EcoLogistics

Low carbon freight for sustainable cities

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

ICLEI Local Governments for Sustainability

Creating Sustainable Cities Through Low-carbon Freight

EcoLogistics in Argentina, Colombia and India

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This document is a deliverable of the "*EcoLogistics: Low carbon freight for sustainable cities*" project.

About the EcoLogistics project

Supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative (IKI), ICLEI's EcoLogistics project (2017 - 2021) aims to increase the capacity of governmental and non-governmental actors to build strategies and policies to promote low carbon and sustainable urban freight in Argentina, Colombia and India, involving nine cities and regions:

- Argentina: Córdoba, Rosario, Santa Fe de la Vera Cruz (Santa Fe)
- Colombia: Capital District of Bogotá, Metropolitan Area of the Aburrá Valley (AMVA), Manizales
- India: Kochi, Shimla, Panaji

For more information, please visit: sustainablemobility.iclei.org/ecologistics

About ICLEI - Local Governments for Sustainability

ICLEI – Local Governments for Sustainability is a global network of more than 1,750 local and regional governments committed to sustainable urban development. Active in 100+ countries, we influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development. Our Members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

Acknowledgement

ICLEI and the Sustainable Mobility Program team would like to acknowledge the work and support of the EcoLogistics project partners, Despacio, Zaragoza Logistics Center and Smart Freight Centre. Through their valuable comments and inputs, this report was made possible.

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Publisher

ICLEI – Local Governments for Sustainability e.V.
Kaiser-Friedrich-Strasse 7 • 53113 Bonn, Germany • www.iclei.org

Disclaimer

The publication should be cited in full as:
"ICLEI – Local Governments for Sustainability (2021). Creating sustainable cities through low-carbon freight - EcoLogistics in Argentina, Colombia and India. Bonn, Germany".

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ABBREVIATIONS, MEASURES AND SYMBOLS

Abbreviations	Definition
AMVA	Metropolitan Area of the Aburrá Valley ("Área Metropolitana del Valle de Aburrá" in Spanish)
BAU	Business as usual
CBD	Central business district
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
cc	Cubic centimeters
GCDA	Greater Kochi Development Area
GDP	Gross domestic product
GLEC	Global Logistics Emissions Council
GHG	Greenhouse gas
GVW	Gross vehicle weight
IEA	International Energy Agency
ICE	Internal combustion engine
ICTT	International Container Transhipment Terminal
ITF	International Transport Forum
IWT	Inland waterways transport
kg	Kilogram
km	Kilometer
kWh	Kilowatt-hour
L	Liter
L/100km	Liters per 100 kilometers
LEV	Low emission vehicle
LEZ	Low emission zone
LCAP-UF	Low carbon action plan for urban freight
MAV	Multi axle vehicle
m^2	Square meter
NDC	National Determined Contribution
NMT	Non-motorized transport
NO_x	Nitrogen oxides
OHD	Off-hour deliveries
$PM_{2.5}$	Fine particulate matter (2.5 micrometers or less in diameter)
PM_{10}	Particulate matter (10 micrometers or less in diameter)
T	Tonne
t-km	Tonne-kilometer
VKT	Vehicle kilometer traveled
ZEV	Zero emission vehicle
> =	More than or equal to
< =	Less than or equal to

GLOSSARY

Name	Brief description
Activity-based approach	Methodology that provides measurement of activity, such as vehicle kilometers travelled or tonnes-kilometers moved, which is multiplied by an emission factor to estimate total emissions.
Base year	A specific year of historical data against which emissions are compared over time.
Baseline scenario	Baseline scenarios are projections of GHG emissions and their key drivers as they might evolve in a future in which no explicit actions are taken to reduce emissions.
Business-as-usual scenario	A reference case that represents future events or conditions most likely to occur as a result of implemented and adopted policies and actions. Sometimes used as an alternative term to "baseline scenario".
CO_2 equivalent	Carbon dioxide equivalent is a unit that describes the impact of different greenhouse gases as a single measure related to the global warming potential of carbon dioxide.
Emission	The release of GHGs into the atmosphere.
Emission factor	A carbon intensity factor that converts activity data into GHG emissions data, usually given in gram carbon dioxide equivalents per kilometer (g CO_2e/km).
Empty running	It is calculated as the percentage of total vehicle kilometers that are run empty.
Freight	Freight is goods transported in bulk by truck, ship, aircraft or any other mode of transport.
Freight transport demand	A measure of the volume of freight transport, typically expressed by tonne-kilometer.
Fuel-based approach	Methodologies that use actual fuel consumption data to estimate emissions, based on the content of the fuel and assumptions regarding its combustion.
Greenhouse gas	Gases that trap heat in the atmosphere, including Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Fluorinated gases
Heavy goods vehicle	A larger vehicle used for the delivery and collection of goods defined (in the EU) having a GVW greater than 3.5 tonnes (t)
Last mile	Last mile is the last leg of a supply chain, when goods are moved to their final destinations.
Light goods vehicle	A smaller vehicle used for the delivery and collection of goods defined (in the EU) having a gross vehicle weight (GVW) of less than 3.5 t
Load factor	The ratio of the shipment weight to the payload capacity of a vehicle or vessel
Payload	The payload of a truck is the total weight minus the actual weight of the vehicle and is equal to the vehicle load capacity.
Tempo	A small commercial vehicle used for the transportation goods, having a payload of less than 0.75 t
Tonne	Metric unit of mass equal to 1000 kilograms
Tonne-kilometer	A unit of measurement of goods transport which represents the transport of one tonnes of goods over a distance of one kilometer. It is also written as tonnes-km or t-km in tables and formulae.
Vehicle kilometer travelled	Distance travelled by a vehicle multiplied by number of vehicles.
Urban freight transport	The movement of freight vehicles principally distributing and dispatching goods into, out of, through and within urban areas.
Urban logistics	The movement of goods, equipment and waste into, out of, through or within urban areas made by non-motorized transport (NMT), light or heavy vehicles, rail, ferries or ships.

EXECUTIVE SUMMARY

In response to the Paris Agreement, governments and businesses are setting ambitious targets for emission reduction. While only 21 percent of the Nationally Determined Contributions (NDCs) highlighting transport refer to freight transport, there is an increasing awareness and focus on sustainable freight at the national and local level. Worldwide more than 500 companies have committed to science-based targets and over 1000 are taking science-based climate actions. However, greenhouse gas (GHG) emissions from freight transport are increasing continuously and reversing this trend is a particular challenge. Without intervention, freight demand is expected to triple and its associated carbon dioxide (CO_2) emissions to more than double by 2050 compared to the 2015 levels.

Against this backdrop, the purpose of this report is to review existing urban freight movement characteristics across nine cities in Argentina, Colombia and India, provide an account of current GHG emissions from urban freight and to evolve strategies to minimize its impact. The report is designed to be used as a baseline from which to measure emissions reductions, and will be used as part of the Low Carbon Action Plan for Urban Freight (LCAP-UF), which details the actions that are planned in order to curtail energy consumption and emissions from urban freight. In alignment of global efforts on carbon accounting for logistics operations, the baseline emissions have been established using ICLEI's EcoLogistics Self-monitoring Tool – a free tool to help cities build policies, guide solutions and measure progress.

As a result of desktop investigation, multi-stakeholder discussions, close consultation with public officials, surveys and interviews with logistics companies and freight transport operators in each city, this report presents the key findings:

- There is an increasing awareness and focus on freight at the national level in all three countries, albeit uneven distribution of efforts among countries. The vision on sustainable freight stimulates local change.
- Air quality and emission reduction are one of the key drivers for sustainable urban freight in the cities.
- Policies geared towards adoption of low carbon fuels for urban logistics operations through stricter emission standards and fuel economy standards are gaining prominence.
- High-quality infrastructure is a precondition for the provision of efficient transport services for both freight and passenger movements, however the infrastructure capacity consumed by freight activities is often overlooked.
- Many cities have recognized the importance of reducing fuel consumption and GHG emissions in the freight sector. However, they often lack reliable data on real-world vehicles that can be used to establish a baseline, which is essential for evaluating the freight transport performance, and identifying future priorities and directions.
- Almost unexpectedly, irrespective of city-scale or location, the profile of urban freight interventions is often piecemeal, place-based and limited to a certain group of stakeholders. A larger effort is needed from the various regulatory agencies in the cities to close the regulatory gap.

Looking ahead, many cities and companies around the world are developing road maps to achieve carbon neutrality and reach low-emission freight but many are yet to start. There are a wide array of policies and measures that could be applied to freight and would provide meaningful climate impact reduction benefits. The following recommendations could help turn promises into actions:

A combination of measures - Carrot and stick: Policymakers could adopt and implement a portfolio of carrots and sticks to drive faster decarbonization of freight transport. Based on the knowledge and experiences gained, a coherent and comprehensive package of mutually reinforcing measures that are tailored to the city context is the key to a successful and effective freight related regulatory program.

Integrating passenger and freight transport: With cities making announcement on zero-emission passenger vehicles and zero-emission zones, the momentum to push for freight to be included in transport planning is now. Policy makers should take a holistic approach to addressing passenger and freight transport together and identify if policies, infrastructure, business models and energy sources serve both sectors.

Working collaboratively across regions and industry: Often, there are silos between different stakeholders and there is a lack of shared vision. By bringing multi-stakeholders onto the same table, it can be ensured that they can be heard and can participate in a constructive fashion, to improve the freight system. On one hand, cities are likely to benefit from pursuing partnerships between public authorities; On the other hand, cities should work to develop and facilitate transparent partnerships with private sectors with access and exchange of information, sharing good practices and ensure industry engagement on regulation consultations.

Leveraging data to make evidence-based decisions: As governments are setting ambitious targets for emission reduction, it is critical that they use data to evaluate and make science-based decisions. While new technology offers the possibility to collect data at relatively low cost, a stronger collaboration between the public sector and private companies could mitigate the data availability issue considerably. Apart from data collection, it is critical to develop and establish robust methodologies for logistics emission calculation to support freight users with adopting the emission reduction targets.


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I. INTRODUCTION

"Freight transport is absolutely essential to modem urban civilisation. The very concept of urbanisation requires a freight system to sustain it, since urbanisation means that large numbers of people are accumulated in areas remote from their sources of food, sources of raw materials for industry, markets for industrial products, and places to dispose of their waste. No urban area could exist without a massive, sustained, and reliable flow of goods to, from, and within it. " (Thomas 1992)

Understanding the fabric and flows of urban freight is a key piece to understanding how the socioeconomic systems of a city work. Managing the freight flows effectively is essential to economic prosperity and more importantly, creating healthy, safe, low-emission, and people-centered urban environments.

Today, global freight accounts for 36 percent of the total transport-related emissions; if unchecked, freight transport demand is expected to triple and its associated CO_2 emissions to more than double by 2050, according to the International Transport Forum (ITF 2019). While nearly 70 percent of freight is shipped by sea, road transport is by far the dominant source of global freight emissions: It made up 62 percent of the freight transport emissions in 2015 and is predicted to rise by 55 percent by 2050.

As cities continue to grow at an unprecedented rate, increasing freight movements present unique urban challenges including congestion, air pollution, traffic accidents and a host of other negative impacts on the mobility system. Against this backdrop, it is imperative for local governments to decarbonize the freight sector, take a holistic approach to planning and create an environment that allows people and goods to move safely, efficiently and sustainably.

1. Background to the EcoLogistics project

ICLEI's *"EcoLogistics: Low carbon freight for sustainable cities"* project (EcoLogistics project) plays a critical role in bridging the knowledge gap and in leading efforts to raise the profile of freight transport in policy arenas. Supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) through its International Climate Initiative (IKI), the project aims to increase the capacity of governmental and non-governmental actors to build strategies and policies to promote low carbon and sustainable urban freight in Argentina, Colombia and India, involving nine cities and regions:

The EcoLogistics project synthesizes current information on urban freight through primary and secondary research, assessing and proposing solutions to a wide range of issues facing urban freight. While urban freight issues are difficult to tackle individually, a broad collaboration between public and private stakeholders is developed through the project. Through active knowledge exchange and competitive intelligence, as well as close collaboration with multi-stakeholders, project cities learn from others to facilitate the sustainable development of urban freight.

2. Objectives and scope of this report

Moving goods within cities is a complex task with mounting challenges. Unlike passenger transport, transportation professionals and policymakers often lack comprehensive understanding, robust data and common terminologies, all of which have major implications for the management of urban freight transport systems, as well as the larger freight network.

There is a need for a greater understanding about freight transport system at an urban level, its relationship with land uses, and its negative environmental externalities. The purpose of this report is to review existing urban freight movement characteristics across the nine project cities in Argentina, Colombia and India, provide an account of baseline GHG emissions (2019) from urban freight and identify possible interventions to minimize its negative impacts. The emissions have been established using the EcoLogistics Self-monitoring Tool. Developed as part of the EcoLogistics project, this is a useful tool for local governments to estimate, evaluate and track their urban freight emissions over time.

The analysis presented in this report is a result of extensive desktop research, multi-stakeholder discussions, close consultation with public officials, surveys and interviews with logistics companies and freight transport operators in each city. City-specific data was used where available, and verified by stakeholders to ensure its robustness and credibility. Drawing on the analysis, policy recommendations and interventions are also presented in this report and will be used as part of the *Low Carbon Action Plan for Urban Freight* (LCAP-UF) in the project cities.

3. Measuring urban freight emissions

To set the strategies to decarbonize freight transport, cities need to understand the emission contributions of different logistics activities. Calculating emissions is a first step. To this end, ICLEI developed the *EcoLogistics Self-monitoring Tool* for local governments to estimate, evaluate and track their urban freight performance over time, as well as engage in uniformed goal-setting and guide future actions in the most impactful way.

The tool can be utilized directly by cities to measure the existing GHG emission performance of urban freight using CO_2 equivalent (CO_2e) values. It can also be used to estimate urban freight emissions in the baseline scenario (or business-as-usual scenario, BAU scenario) and allows the assessment of a target scenario wherein specific technologies or strategies that would improve fuel efficiency or reduce GHG emissions are hypothetically implemented[1]. This tool allows cities to make meaningful comparisons over time and with other cities in terms of urban freight emissions.

Generally, the methodologies for estimating transport emissions can be categorized as fuel-based and activity-based approaches (Smart Freight Centre 2019). The fuel-based approach uses actual fuel consumption data to estimate emissions, whereas the activity-based approach seeks to quantify emissions using information of vehicle activity, such as vehicle kilometer travelled (VKT) or tonne-kilometers (tkm) moved. An appropriate approach was chosen based on the availability and quality of data in each city.

1 The target scenario considers different measures in isolation as determined based on local development priorities, feasibility, costs and benefits assessment. So far, four measures have been implemented in the Self-monitoring Tool for impact assessment: Fuel technology change, Distance reduction, Eco-driving, and Off-hour deliveries (OHD). For more information, please visit sustainablemobility.iclei.org/ecologistics/self-monitoring-tool

The main parameters required to calculate freight emissions are presented in Figure 1 below .

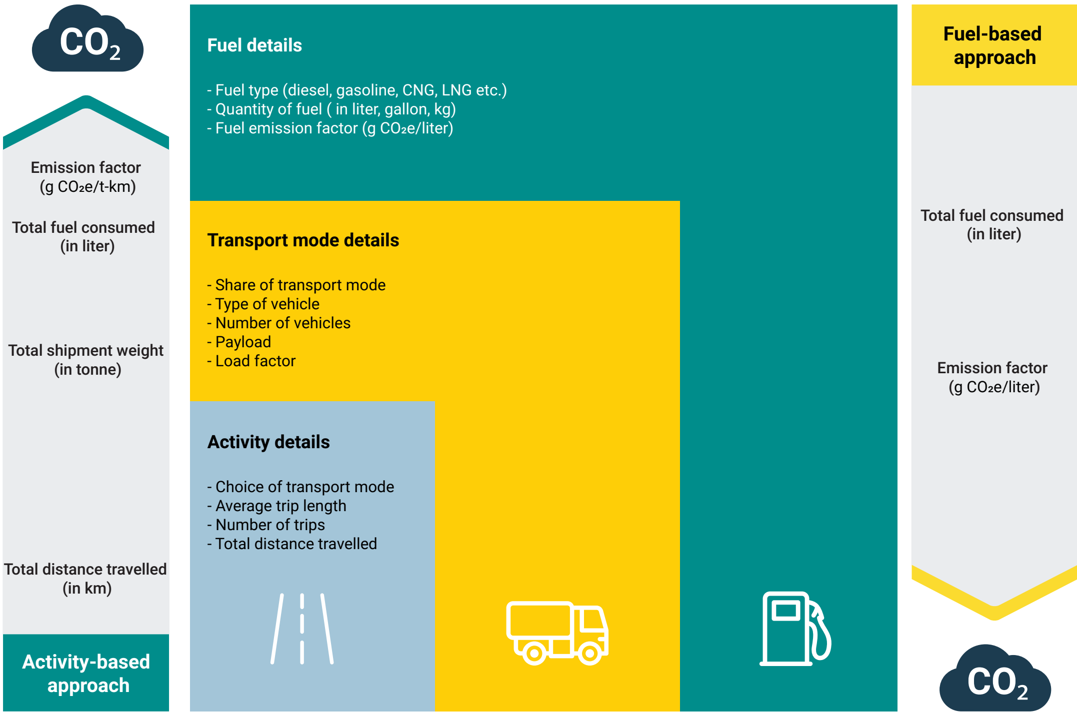


Figure 1: The calculation approach for freight transport emissions. Source: (ICLEI - Local Governments for Sustainability 2020)

Collecting data

Freight activity is difficult to understand because it is very fragmented and there are many actors (e.g., shippers, carriers, distributors, freight forwarders, receivers) involved. The most comprehensive data available often lies with the private sector and there are rarely agreements in place for the data to be shared. As such, a multi-layer, multi-actor approach is required to capture freight patterns and characteristics in the cities. Statistical sources, existing policy documents and plans, previous technical studies are used, and surveys are carried out among the local stakeholders in sample areas. For the survey, the report presents two major methods: vehicle classification counts and origin-destination (O-D) surveys, which include trip-intercept surveys, online and telephone surveys, establishment surveys, carrier surveys and parking surveys. Different types of surveys complement each other.

Some of the key collected data includes: 1) Freight vehicle used (vehicle type, operational age, fuel consumed, and load factor); 2) Origin and destination of the trip; 3) Trip details and

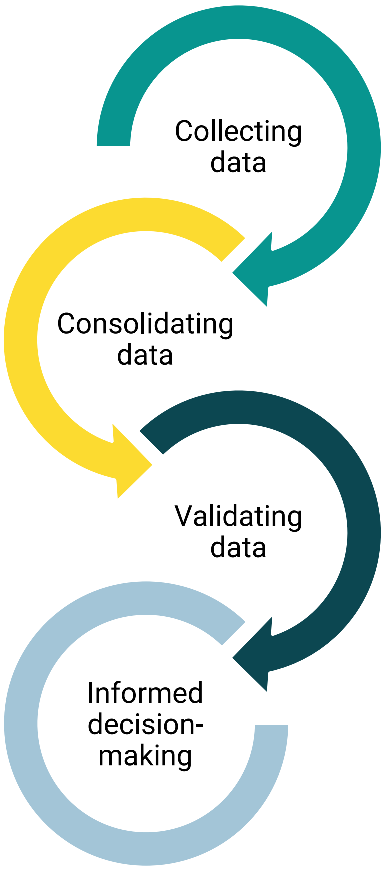


Figure 2: Use data to make informed decisions

patterns of freight vehicles; 4) Commodities transported (quantity, unit, weight, and economic sector); 5) Loading/unloading activity of freight vehicles; 6) Parking activity.

(Note: Additional details are presented in each city report.)

Consolidating data

The report contains formal (official) and informal (unofficial) data gathered from a wide range of sources in a collaborative way (e.g., from project cities, and from academic and research institutions). Sources can be found at the end of the report. Most recent data available for road freight transport and topics are covered; however, the year of the most recent data available varies by city.

Validating data

Data validation and fact-checking is conducted by different stakeholders, ranging from city officials to freight transport operator representatives, researchers and experts in freight transport.

Using data to make informed decisions

Validated data and information provides fact-based evidence and is used to develop a supportive narrative to shape the debate on urban freight and inform decision processes in the project cities.

Practical challenges in quantifying urban freight emissions

Providing a baseline measurement of urban freight emissions offers many advantages. For instance, it can be used as a call to action and to aptly communicate progress on achieving the goal of transport decarbonization. However, freight related activities are full of complexity and heterogeneity, resulting in limitations that must be considered.

There is more to urban freight transport. For most practical purposes, this report focuses on road freight transport, given the dominance of this mode for last mile deliveries in urban areas. While road freight transport offers a level of flexibility, accessibility and overall service level at competitive costs; it represents 18 percent of total freight activity and 57 percent of freight related CO_2 emissions globally (ITF 2019). Nevertheless, this report looks at rail and inland waterways transport (IWT) to the extent that they are helpful to understand cities' emissions.

There is a lack of consistency in data quality. Some of the analysis work was undertaken based on a number of assumptions due to the paucity of available data. City-specific data is used where available, but is supplemented with national and regional data to help build a detailed understanding of urban freight activities. Within the GHG emission calculation process, this report uses representative fuel emission factors and standard values for empty running and load factor sourced from the Global Logistics Emissions Council Framework (GLEC Framework). It must be noted that default data only provides an indication of emissions, but can be considered suitable as a starting point. Besides, the estimates are based on information collected from a sample of vehicles rather than a full enumeration, and are therefore subject to sampling error. The following assumptions have been made:

- Information provided by cities on the registered vehicle fleet are accurate
- Average vehicle kilometers travelled (VKT) and fuel consumption in terms of liters per 100 kilometers (l/100km) are weighted to be representative of the city vehicle fleet
- The boundary conditions described above do not significantly alter the final figures

For a more exhaustive look into the methodology behind the calculation, you can visit our website: https://sustainablemobility.iclei.org/ecologistics/self-monitoring-tool/

II. A QUANTITATIVE ANALYSIS OF URBAN FREIGHT TRANSPORT IN CITIES

This section collates figures and statistics from nine project cities and regions in Colombia, Argentina and India, which have selected urban freight as a priority in order to attain their NDC targets. A wide range of urban freight parameters are provided, analysed and explained in depth below, covering demographic, socio-economic, infrastructural and freight transport specific data. This report aims to provide a quantitative view of urban freight data collected by clustering them into:

Table 1: A quantitative view of road freight transport activity

Demographic and economic characteristics
• The size, density and GDP of project cities
GHG emissions from the transport sector
• Emission reduction targets and strategies • Existing freight-related regulations and measures
Urban freight transport fleet
• The share of freight vehicles in the registered vehicle fleet • The share of freight vehicles by vehicle type • The share of freight vehicles by vehicle age • The share of freight vehicles by fuel type • Urban freight traffic flows • Vehicle kilometers travelled • Road freight activity in terms of tonne-kilometer • Utilization of vehicle capacity
Environment and energy aspects
• Fuel consumption in terms of liters per 100 kilometers • Baseline CO_2e emissions from urban freight transport • Projections for CO_2e emissions from urban freight transport in the BAU scenario • Projections for CO_2eemissions from urban freight transport in the target scenario

1. Demographic and economic characteristics

The size, density and GDP of project cities

The size (in terms of its geographical area and population) and density of the urban area appear to influence urban freight movement, albeit less significantly than for passenger transport. For instance, existing studies suggest that a higher proportion of road freight has been shown to be lifted on internal journeys in large urban areas, rather than the smaller ones (Allen, Browne and Cherrett 2012). Similarly, the urban road layout has an impact on the size of freight vehicles operated in the urban area.

Economic growth plays a vital role in the development of freight transport demand. Worldwide, the number of urban freight trips is projected to continue to grow in line with cities' population and gross domestic product (GDP). Table 2 shows population densities and GDP per capita figures of the project cities. It must be noted that these figures are not always directly related to the number of inhabitants.

Table 2: The size, density and GDP of cities

City	Population	Total area (km^2)	Urban area (km^2)	Population density (inhabitants/ km^2)	Population growth rate per year (%)	GDP (billion USD)
Bogotá	8,181,047	1,636.59	413.88	4,310	1.50%	76.53*
AMVA	3,909,729	1,157.39	340	3,104	0.9%	29.55*
Manizales	440,608	571.8	191.67	760	0.41%	2.33*
Córdoba	1,446,201	576	-	2,274	3.50%	7.42**
Santa Fe	423,212	268	187.6	2,224	2.80%	50.88**
Rosario	995,497	178.69	-	5,726	4.30%	-
Kochi	6,33,553	330.02	94.88	7,100	6.1%	-
Shimla	169,578	100	35	4,800	1.7%	-
Panaji	40,017	21.01	8.12	4,928	1.2%	-

*Source: Information provided by respective cities; *Bogotá, AMVA and Manizales: (DANE 2020); ** Cordoba and Santa Fe: (IPEC 2019); (-) Not available*

2. GHG emissions from the transport sector

Globally the transport sector contributes to nearly one quarter of energy-related GHG emissions. As illustrated in the table below, transport is a major source of emissions in the project cities, ranging from 24 percent to 61 percent. In the cities where information is available, on-road transport makes up a large portion of it, with over 80 percent of transport emissions.

Table 3: Transport-related emissions in the cities

City	Total GHG emissions (t CO_2e)	Reporting year	Transport-related emissions (t CO_2e)	On-road transport related emissions (t CO_2e)	Contribution of transport emissions (% of total emissions)
Bogotá	16,184,908	2016	4,802,062	-	30%
AMVA	7,080,948	2015	4,332,907*	-	61%
Manizales	755,298	2016	199,013	-	26%
Córdoba	5,099,175	2014	1,620,262	-	32%
Santa Fe	1,121,947	2016	505,750	408,355	45%
Rosario	4,555,894	2016	1,093,415	1,011,359	24%
Kochi	5,080,000	2013	-	2,900,000	57%
Shimla	222,637	2013	-	82,376	37%
Panaji	135,137	2013	-	55,406	41%

*Source: Provided by respective cities; *AMVA: (Área Metropolitana del Valle de Aburrá 2018); (-) Not available*

Emission reduction targets and strategies

On the national level, **Colombia** has committed to reduce its GHG emissions by 20 percent with respect to the projected business-as-usual scenario (BAU) by 2030, according to the country's Intended Nationally Determined Contribution (INDC)[2]. Its National Climate Change Policy (2018) has set out strategies to improve energy efficiency of freight vehicles, aiming at reducing emissions.

Argentina has set an absolute emission target of less than 483 million tonnes CO_2e by 2030 in its NDC and a 15 percent reduction in GHG emissions by 2030 in the INDC. However, it has not set any national targets for the transport sector. The National Mitigation and Adaptation Plan foresees a range of measures that could reduce emissions and places a focus on freight; together, these measures could cut emissions by 7.2 percent by 2030 compared to BAU scenario (Vieweg, et al. 2018).

India does not have a specific national emissions target for the transport sector, but it is committed to increasing the share of rail in land transport from 36 to 45 percent. Important targets related to transport include a 100 percent share for electric buses by 2030 and it has policies in place to enhance the energy efficiency for heavy duty vehicles.

On the regional and city level, differences between the project cities are apparent when it comes to specific objectives for emission reductions. Bogotá has set ambitious emission reduction targets, aiming at a 4 percent reduction in GHG emissions by 2020, compared to its 2008 emission level. In addition, it has committed to improving its energy efficiency in electricity and transport sectors[3]. In India, Kochi has also committed to increasing its energy efficiency in final energy consumption by 5 percent by 2020 compared to 2014 level.

It should be noted that most of the project cities do not have any specific targets for the transport sector, but there seems to be a consensus that the transport sector needs to contribute significantly in reductions, in light of climate change goals. When zooming in on the freight transport sector, none of the project cities have specific emission reduction targets. Nonetheless, it is worth noting that Bogotá's Mobility Master Plan (*"Plan Maestro de Movilidad"*) set objectives related to urban freight and the reduction of environmental pollution from transportation (Alcaldía Mayor de Bogotá D.C. 2006). Similarly, Kochi's Draft Comprehensive Mobility Plan (2017) embarks on freight management strategies to reduce air pollution in the city.

Existing freight-related regulations and measures

When it comes to freight related policy interventions, there is a wide spectrum of public-sector actions that could address a freight issue, covering both supply and demand-related initiatives, as well as operational and financial strategies. In line with existing studies, we classified the measures taken by the project cities into eight major groups (Transportation Research Board and National Academies of Sciences, Engineering, and Medicine 2015):

- Infrastructure management
- Parking/Loading areas management
- Vehicle-related strategies
- Traffic management
- Pricing, incentives, and taxation
- Logistical management
- Freight demand/Land use management
- Stakeholder engagement

2 For more information about the countries' NDCs, please visit www.climatewatchdata.org/ndcs/country/COL?document=first_ndc

3 For more information, please visit: carbonn.org/city_profiles/Capital_District_of_Bogot%C3%A1

Table 4 (below) summarizes cities' existing actions. Notably, parking and loading areas management is one of the most common measures implemented by cities for improving urban freight performance; this includes allocating curb space for parking and loading activities, increasing the capacity of parking and loading areas to reduce congestion and improve traffic. Vehicle-related strategies such as emission standards and vehicle renewable programs leverage a range of technologies to reduce the negative externalities produced by vehicles and are commonly deployed by cities. Furthermore, Cities like Bogotá, AMVA, Kochi and Panaji all have implemented some form of traffic management actions, aiming to improve traffic conditions through access restrictions - to limit, grant, or deny access of freight vehicles in terms of vehicle type (e.g., size, weight, load factor, engine type) and time of travel (daytime delivery restrictions, night-time delivery bans, etc.).

Table 4: Existing public-sector actions to address urban freight issues

City	Existing actions for addressing urban freight issues	Group
Kochi	A proposal to redevelop the Ernakulam market area, one of the major hotspots for urban freight, has been initiated. The new redevelopment plan touches upon requirements for freight such as loading/unloading bays, non-motorized transport (NMT) delivery system to shops, clustering of shops and routing strategy. Discussions on revitalization of inland waterways for freight transport have started, together with Integrated Urban Regeneration and ater Transport System (IURWTS).	**Infrastructure management**
Bogotá	Loading/unloading restrictions of freight vehicles; as part of the program *"EnCARGAte de Bogotá"*, freight vehicles may carry out loading and unloading activities from 10 p.m. to 5:30 a.m. on arterial roads, whilst on local roads, vehicles with no more than two axles may load and unload from 8:30 a.m. to 4:30 p.m. and 7 p.m. to 5:30 a.m.	**Parking/ Loading areas management**
AMVA	Dedicated delivery times and spaces for loading/unloading and parking for freight vehicles in the center of Medellín; implementing 71 freight transport initiatives to optimize loading in congested areas.	
Manizales	Manizales's Master Mobility Plan (*"Plan Maestro de Movilidad"*, PMM, 2017) aims to create an inclusive and integrated transport system; it has set out measures to improve urban logistics (e.g., to provide parking space for freight vehicles).	
Córdoba	Córdoba regulates loading and unloading operations of freight vehicles throughout the city.	
Rosario	Rosario has set up exclusive bus lanes and designated areas for loading and unloading activities for goods vehicles in the city, which is used to improve lane utilization and mobility.	
Santa Fe	Parking spaces for loading/unloading are indicated by a yellow line and specific road signs, which specify loading/unloading rules and timing.	
Bogotá	The city will be establishing a facilitation unit to support freight vehicle owners in vehicle scrapping and renewal, making use of the instruments and resources developed by the national government. It aims to renew more than 11,500 light- and medium-sized trucks by 2030.	**Vehicle-related strategies**

AMVA	AMVA has put a strong focus on vehicle fleet renewal program to phase out heavy diesel vehicles and foster the use of emission-compliant or alternatively fuelled vehicles. AMVA and the development bank Findeter, launched a credit line in 2019 to provide financing for the acquisition of zero, ultra-low and low emission vehicles. This project is financed using Findeter's credit line with a compensated rate of 50 billion pesos (around 11 million Euros). The aim is to renew a total of more than 67,000 vehicles; the first phase prioritizes the renewal of 3,500 most-polluting vehicles including trucks, dump trucks and buses "(Área Metropolitana del Valle de Aburrá 2019)".	**Vehicle-related strategies**
Rosario	The Integrated Mobility Plan (*"Plan Integral de Movilidad"*, PIM, 2011) aims to develop an inclusive and integrated transport system that incorporates rail transport, tramway, dedicated transport corridors and electric mobility options, promoting the use of clean and renewable energy.	
Bogotá	**Restrictions by vehicle age:** Restrictions on freight vehicles over 20 years old in the urban area, which applies from Mondays to Fridays from 6 a.m. to 8 a.m., and from 5 p.m. to 8 p.m.; the traffic management policy known as peak and plate (*"Pico y Placa"*) is implemented by restricting license plate numbers of freight vehicles over 20 years old on a rotating basis and currently applies from from 5 a.m. to 9 p.m. on Saturdays. **Access restrictions by gross vehicle weight (GVW) and by number of axles in three zones:** In Zone 1, the circulation of freight vehicles with a GVW greater than 8.5 tons (t) is restricted from 6 a.m. to 8 a.m. and from 5 p.m. to 8 p.m.; in Zone 2, the circulation of freight vehicles less than 20 years old is allowed throughout the day; in the historical center *La Candelaria*, vehicles with two axles or more and a GVW greater than 3.5 t are restricted around the clock[4].	**Traffic management**
AMVA	Time restriction of freight vehicles with a load capacity over 4 t in municipalities such as Medellín, Copacabana, Envigado, Itagui etc.; peak and plate is implemented throughout the day from Monday to Saturday for private cars, freight vehicles and motorcycles in the region, according to the Metropolitan Agreement 04/2020.[5]	
Córdoba	Specific routes for the movement of goods, five radial routes, access restrictions by vehicle size and weight; arious time windows have been set for vehicles transporting goods on weekdays in the downtown area.	
Manizales	Time and access restrictions for loading and unloading operations; ehicles with a gross vehicle weight over 4.5 t are banned from 6 a.m. to 10 p.m. in the downtown area.	
Rosario	Exclusive bus lanes and designated areas for loading and unloading activities for goods vehicles in the city center.	

4 For more information on Bogota's freight transport related restrictions, please visit www.simur.gov.co/portal-simur/consultas/zonas_carga_descarga/zonas-de-circulacion-vehiculos-de-carga

5 To combat air pollution, AMVA has expanded the peak and plate policy for private vehicles, motorcycles and freight vehicles. Find out more at www.metropol.gov.co/Paginas/Noticias/pico-y-placa-ambiental-24-horas-a-partir-del-miercoles-11-de-marzo-de-2020.aspx

Kochi	Kochi's comprehensive mobility plan identifies policies to restrict heavy vehicle movements in the city.	**Traffic management**
Panaji	As part of a larger low-carbon development strategy, Panaji plans to restrict and regulate the entry of heavy vehicles in the city via zoning and time restrictions.	
Bogotá	The city has developed on-demand eco-driving training for vehicle drivers since 2018, in order to encourage the behavioural change amongst drivers to save fuel and improve road safety.	**Logistical management**
AMVA	Together with transport companies and driver education centers, the Secretary of Mobility of AMVA seeks to promote "Green Driving". This program aims to train drivers to drive in eco-friendly ways to save fuel and reduce emissions. This includes good driving practices, stress management and preventive maintenance, among other topics.	
Kochi	As part of the EcoLogistics project, an eco-driving training program was organised organized from 7 - 8 June 2019, in partnership with the Petroleum Conservation Research Association (PCRA), the Ministry of Petroleum and Natural Gas, the Government of India, the Kerala Institute of Labour and Employment (KILE), as well as Government of Kerala. More than 50 drivers of freight vehicles were provided hands-on training to promote behavioral change in driving practices, fuel efficiency and road safety. KILE is planning to launch the training on a larger scale and on a regular basis[6].	
Panaji	Panaji is currently in the process of formulating policies to reduce road fatalities caused by urban freight.	
Shimla	Shimla's City Development Plan has suggested the relocation of large freight generators such as transport hubs and wholesale grain markets to the peripheral areas to decongest the core areas.	**Freight demand/ Land use management**
Kochi	Kochi is developing freight consolidation centers outside the city.	
All cities	As part of the EcoLogistics project, all nine cities are required to establish local multi-stakeholder working groups which comprise a wide range of stakeholders. In Bogotá and AMVA, such working groups already exist prior to the project. Bogotá has a working group for urban freight named *Red de Logística Urbana (RLU[7])*, as part of the program *"EnCARGAte de Bogotá"*. Within the program, more than 160 organizations are committed to improving logistics. The RLU seeks to facilitate the freight traffic flows in Bogotá and promote/recognize good practices of urban logistics. In AMVA, the working group *Alianza Logística Regional Antioquia Líder (ALR)* was established in April 2018 and aims to enhance the efficiency and connectivity of regional freight transport.	**Stakeholder engagement**

Source: Information provided by respective cities. To see an interactive version of the table, please scan the QR-code on the right.

6 More information about the eco-driving training program in Kochi, please visit: southasia.iclei.org/newsdetails/article/kochi-workshop-weighs-sustainable-urban-freight-logistics.html

7 See more information at https://issuu.com/secretariadistritaldemovilidad/docs/plegable_rlu_digital

3. Urban freight transport fleet

Developments in CO_2 emissions are, among other things, determined by underlying developments in transport, such as transport demand, volumes, distances and modal shares. As such, it is important to note that freight transport modal shares differ between the project cities.

On-road freight vehicles are designed to transport goods on public roads or highways. Vehicle classification schemes vary from country to country, based on vehicle size, gross vehicle weight, horsepower, number of axles and a wide range of other local factors. For the purpose of this report, road freight vehicles are broadly classified into the following categories:

Table 5: On-road vehicles classification used in the report

Vehicle characteristics and size	Payload (tons) *	Description
Non-motorized rickshaw/ cart **Bicycle/ cargo bike** **Motorized rickshaw/ tuk tuk** **Motorcycle (Two-wheeler)**	-	These vehicles contribute to freight traffic. Motorcycles are a dominant form of transport in many cities, especially throughout Asia. In India, auto-rickshaws and private cars are often used for transporting goods. However, to differentiate these modes is a difficult task and often they are not registered as part of the freight transport modal mix, therefore it is excluded in the following analysis.
Tempo	0.75	Vehicles having a payload of less than 0.75 t
Light goods vehicle (LGV) (< 3.5 t)	1.3	A smaller vehicle used for the delivery and collection of goods defined (in the Europe Union) having a GVW of less than 3.5 t. They are typically used for small-scale urban deliveries.
Rigid truck (3.5 t - 7.5 t)	2.3	A rigid vehicle having a GVW between 3.5 t - 7.5 t
Rigid truck (7.5 t - 12 t)	5	A rigid vehicle having a GVW between 7.5 t - 12 t
Rigid truck (12 t - 20 t)	8.4	A rigid vehicle having a GVW between 12 t - 20 t
Rigid truck (> 20 t)	15.3	A rigid vehicle having a GVW of more than 20 t
Truck and trailer (> 20 t)	18.4	The combination of a tractor unit and one, or more, trailers to carry freight, having a GVW of more than 20 t

The share of freight vehicles in the registered vehicle fleet

As illustrated in Table 6 (below) registered freight vehicles include pick-ups, vans, trucks, tractors and (semi-) trailers. Notably, the ratio of freight vehicles to total registered vehicles differs in three countries, as the registration methods vary from one to the other. In Colombia, the ratio ranges from 2 to 7 percent, while in Argentina, the ratio is up to 12 percent. In India, freight vehicle represent up to 39 percent of the total registered vehicles in the city.

It should also be noted that while a vehicle may be registered in one city, it does not necessarily mean that the vehicle is kept and used in that city. Similarly, vehicles registered at addresses outside of the city may be kept and used in the city. Therefore, the analysis of vehicles registered in the cities does not capture the reality of urban freight transport in the cities. A complementary perspective on how freight is organized is presented in the following sections.

Table 6: Number of registered freight vehicles in the cities

City	Total number of registered vehicles	Number of freight vehicles	Share of freight vehicles (%)	As of
Bogotá	2,497,245	183,841	7%	2018
AMVA	1,301,291	43,054	3%	2016
Manizales	198,390	3,053	2%	2018
Córdoba	890,331	107,971	12%	2019
Santa Fe	227,489	24,864	11%	2018
Rosario	583,586	71,571	12%	2018
Kochi	25,522	9,992	39%	2011 - 2019
Shimla	77,939	18,498	24%	Mar-19
Panaji	45,183	1,458	3%	Mar-19

Source: AMVA: (Área Metropolitana del Valle de Aburrá 2018); Manizales: (Manizales Cómo Vamos 2020); Córdoba: values are sourced from the Córdoba Metropolitan area, a union of medium localities of the Colón Department (Municipalidad de Córdoba n.d.); Bogotá , Santa Fe, Rosario, Kochi, Shimla and Panaji: information provided by respective cities.

The share of freight vehicles by vehicle type in Argentina and Colombia

The size and distribution of a city's vehicle fleet is often influenced by a wide range of factors, including: geography population density, level of urbanization, major economic activities and the share of light/heavy industry distance among centers of production, processing and consumption as well as regulations and restrictions on freight vehicles in the urban areas, etc. The following section presents the share of road freight vehicles by vehicle type in Argentina and Colombia. In India, it is difficult to segregate the number of registered freight vehicles by vehicle characteristics, therefore such information is not included here.

As shown in Figure 3, more than 90 percent of the registered freight vehicle fleet in Bogotá consist of trucks with two axles and with a GVW less than 3.5 t, followed by approximately 7 percent of two-axle trucks with a GVW between 3.5 t and 7.5 t.

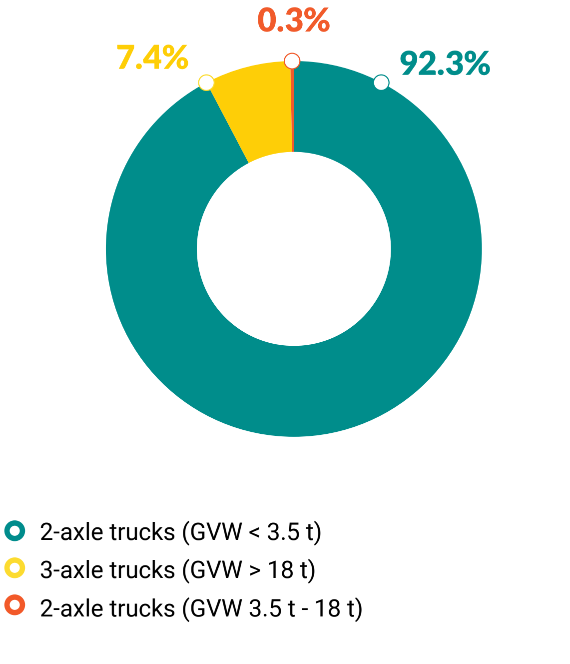


Figure 3: Share of freight vehicles per vehicle type in Bogotá. Source: The Secretariat of Mobility in Bogotá (2019)

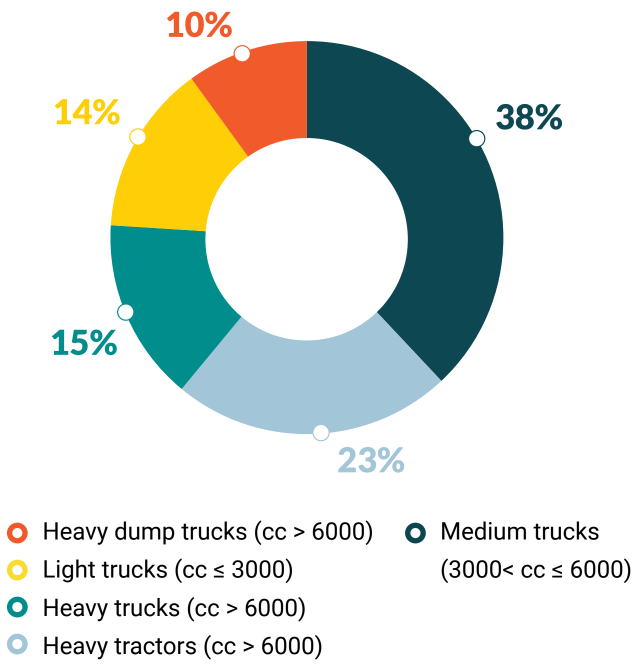


Figure 4: Share of freight vehicles by vehicle type in AMVA. Source: Área Metropolitana del Valle de Aburrá (2018)

AMVA's vehicle categorization is based on its engine displacement - commonly used as an expression of an engine's size and expressed using the metric units of cubic centimetres (cc, equivalent to millilitres). As show in Figure 4, medium trucks with an engine displacement between 3000 cc to 6000 cc make up 38 percent of the vehicle fleet, followed by dump trucks with 23 percent. Light trucks (< 3000 cc) and heavier trucks (> 6000 cc) account for 14 percent and 15 percent of the freight vehicle fleet, respectively.

Figure 5 shows that pick-ups, vans and trucks make up a large share of the registered freight vehicles in Argentina, even though the figure does not specify the share of vehicles active in urban areas.

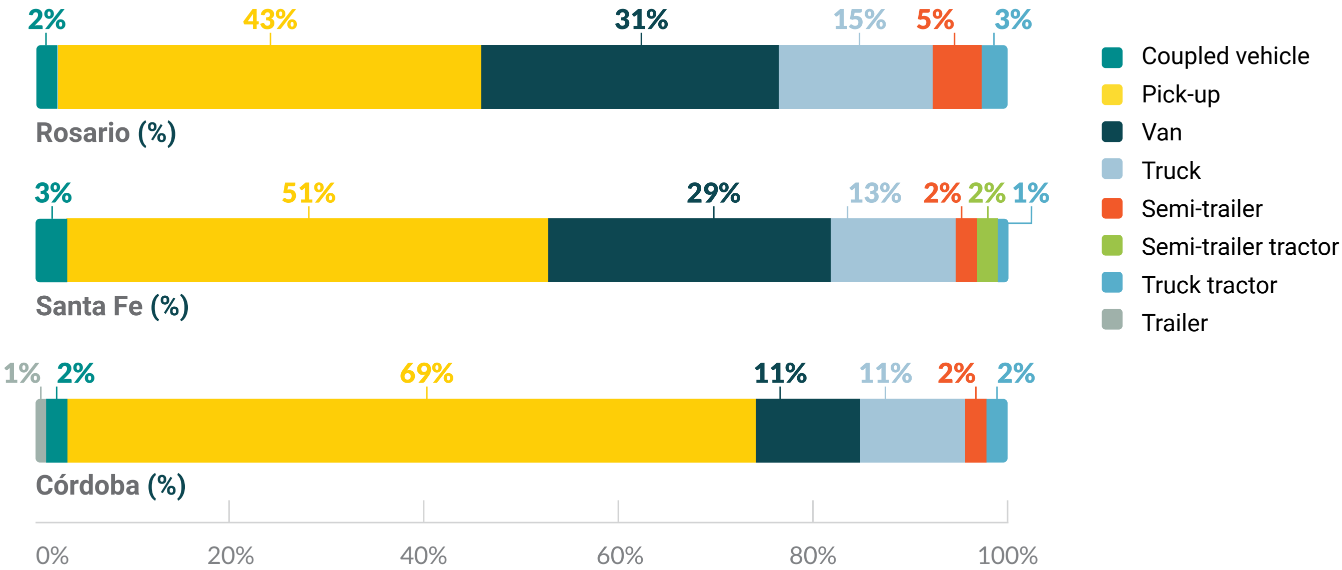


Figure 5 Share of freight vehicles by vehicle type in Argentina. Source: Córdoba: (Municipalidad de Córdoba n.d.); Santa Fe and Rosario: information provided by respective cities. The figures were estimated to enable comparison.

The share of freight vehicles by vehicle age in Argentina and Colombia

The average age of the vehicle fleet is an indirect indication of the environmental performance of road freight transport. The adoption of scrappage schemes financial incentives, mandatory vehicle inspection and maintenance schemes could help decrease the average age of vehicles. The following section provides information about the age of vehicle fleet in the project cities in Colombia and Argentina. Due to paucity of data, such information about vehicles in Indian cities is not included in this section.

The average age of freight vehicle fleet in the project cities is 15 years. Bogotá's fleet has an average age of 16.4 years, Santa Fe's fleet has an average age of 15.9 years, and Córdoba also has older than average freight vehicles – approximately 15.2 years. It should be noted that the average age of these vehicles is modelled and must be treated as estimates, and ideally be weighted to the usage of the vehicle[8]. However, several reliable local data sources on fleet characterisation have been used as input to the model.

As displayed in Figure 6, around 55 percent of Bogotá's vehicle fleet is older than 10 years and 20 percent of the total vehicle fleet is older than 30 years. In AMVA, more than 25 percent of the vehicles are older than 30 years.

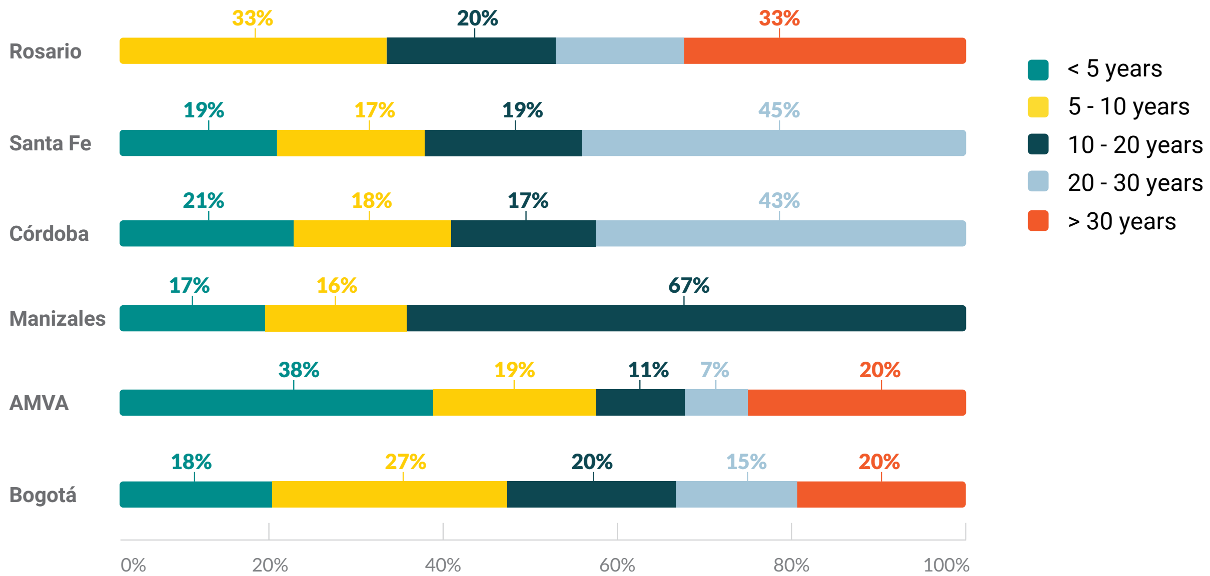


Figure 6 Share of freight vehicles by vehicle age in Argentina and Colombia. Source: AMVA: (Área Metropolitana del Valle de Aburrá 2018); Manizales: (Manizales Cómo Vamos 2020)[9]; Córdoba: (Municipalidad de Córdoba n.d.); Bogotá, Santa Fe and Rosario: information provided by respective cities. The figures were extrapoloated to enable comparison.

Figure 7 and Figure 8 provide a more detailed analysis of the average age of the fleet by vehicle type in these two cities. In Bogotá, light goods vehicles (LGVs) weighing less than 3.5 t and trucks with a GVW between 3.5 t to 18 t are the oldest vehicle type, whereas in AMVA dump trucks have an average age of 15.3 years. An older vehicle fleet means that technology advances found in more modern trucks such as environmental, safety and intelligent transport systems have not been introduced. However, this figure does not specify if these vehicles are performing in urban areas, where health affects resulting from exhaust emissions are most severe. With forecasts predicting an increasing number of freight vehicles and its

8 The population of each vehicle type is distributed in age classes, ranging from 1 to 30 years. The average age is calculated by multiplying the number of vehicles in each class by the mean age of the class (i.e., 2.5, 7.5, 15 years etc.) and then dividing the sum of these by the total number of vehicles in the respective vehicle category (tempos, vans, trucks, tractors, trailers etc.).

9 In Manizales, data about age classes "20 – 30 years" and "> 30 years" is not available; In Rosario, data about age class "< 5 years" is not available.

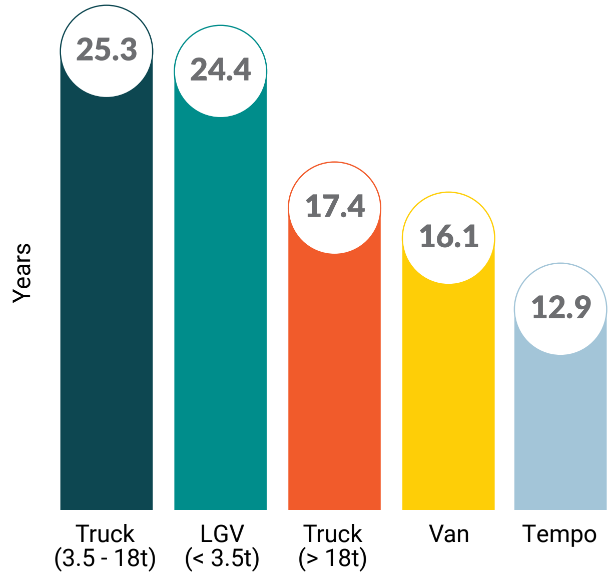


Figure 7: Average age of the freight vehicle fleet in Bogotá. Source: The Secretariat of Mobility in Bogotá (2019)

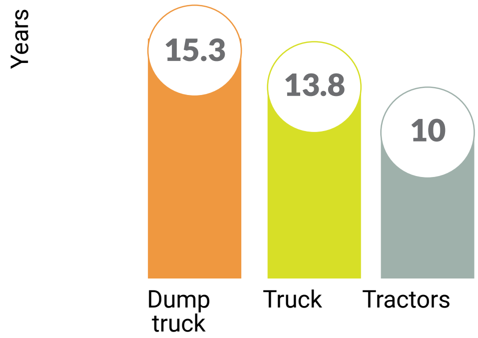


Figure 8: Average age of the freight vehicle fleet in AMVA. Source: (Área Metropolitana del Valle de Aburrá 2018)

adverse impact on air pollution, AMVA has set out a renewable policy for freight vehicles and plans to accelerate the phase-in of ultra-low and zero-emission vehicles.

Figure 9 shows that in three Argentinian cities, coupled vehicles and trailers are the oldest type of vehicle on average of the fleet, around 18.4 and 24.5 years of age on average, respectively. In comparison, the average

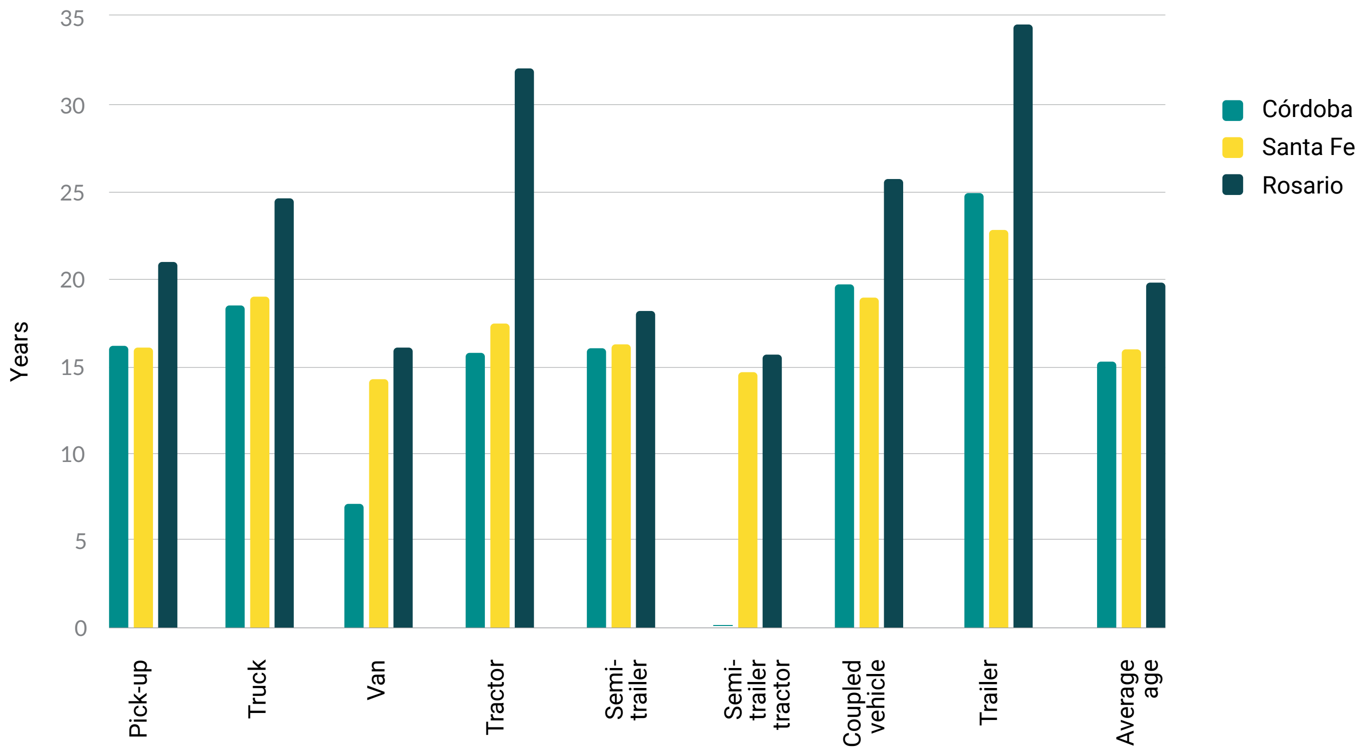


Figure 9: Average age of the freight vehicle fleet by vehicle type in Argentina. Source: ***Córdoba:*** *(Municipalidad de Córdoba n.d.);* ***Santa Fe and Rosario:*** *information is provided by respective cities. The figures were extrapolated to enable comparison.*

age of vans in Europe is 10.9 years, and the average age of heavy commercial vehicles is 12.3 years (ACEA 2020).

The share of freight vehicles by fuel type in Bogotá and AMVA

Fuel use of the registered freight vehicle fleet in Bogotá and AMVA are presented in this section, categorized by vehicle weight class. Fuel use of the vehicle fleets in other cities is not addressed in this report and may be added in the future updates as new information or data becomes available.

As seen in Figure 10 and Figure 11, in Bogotá, the use of gasoline plays an important role, accounting for two-thirds of the total freight vehicle fleet. Gasoline use is largely confined to smaller vehicles: 82 percent of the tempo fleet, 65 percent of the vans, and 48 percent of the LGVs use gasoline as the primary energy source. The share of gasoline use in the freight vehicle fleet gets smaller as the size of the trucks increases. Approximately 28 percent of the vehicle fleet is powered by diesel, while the share of natural gas use constitutes 5 percent of the entire freight vehicle fleet. Around 59 electric vehicles are in operation – almost exclusively tempos and LGVs, indicating that the uptake of electric freight vehicles, especially heavy-duty vehicles, is still at a very early phase in the city.

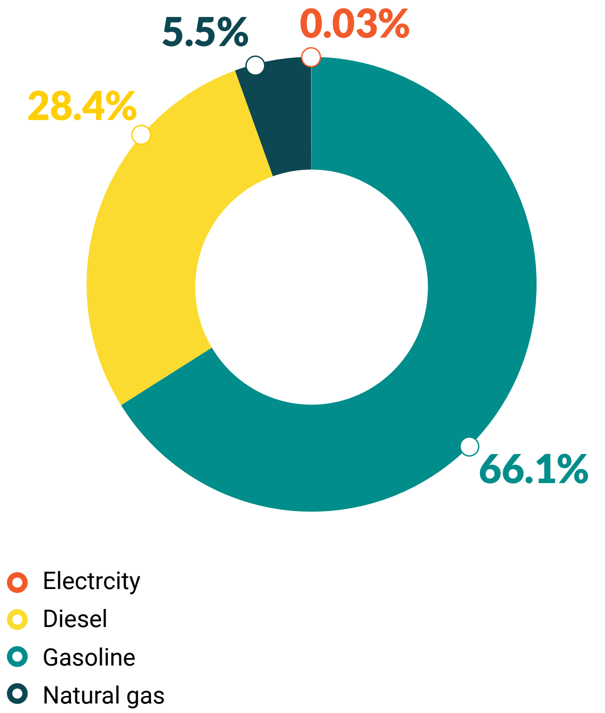


Figure 10: Distribution of fuel use in Bogotá. Source: The Secretariat of Mobility in Bogotá (2019)

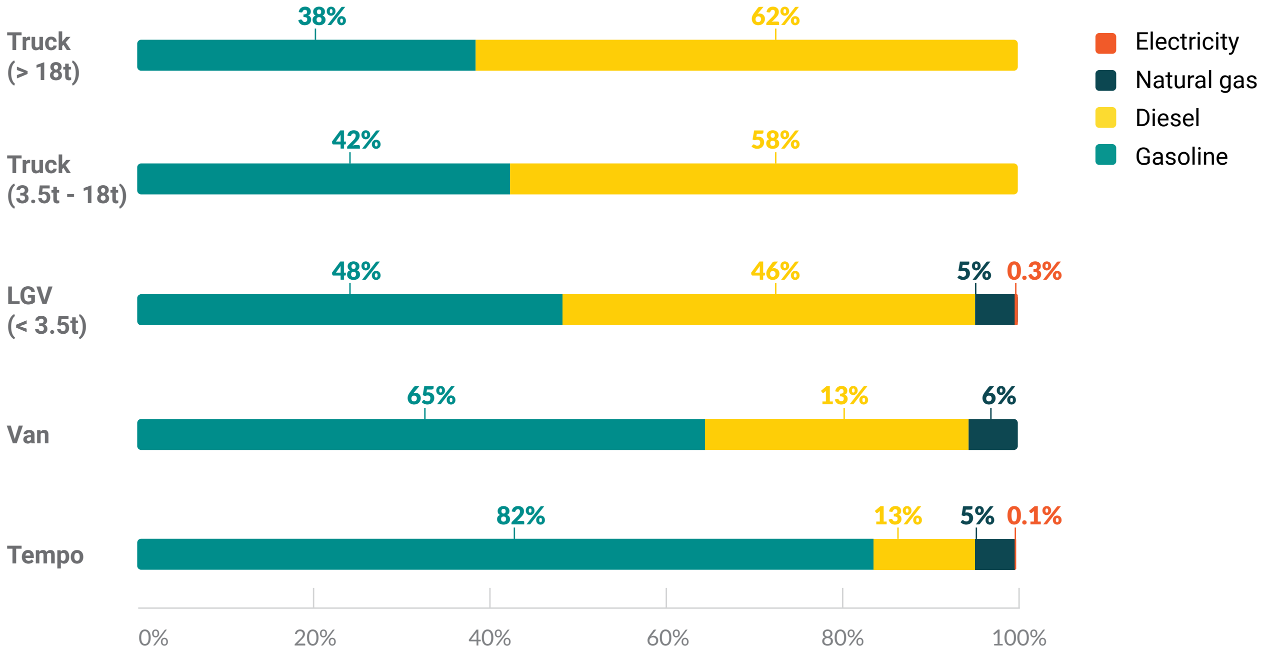


Figure 11: Distribution of fuel use by vehicle type in Bogotá. Source: Ibid.

Furthermore, it is shown that natural gas is the dominant fuel type for smaller freight vehicles in the city while diesel is the primary energy source for heavier vehicles (see Figure 11).

When it comes to the typical fuel types consumed by the vehicle fleet in AMVA, Table 7 shows that, the majority of the fleet is currently diesel-driven (approximately 76 percent), while 14 percent runs on CNG, and a small fraction of the freight vehicle fleet runs on gasoline. For tractors and dump trucks, nearly all oil use is diesel-based due to the higher energy density of the fuel and efficiency of diesel engines in heavy duty vehicles.

Table 7: Fuel use of the registered freight vehicle fleet in AMVA

Vehicle type	Engine displacement	Number of vehicles by fuel type			
		Diesel	Gasoline	CNG	Total
Trucks	Light (cc ≤ 3000)	4,456	718	1,067	6,241
	Medium (3000 < cc ≤ 6000)	9,838	2,551	3,772	16,161
	Heavy (cc > 6000)	4,415	939	1,113	6,467
Tractors	Heavy (cc > 6000)	9,745	-	-	9,745
Dump trucks	Heavy (cc > 6000)	4,440	-	-	4,440
Total number of vehicles		32,894	4,208	5,952	43,054
Share of vehicles by fuel type (%)		76%	10%	14%	100%

Source: (Área Metropolitana del Valle de Aburrá 2018); (-) Not available

Urban freight traffic flows in Bogotá, AMVA and Kochi

Urban freight traffic flows are characterized by the freight movements in the city. Data about the freight traffic flows is available in Bogotá, AMVA and Kochi, and is presented in the following section.

As seen in Table 8, in terms of the freight carried on journeys to, from, within and through the cities, it has been estimated that on average **240,586 tonnes of goods are carried on a daily basis in Bogotá:** with 54 percent by weight of the total freight lifted on journeys to the city and 46 percent from the city, according to the 2015 Origin-Destination (O-D) survey in Bogotá (Secretaría Distrital de Movilidad de Bogotá, Directora de Estudios Sectoriales y de Servicios 2017). In AMVA, according to the latest O-D freight survey (Universidad Nacional de Colombia sede Medellín 2019), **227,491 tonnes of goods are transported on a business day.** Of this, 144,148 tonnes of goods are carried on journeys within the region (intra-city), accounting for approximately 63 percent, followed by intercity inbound trips with 19 percent, and 18 percent outbound.

With regards to the number of freight trips, in Bogotá freight trips are mainly generated from the industrial corridors in the south and west of the city, as well as the business and commercial areas in the city center. It is estimated that on average, approximately **158,000 freight trips are made on a weekday within Bogotá's administrative limit**. Of the trips, 4 percent is through traffic, whilst the vast majority is completely within the city (62 percent); 17 percent of the freight vehicles originate their journey in the city, and 17 percent end it in the city. **In AMVA, the majority (88 percent) of the freight trips had its origin and destination in the metropolitan boundary**. The O-D survey also shows that the commercial sector generates the majority of the daily trips, reaching 20,949 daily trips, followed by the service sector with 25,184 trips.

Table 8: Freight trips in Bogotá (2015) and AMVA (2019)

Type of flows/trips	Bogotá (2015)		AMVA (2019)	
	Average tons carried daily	Number of trips daily	Average tons carried daily	Number of trips daily
Intercity inbound	128,980 **(54%)**	27,492 **(17%)**	42,688 **(19%)**	16,150 **(6%)**
Intercity outbound	111,606 **(46%)**	26,702 **(17%)**	17,340 **(8%)**	10,769 **(4%)**
Intra-city	-	97,644 **(62%)**	144,148 **(63%)**	219,383 **(88%)**
Through-city	-	6,004 **(4%)**	23,315 **(10%)**	2,994 **(1%)**
Total	240,586 **(100%)**	158,000 **(100%)**	227,491 **(100%)**	249,296 **(100%)**

Source: (Secretaría Distrital de Movilidad de Bogotá, 2017), (Universidad Nacional de Colombia sede Medellín, 2019); (-) Not available

It is also important to understand the composition of freight traffic during a day. As shown in Figure 12, in Bogotá, the volume of freight traffic on streets varies. Across the day, the number of trucks steadily rises and peaks from 10:45 a.m. to 11:45 a.m. The volume of vehicles then gradually decreases, but peaks again in the afternoon from 2:30 p.m. and 3:30 p.m. LGVs follow a similar pattern at a lower volume, but the peak is earlier (around 9 a.m.) and has a steadier drop throughout the day.

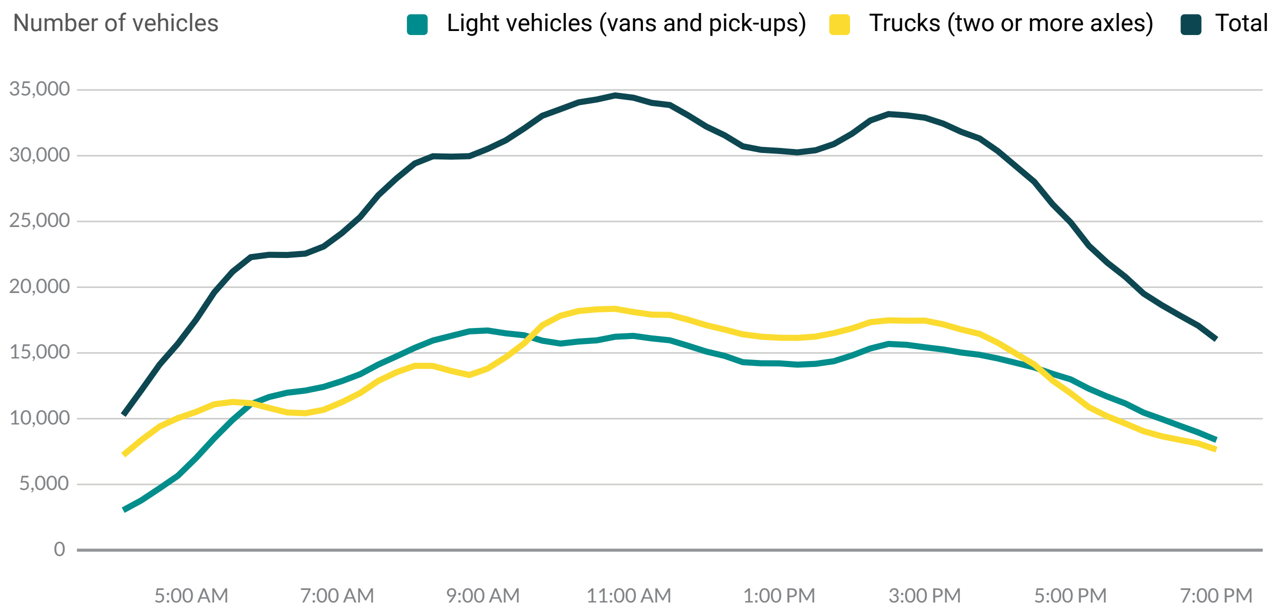


Figure 12 Hourly freight traffic on a business day in Bogotá (2015). Source: (Secretaría Distrital de Movilidad de Bogotá, 2017)

In India, freight traffic shows different characteristics. In Kochi, freight data is sourced from the Comprehensive Mobility Plan (2015), which includes traffic data captured through Classified Vehicle Counts (CVC) at 11 cordon points, road side interviews and CVC at 24 junctions within the Greater Cochin Development Authority (GCDA)[10].

10 Kochi has three administrative areas namely: Kochi Municipal Corporation, Kochi City Region (KCR) and the Greater Cochin Development Authority (GCDA). The GCDA is the planning and development authority of the metropolitan area of Cochin. The jurisdictional area of GCDA comprises of the Kochi City, the commercial capital of Kerala, 6 surrounding

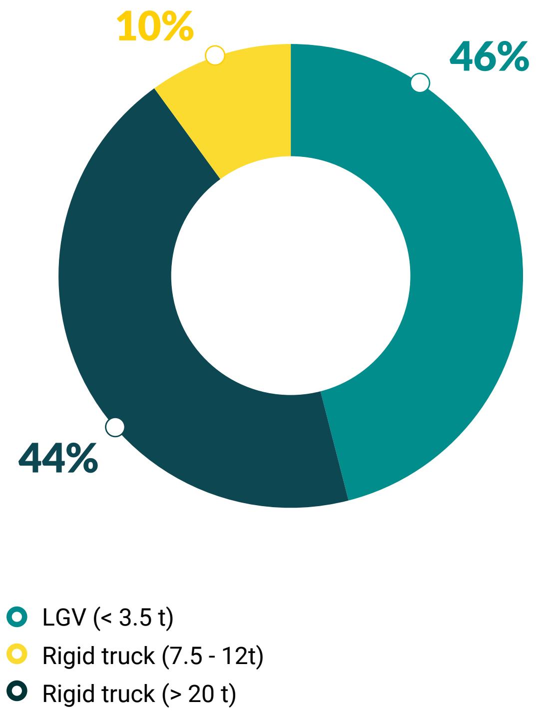


Figure 13: Distribution of freight vehicles used for transportation of goods in Kochi. Source: ICLEI / The Urban Lab

According to the CVC at cordon points, out of the total urban traffic entering the city, the share of freight vehicles is around 14 percent. Moreover, approximately 46 percent of the freight trips are performed by smaller vehicles, including 3- and 4-wheeler rickshaws, pick-ups, vans, tempos and other light goods vehicles, followed by trucks and two-axle vehicles (3.5 t - 12 t) with 44 percent (Figure 13). Multi-axle vehicles (MAV, 12 t - 20 t) account for 10 percent of the freight traffic.

In terms of the distribution of freight traffic in a day, the screen line survey of vehicles depicts the relatively high hourly movement of goods entering the city is from 11 a.m. to 12 p.m. and from 7 p.m. to 8 p.m. The volume of vehicles plying within the city boundary during these periods might create a substantial impact on urban traffic movement. Figure 14 illustrates the maximum per hour trips from all modes of freight transport (i.e., 5.25 percent by LGVs, 2.89 percent by trucks and 4.81 percent by MAVs).

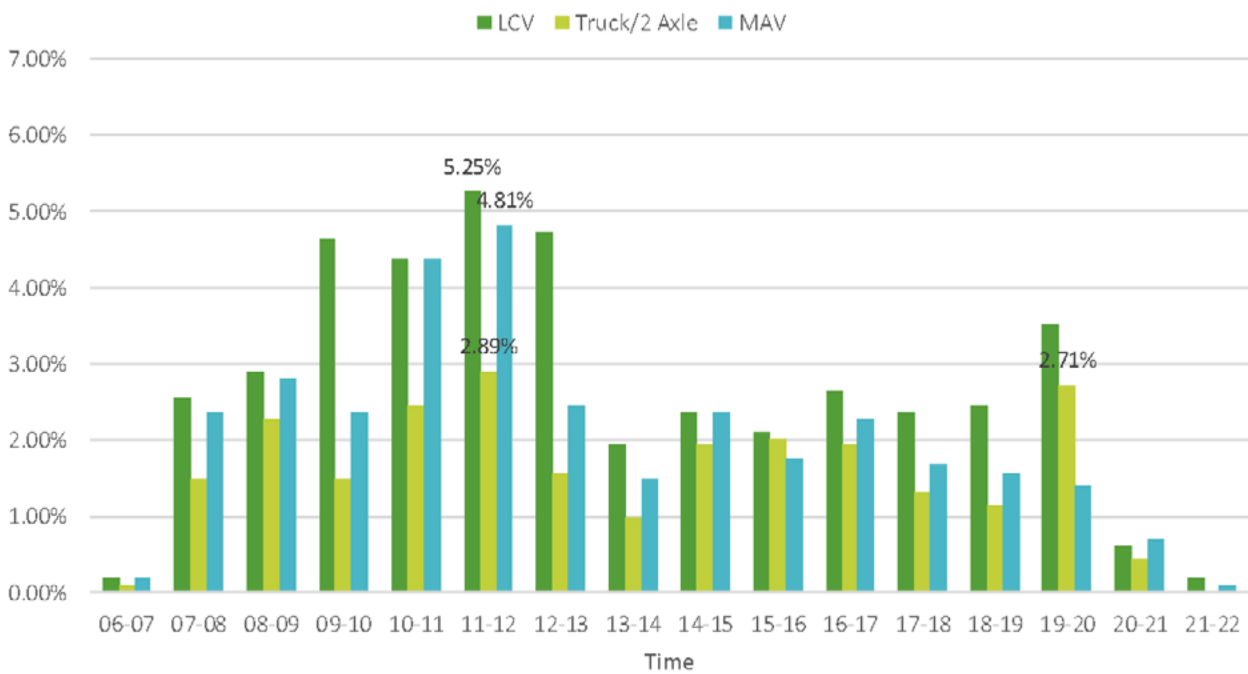


Figure 14: Freight vehicle entering Kochi during different time periods. Source: ICLEI / The Urban Lab

municipalities and 25 intervening panchayats. More info at www.gcda.kerala.gov.in; The CVC at cordon points captured the number of vehicles entering Kochi including buses, private vehicles, Intermediate Public Transport (IPT), freight vehicles and slow-moving passenger vehicles; Road Side Interviews (RSI) captured the details of freight vehicles entering the GCDA area, such as origin and destination, type of commodity transported etc.; and the CVC at 24 junctions within GCDA area captured direction-based movements of all types of vehicles.

Vehicle kilometers travelled (sample)

The following sections present road freight transport in the project cities regarding vehicle kilometers travelled (VKT), freight transport activity in tonne-kilometer, utilization of vehicle capacity, as well as environmental performance including fuel consumption and baseline emissions. The data is drawn from the surveys conducted among local stakeholders and is extrapolated to enable comparison, therefore must be treated as estimates.

VKT measures the total annual distance performed by a given fleet. It is an important indicator to assess its impact on the urban road network and environmental impacts. The figure below compares VKT by vehicle type in the surveys conducted in Argentinian and Colombian cities, as well as two Indian cities. The distance obtained for each city depends on the size of the city and on its involvement in intercity transport where longer distances are travelled. It should be noted that the available information of VKT consists of indirect estimates based on various sets of assumptions.

Figure 15 shows that in Bogotá, heavier trucks (> 3.5 t) account for a sizeable share of VKT, despite much lower shares in the registered vehicle fleet (see Figure 3). This is because heavy vehicles typically serve long-haul delivery of goods, resulting in higher mileages. In AMVA, it can be observed that nearly two-thirds (66 percent) of these kilometers were performed by smaller vehicles weighing less than 3.5 t within the regional administrative boundary. In Manizales, a significant share of the VKT is performed by heavier vehicles (> 3.5 t) - approximately 89 percent.

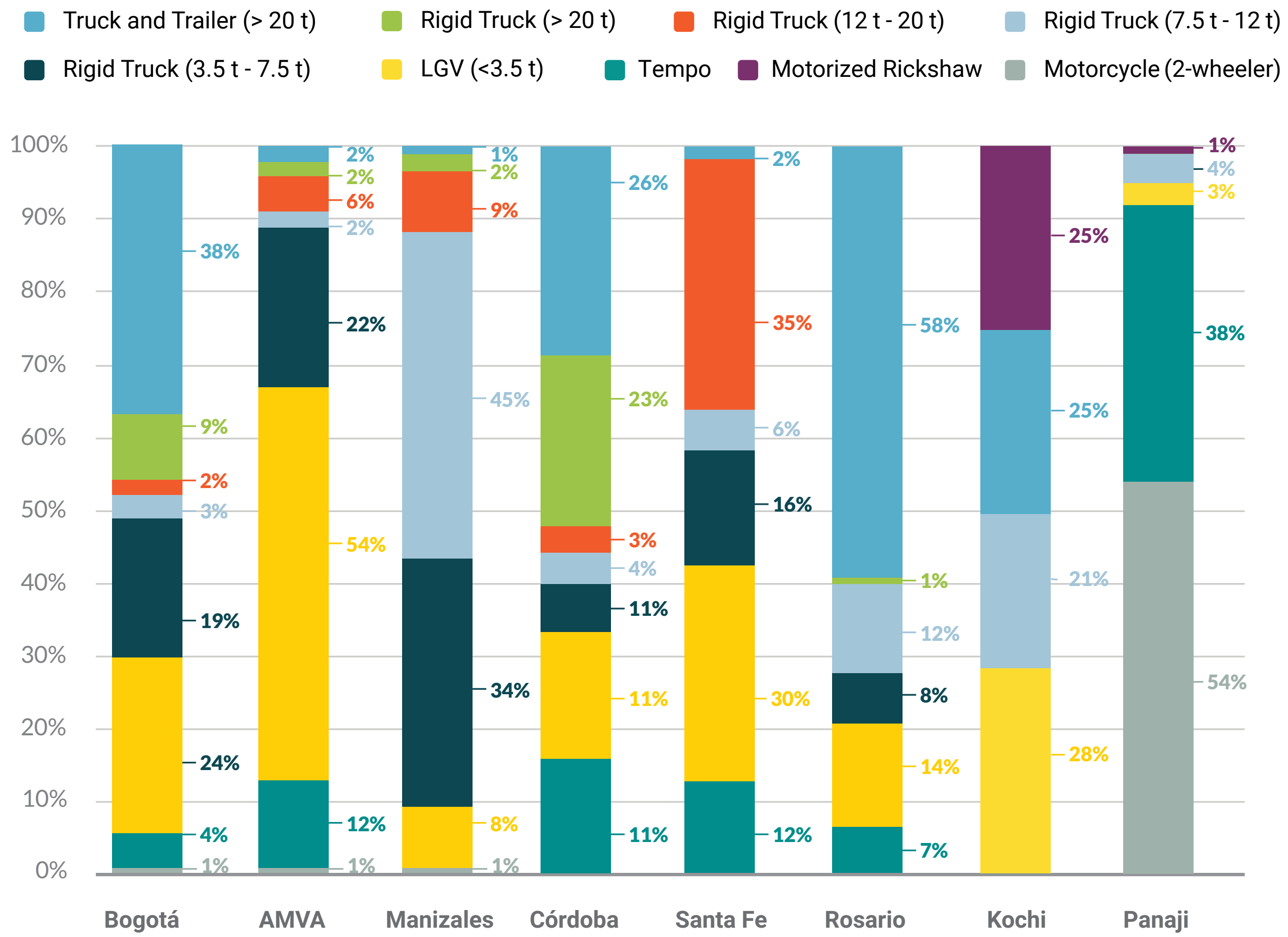


Figure 15: Distribution of vehicle distance travelled by vehicle type in the cities. Source: ICLEI / Despacio / The Urban Lab / SGArchitects

Note: In Argentina and Colombia, VKT is estimated based on the sample vehicle fleet; In India, VKT is extrapolated based on freight data captured through classical vehicle counts at cordon points and junctions.

In Argentina, differences exist in the three cities. In Córdoba, rigid trucks more than 20 t as well as truck and trailer account for nearly half of the total VKT; whilst in Santa Fe, the rigid truck (12 t - 20 t) makes up a large share of 35 percent. In the port city Rosario, truck and trailer account for 58 percent of the VKT. It is estimated that more than 4 million tons of oilseed, grains, and agricultural by-products arrive every year at the Port of Rosario, which explains the high number of VKT driven by truck and trailer (> 20 t)[11]. The truck drivers often bypass the city center through ring road *Avenida de Circunvalación 25 de Mayo*, alternatively, they cross the city, especially in the southern zone.

In Kochi, the VKT is rather evenly distributed, 38 percent by LGVs, 28 percent by rigid trucks (7.5 t - 12 t) and 34 percent by truck and trailer (> 20 t). In Panaji, more than half (54 percent) of the VKT is driven by two-wheelers, followed by LGVs with 38 percent. This is because two-wheelers are commonly used for freight trips from/to establishments, and most of the distances covered by two-wheelers are for deliveries from hotels and restaurants.

Road freight activity in terms of tonne-kilometer (sample)

The activity of on-road freight vehicles is typically measured in tonne-kilometer (tkm), which is useful to express freight transport efficiency. However, information about shipment weight and distance can be surprisingly difficult to capture.

For the purpose of this report, the total tkm is estimated using the *EcoLogistics Self-monitoring Tool*, where standard values for load factor and empty running are embedded. The default values are based on a particular set of assumptions and chosen from a larger set of possibilities available in the GLEC Framework (Smart Freight Centre 2019). It should be noted that the values might not be representative of the specific urban freight operations in the cities.

It can be seen on Figure 16 that heavy duty vehicles have the largest share of road freight transport performance among all project cities. However, difference exists among cities. For example, in Panaji, rigid trucks (7.5 t - 12 t) account for 41 percent of the total freight transport activity, largely due to the transportation of soil using heavy tankers within the city. Nevertheless, the importance of two-wheelers and light goods vehicles in the city is evident – LGVs account for approximately a third of the total tkm while two-wheelers account for 21 percent. This is essentially linked to its city size and the freight trip characteristics. A detailed breakdown of freight deliveries within Panaji can be seen in Figure 17.

Figure 17 shows that in terms of the distance travelled within the city boundary of Panaji, the majority of it is performed by two-wheelers, accounting for 53 percent, followed by tempos with 36 percent. Regarding the weight of the goods transported, the majority of the goods are delivered by HGVs with 40 percent, followed by tempos with 35 percent and LGVs with 12 percent. Furthermore, two-wheelers produce half of the total freight trips per day, including first-and-last mile delivery trips, as well as trips for sewage and waste collection. Tempos and LGVs produce a relatively big share of trips too, accounting for 32 percent and 10 percent, respectively.

11 The Port of Rosario is a crucial element of development that connects through Paraná-Paraguay waterway, the city of Rosario, and inland regions of the northeast of the country. In 2019, it is estimated that approximately 4,715,009 tons of goods were handled at the terminals in the Port of Rosario. The most important commodities handled to and from the Port in terms of weight were grains, byproducts, fertilizers, and oil. See more www.argentina.gob.ar/puertos-vias-navegables-y-marina-mercante/estadisticas-de-carga/no-containerizada

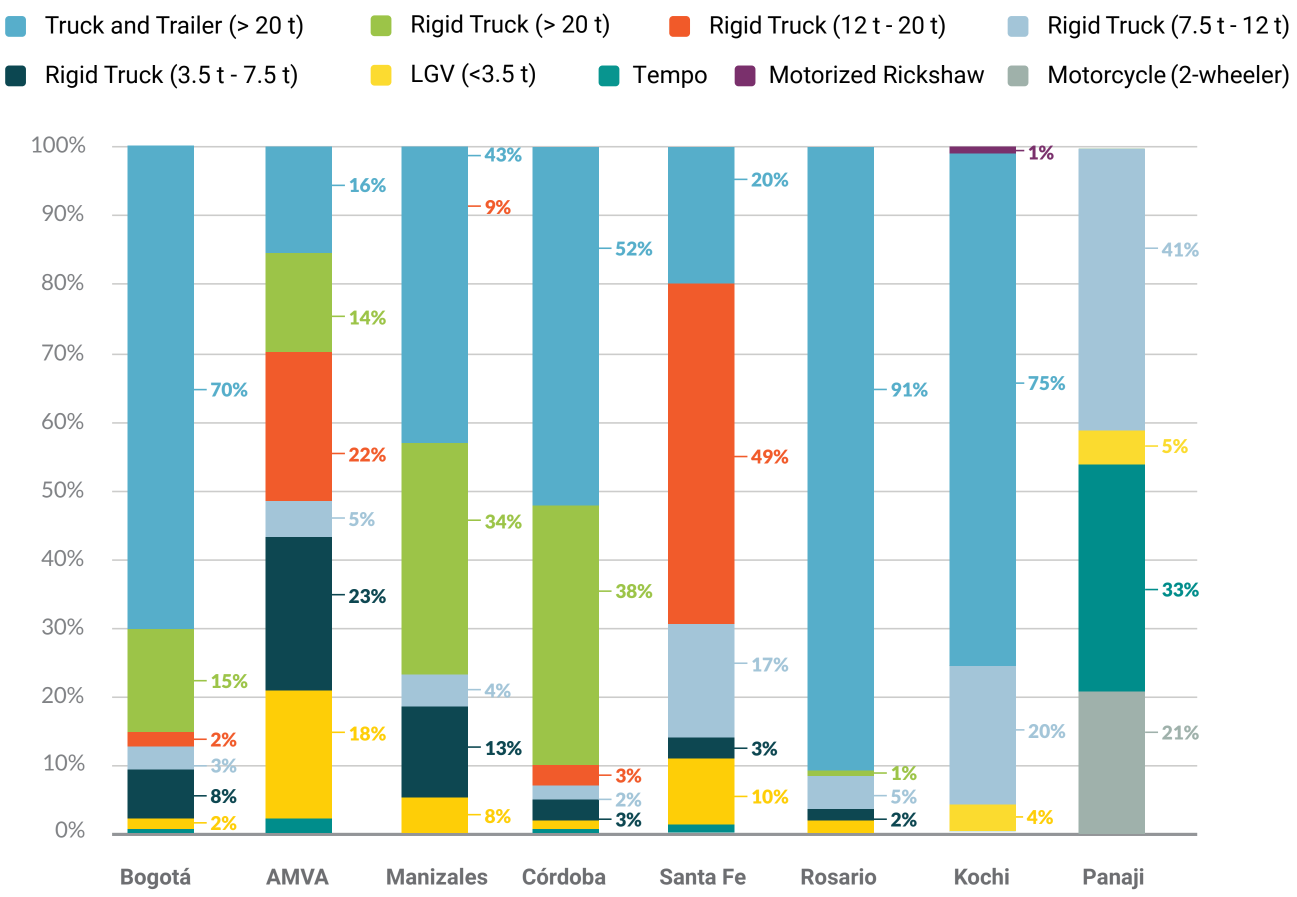


Figure 16 Distribution of tonne-kilometer of road freight transport in the cities. Source: Ibid

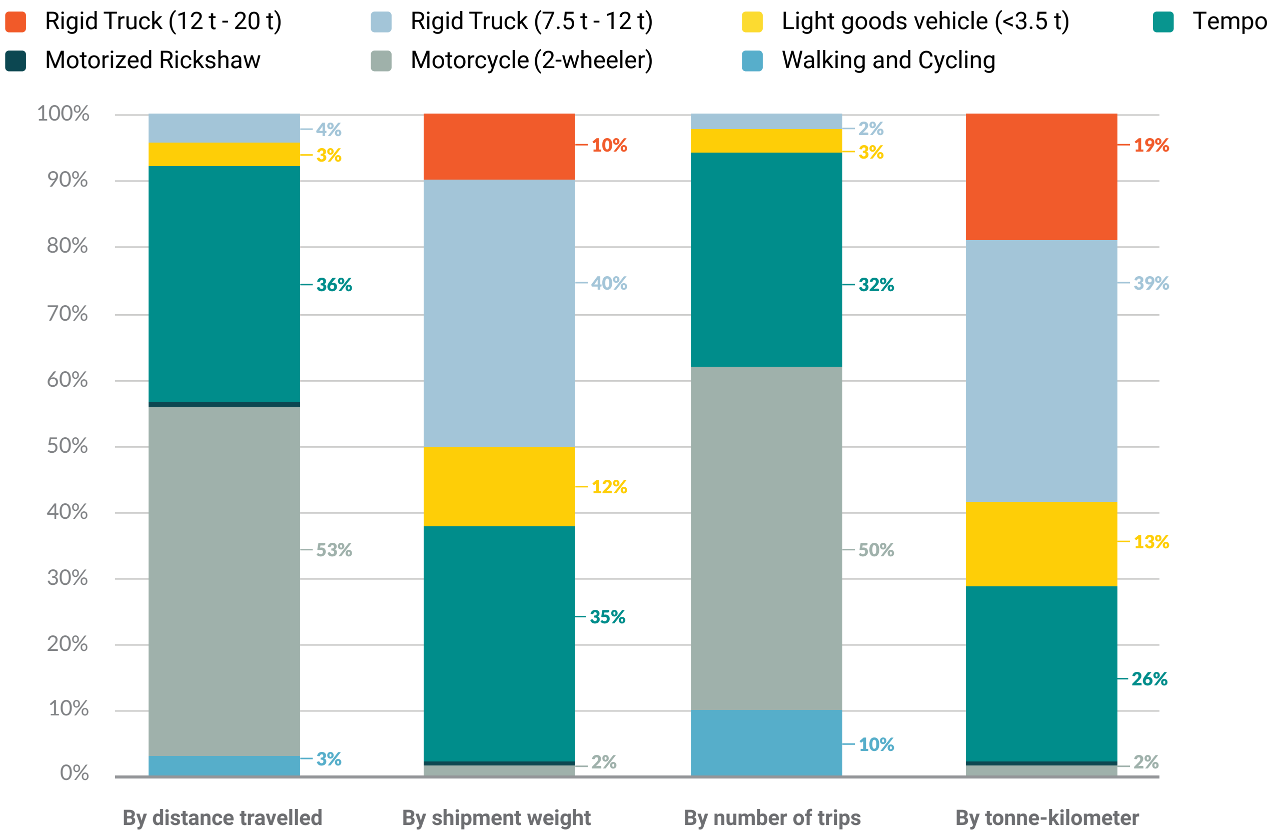


Figure 17: Breakdown of freight delivery within Panaji. Source: ICLEI / SGArchitects

Utilization of vehicle capacity in Panaji and AMVA (sample)

The utilization of vehicle capacity is an important indicator of operational efficiency. It is subject to the inter-functional relationship between transport and other activities such as production and warehousing. The under-utilization of vehicle capacity is often unplanned and not based on any analysis of cost trade-offs. By improving loading, it is possible to reduce the amount of freight vehicle traffic required to move a certain freight, resulting in emission reduction and enhanced operational efficiency. Due to data availability, the section below only presents the load factors of freight vehicles in Panaji and AMVA.

In Panaji, analysis of data collected through primary survey suggests that most of the freight vehicles and freight trips operate at low utilization level (below 30 percent), leading to inefficiencies and additional trips. Figure 18 shows the average load factor for deliveries to retailers, as well as average load factor for home deliveries from retailers. It is suggested that the efficiency levels of freight trips from the establishments (to home) are much lower than that of trips to establishments (from distributors). There is therefore scope for improving the overall utilization of existing freight inventory in order to reduce the number of freight trips (freight traffic) and emissions from freight in the city.

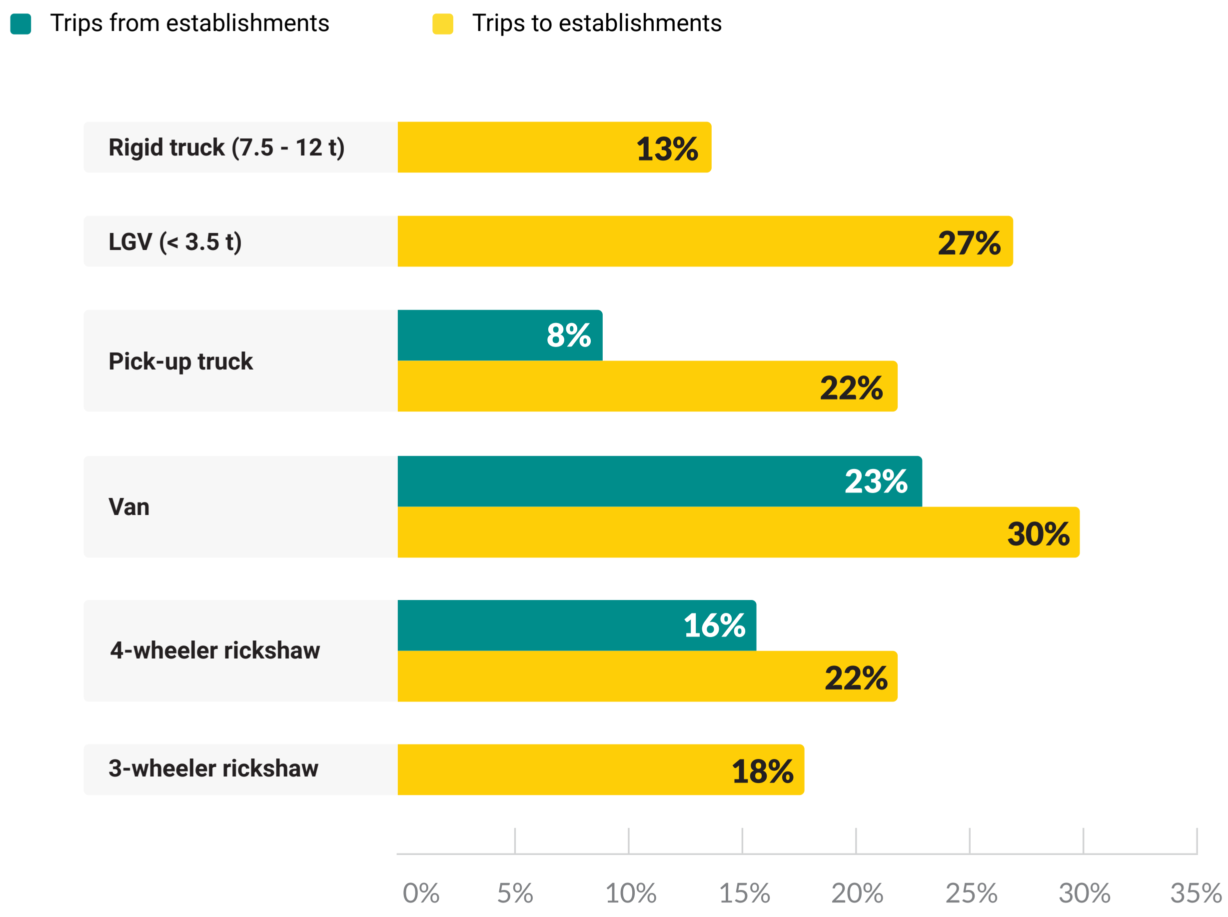


Figure 18: Average load factor of freight vehicles by freight trip in Panaji. Source: ICLEI / SGArchitects

In AMVA, findings show that load factor in urban freight transport is relatively low, ranging from 9 to 41 percent (Figure 19). The lowest rates are with vans (0.75 t - 1.5 t) and trucks with a GVW between 3.5 and 7.5 tons. Trucks and trailers (7.5 t - 18 t) have the highest load capacity of 41 percent.

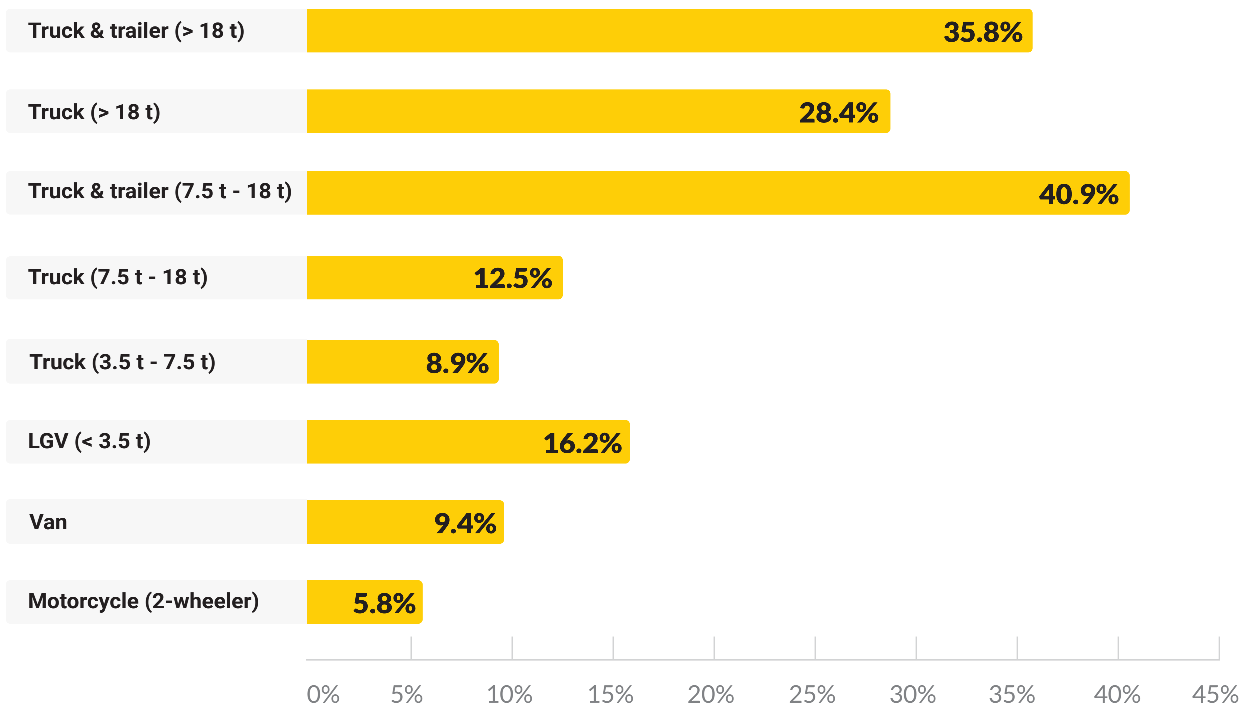


Figure 19: Average load factor of freight vehicles in AMVA. Source: Information provided by AMVA (2019)

4. Environment and energy aspects

Fuel consumption in terms of liters per 100 kilometers (sample)

Fuel consumption figures, expressed as liters per 100 kilometers (l/100 km) or kilogram per 100 kilometers (kg/100 km), refer to the amount of fuel a vehicle needs to travel a certain distance. Based on the total fuel use and total VKT from the individual vehicle fleets of the surveyed companies in Argentina and Colombia, the fuel consumption data is derived and aggregated, providing information about the fuel efficiency performance of the fleets[12]. It should be noted that some of the datasets are based on estimates provided by surveyed companies and the consultants who conducted the surveys, and it may be difficult to ensure the accuracy of the data. In India, surveys were carried out with a 10 percent sample size, in Kochi and in Panaji, a total of 193 vehicles/drivers were surveyed, however the sample size of freight vehicle when divided by fuel type is not sufficient to provide a reliable mean values, thus it is not included in the chart below.

Figure 20 show that fuel and power train types play a significant role in the fuel consumption. In both Argentina and Colombia, diesel vehicles were found to have more fuel per 100 kilometers, as compared to gasoline and CNG powered vehicles, reaching 34.13 l/100km in Argentina and 38.04 l/100km in Colombia. In comparison, the vehicle fleet in Argentina is more economic.

12 The average fuel consumption per fuel type data is calculated by multiplying the fuel consumption value of each vehicle by the number of vehicles powered by the fuel type and then dividing the sum by the total number of vehicles in the respective fuel type (i.e., CNG, diesel, gasoline). Similarly, the fuel consumption per vehicle type is calculated by multiplying the fuel consumption value of each vehicle by the number of vehicles in each vehicle category and then dividing the sum by the total number of vehicles in the respective category (i.e., tempos, LGVs, rigid trucks, truck and trailers).

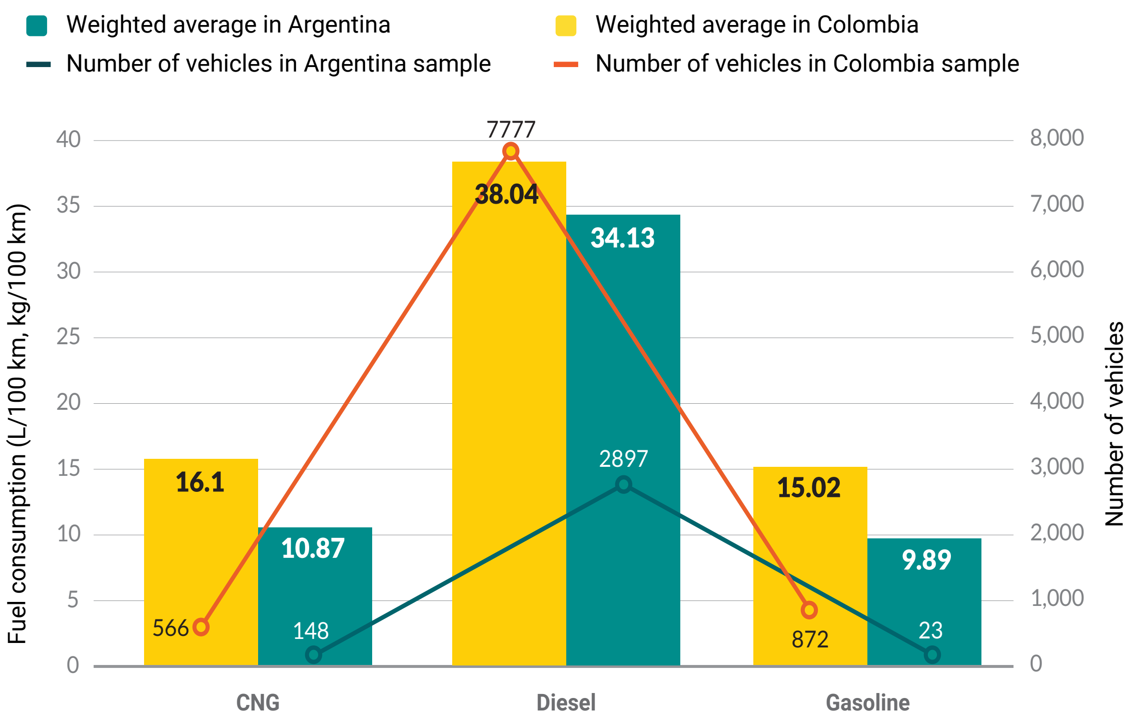


Figure 20: Average fuel consumption of the sample by vehicle type in Argentina and Colombia. Source: ICLEI / Despacio

Note: The line chart displays the size of sample per fuel/power train type. In Indian city Kochi, the surveys were carried out with a 10 percent sample size; In Panaji, a total of 193 vehicles/drivers were surveyed, however the sample size of freight vehicle when divided by fuel type is not sufficient to provide a reliable mean values, thus it is not included in the analysis above.

In addition to variations among fuel types, the fuel consumption values vary by the type of vehicle. Figure 21 shows that tempos and LGVs account for a relatively big share of entries in the Argentinian and Colombian datasets, and their weighted average fuel consumption values tend to be lower, as smaller vehicle weight negatively correlates with fuel consumption. Truck and trailers also make up relatively high shares of the sample, and they consume more

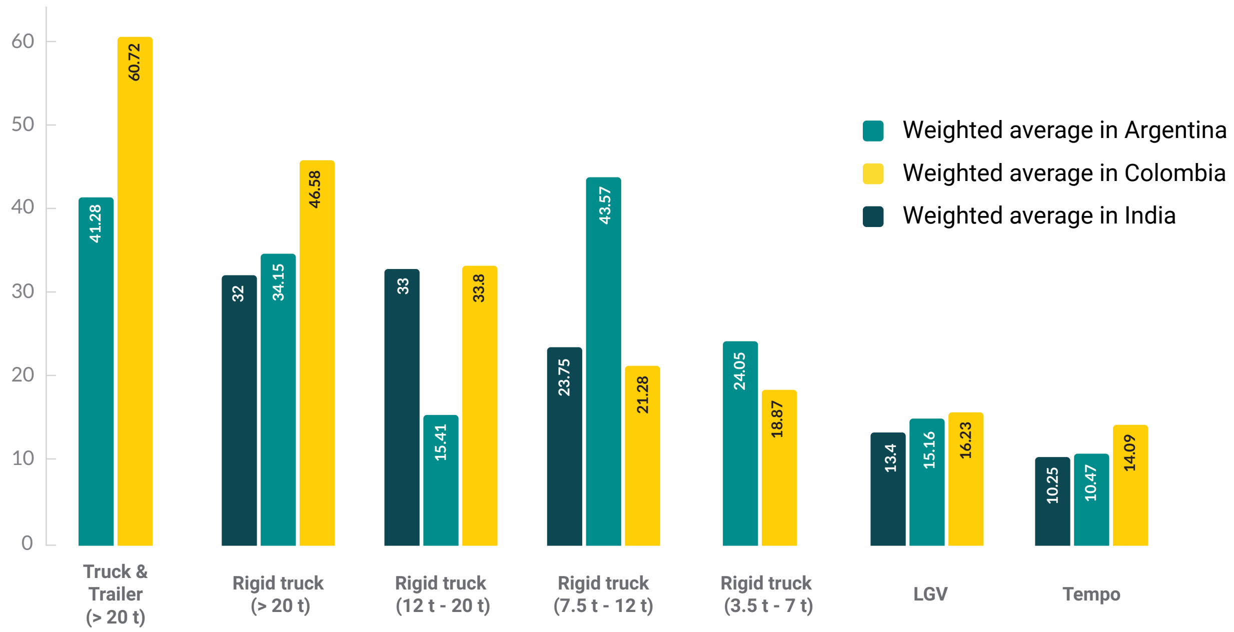


Figure 21: Average fuel consumption of the sample by vehicle type in Argentina, Colombia and India. Source: ICLEI / Despacio / The Urban Lab / SGArchitects

fuel because of the additional energy needed for acceleration. However, it is important to acknowledge that these variations in the fuel efficiency of the vehicles exist, due to varying characteristics including dimensions, number of axles, configuration, and payloads, as well as city-specific characteristics (e.g., topography, traffic conditions, average speeds, road conditions and driver behavior). To better understand the real-world impacts of fuel efficiency, there is a need for additional data collection for vehicle fuel use and activity. For more information about real-world fuel consumption values, Annex II provides a non-exhaustive list of the studies that are based on publicly available data from other cities and regions (Sharpe and Muncrief 2015).

Baseline CO_2e emissions from urban freight transport (sample)

Based on the vehicle activity and fuel use data collected from the survey, the baseline CO_2e emissions[13] of the vehicle fleets in each city is estimated, using the *EcoLogistics Self-monitoring Tool*.

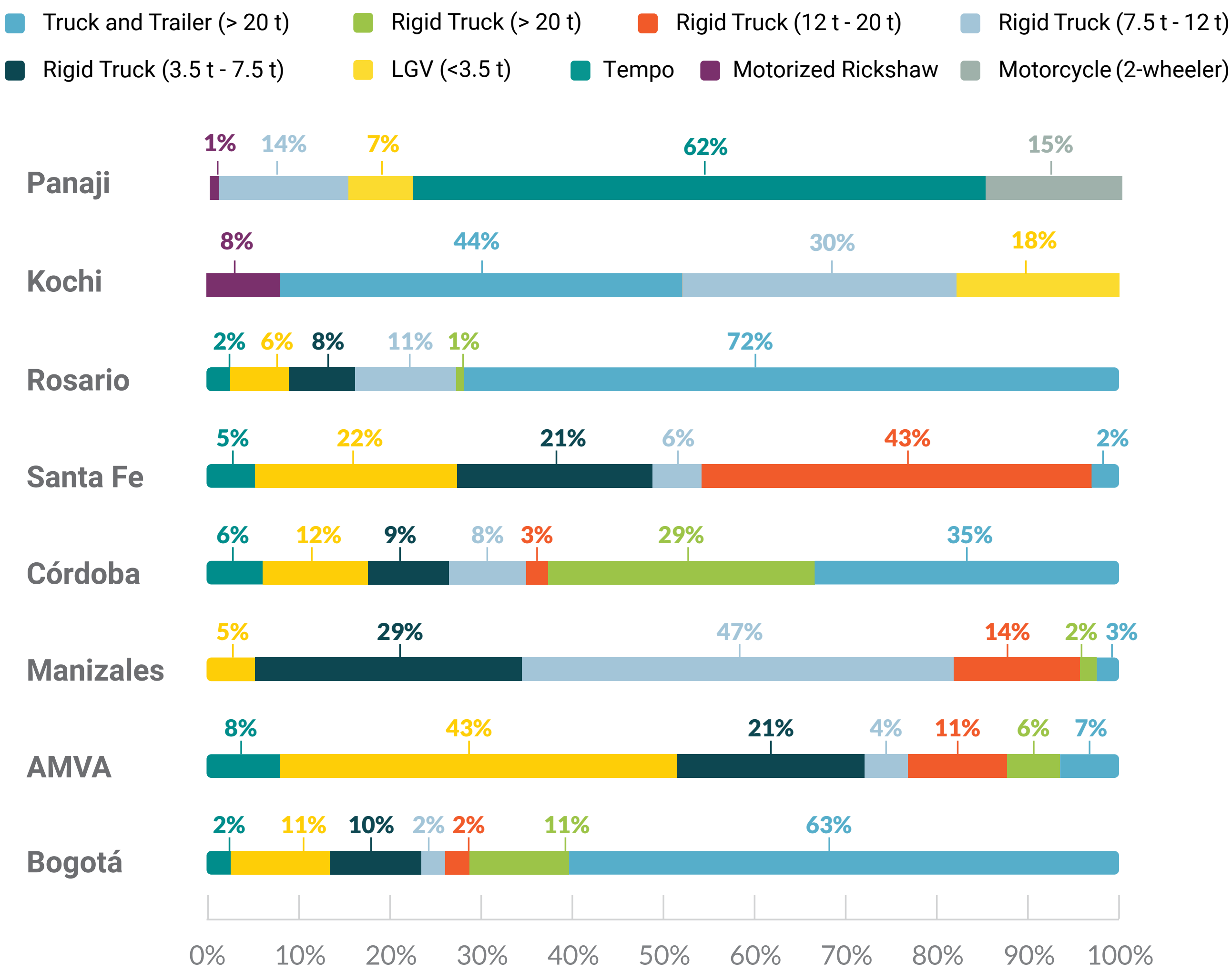


Figure 22: Share of baseline CO_2e emissions by vehicle type (sample). Source: ICLEI / Despacio / The Urban Lab / SGArchitects

13 Estimates of on-road diesel vehicle emissions are subject to multiple sources of uncertainty. The quality and comprehensiveness of information available for emissions estimates varies substantially among cities. Input data collected through the samples include vehicle type, age, fuel consumption, distance travelled, vehicle activity and other datasets. Default emission factors are provided and standard values for load factor, empty running are embedded in the *EcoLogistics Self-monitoring Tool*. Although the values are based on average freight transport operating practices, more accurate quantification of fuel consumption and GHG emissions requires more city-specific data.

In Colombia, the fuel emission factors are drawn from the new Colombian Energy Balance (“*Balance Energético Colombiano*”, BECO), produced by the Mining and Energy Planning Unit (“*La Unidad de Planeación Minero Energética*”, UPME)[14]. In Argentina, the emission factors are sourced from the Ministry of Energy and Mining (“*Ministerio de Energía y Minería*”, MME). In India, the emission factors are sourced from the GLEC Framework, which is based on average freight transport operating practices and provides a general indication of fuel consumption and emissions.

It can be observed from Figure 22 that the majority of the CO_2e emissions from the freight vehicles are attributable to heavier vehicles, such as rigid truck (> 20 t), as well as truck and trailer (> 20 t). In Bogotá, Córdoba, and Rosario, these contributed to more than 60 percent of the urban freight transport-related emissions, owning to their importance in transporting goods in the area with industrial activity over long distances. Although the share of heavy vehicles is generally much smaller than that of the light goods vehicles, their annual mileage and fuel consumption are higher.

In addition, while data from the surveys shows a large share of the emissions comes from diesel-fuelled vehicles (over 80 percent) (see FIgure 23), vehicles running on gasoline also produce a relatively big share of the emissions. In Bogotá, CNG powered vehicles accounted for 3.2 percent of the total emissions from the vehicle fleet in the sample – almost exclusively from smaller vehicles weighing less than 3.5 tonnes with lower annual mileage and/or less regular operations.

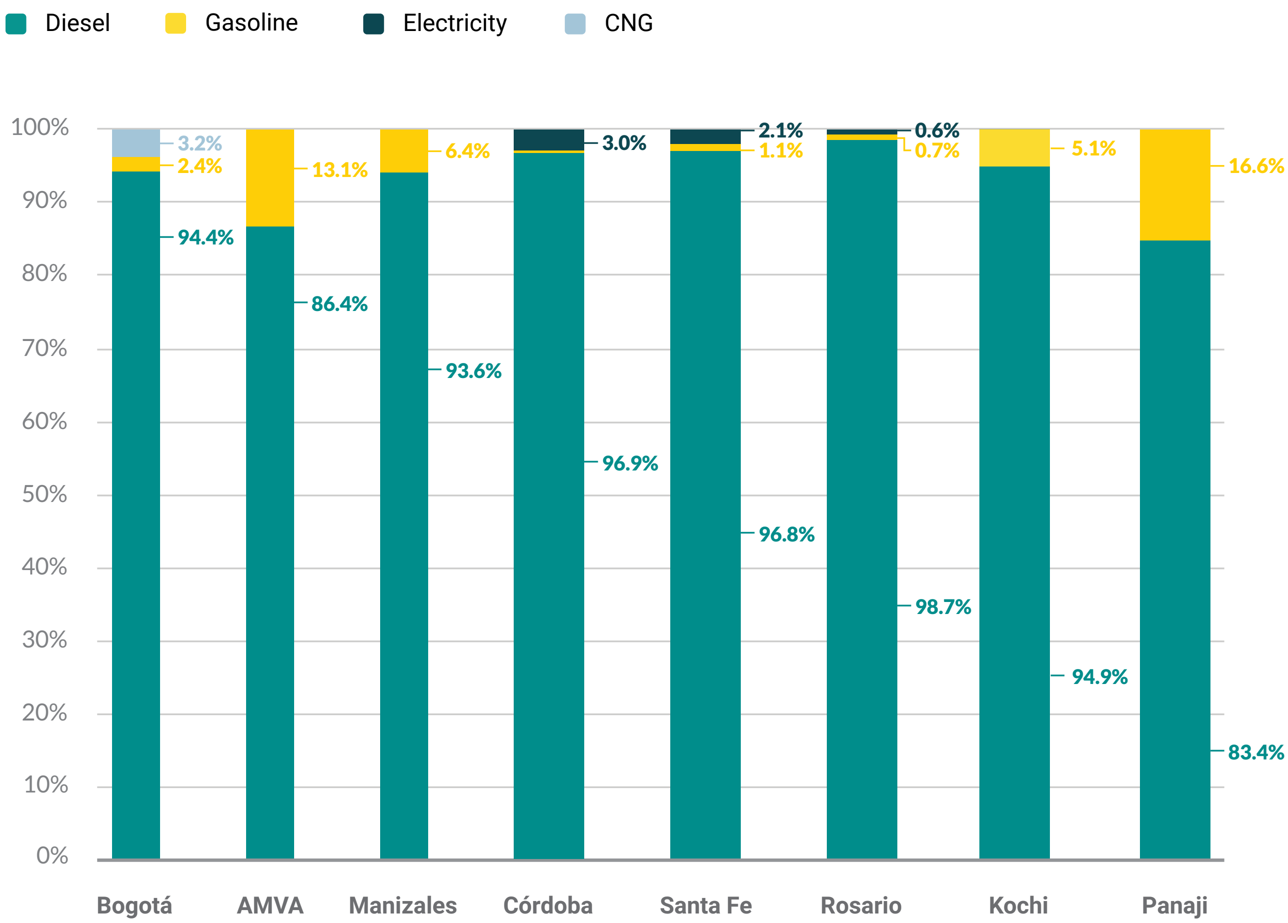


Figure 23: Share of baseline CO2e emissions by fuel type from the surveyed vehicle fleets. Source: ICLEI / Despacio / The Urban Lab / SGArchitects

14 More information at: www1.upme.gov.co/InformacionCifras/Paginas/BalanceEnergetico.aspx

Projections for CO_2e emissions from urban freight transport in the BAU scenario (sample)

With regards to forecasts for CO_2e emissions under the business-as-usual (BAU) scenario (i.e., under circumstances that may happen without interventions). In order to provide indicative estimates to fill data gaps, the *EcoLogistics Self-Monitoring Tool* uses the estimated global freight transport demand annual growth rate of 3 percent (ITF 2019) where good quality country-specific/or region-specific data is not available. It must be noted that projections of transport volumes use assumptions on the most likely development of factors influencing transport demand (e.g., demographics, GDP and investments in transport infrastructure etc). Therefore, it can be misleading to rely on global data[15].

In Colombia, a 3 percent growth rate is used to project emissions. However, the accuracy of growth projections is uncertain, in light of the current instability of the global economy.

In Argentina, it is estimated that freight volumes will increase by 3 percent annually and passenger volumes by 2 percent between 2015 and 2030 (ITF 2020). Taking this into account, a 3 percent growth rate is used to forecast emissions in this country. In India, freight transport volumes will grow by 6 percent annually between 2015 and 2030, according to ITF estimates. This corresponds to around three times the estimated rate of increase of transport volumes in the Organisation for Economic Co-operation and Development (OECD) countries[16] for the same period.

Table 9 and Figure 24 illustrate the estimates of CO_2e emissions from the urban freight transport in the base year (2019), and the resulting forecast for road freight emissions toward 2025, 2030 and 2050. This scenario points to road freight emissions' sustained growth in the project cities, in particular megacity Bogotá, if no additional measures are taken.

Table 9: Baseline CO_2e emissions and forecasts from the surveyed vehicle fleet

City	No. of vehicles (survey data)	Baseline CO_2e (tonnes)	2025 CO_2e (tonnes)	2030 CO_2e (tonnes)	2050 CO_2e (tonnes)
Bogotá	7,699	175,553	209,620	243,007	438,897
AMVA	1,612	19,489	23,271	26,977	48,724
Manizales	544	2,159	2,578	2,989	5,398
Córdoba	724	47,401	57,596	67,747	129,687
Santa Fe	331	4,837	5,877	6,913	13,233
Rosario	2,559	11,067	13,447	15,817	30,279
Kochi	-	49,894	70,776	94,714	303,759
Panaji	-	2,843	4,033	5,398	17,311

Source: ICLEI / Despacio / The Urban Lab / SGArchitects; (-) Not available

15 More detailed information and methodology for emission forecasting can be found in the Tool User Guide (Version 2.0) at sustainablemobility.iclei.org/wpdm-package/iclei-ecologistics-self-monitoring-tool-user-guide

16 There are currently 37 members of the OECD, check out the website for more information: www.oecd.org/about/members-and-partners/

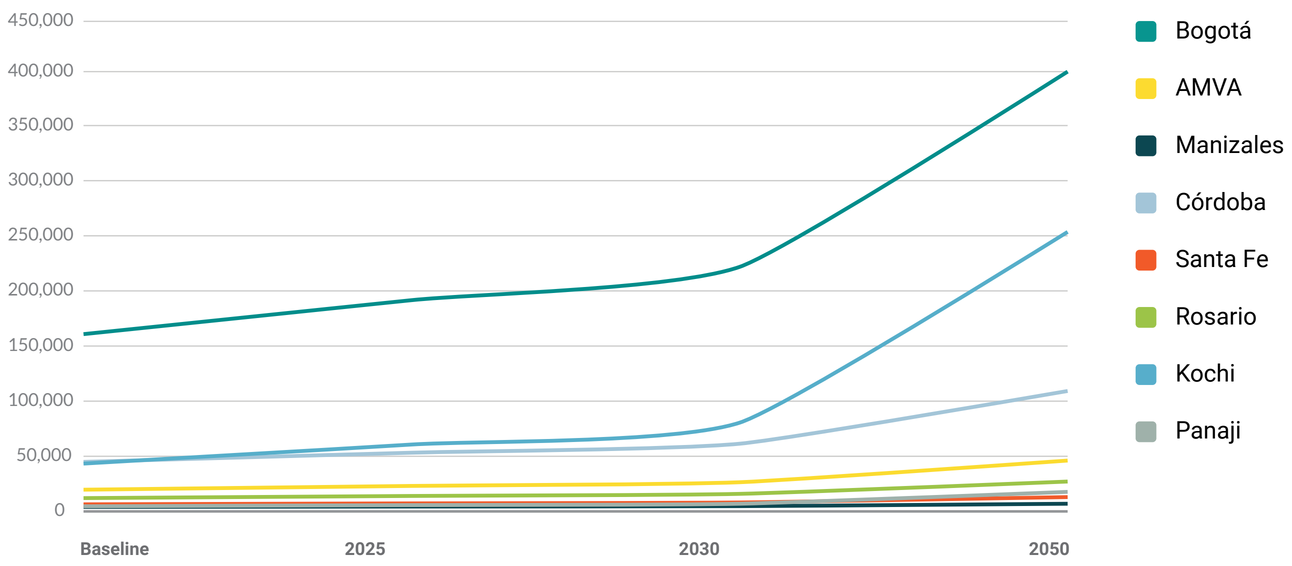


Figure 24 Forecasts for urban freight CO_2e emissions in the BAU scenario. Source: ICLEI / Despacio / The Urban Lab / SGArchitects

Projections for CO_2e emissions from urban freight transport in the target scenario (sample)

Cities can potentially deviate from the BAU emission trajectory with more efficient operational practices like off-hour deliveries (OHD) and eco-driving, which have the potential to reduce emissions without large capital investments. Low emission fuel technologies are also increasingly available and have strong potential for emission cutting.

As such, the *EcoLogistics Self-monitoring Tool* estimates "target scenarios" where different measures are implemented, which allows the freight transport sector to deviate from the BAU emission trajectory. The target scenario considers measures in isolation as determined based on local development priorities, feasibility, costs and benefits assessment[17].

For example, the Tool is used to estimate target scenarios where OHD is implemented hypothetically. Existing studies suggest that with the OHD (between 18:00 p.m. to 22:00 p.m.) used in Bogotá, the emission reductions were about 13 percent (Holguín-Veras, et al. 2016). Drawing on this, it is assumed that the freight transport demand in the city will grow by 3 percent annually and local vehicle activity data was used to calculate the potential emissions (activity-based approach). The result, as can be seen in FIgure 25 (next page), shows a decrease in the GHG emissions from each freight vehicle type.

Similarly, the Tool also considers eco-driving as one of the selected measures for potential emission reduction. Eco-driving is encouraging behavioural change amongst drivers to drive in more eco-friendly ways to save fuel and reduce emissions. The Tool assumes an average value of 10 percent of fuel saving rate based on existing studies (Winder 2016); besides, fuel savings are assumed to be equivalent to emission savings, which is commonly used by other studies looking at CO_2 effects. However, the extent to which drivers commit to eco-driving behavior is a major uncertainty factor. The results are highly variable in terms of context: vehicle type, road type, traffic flow and so on.

17 In the EcoLogistics Self-monitoring Tool, four strategies have been introduced so far: fuel technology change, distance reduction, off-hour deliveries and eco-driving. The existing strategies are considered at this stage based on local development priorities, feasibility, costs and benefits assessments in project cities. The target scenario might evolve and other measures might be added in the future. For more information on the measures, please visit sustainablemobility.iclei.org/wpdm-package/iclei-ecologistics-self-monitoring-tool-user-guide

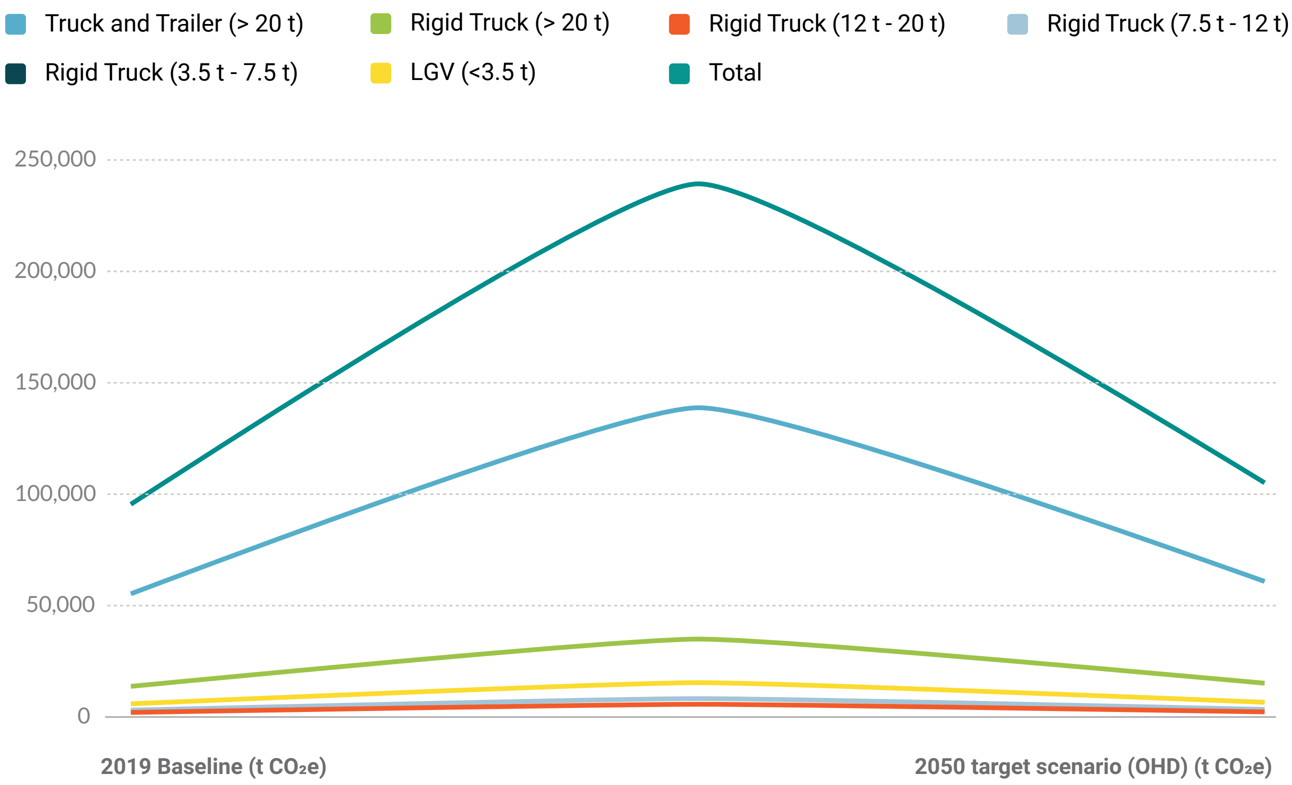


Figure 25: Projected CO_2e emissions in the target scenario (OHD) in Bogotá. Source: ICLEI / Despacio

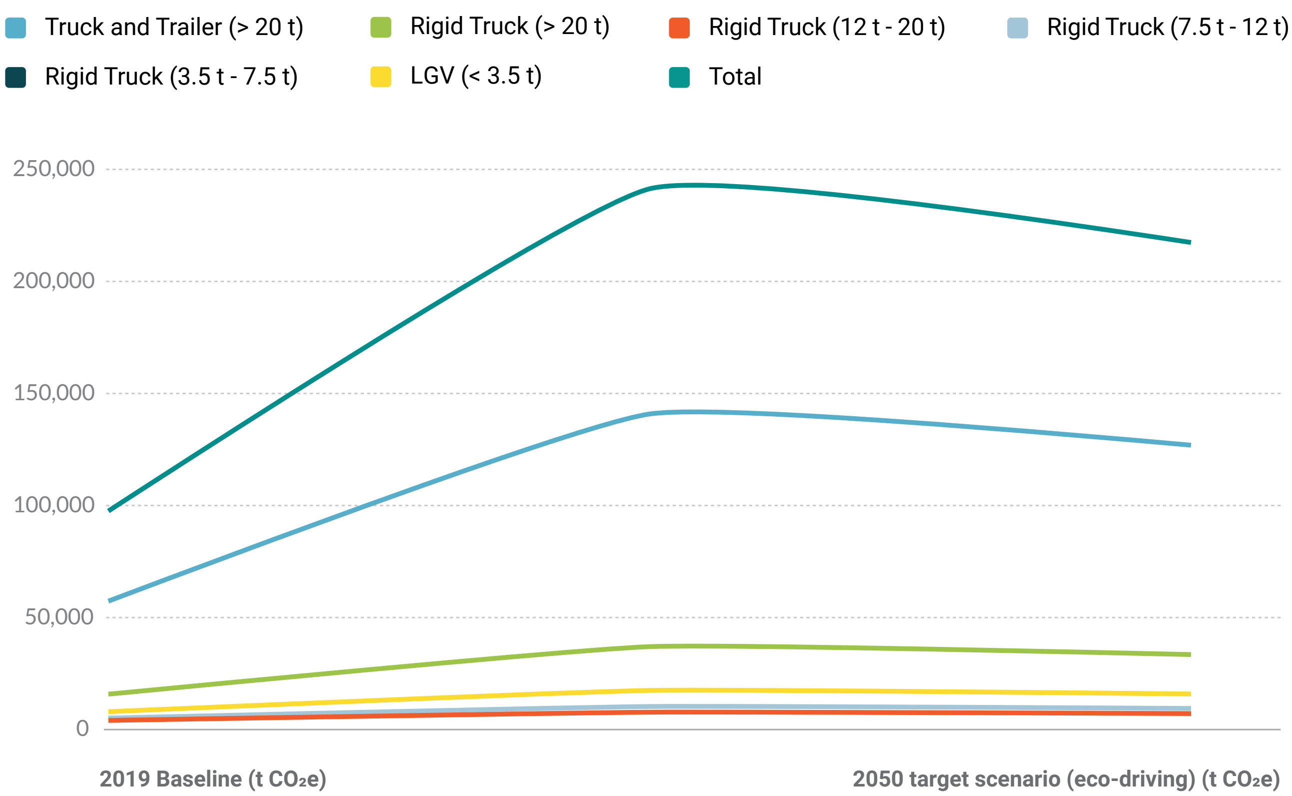


Figure 26: Projected CO_2e emissions in the target scenario (Eco-driving) in Bogotá. Source: ICLEI / Despacio

III. SYNTHESIS: WHAT HAVE WE FOUND?

This section presents key findings from the assessment of the project cities.

1. National governments' vision on sustainable freight

There is an increasing awareness and focus on sustainable freight at the national level in all three countries, albeit uneven distribution of efforts among countries. **Argentinian** government, both national and local level, has taken steps to improve freight transport and reduce the externalities. At the national level, there has been a focus on improving transportation infrastructure to encourage intermodal freight and to revive rail transport for passengers and freight, apart from a fleet renewal program and driver training programs. The Ministry of Transportation is spearheading the Intelligent Transport program (*"Transporte Inteligent"*, PTI)[18], which is a public-private initiative aiming at improving energy efficiency and it helps assess the impacts of low carbon policy measures proposed in the *National Action Plan for Transport and Climate Change ("Plan de Acción Nacional de Transporte y Cambio Climático", PANTyCC)*. Such models mitigate existing gaps on data collection for road freight movements (ITF 2020). Considering this, Santa Fe works to encourage multimodality and reduce transportation-related costs through the "*InterPuertos*" project. Financed through public-private partnership, it is a multimodal logistics park situated in the northwest of the city. Rosario has a long-standing tradition of sustainable mobility planning. Its mobility plan (Municipalidad de Rosario 2011) aims to develop an inclusive and integrated urban mobility and urban freight system that incorporates rail transport, tramway, dedicated transport corridors and electric mobility options.

The Government of **Colombia** has a long-term vision of green growth. The National Development Plan (NDP) 2018-22 has set out objectives to accelerate electrification in public transport and aims to enlarge the electric vehicle fleet up to 600,000 (currently only 1,695) by 2030[19]. In the freight transport sector, under the framework of *CONPES 3963*[20] (2019), a mix of regulatory and financial incentives will be used to accelerate the renewal and scrapping of the freight vehicle fleet, as well as the implementation of new technologies. The Freight Vehicle Modernization Program (called "*Programa de Modernización de Vehículos de Carga*" in Spanish, *PMVC*) is currently implemented by the national government and it aims to renew 47 percent of the vehicle fleet older than 20 years by 2025, and to have an average age of 15 years for the fleet by 2022 (Ministry of Transport of Colombia 2020). It is estimated that 1.1 billion pesos (approximately 250,000 Euros) will be invested for the program and tax incentives will be provided to small transport owners for vehicle renewal. The national government also aims to promote rail freight and to provide infrastructure to support multimodality (Lütkehermöller 2018). In line with the national strategies, Bogotá seeks to establish a facilitation unit supporting vehicle owners in vehicle scrapping and renewal. It also provides on-demand eco-driving training. Meanwhile, AMVA seeks to renew a fleet of 95,706 vehicles into natural gas, electric or hybrid in the region.

India has measures in place to support low-carbon freight and policies to enhance the energy and carbon efficiency of vehicles, including a fuel efficiency standard for heavy duty vehicles since 2018. Its NDC states the mitigation strategy of Dedicated Freight Corridors (DFCs) and energy efficient railways to reduce the environmental impacts. Developed by the Department of Commerce, its

18 The Program is voluntary and is made up of a wide range of stakeholders, including transport operators, freight forwarders, chambers of commerce, universities and related government agencies. The Program allows companies to manage the fuel consumption of its vehicle fleet, measure its baseline, implement measures and estimate the potential fuel savings obtained after the application of energy efficiency measures. More information at www.transporteinteligente.gob.ar/institucional

19 See more about the Green Growth at gggi.org/colombia-presents-a-2030-green-growth-roadmap

20 CONPES stands for the National Council for Economic and Social Policy and it is the highest coordinating body for economic policy in Colombia. Find out more at www.minambiente.gov.co/index.php/normativa/conpes

Draft National Logistics Policy aims to improve economic growth through an integrated, reliable and cost-effective logistics network. It further mentions that there is a significant potential to integrate and optimize elements of logistics value chain for an efficient logistics sector. A Logistics Division was set up in the Department of Commerce in July 2017 to coordinate integrated development of the sector (Department of Commerce, Ministry of Commerce and Industry 2019). At the regional level, the Government of Kerala (where the City of Kochi is located) emphasizes the importance of efficient, safe and sustainable movement of people and goods. Through its Rebuild Kerala Initiative (RKI) and the Electric Vehicle policy, Kerala envisages developing bus ports and logistics ports for the state and preparing a state action plan for e-mobility. In line with this, Kochi has set out strategies to explore the inland waterways for goods transport and is exploring alternatives to mainstream electric mobility in the city.

2. Air quality and emission reduction: Key drivers for sustainable urban freight

Most cities are confronted with problems of air- and noise-pollution caused by road traffic. Air pollution is linked to a range of health problems including premature mortality, aggravation of respiratory and cardiovascular disease, asthma, bronchitis, and decreased lung function.

Heavy duty trucks consume 7.3 percent of global energy-related emissions and will almost double according to the International Energy Agency (International Energy Agency 2017). Based on the previous analysis (see page 20), the freight vehicle fleet in Argentina and Colombia tends to be old and a large proportion of them are powered by diesel. Targeting emissions from these vehicles could generate substantial benefits for public health, as they account for a high proportion of the city's transportation attributable deaths from air pollution.

Studies in AMVA show that motorized vehicles were responsible for 81 percent of $PM_{2.5}$ emissions in 2015; trucks were responsible for 64 percent of $PM_{2.5}$, despite comprising only 4 percent of total vehicles in the region. In response, AMVA's Comprehensive Air Quality Management Plan (Metropolitan Agreement 016/2017) set out a renewal program for freight vehicles to phase-in ultra-low and zero-emission vehicles. It is estimated that in the first phase of the program, 10 percent of the old freight vehicle fleet will be renewed, which will lead to an estimated reduction of 55 percent of $PM_{2.5}$ emissions by 2023 (Área Metropolitana del Valle de Aburrá 2017). Fleet renewal can replace the oldest and dirtiest vehicles in the fleet, and such program would be most cost-effective if combined with the introduction of Euro VI equivalent standards and fuel efficiency measures for new vehicles.

In Manizales, freight transport contributed to 21 percent of nitrogen oxides (NO_x) and 24 percent of PM_{10}; nearly 96 percent of $PM_{2.5}$ emissions came from on-road transport, with freight vehicles being the largest source contributing 24 percent. Against this backdrop, Manizales's Municipal Action Plan (2015) has set out actions to facilitate goods movement and promote the efficient use of infrastructure.

3. Low carbon fuels and vehicles are on the rise

Policies geared towards adoption of low carbon fuels for urban logistics operations through stricter emission standards and fuel economy standards are gaining prominence. Argentina, Colombia and India are planning to complete the transition to ultralow-sulfur diesel by 2023, 2023 and 2020, respectively (Miller, J. D., & Jin, L. 2019). To reduce the health impacts of HGVs, Argentina's national government has introduced progressively more stringent emission standards and is interested in developing a fuel efficiency verification framework and the deployment of zero-emission fleets (Miller and Braun 2020). Aiming to accelerate the transition towards cleaner technologies, the Colombian law requires that all HGVs meet Euro VI-equivalent standards by 2035. As of April 2020, India has officially adopted tighter emission norms ("Bharat Stage-VI") for motorized two- and four-wheelers and only low-sulphur fuel will be sold, despite the COVID-19 lockdown (Amid lockdown, India switches to BS-VI emission norms 2020).

Some progress has been made to develop freight vehicles leveraging biofuels while working towards electrification. In addition to bolstering energy security, biodiesel has been praised for its GHG reduction potential and air quality benefits. As an example, Argentina currently has a 10 percent blend mandate for biodiesel in diesel products. In the Province of Santa Fe, where most of the biodiesel plants are located, a bioenergy league has been formed to promote the production and use of biodiesel and bioethanol. Santa Fe has been exploring the use of B25 and B100 in public buses (Office of Agricultural Affairs, Foreign Agricultural Service (FAS) 2019). Rosario is a front-runner in Argentina considering the actions and policies it is implementing on energy efficiency. Faced with traffic congestion and pollution caused by heavy duty freight vehicles, the city's transport authority is looking into possibilities to remove combustion engine-driven vehicles in the city center, through the development of mandatory efficiency standards and vehicle labelling directives. It is also considering subsidy schemes to replace old inefficient heavy-duty vehicles (Copenhagen Centre on Energy Efficiency 2017).

Cities in India have also geared towards electrification in rickshaws and reduction of conventional fuel use in two-and three-wheelers, which are commonly used to transport goods. The State of Kerala which includes the City of Kochi gave an initial approval for operations of e-rickshaws in 2016 and it plans to issue taxi-permits to e-rickshaws only to reduce the number of conventional three-wheelers. However, except for a few private operators, the e-rickshaws sector in Kochi is still at a nascent stage and yet to reach its potential. Similarly, to transition from fossil fuel based internal combustion engine (ICE) modes to more efficient and greener electric modes, it is recommended that Panaji initiates the development of electric vehicle policy with specific provisions for freight vehicles.

4. Infrastructure capacity is often overlooked

High-quality infrastructure is a precondition for the provision of efficient transport services for both freight and passenger movements, however the infrastructure capacity consumed by freight activities is often overlooked. Such constraints have long-term implications for economic productivity and inequality. The World Bank's 2018 Logistics Performance Index places Argentina, Colombia and India at 61st, 58th and 44th rank[21]. The three common reasons for the poor rankings are: complicated customs clearance process, lack of appropriate infrastructure, and logistics incompetence. Growing freight demand poses an opportunity to increase the investment in urban rail infrastructure, cross docking and port handling capacity.

Kochi is a major port city in the State of Kerala. Freight vehicles accounted for nearly 60 percent of all registered vehicles in the State of Kerala, however services and amenities for the flow of goods is very much lacking. In 2017-18, 774,569 t of goods were unloaded at the Kochi Port, accounting for 16 percent of total freight. In 2018 and 2019, the port recorded its highest growth rate of 9 percent in cargo handling. However, its logistics efficiency suffers due to labor union strikes and the deteriorating quality of road networks connecting to the port terminal[22]. Similarly, a negligible amount of freight enters the city by rail, but the road to access railway station is often narrow and not paved. Changes are in progress, with roads being widened, road stretches being surfaced to facilitate the movement of goods, but more can be done. A dedicated freight corridor from railway terminals Kalamaserry Station and the International Container Transhipment Terminal (ICTT) to Kochi Port could provide further improvement.

Similarly, the Port of Rosario is an important element of development that connects, through Paraná-Paraguay waterway, the City of Rosario and the inland regions. It acts as

21 See more about the Logistics Performance Index at https://lpi.worldbank.org/international/global

22 The Logistics Ease Across Different States 2019 report prepared by the Department of Commerce, Ministry of Commerce & Industry, Government of India, ranked the State of Kerala at 12th position. The report highlights that the road infrastructure connecting to the ports require immediate improvement. Download the report at https://commerce.gov.in/writereaddata/UploadedFile/MOC_637051086790146385_LEAD_Report.pdf

a crucial node for the inbound and outbound freight traffic, with an estimated 4,715,009 t of goods being handled at the port in 2019. Rosario has the potential to enhance improved multimodality, including further expansion of the train system and its integration with the port terminals. The new Urban Plan [5 + 5] (Municipalidad de Rosario 2019) sets out strategies and actions to promote the consolidation of the logistics-industrial park, optimize the logistics activities and shift rail freight transport to other platforms developed in close collaboration with the port terminals. Related to this, the city aims to prioritize the infrastructure that is essential for the transport of goods and passengers. With the aim to develop the low carbon action plan for urban freight (LCAP-UF), the City of Rosario has convened members of the multi-stakeholder working group and identified actions to set up consolidation centers or distribution nodes, establish loading/unloading areas for last mile logistics, and to manage collection points for online shipping.

5. Urban freight data: What is missing?

Many cities have recognized the importance of reducing fuel consumption and GHG emissions in the freight sector. However, they often lack reliable data on real-world vehicles that can be used to establish a baseline, which is essential for evaluating the freight transport performance, and identifying future priorities and directions (Gonzalez-Feliu, Semet and Routhier 2013).

In each project city, commonly used data collection techniques (e.g., general surveys, stakeholder specific surveys and vehicle specific surveys) are used to understand freight transport activity patterns and characteristics (Allen, Browne and Cherrett 2012). The responses provided by local consultants carried out as part of this project has identified a range of common urban freight data issues (Raj and Vigran 2020), including but not limited to:

- Existing freight data collection usually takes place on a national basis, thus the data is primarily on a national level and not on an urban or regional level; however, this is not the case in all cities. In Bogotá and AMVA, for example, both cities have recognized the importance of freight transport and are making greater sources available for freight transport initiatives and data collection.
- The urban freight data that is collected is mainly for studies on solving a specific problem at a certain time;
- There is also little consistency or standardization in terms of the data collected about urban goods and vehicle flows;
- There is relatively less data about the activities of LGVs, as well as two-and three-wheelers, when compared with heavier vehicles;
- Data about freight transport and logistics infrastructure is lacking;
- Sectoral data about urban freight activity, i.e. only partial information about the main sector specificities of the organization of the supply chain is available and the cargo transported is often not well documented;
- Freight carried by consumers (mainly shopping) in cars of public transport vehicles is often not taken into account and so has not been included in emission calculations for freight transport;
- There is insufficient data regarding non-road modes of freight transport, i.e. rail and inland waterways;
- The impacts of urban freight trends and evolutions such as e-commerce is often lacking in the existing analysis;
- Data about distance travelled and the amount of fuel consumed can be sensitive information for many freight transport operators and companies, leading to insufficient or unreliable data;
- Insufficient geographical details about the freight trips taken place in urban areas;
- For many local governments, collecting urban freight data can be costly, time consuming, and often they do not have the financial resources to collect high quality data, limiting their ability to understand freight transport performance and make evidence-based decisions;
- Private companies often do not have clear

idea about the type of in-use vehicles for their operations, this results in data gaps when comparisons between datasets are attempted;

- Large national companies often subcontract to smaller companies, which reduce the possibility of obtaining reliable data.

6. Regulatory gap: What we have?

General understanding and awareness has grown exponentially in recent years and many cities have been active to introduce schemes, measures and pilot projects to solve urban freight related issues, such as congestion, air quality, safety and quality of life. Almost unexpectedly, irrespective of city scale or location there is a high degree of similarity in terms of urban freight interventions: there is no integrated body of urban freight management; the cities seem to focus largely on restrictions and measures influencing freight transport vehicles as well as programs for emission controlling; the profile of these interventions is piecemeal, place-based and limited to a certain group of stakeholders. A larger effort therefore is needed from the various regulatory agencies in the cities to close the regulatory gap (Hernandez and Façanha 2017).

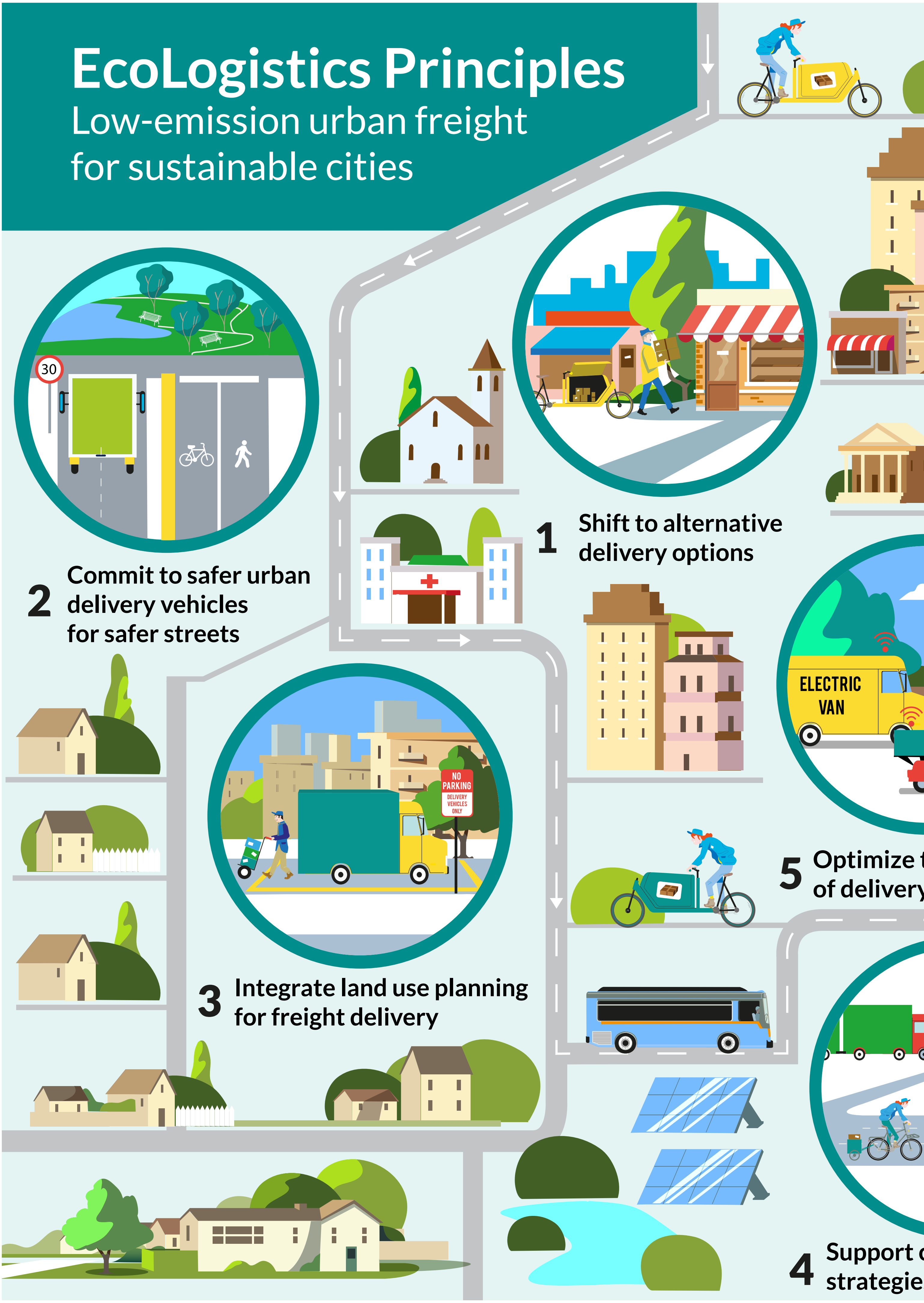
As can be seen in previous discussions, cities like Bogotá, AMVA, Shimla, Kochi and Panaji all have introduced some form of access restrictions – to limit, grant, or deny access of freight vehicles in terms of vehicle type (e.g., size, weight, load factor, engine type), and time of travel (daytime delivery restrictions, daytime delivery bans and night-time delivery bans). Often, these policy decisions can result in unintended problems and can be a challenging topic for decision makers. For instance, vehicle size and weight restrictions are commonly implemented in the city centers due to the concern of congestion and road accidents caused by large trucks. However, a growing body of research suggests that, although the look of a target area (e.g., city center) is enhanced due to restrictions, an increase in pollution in the outskirt of the city can result. Besides, restrictions are not well received by carriers, as they result in operational changes and higher costs. Private sector freight companies may be burdened with additional costs due to time, lane or parking restrictions imposed by the government as well.

In this, it is essential that the public sector ameliorates the negative impacts or consequences and ensure that operators are implicated in an integrated and sustainable approach so that the costs for the private sector can also be reduced.

From the analysis above emerges the important weight of urban freight transport. Whether from the point of view of the transport activity, modal distribution of flows, environmental impacts, or political responsibility and public organization of the supply chain, urban logistics is at the center of attention. Cities with different topographies, economies and societies present different opportunities to shape the transportation system. The EcoLogistics Principles (below) aims to inspire and support governments at all levels to transform their urban freight transport systems through collaborative efforts in stakeholder engagement, technologies, policies and land use planning.

EcoLogistics Principles

Low-emission urban freight for sustainable cities



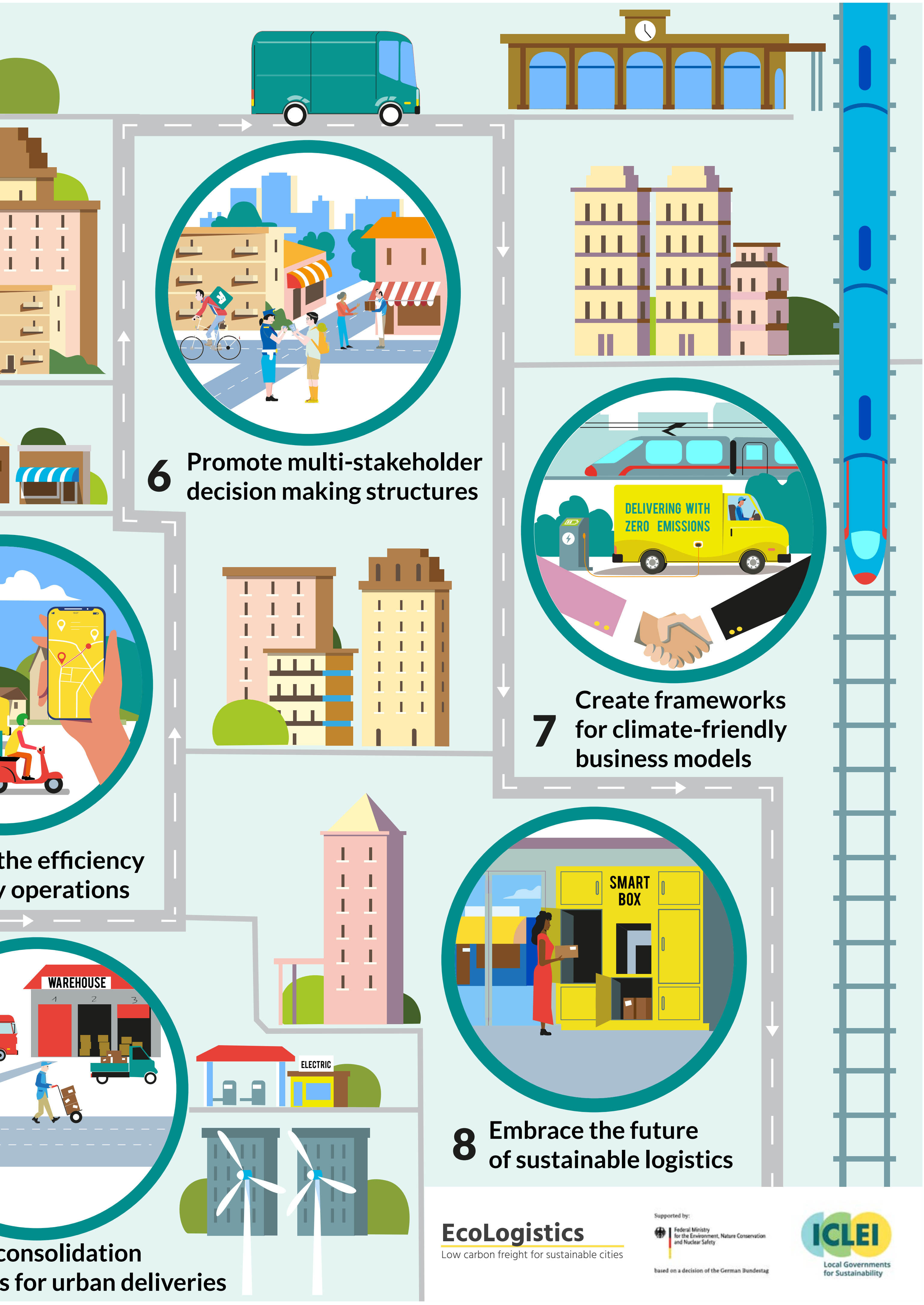
1 Shift to alternative delivery options

2 Commit to safer urban delivery vehicles for safer streets

3 Integrate land use planning for freight delivery

5 Optimize t
of delivery

4 Support c
strategie


6 Promote multi-stakeholder decision making structures
DELIVERING WITH ZERO EMISSIONS
7 Create frameworks for climate-friendly business models
the efficiency
y operations
SMART BOX
8 Embrace the future of sustainable logistics
WAREHOUSE
ELECTRIC
consolidation
s for urban deliveries
EcoLogistics
Low carbon freight for sustainable cities
Supported by:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
based on a decision of the German Bundestag
ICLEI
Local Governments for Sustainability

IV. LOOKING AHEAD: RECOMMENDATIONS FOR CITY LEADERS

This section presents lessons from sustainable freight policy development, and recommended measures that city leaders could employ to reduce emissions from the sector.

1. A combination of measures: Carrot and stick

Policymakers could adopt and implement a portfolio of carrots and sticks to drive faster decarbonization of freight transport, including a combination of reducing freight demand, shifting to low-carbon transport modes, better asset utilization, enhanced energy efficiency and new energy sources.

Based on the knowledge and experiences gained, a coherent and comprehensive package of mutually reinforcing measures which are tailored to the city context is the key to a successful and effective freight related regulatory program. Vehicle regulations such as emission standards, fuel economy, and fleet purchase rules will send strong signals to manufacturers and fleet managers. Supported by financial incentives and infrastructure investment, they should ideally leverage higher technology readiness. Market-based measures that provide incentives to freight operators will accelerate the deployment of fuel-saving strategies that reduce emissions and increase profits.

Other measures such as low/zero emission zones/pricing have been effective in delivering local benefits if designed well; reserved loading/ unloading areas for clean fleets and rewarding/ recognition schemes could be used to drive low emission vehicle adoption. In the last-mile logistics, local authorities could encourage the use of electric vans and cargo bikes for the final segment of deliveries; low-emission alternatives to road transport, such as waterways and urban rail have also the potential to cut emissions.

2. Integrating passenger and freight transport

With cities making announcement on zero-emission passenger vehicles and zero-emission zones,[23] the momentum to push for freight to be included in transport planning is now. Policy makers should take a holistic approach to addressing passenger and freight transport together and identify if policies, infrastructure, business models and energy sources serve both sectors.

To achieve this, integration in freight transport planning and operation is needed. This could be achieved by establishing a leading authority to provide strategic guidance and make informed decisions. For instance, the Government of Kerala envisages developing bus ports and logistics ports and, as part of the Kerala Rebuild Initiative, proposes to set up a Special Purpose Vehicle (SPV) named the Kerala Freight Port Limited. This semi government body will be implementing and managing all the freight transport related infrastructure development projects in the state. In addition, a close collaboration between different departments in the public sector, researchers, freight industry operators, international agencies and other stakeholders can be useful to create an ecosystem of support.

3. Working collaboratively across regions and industry

Incorporating urban freight into city development plans and mobility plans requires detailed studies about the interactions between freight flows and the urban environment, as well as how to integrate the interest of multiple stakeholders – public, private and community, into planning (see the Figure 27 below for an non-exhaustive list of key stakeholders).

Often there are silos between different stakeholders and there is a lack of shared vision. By bringing multi-stakeholders onto the

23 More than 250 European cities have Low Emission Zones (essentially banning polluting cars and trucks) and electric delivery vans and trucks. See more at https://www.transportenvironment.org/sites/te/files/publications/2019_09_Briefing_LEZ-ZEZ_final.pdf

same table, it can be ensured that they can be heard and can participate in a constructive fashion, to improve the freight system. Many approaches and techniques are considered effective mechanisms for stakeholder engagement, such as conferences, workshops, consultations and surveys. Urban freight roundtables and forums should be established for targeted discussions and negotiations.

On one hand, cities are likely to benefit from pursuing partnerships between public authorities such as regional or city vehicle registration bureaus, environmental agencies, statistical bureaus and transportation departments, etc. This will help accelerate the development of low emission programs. On the other hand, cities should work to develop and facilitate transparent partnerships with private sectors with access and exchange information, sharing good practices and ensure industry engagement on regulation consultations. Finally, cities should frame the need for emission reductions based on the issues that are most relevant to the public and local communities, such as traffic congestion, noise pollution and air pollution. This involvement will garner greater understanding and buy-in for further low emission solutions and strategies.

Within the framework of the EcoLogistics project, project cities have established multi-stakeholder local working groups, which are led by the cities and comprise of the private sector, civil society and academia, thus involving all sectors to contribute towards decision-making. The working groups are to meet on a regular basis and play a major role in developing and implementing local urban freight strategies and policies for their cities.

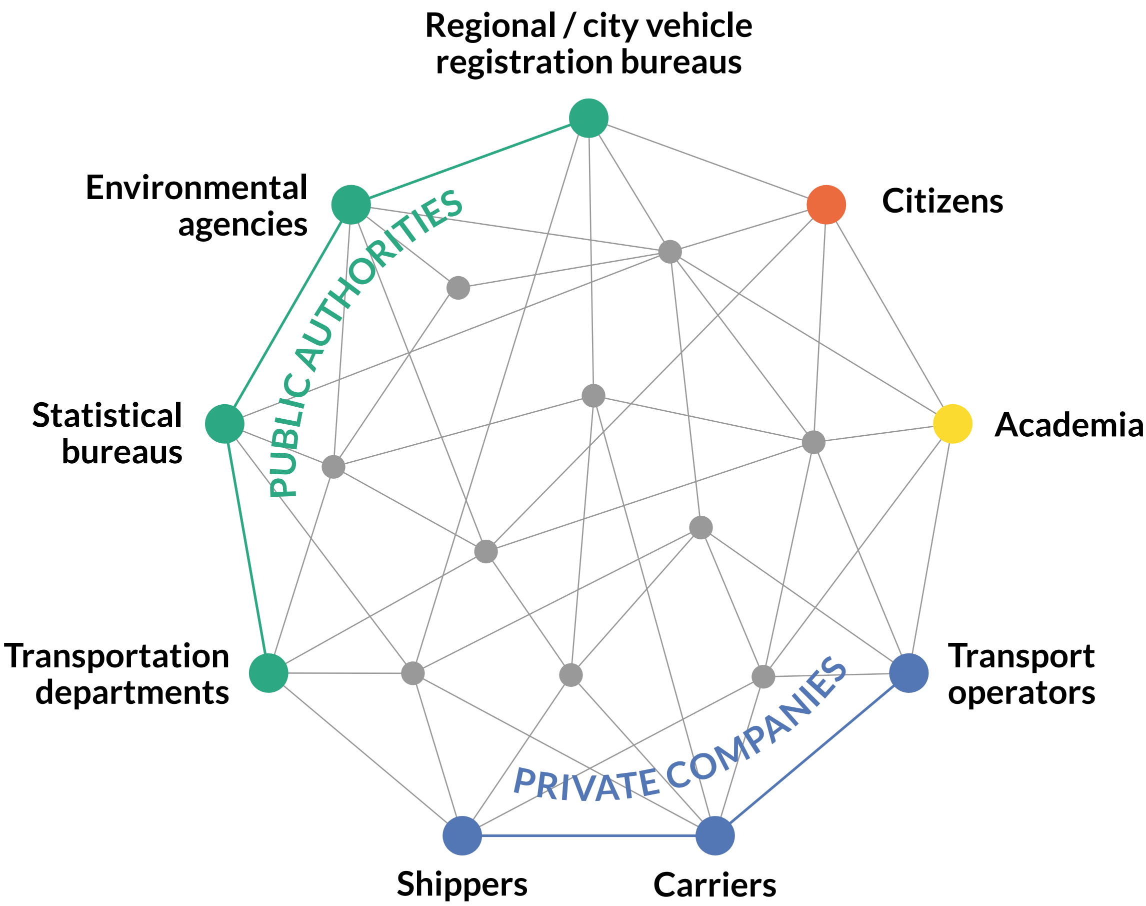


Figure 27: Urban freight transport related stakeholders

4. Leveraging data to make evidence-based decisions

As governments are setting ambitious targets for emission reduction, it is critical that they use data to evaluate and make science-based decisions. For local governments, collecting and updating urban freight data can be expensive and often they do not have the resources to access high quality data. To establish a comprehensive logistics profile, it is worth looking in detail to the demand for transportation of goods from the main economic players: retail, tertiary services, courier, industry, construction and waste due to their role as main generators of movement of goods. When publicly available information is limited, it is necessary to consider this estimate of urban freight as exploratory work, the results of which should support the pursuit of quantitative analyses relating to the collection of necessary data.

While new technology offers the possibility to collect data at relatively low cost, a stronger collaboration between the public sector and private companies could mitigate the data availability issue considerably. Steps taken to preserve anonymity through some green freight programs, such as the voluntary public-private SmartWay program of the U.S. Environmental Protection Agency [24] helps ensure freight operators can derive benefits from data sharing without subjecting to unwanted disclosures.

Apart from data collection, it is critical to develop and establish robust methodologies for logistics emission calculations to support freight users with adopting the emission reduction targets. ICLEI's *EcoLogistics Self-Monitoring Tool* is a free tool that makes it easier for cities to measure, plan and reduce overall GHG emissions from the urban freight sector. This tool can then help build policies, guide solutions and measure progress.

Check out the EcoLogistics Self-Monitorng Tool: https://sustainablemobility.iclei.org/ecologistics/self-monitoring-tool/

24 See more about the EPA's SmartWay program at https://www.epa.gov/smartway

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ANNEX I APPROACHES FOR THE CALCULATION OF TRANSPORT EMISSIONS

Fuel-based approach and activity-based approach

The fuel-based approach uses the fuel consumption data and converts fuel use into GHG emissions with defined emission factors. This method calculates emissions based on the amount of fuel sold within the city boundary. The data on the amount of fuel sold can be obtained from fuel dispensaries or fuel sales tax receipts. Different types of fuel emit different amounts of carbon. Thus, it is important to calculate item by item for each fuel type separately. This approach uses the following equation:

Equation 1: Fuel-based approach for emission calculation.

CO_2 emissions =
∑ (quantity of fuel consumed (liters) × emission factor for the fuel (e.g., kg CO_2e/liter)
+
sum across grid regions:
∑ (quantity of electricity consumed (kWh) × emission factor for electricity grid (e.g., kg CO_2e/kWh))

Description	Value
Total CO_2e emissions in tons	Computed
Quantity of fuel consumed in liters, gallons or kilograms	User input
Emission factor for the fuel (e.g., kg CO_2e/liter, or kg CO_2e/gallon, or kg CO_2e/kg)	Default data
Emission factor for electricity grid (e.g., kg CO_2e/kWh)	Default data

Source: (Global Protocol for Community-Scale Greenhouse Gas Emission Inventories 2014)

If access to fuel consumption data is limited or incomplete, a calculation using the activity-based approach is recommended. This approach seeks to quantify emissions within the city, including the trips that begin, end, or within the city. This requires information on VKT for each vehicle type, vehicle occupancy, information on fuel efficiency or emission intensity factors, which are applied in multiple steps. The component variables can be disaggregated. The approach uses the equation as follows:

Equation 2: Activity-based approach for emission calculation.

Sum across transport modes and/or vehicle types:
∑ (mass of goods transported (tons)
× distance travelled (kilometers)
× emission factor of transport mode or vehicle type (e.g., kg CO_2e/tonne-kilometer)

Description	Value
Total CO_2e emissions in tons	Computed
Mass of goods transported in tons	Default data
Distance travelled in kilometers	User input
Emission intensity factor in kg CO_2e/t-km	Default data
Emission factor for electricity grid = Electricity emission factor (e.g., kg CO_2e/kWh)	Default data

Source: (Global Protocol for Community-Scale Greenhouse Gas Emission Inventories 2014)

ANNEX II REAL-WORLD FUEL CONSUMPTION OF FREIGHT VEHICLES WORLDWIDE

Source	Region	Year	Data collection methodology	Vehicle type	Fuel type	L/100 km
Spritmonitor.de database	Germany	2020	Based on declared values of 10,756 commercial vehicles, taken from the spritmonitor.de database. For each vehicle, the real-world fuel consumption value is calculated as the total fuel consumption of the vehicle divided by its total mileage.	Commercial vehicles	Diesel	17.74
					Gasoline	10.56
					CNG	10.10
					LPG	16.41
					Electricity	15.66
				Plug-in hybrid	Diesel	9.26
					Gasoline	4.96
Federal Statistical Office (Destatis) of Germany (Fehrentz 2019)	Germany	2007-2017	The basic data on mileage and consumption by residents was determined by the German Institute for Economic Research (DIW) based on driving performance surveys and data from the German Federal Motor Transport Authority (KBA).	HGV (Trucks with a load capacity > 3.5 t, truck-trailers)		34.1
				LGV (with a load capacity < 3.5 t)		13.7
International Council on Clean Transportation (ICCT)	US	2013	EPA SmartWay: Aggregated data for 2500 fleets	Tractor-trailer (GVW 36 t)		39.1
	China	2013	Schuckert: Estimate from industry expert based on input from leading manufactures in China	Tractor-trailer (GVW 49 t)		47
	Europe	2011	AEA-Ricardo: Fleet-wide estimate based on attributing total fuel use and VKT travelled to 8 HDV vocations	Tractor-trailer (GVW 40 t)		30.9

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