Experience Spotlight: Chile and Colombia
Spotlight experience on schemes for monitoring GHG emissions reduction in urban electric transport projects[1]

September 2021

1. Context

Work done by the Technical Subgroup on Monitoring, Reporting and Verification (SGT-MRV) of the Pacific Alliance has highlighted the importance of having harmonized systems of monitoring, reporting and verification of mitigation actions (MRV-MA) for greenhouse gases (GHG) in the member countries of the Pacific Alliance[2]. Increased trust between the countries, due to greater transparency and comparability in mitigation reports, and the acceptance of reports between the parties, are among the advantages of having harmonized MRV systems. Although Chile, Colombia, Mexico, and Peru have different levels of progress, they are in a still very much in the early stage of structuring frameworks to account, design and implement MRV-MA systems. Currently, regional harmonization contributes to better use of resources for this purpose, adding efforts and experiences towards methodologies and monitoring and reporting schemes that are consistent at regional level.

In this Experience Spotlight, through three case studies in Colombia and Chile, some of the existing GHG emissions monitoring practices from the transport sector are characterized and key issues are identified towards the harmonization of the MRV-MA systems. The countries of the Pacific Alliance have shown a common interest in achieving a meaningful proportion of electric vehicles in the transport sector. Therefore, this document focuses on urban public transport electrification projects, given their current relevance in the region and their future potential in mitigating climate change. Likewise, the common urban context in the countries of the region and the goals that in terms of electromobility are beginning to be defined, are a motivation to seek learning opportunities based on current experiences that promote a common methodological and reporting framework.

2. Electric mobility in Latin America

According to the report; Forging low-emission development trajectories in Latin America and the Caribbean, the region faces unique and very critical challenges in terms of access to opportunities, quality of life and environmental sustainability of its cities. Latin America has become the most urbanized region in the world and public transport is a central axis in the region's urban systems. It is estimated that 68% of daily trips in cities in Latin America and the Caribbean (LAC) are made in this mode of transport (Estupiñan et al. 2018). Increased urbanization has caused an overproportioned growth in the spatial footprint of cities, which implies an additional challenge for transport systems, and precarious mobility conditions for most of the population. The main users of public transport systems come from low-income demographics, who most of the time also live far away from work and education centers, which means long travel times. Vasconcellos and Mendoca (2016) report that users of public transport in the region spend between 50% and 100% more time traveling, compared to private modes, almost always in worse comfort and security conditions, and with high costs for access the service, accounting for up to 30% of the income of the most vulnerable population (Kaltheier 2002).

[1]Document prepared by Mónica Espinosa, Florentino Márquez and Jose Pacheco (MRV and Transport Experts at Hill).
[2]Highlighted experience: Relevance and Effectiveness of MRV of GHG Mitigation Actions

Of the total GHG emissions from energy consumption at global level, 25% is attributed to the transport sector. This share is 30% in Colombia, 34% in Peru and 27% in Mexico (Bataille et al. 2020), while in the case of Chile it accounts for 33% (MMA, 2020). In Latin American cities, transport is also a major contributor to local air pollution phenomena.

In this social and environmental context, the technological and operational transformation of public transport systems is a priority, not only because of its impact on the consumption of fossil fuels and GHG emissions, but also because of other negative externalities that affect most of the population in large cities, particularly in terms of local air pollution and higher occurrence of cardiorespiratory diseases.

The electrification of public transport has been gaining relevance in the LAC region, by giving priority to different technological projects in the agendas of climate change, mobility, sustainable development, and energy efficiency. In Chile, for example, the National Electromobility Strategy envisions that by 2050, 100% of public transport vehicles will be electric, and 40% of private vehicles. Today the country has electric rail transport systems (Metro de Santiago, Valparaiso Metro, Tren Central and Biotrén) and is scaling initiatives for electrifying buses and taxis. Furthermore, the Long-Term Climate Strategy, which is currently undergoing a public consultation process, recommends even more ambitious objectives subject to validation, including:

i) reconversion of all buses in the different regions of the country by 2040;

ii) electric vehicles accounting for 60% of the country's total fleet by 2050, including both private and commercial vehicles; and

iii) 71% conversion level for load transport vehicles based on electromobility and green hydrogen by 2050; and

iv) achieving full conversion (100%) of basic and collective taxis by 2050.

In Colombia they are proposing -through the law for the promotion of electric vehicles (Law 1964 of 2019)- that by 2030 all vehicles purchased for mass passenger transport systems in the main cities of the country have to be electric or zero-emission, and that by 2026, 30% of the fleet of official vehicles in cities with more than 100,000 inhabitants must be electric (Colombia's government 2019b). Likewise, the National Electric Mobility Strategy (ENME) aims at having 600,000 electric vehicles circulating in the country by 2030 (Colombia's government 2019a).

Strengthening the mechanisms for monitoring, reporting, verification, and improved follow-up of the operational and environment performance of such projects should be developed in a complementary manner. Among other advantages, this would give transparency to the impacts in mitigating GHG emissions, and the standardization of methodologies would allow reducing transaction costs for MRV processes, as well as facilitating and enabling the participation of PA countries in carbon markets.

3. Case studies

This paper was developed with three case studies: the electric cable cars of Medellin (Metro Cable) and Bogota (TransmiCable), which serve as feeders to the mass Metro system and to a bus rapid transit system (BRT), respectively; and the third case, the fleet of electric buses of the Metropolitan Mobility Network in Santiago, Chile.

Transmicable: is an 3.3 km overhead electric cable car in a steeply sloping outlying area in southern Bogota. This area is characterized by informal settlements, with limited access to public services, transport, and urban facilities deficits (Sarmiento et al., 2020). The intervention project consists of the cable and 16 comprehensive development projects for the area, which include the improvement of access roads, parks, and cultural centers, among other facilities. The cable car system is made up of 163 cabins with a total capacity of 3,600 passengers per hour/direction. This comprehensive intervention seeks to benefit 669,000 people in the project's area of influence.

SITVA cable lines J and K: the Integrated Public Transport System of the Aburrá Valley (SITVA, by its Spanish acronym), has five cable car lines located on the marginal slopes of the city, between 1 and 5 km apart, which mainly serve as feeders to the metro system and the local tram. This document is focused on lines J and K, which were registered as a project in the Clean Development Mechanism (CDM)[3] and which have a capacity to transport 3,000 passengers per hour per direction along 2.7 and 2.07 km, respectively.

Electric buses in Santiago's Metropolitan Area: The Metropolitan Mobility Network (formerly known as *Transantiago* and now just as *Red*) integrates the city´s public transport services and the fare system. It is operated by six concessionaires over 380 routes, in addition to the Santiago Metro and the MetroTren. The bus service covers 680 km^2, corresponding to the 32 communes that make up the Santiago metropolitan area, home to some 6.2 million people. To meet the demand, it uses about 6,950 buses, of which 32% are zero or ultra-low emissions, complying with the Euro VI pollutant emission standard. With the electrification process of the fleet, which began in 2017, 784 electric buses have been incorporated to date.

[3] Project 3224: Cable Cars Metro Medellin, Colombia.

4. MRV Systems for GHG emissions in the case of studies

Do the NDCs of Colombia and Chile include these electric mobility projects?

Although the three cases presented in this paper reduce GHG emissions from the transport sector, only the Santiago Metropolitan Area electric bus system (*Red*) is included in the portfolio of mitigation measures of Chile's NDC. The J and K lines of Medellin's SITVA cable, which were part of the MDL mechanism up until 2017, are not considered among transport sector mitigation actions at the national level. The Bogota cable is not among the projects included in Colombia's NDCs (2015, 2020).

Table 1. *Characteristics of the electric transport systems in the case studies.*

Case Study	Project Type	Are GHG emission reductions monitored?	Are these projects part of the NDCs?
Transmicable ***Bogota, Colombia***	Electric cable car	Yes, but presented in terms of carbon intensity.	No, but can potentially be included.
SITVA cable lines J & K ***Medellin, Colombia***	Electric cable car	Yes, until 2017.	No, certified reductions are attributable to whoever buys the CERs.
Metropolitan Mobility Network ***Gran Santiago, Chile***	12-meter electric buses	No, but the operating data reported would allow them to be estimated.	Yes. It is also included in the National Electromobility Plan, the GHG Mitigation Plan for the energy sector, and in the Long-Term Climate Strategy

Source: Prepared by the authors based on a review of BUR, NDC and national climate change policies in both countries.

Why are the GHG emission reductions of these electric mobility projects monitored?

GHG emissions are monitored in all three case studies; however, monitoring in each project responds to different reasons as explained below.

- The Transmicable project, prioritized in the city's development plan, is covered by Bogota's Public Policy Monitoring and Evaluation System (SSEPP). Under this system, the local government develops project evaluations to generate information for decision-making and to allow the traceability of projects and policies over time. In particular, for Transmicable, an impact assessment methodology was designed for five components: urban, social, transport, economic and environmental (District Mobility Secretariat, 2020). The methodology for the environmental component includes:
  - i) identification of ecologically sensitive areas and mass removal processes.
  - ii) air quality: local emissions from public transport and personal exposure to air pollution; and
  - iii) the carbon intensity of trips with origin or destination in the intervention area.
- Monitoring of emissions by the SITVA cable lines J and K in Medellin, was developed under the CDM between 2010 and 2017. The monitoring was carried out with the "Small-scale Methodology - Cable cars for mass rapid transit systems (MRTS)" standardized methodology.
- This methodology considers GHG emissions by combustion in the operation of transport modes other than cable, emissions from feeders to the cable stations, and electricity used in cable operation.

- In Chile, the Urban Roads and Transportation Program (known as SECTRA, after the acronym of the former Secretary of Transport Planning) monitors emissions of the mobility system in the Santiago Metropolitan Area, based on annual updates of the Vehicle Emissions Model - MODEM[4]. This tool quantifies the emissions of local and global pollutants to comply with Article N°6 of the Metropolitan Region Atmospheric Decontamination and Prevention Plan, which requires an annual emissions report for the *Red* system. For this, characterization data of the bus fleet and annual activity levels are collected and processed, among other datasets. The emission factors of the different pollutants, including GHGs, come from the European COPERT model[5]. It should be noted that these reports are not made to report GHG emissions with respect to monitoring national mitigation goals, since the vehicle emissions model is a tool for evaluating the emissions of transport systems on an urban scale, not regional or national.

Are the same guidelines followed when monitoring GHG emissions in these different electric mobility projects?

For the evaluation of GHG emissions in Transmicable, two indicators related to GHG emissions are used, which are compared during the execution of the project against the baseline.

- **CO_{2e} emissions per trip:** this indicator is calculated considering the modal distribution of trips on working days, made by the population in the project intervention area. This is determined through surveys that are carried out as part of the impact evaluation. Representative emission factors for the fleet are assigned considering the characteristics of the public transport buses that provide service in the area, and the characteristics of the city's fleet for the other modes.
- **CO_{2e} emissions during morning rush hour** of the public transport system that operates in the intervention area. This is determined considering information provided by the companies that supply the public transport service, covering the fleet's activity and the main characteristics of the buses.

These two indicators are not directly comparable with the information generated in a national GHG emissions inventory. However, from the first one, emissions reductions can be estimated and compared with the national inventory.

Lines J and K of the Medellin cable system employ the "Small-scale Methodology - Cable cars for mass rapid transit systems (MRTS)" methodology endorsed by the United Nations Framework Convention on Climate Change (UNFCCC). This includes the analysis of the complete trips of the passengers who use the cable at some stage between origin and destination using different modes of transport. Figure 1 is a diagram of the methodology to estimate the emissions reduced comparing a baseline scenario and a mitigation scenario.

In this sense, emissions can be quantified as:

- Base emissions: generated in the absence of a project.
- Indirect emissions: generated during entry and exit of the cable stations, when the project is in operation.
- Direct emissions: generated by operation of the cable (through consumption of electricity).

[4] The development of MODEM was commissioned in 1999 by SECTRA / MIDEPLAN to incorporate the environmental variable in the Development Plan (PdD) applied to the Urban Transportation System (STU). Since then, it has been improved and updated based on the availability of input data such as vehicle flows, emission factors and vehicle categories.
[5] COPERT is the emissions model used by the European Environment Agency (EEA).

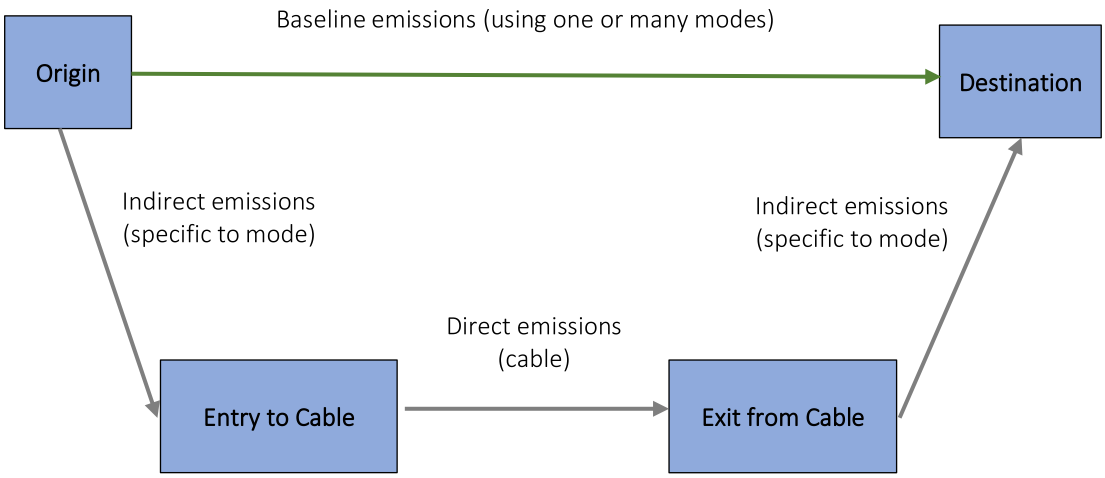

Figure 1: *Stages of each trip used to calculate direct and indirect emissions.*
Source: Adaptation of the ASM-III.U – Cable Cars for Mass Rapid Transit Methodology.

Strictly speaking, this CDM methodology does not coincide with the top-down orientation for national and regional GHG inventories. Although Certified Emission Reductions (CER) that haven't been commercialized can be reported within the framework of the NDC, these projects have suspended the verification processes due to a lack of financial resources and the uncertainty of the carbon markets.

To monitor the environmental impacts of operating the *Red* bus system, the Chilean government uses the MODEM emissions model, which is based on the methodology used by the Environment Ministry (former National Environmental Commission) to determine Emission Inventories in the Metropolitan Region and other intermediate cities (Osses, 2002). MODEM is integrated into the ESTRATUS[6] transport model and in the emission factors database used in the COPERT model, allowing to obtain emission data for specific pollutants associated with different vehicle categories from the vehicle activity data calculated across the Greater Santiago Road network. This ensures that emissions estimates follow a bottom-up approach that reflects the operating conditions of the mobility system, and with a high degree of technical rigorousness.

MODEM is used as an urban transport planning tool, with the purpose of making environmental evaluations of transport plans or projects. MODEM results are not comparable with national GHG inventories. The model is run for 22 cities (80% of the population) and not for the entire national road transport system. A review of the territorial limits used for analysis in MRV schemes is very important to guarantee the comparability of the national, regional and local emission inventories.

[6] ESTRATUS is a classic 4-stage transport model (generation, distribution, modal partition, allocation) based on the road network (links and nodes), the characteristics of the traffic-network (length, free-flow time, capacity, flow fixed vehicle) and simulation results for each network link (allocated flow, travel time, travel speed).

Is there a GHG emissions verification mechanism in these electric mobility projects?

- In the region, there are technical and institutional capacities that can carry out emission mitigation verification processes, either first-party (entities that meet the requirements to verify their own data and processes) or third-party (entities endorsed or certified to carry out verification processes on behalf of the interested parties). However, the existence of common technical verification guidelines among the cases studied is not evident.
- First-party verification is done for the Transmicable project. Impact evaluation studies are commissioned by Local Government to a third party, and compliance with minimum levels of precision and reliability in the follow-up analyzes is requested. These evaluations are carried out with local government auditors and no additional verification processes are required. The verification process covers the five components of the assessment and not just GHG emissions.
- The monitoring system for the reduction of emissions by SITVA's J and K cable lines in Medellin, as it is CDM, requires a third-party verification process. The project was verified by the Colombian Institute of Technical Norms and Certification (ICONTEC) for the two reporting periods registered.
- For the case analyzed in Chile, the entity responsible for verifying compliance with sectoral mitigation goals, framed in the NDC, is the Environment Ministry, which does so through tools such as the National Greenhouse Gases Inventories System (SNICHILE), and the National Prospective System. However, no evidence of verification processes was found for emissions reduction calculations associated directly with operation of the *Red* electric bus fleet, which are used instead by the Metropolitan Region Prevention and Atmospheric Decontamination Plan. Given the installed capacity, it is possible to implement verification schemes with adequate coordination of the Environment, Energy and Transport & Telecommunications Ministries, the Metropolitan Public Transport Directory (DTPM) and the electric bus operating companies.
- Additionally, it is possible to take advantage of the *Huella Chile* climate management program, which seeks to promote the calculation, reporting and management of greenhouse gases in public and private sector organizations. For this, it offers technical support, quality labels, and manages a registry of emissions inventories, business sector carbon footprints, and mitigation measures. The program requires participating organizations to have third-party verification of their emissions reports and mitigation actions. The *Huella Chile* team confirms that the verifiers have all the legal requirements.

5. Conclusions

The three cases of electric transport projects studied monitor the impacts on GHG emissions with different motivations:

Transmicable in Bogota: due to the monitoring of local public policies on urban mobility, development, and poverty alleviation, reflected in Bogota's Public Policy Monitoring and Evaluation System (SSEPP).

Medellin cable car: due to the obligation to certify reductions under Clean Development Mechanism (CDM) projects.

Electric buses in Santiago's Metropolitan Mobility Network: monitoring of metropolitan air pollution policies and the Strategic Plan for Electromobility (the latter, included in the Chilean Nationally Determined Contribution, NDC).

Although monitoring practices are carried out in all three cases, these are not necessarily reflected in the national monitoring systems of transport GHG emissions. Better coordination and integration between local and national authorities is needed, in terms of identifying the projects that are contributing to reducing GHG emissions, but which are not considered in the portfolio of actions to achieve the NDC, as happens with the two Colombian cases. An example for other countries in the Pacific Alliance may be the case of Chile, in which the electrification of the fleet of buses in the Metropolitan Area of Santiago and the different regions is explicitly mentioned in the NDC and in the Long-Term Climate Strategy.

There is an opportunity to harmonize national MRV-MA systems with monitoring systems at local and sectoral level. The two projects analyzed in Colombia are not part of the NDC, however, both have MRV systems for GHG emissions. In Chile, there is a commitment to report information from operating companies of the Metropolitan Mobility Network, which are compiled by the DPTM and SECTRA to update local pollutant emission models. Despite having standardized bottom-up estimates, these are not part of a formal NDC monitoring system.

There are differences in the limits of the analysis systems and in the emission factors used to monitor local projects with respect national GHG inventories. Mechanisms should be sought to align local project monitoring processes with national and regional monitoring guidelines, including the standardization of mitigation project registries, as well as the calculation and data collection methodologies. For example, to the extent that the local project analyses are aligned to be consistent with the national inventories, there will also be comparable analyses between countries because national inventories are standardized under the IPCC methodology.

The bottom-up approach is common among the GHG emission estimation methodologies used to monitor the impacts of the electric transport projects analyzed in this document. This demonstrates the technical background and capacities of the authorities responsible for monitoring the impact of these projects presents an opportunity for the countries analyzed to move towards harmonizing and achieving common monitoring and reporting methodologies within the framework of the Pacific Alliance.

There is technical capacity available at the local level to develop emission reduction verification processes. First-party verification processes are developed for the Transmicable project in Bogota. For the Medellin project, since it is a CDM, there were third-party verification processes. In both cases, the verification was carried out by local entities. In Bogota a public entity conducts the verification - the District Mobility Secretariat, and in Medellin it was carried out by the ICONTEC. In the case of *Red*, the DTPM collects detailed information on fleet operations to monitor the performance of the public transport service, but no evidence of emission verification is found. The calculation protocols, in any case, are documented.

6. Recommendations for the SGT-MRV

Developing common MRV-MA standards for the Pacific Alliance countries by project type is a first step in harmonizing methodologies for calculating and reporting climate impacts, in line with the purpose of the SGT-MRV. Sharing common guidelines allows for:

- Reduced transaction costs compared to a scenario in which each country develops their own MRV rules.
- Facilitate comparability and monitoring compliance with climate goals.
- Enable regional carbon markets.
- Understand that there is no single methodology to monitor, report and verify GHG emissions from electric transport projects. Local context, and technical and financial capacity are crucial when adapting a monitoring and reporting method.
- Encouraging the registration of these mitigation projects in the official mechanisms available nationwide (National Registry of emission reductions in Colombia (RENARE) and the Chile Footprint Program).
- Promoting an exchange of experiences between the verifying bodies in the region, with the aim of improving the processes of validation and verification, help developing standards, and identify bottlenecks for their implementation.
- Previous experiences, such as those with the CDM, have demonstrated the importance of reducing costs to make verification processes viable in the urban context of the countries of the Pacific Alliance. Sharing these experiences can help identify viable alternatives for MRV-MA processes.

Acknowledgments

Document prepared by Mónica Espinosa, Florentino Márquez and Jose Pacheco (MRV and Transport Experts at Hill). The SGT-MRV of the Pacific Alliance also thanks the people who contributed information for this document. Especially Rubén Triviño from the Ministry of Transport of Chile for his thorough review.

For more information on this 'spotlight' or for more information on any other Spotlight Series document, contact the Technical Coordinator of the MRV Technical Subgroup of the Pacific Alliance (SGT-MRV) Mr. Francisco Pinto.

This project was undertaken with the financial support of:
Ce projet a été réalisé avec l'appui financier de :

Environment and Climate Change Canada   Environnement et Changement climatique Canada

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