74,363	75,669	76,997	78,349	79,725	81,125	82,550
Replacement vehicles	3,496	3,557	3,619	3,683	3,748	3,813	3,880	3,949	4,018	4,088	4,160
Additional new vehicles	1,197	1,218	1,239	1,261	1,283	1,306	1,329	1,352	1,376	1,400	1,425
EV vehicle fleet new	118	155	203	266	348	456	515	582	657	742	838
EV vehicle fleet stock	118	273	476	742	1,091	1,547	2,062	2,644	3,301	4,043	4,881
EV fleet as % of stock	0%	0%	1%	1%	1%	2%	3%	3%	4%	5%	6%
GHG reduction WTW in tons	3,327	7,686	13,395	20,873	30,668	43,500	57,988	74,348	92,822	113,681	137,236
Electricity demand GWh	4.0	9.2	16.0	24.9	36.6	52.0	69.3	88.8	110.9	135.8	164.0

Small Bus S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	69,361	70,579	71,819	73,080	74,363	75,669	76,997	78,349	79,725	81,125	82,550
Replacement vehicles	3,496	3,557	3,619	3,683	3,748	3,813	3,880	3,949	4,018	4,088	4,160
Additional new vehicles	1,197	1,218	1,239	1,261	1,283	1,306	1,329	1,352	1,376	1,400	1,425
EV vehicle fleet new	237	310	406	532	697	913	1,031	1,164	1,314	1,484	1,675
EV vehicle fleet stock	237	547	953	1,485	2,181	3,094	4,125	5,288	6,603	8,086	9,762
EV fleet as % of stock	0%	1%	1%	2%	3%	4%	5%	7%	8%	10%	12%
GHG reduction WTW in tons	6,655	15,371	26,789	41,746	61,337	86,999	115,976	148,697	185,644	227,363	274,471
Electricity demand GWh	8.0	18.4	32.0	49.9	73.3	104.0	138.6	177.7	221.8	271.7	328.0

Small Bus target Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	69,361	70,579	71,819	73,080	74,363	75,669	76,997	78,349	79,725	81,125	82,550
Replacement vehicles	3,496	3,557	3,619	3,683	3,748	3,813	3,880	3,949	4,018	4,088	4,160
Additional new vehicles	1,197	1,218	1,239	1,261	1,283	1,306	1,329	1,352	1,376	1,400	1,425
EV vehicle fleet new	0	239	1,215	1,978	3,019	4,095	5,209	5,301	5,394	5,488	5,585
EV vehicle fleet stock	0	239	1,453	3,431	6,450	10,545	15,754	21,055	26,449	31,937	37,522
EV fleet as % of stock	0%	0%	2%	5%	9%	14%	20%	27%	33%	39%	45%
GHG reduction WTW in tons	0	6,713	40,867	96,472	181,345	296,496	442,962	592,000	743,655	897,974	1,055,002
Electricity demand GWh	0.0	8.0	48.8	115.3	216.7	354.3	529.3	707.4	888.7	1073.1	1260.7

Small Bus High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	69,361	70,579	71,819	73,080	74,363	75,669	76,997	78,349	79,725	81,125	82,550
Replacement vehicles	3,496	3,557	3,619	3,683	3,748	3,813	3,880	3,949	4,018	4,088	4,160
Additional new vehicles	1,197	1,218	1,239	1,261	1,283	1,306	1,329	1,352	1,376	1,400	1,425
EV vehicle fleet new	0	66	67	189	397	709	1,143	1,715	2,443	3,345	5,585
EV vehicle fleet stock	11	77	144	333	730	1,439	2,582	4,297	6,739	10,084	15,669
EV fleet as % of stock	0%	0%	0%	0%	1%	2%	3%	5%	8%	12%	19%
GHG reduction WTW in tons	309	2,157	4,038	9,354	20,524	40,467	72,595	120,807	189,491	283,533	440,561
Electricity demand GWh	0.4	2.6	4.8	11.2	24.5	48.4	86.8	144.4	226.4	338.8	526.5

Urban bus standard S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	63,592	64,709	65,845	67,001	68,178	69,375	70,593	71,833	73,094	74,378	75,684
Replacement vehicles	3,205	3,261	3,318	3,377	3,436	3,496	3,558	3,620	3,684	3,748	3,814
Additional new vehicles	1,097	1,117	1,136	1,156	1,177	1,197	1,218	1,240	1,261	1,284	1,306
EV vehicle fleet new	108	142	186	244	319	418	472	533	602	680	768
EV vehicle fleet stock	108	251	437	681	1,000	1,418	1,891	2,424	3,027	3,707	4,475
EV fleet as % of stock	0%	0%	1%	1%	1%	2%	3%	3%	4%	5%	6%
GHG reduction WTW in tons	10,303	23,798	41,476	64,632	94,964	134,695	179,559	230,218	287,420	352,012	424,947
Electricity demand GWh	7.6	17.5	30.6	47.6	70.0	99.3	132.4	169.7	211.9	259.5	313.2

Urban bus standard S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	63,592	64,709	65,845	67,001	68,178	69,375	70,593	71,833	73,094	74,378	75,684
Replacement vehicles	3,205	3,261	3,318	3,377	3,436	3,496	3,558	3,620	3,684	3,748	3,814
Additional new vehicles	1,097	1,117	1,136	1,156	1,177	1,197	1,218	1,240	1,261	1,284	1,306
EV vehicle fleet new	217	284	372	488	639	837	945	1,067	1,205	1,360	1,536
EV vehicle fleet stock	217	501	874	1,361	2,000	2,837	3,782	4,849	6,053	7,414	8,950
EV fleet as % of stock	0%	1%	1%	2%	3%	4%	5%	7%	8%	10%	12%
GHG reduction WTW in tons	20,606	47,597	82,952	129,264	189,928	269,391	359,118	460,436	574,841	704,024	849,894
Electricity demand GWh	15.2	35.1	61.1	95.3	140.0	198.6	264.7	339.4	423.7	519.0	626.5

Urban bus UPME Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	63,592	64,709	65,845	67,001	68,178	69,375	70,593	71,833	73,094	74,378	75,684
Replacement vehicles	3,205	3,261	3,318	3,377	3,436	3,496	3,558	3,620	3,684	3,748	3,814
Additional new vehicles	1,097	1,117	1,136	1,156	1,177	1,197	1,218	1,240	1,261	1,284	1,306
EV vehicle fleet new	0	518	178	227	277	422	955	1,458	2,473	3,522	4,096
EV vehicle fleet stock	0	518	696	923	1,199	1,622	2,577	4,035	6,507	10,030	14,126
EV fleet as % of stock	0%	0.8%	1%	1%	2%	2%	4%	6%	9%	13%	19%
GHG reduction WTW in tons	0	49,159	66,080	87,603	113,883	153,997	244,702	383,150	617,948	952,438	1,341,424
Electricity demand GWh	0.0	36.2	48.7	64.6	83.9	113.5	180.4	282.4	455.5	702.1	988.8

Urban bus target Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	63,592	64,709	65,845	67,001	68,178	69,375	70,593	71,833	73,094	74,378	75,684
Replacement vehicles	3,205	3,261	3,318	3,377	3,436	3,496	3,558	3,620	3,684	3,748	3,814
Additional new vehicles	1,097	1,117	1,136	1,156	1,177	1,197	1,218	1,240	1,261	1,284	1,306
EV vehicle fleet new	0	219	267	317	369	469	716	972	1,484	2,013	2,560
EV vehicle fleet stock	0	219	486	803	1,172	1,642	2,358	3,330	4,814	6,826	9,387
EV fleet as % of stock	0%	0%	1%	1%	2%	2%	3%	5%	7%	9%	12%
GHG reduction WTW in tons	0	20,786	46,168	76,299	111,340	155,911	223,940	316,238	457,117	648,254	891,371
Electricity demand GWh	0.0	15.3	34.0	56.2	82.1	114.9	165.1	233.1	337.0	477.9	657.1

Urban bus High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	63,592	64,709	65,845	67,001	68,178	69,375	70,593	71,833	73,094	74,378	75,684
Replacement vehicles	3,205	3,261	3,318	3,377	3,436	3,496	3,558	3,620	3,684	3,748	3,814
Additional new vehicles	1,097	1,117	1,136	1,156	1,177	1,197	1,218	1,240	1,261	1,284	1,306
EV vehicle fleet new	0	50	61	173	364	650	1,048	1,572	2,240	3,066	5,120
EV vehicle fleet stock	42	92	153	327	691	1,341	2,389	3,961	6,200	9,267	14,387
EV fleet as % of stock	0%	0%	0%	0%	1%	2%	3%	6%	8%	12%	19%
GHG reduction WTW in tons	3,988	8,737	14,560	31,022	65,607	127,360	226,845	376,133	588,811	880,008	1,366,241
Electricity demand GWh	2.9	6.4	10.7	22.9	48.4	93.9	167.2	277.3	434.0	648.7	1007.1

LCV S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	1,026,740	1,049,542	1,072,851	1,096,677	1,121,033	1,145,929	1,171,378	1,197,392	1,223,985	1,251,167	1,278,954
Replacement vehicles	66,962	68,449	69,969	71,523	73,112	74,736	76,395	78,092	79,826	81,599	83,411
Additional new vehicles	22,307	22,802	23,309	23,826	24,355	24,896	25,449	26,014	26,592	27,183	27,786
EV vehicle fleet new	2,251	2,962	3,898	5,129	6,750	8,882	10,075	11,428	12,963	14,704	16,680
EV vehicle fleet stock	2,251	5,213	9,111	14,241	20,990	29,872	39,946	51,374	64,337	79,042	95,721
EV fleet as % of stock	0%	0%	1%	1%	2%	3%	3%	4%	5%	6%	7%
GHG reduction WTW in tons	15,525	35,954	62,836	98,209	144,756	206,006	275,484	354,295	443,693	545,100	660,128
Electricity demand GWh	13.5	31.3	54.7	85.4	125.9	179.2	239.7	308.2	386.0	474.2	574.3

LCV S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	1,026,740	1,049,542	1,072,851	1,096,677	1,121,033	1,145,929	1,171,378	1,197,392	1,223,985	1,251,167	1,278,954
Replacement vehicles	66,962	68,449	69,969	71,523	73,112	74,736	76,395	78,092	79,826	81,599	83,411
Additional new vehicles	22,307	22,802	23,309	23,826	24,355	24,896	25,449	26,014	26,592	27,183	27,786
EV vehicle fleet new	4,502	5,925	7,796	10,259	13,499	17,763	20,149	22,856	25,926	29,409	33,359
EV vehicle fleet stock	4,502	10,427	18,223	28,481	41,981	59,744	79,893	102,748	128,675	158,083	191,443
EV fleet as % of stock	0%	1%	2%	3%	4%	5%	7%	9%	11%	13%	15%
GHG reduction WTW in tons	31,050	71,908	125,672	196,419	289,513	412,013	550,969	708,591	887,386	1,090,199	1,320,257
Electricity demand GWh	27.0	62.6	109.3	170.9	251.9	358.5	479.4	616.5	772.0	948.5	1148.7

LCV UPME Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	1,026,740	1,049,542	1,072,851	1,096,677	1,121,033	1,145,929	1,171,378	1,197,392	1,223,985	1,251,167	1,278,954
Replacement vehicles	66,962	68,449	69,969	71,523	73,112	74,736	76,395	78,092	79,826	81,599	83,411
Additional new vehicles	22,307	22,802	23,309	23,826	24,355	24,896	25,449	26,014	26,592	27,183	27,786
EV vehicle fleet new	0	6,297	5,597	5,721	5,848	5,978	8,148	10,411	13,834	17,405	22,239
EV vehicle fleet stock	0	6,297	11,894	17,615	23,463	29,441	37,588	47,999	61,833	79,238	101,478
EV fleet as % of stock	0%	1%	1%	2%	2%	3%	3%	4%	5%	6%	8%
GHG reduction WTW in tons	0	43,428	82,025	121,479	161,809	203,035	259,223	331,019	426,425	546,457	699,829
Electricity demand GWh	0.0	37.8	71.4	105.7	140.8	176.6	225.5	288.0	371.0	475.4	608.9

LCV target Colombia	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	1,026,740	1,049,542	1,072,851	1,096,677	1,121,033	1,145,929	1,171,378	1,197,392	1,223,985	1,251,167	1,278,954
Replacement vehicles	66,962	68,449	69,969	71,523	73,112	74,736	76,395	78,092	79,826	81,599	83,411
Additional new vehicles	22,307	22,802	23,309	23,826	24,355	24,896	25,449	26,014	26,592	27,183	27,786
EV vehicle fleet new	0	0	466	953	487	996	2,037	3,123	4,257	6,527	8,896
EV vehicle fleet stock	0	0	466	1,420	1,907	2,904	4,940	8,064	12,320	18,847	27,743
EV fleet as % of stock	0%	0%	0%	0%	0%	0%	0%	1%	1%	2%	2%
GHG reduction WTW in tons	0	0	3,216	9,792	13,153	20,024	34,071	55,610	84,966	129,977	191,326
Electricity demand GWh	0.0	0.0	2.8	8.5	11.4	17.4	29.6	48.4	73.9	113.1	166.5

LCV High growth Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	1,026,740	1,049,542	1,072,851	1,096,677	1,121,033	1,145,929	1,171,378	1,197,392	1,223,985	1,251,167	1,278,954
Replacement vehicles	66,962	68,449	69,969	71,523	73,112	74,736	76,395	78,092	79,826	81,599	83,411
Additional new vehicles	22,307	22,802	23,309	23,826	24,355	24,896	25,449	26,014	26,592	27,183	27,786
EV vehicle fleet new	0	50	1,284	3,646	7,696	13,804	22,340	33,677	48,196	66,292	111,197
EV vehicle fleet stock	276	326	1,610	5,257	12,952	26,757	49,097	82,774	130,971	197,262	308,460
EV fleet as % of stock	0%	0%	0%	0%	1%	2%	4%	7%	11%	16%	24%
GHG reduction WTW in tons	1,903	2,248	11,104	36,251	89,325	184,524	338,591	570,841	903,220	1,360,390	2,127,248
Electricity demand GWh	1.7	2.0	9.7	31.5	77.7	160.5	294.6	496.6	785.8	1183.6	1850.8

Truck <7.5t S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	101,116	103,362	105,657	108,004	110,402	112,854	115,361	117,922	120,541	123,218	125,955
Replacement vehicles	5,073	5,185	5,301	5,418	5,539	5,662	5,787	5,916	6,047	6,182	6,319
Additional new vehicles	2,197	2,246	2,295	2,346	2,399	2,452	2,506	2,562	2,619	2,677	2,736
EV vehicle fleet new	183	241	317	418	550	723	820	931	1,056	1,197	1,358
EV vehicle fleet stock	183	425	742	1,160	1,709	2,433	3,253	4,184	5,239	6,437	7,795
EV fleet as % of stock	0%	0%	1%	1%	2%	2%	3%	4%	4%	5%	6%
GHG reduction WTW in tons	2,421	5,607	9,800	15,317	22,576	32,129	42,965	55,256	69,198	85,014	102,954
Electricity demand GWh	4.1	9.5	16.6	26.0	38.3	54.5	72.9	93.7	117.4	144.2	174.6

Truck <7.5t S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	101,116	103,362	105,657	108,004	110,402	112,854	115,361	117,922	120,541	123,218	125,955
Replacement vehicles	5,073	5,185	5,301	5,418	5,539	5,662	5,787	5,916	6,047	6,182	6,319
Additional new vehicles	2,197	2,246	2,295	2,346	2,399	2,452	2,506	2,562	2,619	2,677	2,736
EV vehicle fleet new	367	482	635	835	1,099	1,447	1,641	1,861	2,111	2,395	2,717
EV vehicle fleet stock	367	849	1,484	2,319	3,419	4,865	6,506	8,367	10,479	12,874	15,590
EV fleet as % of stock	0%	1%	1%	2%	3%	4%	6%	7%	9%	10%	12%
GHG reduction WTW in tons	4,843	11,215	19,600	30,633	45,152	64,258	85,929	110,512	138,397	170,028	205,907
Electricity demand GWh	8.2	19.0	33.2	52.0	76.6	109.0	145.7	187.4	234.7	288.4	349.2

Truck 7.5-16t S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	101,116	103,362	105,657	108,004	110,402	112,854	115,361	117,922	120,541	123,218	125,955
Replacement vehicles	5,073	5,185	5,301	5,418	5,539	5,662	5,787	5,916	6,047	6,182	6,319
Additional new vehicles	2,197	2,246	2,295	2,346	2,399	2,452	2,506	2,562	2,619	2,677	2,736
EV vehicle fleet new	183	241	317	418	550	723	820	931	1,056	1,197	1,358
EV vehicle fleet stock	183	425	742	1,160	1,709	2,433	3,253	4,184	5,239	6,437	7,795
EV fleet as % of stock	0%	0%	1%	1%	2%	2%	3%	4%	4%	5%	6%
GHG reduction WTW in tons	4,243	9,826	17,173	26,841	39,563	56,303	75,292	96,831	121,264	148,979	180,417
Electricity demand GWh	6.6	15.3	26.7	41.7	61.5	87.6	117.1	150.6	188.6	231.7	280.6

Truck 7.5-16t S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	101,116	103,362	105,657	108,004	110,402	112,854	115,361	117,922	120,541	123,218	125,955
Replacement vehicles	5,073	5,185	5,301	5,418	5,539	5,662	5,787	5,916	6,047	6,182	6,319
Additional new vehicles	2,197	2,246	2,295	2,346	2,399	2,452	2,506	2,562	2,619	2,677	2,736
EV vehicle fleet new	367	482	635	835	1,099	1,447	1,641	1,861	2,111	2,395	2,717
EV vehicle fleet stock	367	849	1,484	2,319	3,419	4,865	6,506	8,367	10,479	12,874	15,590
EV fleet as % of stock	0%	1%	1%	2%	3%	4%	6%	7%	9%	10%	12%
GHG reduction WTW in tons	8,486	19,653	34,347	53,683	79,126	112,606	150,583	193,662	242,528	297,959	360,835
Electricity demand GWh	13.2	30.6	53.4	83.5	123.1	175.1	234.2	301.2	377.2	463.4	561.2

Truck 16-32t S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	45,161	46,164	47,189	48,237	49,308	50,403	51,523	52,667	53,836	55,032	56,254
Replacement vehicles	2,104	2,151	2,198	2,247	2,297	2,348	2,400	2,453	2,508	2,564	2,621
Additional new vehicles	981	1,003	1,025	1,048	1,071	1,095	1,119	1,144	1,170	1,196	1,222
EV vehicle fleet new	78	102	135	177	233	307	348	395	448	508	576
EV vehicle fleet stock	78	180	315	492	725	1,032	1,380	1,775	2,223	2,732	3,308
EV fleet as % of stock	0%	0%	1%	1%	1%	2%	3%	3%	4%	5%	6%
GHG reduction WTW in tons	2,657	6,154	10,755	16,810	24,777	35,261	47,153	60,643	75,945	93,302	112,991
Electricity demand GWh	4.7	10.8	18.9	29.5	43.5	61.9	82.8	106.5	133.4	163.9	198.5

Truck 16-32t S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	45,161	46,164	47,189	48,237	49,308	50,403	51,523	52,667	53,836	55,032	56,254
Replacement vehicles	2,104	2,151	2,198	2,247	2,297	2,348	2,400	2,453	2,508	2,564	2,621
Additional new vehicles	981	1,003	1,025	1,048	1,071	1,095	1,119	1,144	1,170	1,196	1,222
EV vehicle fleet new	156	205	269	355	466	614	696	790	896	1,016	1,153
EV vehicle fleet stock	156	360	630	984	1,451	2,065	2,761	3,551	4,447	5,463	6,616
EV fleet as % of stock	0%	1%	1%	2%	3%	4%	5%	7%	8%	10%	12%
GHG reduction WTW in tons	5,315	12,308	21,511	33,620	49,554	70,522	94,307	121,286	151,890	186,604	225,982
Electricity demand GWh	9.3	21.6	37.8	59.1	87.0	123.9	165.7	213.0	266.8	327.8	397.0

Truck >32t S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	50,302	51,420	52,561	53,729	54,922	56,142	57,389	58,663	59,966	61,298	62,659
Replacement vehicles	2,982	3,049	3,116	3,186	3,256	3,329	3,403	3,478	3,555	3,634	3,715
Additional new vehicles	1,093	1,117	1,142	1,167	1,193	1,220	1,247	1,275	1,303	1,332	1,361
EV vehicle fleet new	103	135	178	234	308	405	460	522	592	671	761
EV vehicle fleet stock	103	238	416	650	958	1,364	1,824	2,345	2,937	3,608	4,370
EV fleet as % of stock	0%	0%	1%	1%	2%	2%	3%	4%	5%	6%	7%
GHG reduction WTW in tons	5,748	13,311	23,264	36,361	53,594	76,271	101,994	131,172	164,271	201,815	244,403
Electricity demand GWh	11.2	26.0	45.4	71.0	104.6	148.9	199.1	256.1	320.7	394.0	477.2

Truck >32t S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stock all vehicles	50,302	51,420	52,561	53,729	54,922	56,142	57,389	58,663	59,966	61,298	62,659
Replacement vehicles	2,982	3,049	3,116	3,186	3,256	3,329	3,403	3,478	3,555	3,634	3,715
Additional new vehicles	1,093	1,117	1,142	1,167	1,193	1,220	1,247	1,275	1,303	1,332	1,361
EV vehicle fleet new	206	270	356	468	616	811	920	1,043	1,184	1,343	1,523
EV vehicle fleet stock	206	476	832	1,300	1,916	2,727	3,647	4,691	5,874	7,217	8,740
EV fleet as % of stock	0%	1%	2%	2%	3%	5%	6%	8%	10%	12%	14%
GHG reduction WTW in tons	11,496	26,623	46,528	72,721	107,188	152,542	203,988	262,345	328,541	403,630	488,805
Electricity demand GWh	22.4	52.0	90.8	142.0	209.3	297.8	398.3	512.2	641.5	788.1	954.4

Total excl. trucks >7.5t S1	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
GHG reduction WTW in tons	65,388	152,115	267,156	419,768	622,240	890,887	1,198,187	1,549,736	1,951,940	2,412,140	2,938,749
Electricity demand GWh	56	131	230	361	535	766	1,029	1,331	1,676	2,070	2,521

Total excl. trucks >7.5t S2	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
GHG reduction WTW in tons	130,776	304,231	534,312	839,536	1,244,479	1,781,773	2,396,374	3,099,471	3,903,879	4,824,281	5,877,498
Electricity demand GWh	113	262	460	722	1,070	1,531	2,059	2,662	3,351	4,140	5,041

GHG Transport Projections WTW

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BAU	44,601,044	45,637,505	46,698,052	47,783,245	48,893,656	50,029,871	51,192,490	52,382,127	53,599,409	54,844,979	56,119,494
EV15@30	44,535,656	45,485,390	46,430,896	47,363,477	48,271,416	49,138,985	49,994,303	50,832,391	51,647,469	52,432,838	53,180,745
GHG reduction EV15@30	65,388	152,115	267,156	419,768	622,240	890,887	1,198,187	1,549,736	1,951,940	2,412,140	2,938,749
Electricity demand EV15@30	79	183	321	503	745	1,064	1,428	1,844	2,318	2,859	3,477
EV30@30	44,470,268	45,333,275	46,163,740	46,943,709	47,649,176	48,248,098	48,796,116	49,282,656	49,695,530	50,020,698	50,241,996
GHG reduction EV30@30	130,776	304,231	534,312	839,536	1,244,479	1,781,773	2,396,374	3,099,471	3,903,879	4,824,281	5,877,498
Electricity demand EV30@30	158	366	642	1,007	1,489	2,128	2,857	3,688	4,637	5,719	6,954
EV Scenario UPME Colombia	44,601,044	45,447,943	46,414,432	47,362,992	48,270,256	49,108,264	49,885,199	50,577,667	51,115,571	51,498,940	51,734,427
GHG reduction UPME Colombia	0	189,562	283,621	420,253	623,400	921,607	1,307,291	1,804,460	2,483,838	3,346,039	4,385,067
Electricity demand UPME scenario	0	166	242	353	520	773	1,094	1,504	2,062	2,763	3,610
EV Scenario target Colombia	44,601,044	45,600,221	46,569,235	47,509,217	48,415,582	49,261,028	50,026,229	50,736,056	51,356,291	51,864,929	52,242,034
GHG reduction target Colombia	0	37,284	128,817	274,028	478,074	768,843	1,166,261	1,646,071	2,243,118	2,980,050	3,877,460
Electricity demand Colombian target	0	33	124	271	481	781	1,186	1,666	2,250	2,958	3,811
EV scenario Potential	44,505,206	45,414,430	46,297,233	47,117,214	47,832,571	48,390,202	48,792,610	48,990,636	48,928,175	48,541,796	47,421,948
GHG reduction Potential	95,838	223,075	400,819	666,031	1,061,085	1,639,669	2,399,880	3,391,491	4,671,234	6,303,183	8,697,545
Electricity demand potential	104	243	435	714	1,121	1,709	2,466	3,438	4,676	6,239	8,488

Potential scenario impact only 4 vehicle sectors (taxis, small and large buses, LCVs)

Parameter	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
GHG reduction WTW in tons	6,201	14,140	33,097	86,950	200,649	404,679	735,028	1,233,273	1,946,728	2,928,648	4,576,814
Electricity demand GWh	5	12	29	76	176	355	645	1,083	1,710	2,573	4,022

Potential scenario impact 4 vehicle sectors plus highest for other vehicle categories

Parameter	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
GHG reduction WTW in tons	95,838	223,075	400,819	666,031	1,061,085	1,639,669	2,399,880	3,391,491	4,671,234	6,303,183	8,697,545
Electricity demand GWh	104	243	435	714	1,121	1,709	2,466	3,438	4,676	6,239	8,488

GHG WTW emissions in tCO2e of selected 4 commercial vehicle sectors (LCVs, small and urban bus, taxis)

Scenario	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BAU	20,752,256	21,198,594	21,655,354	22,122,805	22,601,228	23,090,908	23,592,141	24,105,231	24,630,492	25,168,244	25,718,822
EV15@30	20,719,038	21,121,655	21,520,866	21,912,566	22,291,272	22,649,681	23,001,941	23,345,958	23,679,325	23,999,275	24,302,627
EV30@30	20,685,820	21,044,715	21,386,378	21,702,327	21,981,316	22,208,455	22,411,741	22,586,685	22,728,159	22,830,305	22,886,433
EV Scenario UPME Colombia	20,752,256	21,104,477	21,497,009	21,885,371	22,259,514	22,589,520	22,913,314	23,184,400	23,346,430	23,395,321	23,355,931
target Colombia	20,752,256	21,169,420	21,559,944	21,926,026	22,264,223	22,557,935	22,789,899	22,987,179	23,117,893	23,173,606	23,143,666
Potential scenario	20,746,055	21,184,455	21,622,257	22,035,855	22,400,579	22,686,229	22,857,113	22,871,959	22,683,764	22,239,596	21,142,007

Potential scenario

Parameter	Taxis	Small Buses	Urban Buses	LCVs	Total
EV stock 2025	5,247	1,439	1,341	26,757	34,784
EV Stock 2030	64,449	15,669	14,387	308,460	402,964
GHG impact 2025 tCO2	52,328	40,467	127,360	184,524	404,679
GHG impact 2030 tCO2	642,765	440,561	1,366,241	2,127,248	4,576,814
PM2.5 reduction 2030 (tons)	4	38	47	43	132
NOx reduction 2030 (tons)	216	4,787	5,459	1,231	11,693
Savings emision costs 2030 (MUSD)	27	40	82	101	251
Emissions savings excl. GHG	2	23	27	16	68
Vehicle CAPEX 2025 cumulative MUSD	335	107	293	602	1,336
Vehicle CAPEX 2030 cumulative MUSD	1305	978	2774	6,398	11,455