ELLA
Evidence and lessons from Latin America

Energy efficient modes of transport – like Bus Rapid Transit (BRT) systems, bicycles and electric taxis – are providing an effective means for reducing urban greenhouse gas emissions in Latin American cities.

CAPITALISING ON PUBLIC TRANSPORT: REDUCING GHG EMISSIONS IN LATIN AMERICAN CITIES

SUMMARY

The transport sector is one of the largest contributors to global GHG emissions, both worldwide and in the Latin America region. In response, some cities in Latin America are taking steps to revamp their transport sectors as part of a strategy to mitigate GHG emissions. This Brief begins by discussing the environmental impacts of the transport sector before turning to three key Latin American transportation innovations: Bus Rapid Transit (BRT) systems; bicycle lanes; and electric taxis. While stronger monitoring systems are still necessary, initial results do point to important mitigation effects in the cities that are implementing these new transportation options. Key contextual factors and lessons learned are also presented to help cities in other regions consider whether these types of innovations might work in their own contexts.

THE GROWING IMPACTS OF THE TRANSPORT SECTOR ON GHG EMISSIONS

Establishing a transport system that caters to each city's distinct needs is a key factor in the success of urban development worldwide. No matter the level of development in any given city, transport systems are hugely important in many ways. Transport influences development of the economy overall, and of particular sectors like energy, and can have significant impacts on the environment and on the quality of life of urban dwellers. Today, these issues are attracting more attention from civil society and the scientific community.

The transport sector is also classified as the second greatest contributor to CO_2 emissions in the world after electricity and heat. In 2010, the transport sector was responsible for 22% of global GHG emissions (Figure 1), predominately as a result of road transport. During the last decade, GHG emissions from transport increased at

KEY LESSONS LEARNED

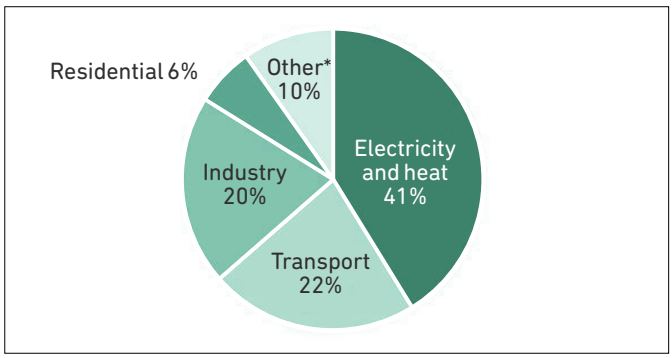
Although further research and evidence is required, preliminary results show that BRT systems, cycle paths and electric taxis are all helping Latin American cities to reduce GHG emissions.

The BRT system as implemented in Latin America has been shown to have relatively low implementation costs and be easier to construct than other large-scale mass transport systems. It may therefore be the more feasible option for cities that are experiencing growth and expansion.

The combination of the BRT system with other energy efficient options represents a significant opportunity for mitigating GHG emissions. Examples from the Latin America region that illustrate this potential include both the use of biofuels to power mass transport systems and the simultaneous implemention of both BRT and cycle path systems.

a much faster rate than any other type of energy.[1] Furthermore, the transport sector currently accounts for 50% of global energy demand, and this percentage is also projected to grow.[2]

Figure 1: World CO_2 Emissions by Sector, 2010



*Other includes commercial/public services, agriculture/forestry, fishing, energy industries other than electricity and heat generation, and other emissions not specified elsewhere.
Source: International Energy Agency (IEA). 2012. *CO_2 Emissions from Fuel Combustion: Highlights*. IEA, Paris.

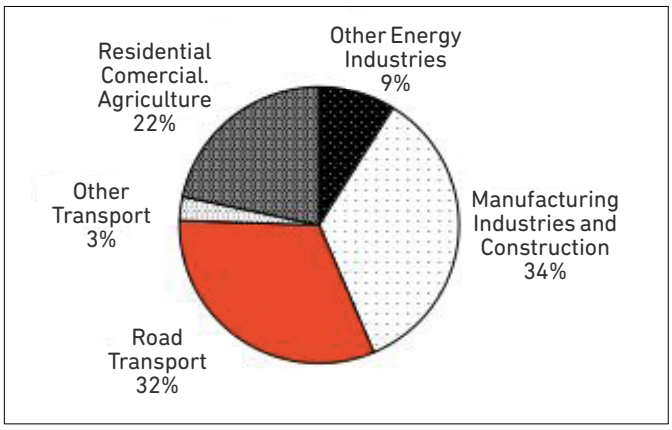
In Latin America and the Caribbean, the transport sector contributed to 35% of regional GHG emissions in 2006 (Figure 2). In Brazil alone, approximately 50% of oil derivatives, mainly gas and diesel, two major pollutants, are consumed by the transportation sector.[3]

Cities are also a hotspot for GHG emissions. Home to half the world's population,[4] cities produce two-thirds of global GHG emissions. This figure is expected to rise to 74% by 2030, largely due to rises in emissions in developing countries.[5] In Latin America, economic growth, urban expansion and rising populations are all contributing to increases in GHG emissions, and are having a particular impact on the transport sector.[6]

Against this backdrop, cities across the world face the urgent and challenging task of improving the efficiency and sustainability of the urban transport sector. To achieve this, cities must understand the main characteristics of their existing transport sectors and identify where potential reductions in GHG can be made. Latin American cities currently maintain a mix of large public transport systems and intensive private vehicle use. Several Latin American cities have carried out this analysis and as a result have developed more sustainable transport systems that are reducing GHG emissions, while at the same time improving the well-being of the urban population and reducing traffic. In this Brief, we highlight some key examples, including the Bus Rapid Transport (BRT) systems and cycle paths in Curitiba, Brazil and Bogota, Colombia, and electric taxi projects in Bogota, Colombia, and Mexico City, Mexico.

A key aim of this Brief is to help readers develop an understanding of GHG emissions in the Latin American urban transport sector, and how cities might reduce these emissions. Experts producing GHG emissions scenarios to 2030 suggest that rather than developing new technologies for the transport sector, employing existing technologies and scaling-up good practices will be sufficient to achieve acceptable emissions reductions.[7] With this assessment in mind, this Brief provides an analysis of low-emission transport options being implemented across Latin America in order to draw out key lessons that could help African and Asian cities adapt these practices to their specific needs.

Figure 2: CO_2 emissions by Latin America and Caribbean Nations by Sector in 2006 (total 2.5 tonnes/capita)



Source: Schipper, L. *et al.* 2009. *Considering Climate Change in Latin American and Caribbean Urban Transportation: Concepts, Applications and Cases*. Center for Global Metropolitan Studies, University of California, Berkeley.

[1] Kahn Ribeiro, S. *et al.* 2007. Transport and its Infrastructure. In: Metz, B. *et al.* (eds). *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge and New York; C40 – Climate Leadership. 2013. *Low Carbon Technologies Can Transform Latin America's Bus Fleets. Lessons from the C40-CCI Hybrid and Electric Bus Test Program: Hybrid and Electric Technologies Are a Viable Solution to Reduce Carbon Emissions in the World's Megacities*. C40 Cities Climate Leadership Group, Clinton Climate Initiative, Inter-American Development Bank.
[2] IEA. 2012. *IEA Plots Path to Halving Fuel Used for Road Transport in Under 40 Years*. IEA Press Release, Paris.
[3] Ribeiro, S. K. 2007. A Importância do Setor de Transporte de Painel Intergovernamental de Mudanças Climáticas - IPCC (The Importance of the Transport Sector in the Intergovernmental Panel On Climate Change - IPCC). *Revista Transportes (Transport Journal)* 15 (1) 5-6.
[4] World Bank. 2010. *Cities and Climate Change: An Urgent Agenda*. World Bank, Washington, DC.; C40 – Climate Leadership 2013, above n2.
[5] IEA. 2008. *World Energy Outlook*. IEA, Paris.
[6] De la Torre, A., Fajnzybler, F., Nash, J. 2009. *Low Carbon, High Growth: Latin American Responses to Climate Change: An Overview*. World Bank, Washington, DC.
[7] Ribeiro. 2007, above n3.

One advantage of cities that are still developing is that there is greater room - as physical space - for enhancing the efficiency of transport projects, and so a greater capacity to plan for and implement improvements to the transport systems, in contrast to cities that are already at an advanced stage of development and have a relatively fixed closed design.[8]

One key constraint, though, is that there continues to be a lack of effective monitoring of GHG emissions reductions resulting from the adoption of more energy efficient transport models. Despite this, the adoption of alternative models is undoubtedly proving beneficial in terms of reducing environmental damages and improving the quality of life of urban dwellers. Furthermore, it is difficult to measure the total impact of these types of initiative, because introducing transport models aimed at reducing GHG emissions also tends to address other urban challenges (even if only indirectly), given that improvements in the organisation of transport systems can facilitate the logistics of a whole city. Acknowledging these limits in tracking impacts, this Brief highlights what evidence does exist on the effectiveness of the initiatives included.

GREENING TRANSPORT SYSTEMS IN LATIN AMERICA: BRT SYSTEMS

The Bus Rapid Transport - or BRT - system seeks to achieve greater urban mobility with lower cost and higher efficiency. The BRT system differs from a simple bus or metro system in that it employs more modern infrastructure and technology, including exclusive bus lanes to reduce travel time, staffed ticket and information booths and enhanced accessibility for disabled passengers.[9] In spite of metro systems arguably transporting a higher quantity of passengers, the BRT system is a quicker, cheaper means of sustaining a high volume of commuters.[10]

One study conducted into the implementation of the BRT system in Latin America concludes that it "delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service. It is a flexible system that offers solutions to mass transit challenges in congested and fast growing cities and towns."[11] In its 2007 report on BRT, the Institute for Transportation and Development Policy found that, "by allowing cities to provide a functional network of public transport corridors, BRT permits even low-income cities to develop a high-quality mass transit system that serves the public's daily travel needs."[12]

Figure 3 illustrates the quantity of passengers transported by BRT systems in cities throughout the world. Readers will note that Latin America is the region where BRT systems are most widely in use.

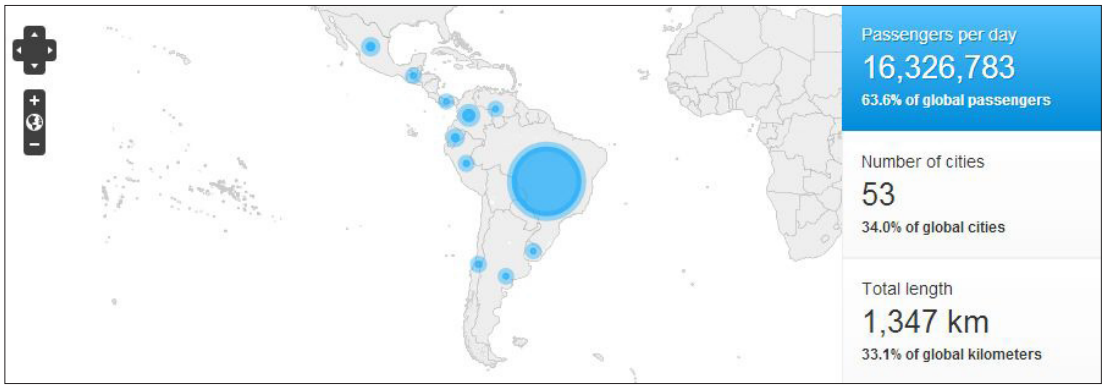
In fact, of the 157 BRT systems currently in use in the world, 53 are functioning in Latin American cities and a third of all BRT bus lines are concentrated in this region. Many cities on the continent have already implemented BRT systems while others are planning major expansions and improvements to their existing systems.

Figure 3: Distribution of BRT Systems by Region

Source: Data produced by BRTdata.org,[3] accessed 6 June 2013.

[8] Hidalgo, D., Huizenga, C. 2013. Implementation of Sustainable Urban Transport in Latin America. *Research in Transportation Economics* 40(1) 66-77.
[9] Levinson, H. *et al.* 2003. *Transit Cooperative Research Program Report 90. Bus Rapid Transit. Volume 2: Implementation Guidelines*. Transportation Research Board, Washington, DC.
[10] Gwilliam, K. 2012. Cities on the Move: Ten Years After. *Research in Transportation Economics* 40(1) 3-18.
[11] Mejía-Dugand, S. 2012. Lessons from the Spread of Bus Rapid Transit in Latin America. *Journal of Cleaner Production* 50(1) 82-90.
[12] Institute for Transportation and Development Policy (ITDP). 2007. *Bus Rapid Transit - Planning Guide*. ITDP, New York.
[13] BRTData.org publishes worldwide statistics and information on BRT systems. One of their data sources is the Latin American Association of Integrated Transport Systems (ITS) and BRT (SIBRT), which is another useful source of information about BRT in the region.

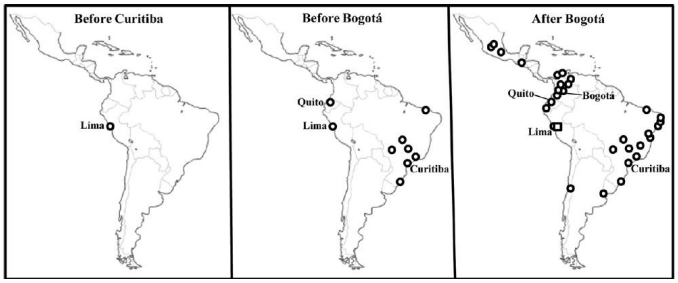
Figure 4: Distribution of BRT Systems in Latin American Countries



Source: Data produced BRTdata.org, accessed 6 June 2013.

The adoption of BRTs across Latin America came about gradually after the implementation of segregated transport lines in Lima, Peru.[14] Although the *Via Expresa* system in Peru was only a rough prototype of what would later become the BRT system, it was the initial experience that inspired other cities to follow suit. Following Peru's example, larger systems were implemented such as the BRT systems in Curitiba, Brazil and in Bogota, Colombia. Figure 5 below shows the expansion of the model throughout the Latin American continent.

Figure 5: Important Landmarks in BRT System Development in Latin America



Source: Mejía-Dugand, S. 2012. Lessons from the Spread of Bus Rapid Transit In Latin America. *Journal of Cleaner Production* 50(1) 82-90.

The Curitiba BRT system, known as the Integrated Transport Network (*Rede Integrada de Transporte*), is renowned throughout the world and has been used as a model for other cities and governments. It was the first large-scale transport project in Latin America and has brought great benefits to the transport sector within the state capital of Parana (Figure 5). The need for an efficient urban transport system had been identified well before the project was ultimately implemented, and consequently the development of the BRT was carried out in accordance with existing land use plans and other development objectives identified in the city's master plan.

A key example of the commitment of Curitba's BRT system to addressing environmental issues like GHG emissions is the implementation of the Green Line system. This line was designed and implemented with environmental improvement as a primary objective. The buses were selected based on the energy efficiency of the engines in order to reduce GHG emissions. In addition, six buses run on 100% biofuel made from soybeans. Despite this project's clear intentions to reduce GHG emissions, there is no existing monitoring programme for this initiative, making it difficult to prove with accuracy its effectiveness.

Subsequent to the pioneering of the BRT system in Curitiba, the city adopted an integrated BRT command system. Together with the communications company Ericsson, Curitiba's BRT system has implemented a 3G internet platform for communication and command of the entire system. This system helps to reduce travel time and spending on fuel, which in turn increases the quality of travel and reduces CO_2 emissions. Preliminary results from a study conducted by the project implementer show that there may in fact be a reduction in travel time and CO_2eq emissions.[15]

Another famous BRT in Latin America is Bogota's *TransMilenio* system, which is said to be among the best public transport systems in the world.[16] Bogota's BRT system is currently the largest such system in Latin America in terms of its corridor mobility and the number of passengers it can transport. The BRT became operational in 2000 thanks to a public-private partnership that is still continuing today. This partnership involves the Government of Colombia, the city of Bogota's Mayor, Enrique Penãlosa, and a private sector company.

Although Bogota's BRT system was designed based on the successes in Curitiba, the Colombian version currently surpasses the Brazilian project in terms of quality and quantity of services.[17] In addition, Bogota continues to make improvements to its BRT system, with the current phase of development set to extend bus lanes by a further 60km.

[14] "In Latin America, Lima (Peru) has been considered an initiator of these kinds of systems with its Vía Expresa, which began operating in 1972. The system as such is not considered a BRT, but it undoubtedly laid the ground for prioritised public transport in the region." Quoted in: Mejía-Dugand 2012, n11 above.
[15] Again, these results should be read with caution given that they were generated by the project implementer themselves. Ericsson. 2012. *Assessment of CO_2e Emissions Related to Curitiba's BRT System*. Ericsson, Stockholm.
[16] Lindau, L.A., Hidalgo, D., Facchini, D. 2010. Curitiba - The Cradle of Bus Rapid Transit. In: *Built Environment* 36: 274-282.

Bogota's BRT is also held up as a reference for other cities because it is the first BRT transport system to be qualified as a Clean Development Mechanism (CDM) by the United Nations.

Figure 6: *TransMilenio*'s 100 Street Station During Rush Hour

Source: Gwen Kash.

The CDM project of the Bogota BRT system was registered in 2006 and renewed in 2012, and a number of benefits in terms of the quality of life of city inhabitants have been found.[18] In terms of emissions reductions, which is a significant component of the initiative, the BRT earns Certified Emission Credits (CERs), thereby encouraging even further development of the BRT system.[19] With an operational life of 21 years, the CDM project is planned to end in 2027. The intention is to achieve 246,563 (tCO_2eq/year) in CERs, and a total of 5,177,823 (tCO_2eq) credits by the end of the project.[20] Indeed, there is significant potential for GHG emission reductions over the years, based on continuing investment in the system.

A third example is Mexico City's *Metrobus* system. Mexico City's BRT system is the newest of the three systems presented in this study, having been implemented only recently in 2005. This project also emerged out of a partnership between the government and the private sector and was carefully planned to meet the current and future needs of the city. In contrast to the other two examples, the Mexican BRT system aimed to reduce GHG emissions right from inception. Although the project was not designed with the sole purpose of reducing environmental impacts, the planning and design of the project clearly and deliberately encompassed a climate change mitigation strategy.[21]

Table 2 presents key indicators, including reductions in GHG and other gas emissions, for each of the three BRT projects described in this Brief. It should be noted that this information is still preliminary and sufficient data on GHG emissions is not available in all cases, meaning it will be crucial to continue developing accurate measures of GHG emissions in the future. Nonetheless, initial indicators for these three BRT systems point to success in terms of GHG mitigation.

Table 2: Summary of the BRT Systems in Curitiba, Bogota and Mexico City

	Rede Integrada de Transporte, Curitiba	*TransMilenio*, Bogota	*Metrobus*, Mexico City
Annual demand (passengers per year)	151,500,000	540,000,000	226,500,000
Daily demand (passengers per day)	505,000	1,800,000	755,000
Fuel type	Biodiesel and Diesel	Diesel	Diesel
Funded by	A government initiative sponsored by the World Bank	A public-private partnership, in which the public sector is responsible for investing in infrastructure (segregated lanes, stations, terminals, etc.), while the private sector is responsible for the bus fleet, the ticket system, and for the operation of the trunk and feeder services.	Mexico City Government leads the planning, coordination, rectory and management, as well as the financing of the construction and maintenance of the corridor infrastructure in partnership with the private sector, who manages more administrative aspects like purchasing buses..
Peak frequency (buses per hour)	67	320	64
Reduction in Greenhouse Gases (GHG) and other gas emissions	Reduction in CO and CO_2 emissions by 30% and 20% respectively[23]	Reduction in GHG emissions by 40%[24]	Reduced passenger exposure to CO, benzene, and PM 2.5 by up to 50% compared with previous bus services. Reduction of CO_2 by 35,000 tonnes annually.[25]
System length (km)	81,4	106	95
Corridors	6	8	4
Initial year of operation	1974	2000	2005

Own elaboration.
Source: Data from BRTdata.org, Rede Integrada, TransMilenio and MetroBus. Data accessed May 2013.

[17] Mejía-Dugand. 2012, n11 above.
[18] UNFCCC. (No publication date). CDM Project Co-benefits in Bogotá, Colombia. UNFCC, Bonn.
[19] ITDP. (No publication date). Bus Rapid Transit. Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities. ITDP, New York.
[20] UNFCCC (No publication date), above n18. For a chart detailing the estimated emissions reductions per year of TransMilenio versus other transportation methods, see page 284 of: ITDP. (No publication date). Bus Rapid Transit. Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities. ITDP, New York.
[21] Schipper, L. *et al.* 2009. *Considering Climate Change in Latin American and Caribbean Urban Transportation: Concepts, Applications and Cases*. Center for Global Metropolitan Studies, University of California, Berkeley.
[22] Hidalgo, D., Pereira L., Estupiñán, N., Jiménez, P. L. 2013. TransMilenio BRT System in Bogota, High Performance and Positive Impact: Main Results of an Ex-post Evaluation. In: *Research in Transportation Economics* 39(1) 133-138.
[23] Institute for Research and Urban Planning of Curitiba. 2011. BRT Bus Rapid Transit: Curitiba's Experience. Presentation to the C40 Large Cities Climate Summit, Sao Paulo, 2011.
[24] C40 Cities. (No publication date). *BRT System Reduced Traveling Time 32%, Reduced Gas Emissions 40% and Reduced Accidents 90%*. C40 Cities, online publication.
[25] World Resources Institute (WRI). 2011. *A Compilation of Green Economy Policies, Programs, and Initiatives from Around the World*. Compiled for The Green Economy in Practice Interactive Workshop, 11 February 2011.

BICYCLE PATHS

Although the bicycle is a popular mode of transport in developed countries, it is not widely used as a daily means of transport in Latin American cities. Population and car ownership increases - with the resulting urban traffic congestion - have led to bicycles gaining popularity amongst the general public and the government.

Aside from individual cycle path projects, initiatives in partnership with BRT projects have also been proving successful in Latin America. One such example is the *CicloRuta* (Cycle Route) project launched alongside the Transmilenio in Bogota, Colombia in 2000. The *CicloRuta* initially promoted the use of bicycles on Sundays by closing the city's main roads to motorised traffic.[26] It has since expanded to include the construction of 344km of paths, with approximately 300km exclusively designated for cyclists, with some arguing it is one of the most comprehensive bicycle transport systems worldwide.[27] Approximately 83,000 cyclists use the lanes daily, primarily for traveling to school or work. Given the great success of the initiative, the city is now working on plans to expand the system.

In terms of energy efficiency, between 2000 and 2007, it is estimated that approximately 36.8 thousand tonnes of CO_2eq were mitigated thanks to the use of bicycles in the city (Table 3).

Table 3: Reduction in CO_2eq (tonnes) 2007 in Bogota through the use of *CicloRuta*, 2000-2007

YEAR	Reduction in Tonnes of CO_2EQ
2000	1,688
2001	3,622
2002	4,408
2003	4,834
2004	5,101
2005	5,284
2006	5,418
2007	6,449
CUMULATIVE	36,803

Source: C40. 2007. *Bogota's CicloRuta Is One of the Most Comprehensive Cycling Systems In the World*. C40, online publication.

ELECTRIC TAXIS

Another interesting transport option contributing to reductions in GHG emissions in Latin American cities is the adoption of electric taxis - automobiles powered entirely or partially by electricity. Through a partnership between C40 Cities, the Clinton Climate Initiative and the Bogota City Government, a pilot project was launched in 2012 to deploy 50 electric taxis in the city with the aim of reducing fuel consumption, principally petrol, reducing GHG emissions and other pollutants by 70%, and reducing air and noise pollution. To encourage the use of the electric taxis, the city government has implemented economic incentives, reducing tax rates, circulation restrictions and permitting requirements for electric car users (applicable to the pilot project taxis as well as privately-owned electric vehicles). It is hoped that these strategies will encourage taxi drivers to change from their old, fossil-fuel driven vehicles to the new, cleaner and more efficient technology.

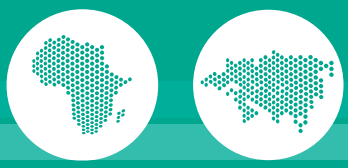
Mexico City also has electric taxis, launched via the *Zero Emission Taxis* system in 2011. This pilot project receives support from the Japanese company, Nissan, which provides the electric cars. There are 70 electric taxis in total in Mexico, with 20 located in the capital city.[28] Passengers and drivers have received this new system well, and many identified the change in the fuel use from fossil fuels to electric sources as a significant financial advantage.

These projects are still very new and therefore studies are required in order to determine whether intended goals are indeed being achieved. Nonetheless, the expected level of GHG mitigation from these projects is large. Thus, it is expected that the success of electric taxi projects in Latin American countries such as Colombia and Mexico will help encourage other cities to adopt similar transport technologies.

[26] This same strategy is being used in other Latin American cities such as Sao Paulo and Rio de Janeiro in Brazil.
[27] C40. (No publication date). *Bogota's CicloRuta Is One of the Most Comprehensive Cycling Systems In the World*. C40, online publication.
[28] The company itself estimates that about 3 tonnes of CO_2 emissions have been avoided, since that is what normal taxis would have emitted. That being said, there have been no external evaluations conducted so far, and these numbers are estimates from the company implementing the initiative. Nissan. 13 February 2013. *Nissan Mexicana Blazes the Path for a Zero Emissions Future*. Online publication.

CONTEXTUAL FACTORS

ENABLING SUCCESSFUL LATIN AMERICAN TRANSPORT APPROACHES



In the case studies presented in this Brief, preliminary results indicate that greener transport options are reducing GHG emissions, as well as having other social and economic impacts such as reducing traffic flow and improving citizens' overall wellbeing. Such successes result from extensive preparation carried out prior to the implementation of the new transport models, the commitment of public officials, and their capacity to undertake preliminary studies and design the systems accordingly. The interaction between the city and the transportation sector, as well as with other stakeholders, also proved to be key. The willingness to undertake public-private partnerships also underpinned the success of almost all of the initiatives presented.

Likewise, advanced planning is key to the success of projects in diverse urban contexts as it helps to ensure that any new transport projects are able to meet current and future transport needs and are integrated into broader city development plans. These are vital steps to ensure long-term sustainability and political commitment. Indeed, government support has been crucial for the success of the transport systems presented in this Brief. The ability to access the CDM mechanism and emissions credits provided an important incentive to public officials, as did the general climate of growing interest in emissions reductions in cities in Latin America and beyond.

Finally, regional and global networks of public officials and civil society also played a key role. And of course the spread of the BRT systems in particular was in many ways a result of the publicity and knowledge sharing that emerged after the onset of the initial experiences.

LESSONS LEARNED

1. The BRT system as implemented in Latin American has been shown to have relatively low implementation costs and be easier to construct than other large scale mass transport systems. It may therefore be the more feasible option for cities that are experiencing growth and expansion.

2. Although further research and evidence is required, preliminary results show that BRT systems, cycle paths and electric taxis are all helping cities to reduce GHG emissions, while also providing additional environmental, health and financial benefits. The use of alternative transport models is an important strategy for cities concerned with preparing for the future without sacrificing current growth.

3. The combination of the BRT system with other energy efficient options represents a significant opportunity for mitigating GHG emissions. Examples from the Latin America region that illustrate this potential include both the use of biofuels to power mass transport systems, and the parallel implementation of BRT and cycle path systems.

4. Changes to urban transport systems must be fine-tuned with city planning across all sectors, and particularly in relation to land-use plans. Transport system changes must also reflect social, economic and environmental priorities in order to provide benefits to different sectors, from urban inhabitants to the private sector.

CONACT SNN

To learn more about transportation and climate issues in Latin America, contact the author, Vivien Green Short Baptista, PhD candidate in the Energy Planning Program at COPPE/UFRJ and Researcher at the Interdisciplinary Laboratory for the Environment and the Brazilian Panel of Climate Change, at vivien.green@lima.coppe.ufrj.br.

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