Chapter Four

The Energy of Transportation: A Focus on Latin American Urban Transportation

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Latin America faces unique transportation challenges. As a developing region, Latin America's growth in oil demand and greenhouse gas (GHG) emissions is closely linked to economic growth. Latin America is largely a region of middle income countries, with sizeable and fast-growing middle classes that enjoy improving purchasing power. As a result, demand for private light-duty vehicles is mushrooming. Demand for heavy-duty vehicles used mainly to transport commercial goods is also growing as economies expand.

This contrasts sharply with developed countries like the United States and Europe where oil demand and emissions have peaked as populations are scarcely growing, most adults already own cars, and improved energy efficiency has led to declines in energy and emissions intensity. Latin America also contrasts with lower income regions, such as Africa, where much smaller portions of the population can afford private vehicles and car ownership is growing at a slower clip (see Chapter Five).

Latin America is also unique in its high rate of urbanization—some 80 percent of inhabitants live in cities. This reality exacerbates problems of congestion and air pollution, but it also creates opportunities to meet much of the population's need with public mass transit. Finally, Latin America also suffers from extremely weak fuel efficiency, vehicle emissions, and fuel quality standards and enforcement. As a result, each kilometer driven consumes more fuel and emits more pollutants than in countries with stronger regulation.

Addressing the transportation challenge requires an integrated approach. Firstly, Latin American countries need to stem the growth in demand for private cars by improving public transportation systems and non-motorized transportation options, such as cycling and walking. These solutions would also reduce the growing problem of traffic congestion. Many Latin American cities have seen great success in public transportation systems. The region pioneered the bus rapid transit (BRT) system and boasts the largest number

of BRT systems in the world. However, public transportation systems in Latin America are no longer adequate to meet the demands of passengers, and most cities have not done enough to promote alternative forms of transportation.

Secondly, Latin American countries urgently need to improve fuel efficiency and fuel quality. Experience from other countries, such as the United States, demonstrates that developing and implementing more stringent fuel economy standards can have the largest impact on reducing oil demand of any policy measure. In addition, Latin America is far behind the developed world in imposing fuel quality standards, which not only contributes to GHG emissions but also increases local air pollution, with detrimental effects on human health.

Thirdly, Latin American countries need to do more to diversify fuel sources for transportation. In the long term, it is most important to transition to electric vehicles (EVs), which provide the most viable pathway to zero emissions transportation. While some countries in the region have instituted policies and incentives to promote electric mobility, Latin America has a long way to go toward large-scale use of EVs, and EV markets are tiny compared to many in Europe, Asia, and the United States. Other lower carbon fuel sources, such as natural gas and biofuels, have helped to reduce emissions from the transportation sector in some Latin American countries, and there is potential to expand these markets.

This chapter analyzes the transportation challenge in Latin America and provides critical policy solutions. The chapter focuses on passenger road transportation because although freight transport is responsible for about half of Latin American road carbon emissions, there is more potential to reduce emissions from passenger transport. This is in part because Latin America's high urbanization rate, which is projected to reach almost 90 percent of the population in 2050,[1] makes it feasible for mass public and nonmotorized transportation to cover a large portion of the population's mobility needs. Indeed, urban population density is inversely correlated with GHG emissions from land transport.[2] In addition, there is great potential to expand

1. Comisión Económica para América Latina y el Caribe, "Estimaciones y proyecciones de población total, urbana y rural, y económicamente activa" (Revisión 2017) https://www.cepal.org/es/temas/proyecciones-demograficas/estimaciones-proyecciones-poblacion-total-urbana-rural-economicamente-activa (accessed September 29, 2017)

2. Ralph Sims, Roberto Schaeffer, Felix Creutzig, Xochitl Cruz-Núñez, Marcio D'Agosto, Delia Dimitriu, Maria Josefina Figueroa Meza, Lew Fulton, Shigeki Kobayash, Oliver Lah, Alan McKinnon, Peter Newman, Minggao Ouyang (China), James Jay Schauer (USA), Daniel Sperling, Geetam Tiwari, "Transport" in *Climate Change 2014: Mitigation of Climate*

electrification for passenger vehicles but current battery technology does not allow heavy-duty vehicles to travel the long distances needed for freight transport. Meanwhile, non-road transport—including marine, aviation, and rail—remains very limited making up only one quarter of the region's carbon emissions from transportation.

The Transportation Challenge in Latin America

A Rapidly Growing Vehicle Fleet

Latin America's vehicle fleet is growing rapidly—it is projected to triple in the next 25 years and grow to more than 200 million vehicles by 2050 (see Table 1).[3] The region also has the fastest growing motorization rate in the world—approximately 4.5 percent per year.[4] Since 2000, the motorization rate has almost doubled from 100 vehicles per 1000 inhabitants to 170 per 1000 inhabitants.[5]

Vehicle fleet growth in Latin America is more closely correlated with purchasing power and growing numbers of people entering the middle class than with population growth.[6] Between 2006 and 2016 the region's middle class almost doubled, from 99 million to 186 million people.[7] Historically, the vast majority of Latin Americans have relied on public transportation. Of the region's 570 million inhabitants, 200 million use public transportation on a

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Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change ed. Elizabeth Deakin and Suzana Kahn Ribeiro (Cambridge, United Kingdom and New York, NY, USA 2014), p. 619 https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ ipcc_wg3_ar5_chapter8.pdf (accessed September 28, 2017).

3. United Nations Environment Program, "Movilidad Eléctrica: Oportunidades para Latinoamérica" (October 10, 2016), p. 3 http://www.pnuma.org/cambio_climatico/publicaciones/informe_movilidad_electrica.pdf (accessed July 5, 2017).

4. "Regional Experiences to Keep Latin America Green and Growing," The World Bank Group, (June 26, 2013) http://www.worldbank.org/en/news/feature/2013/06/26/latin-america-green-growth (accessed July 5, 2017).

5. Walter Vergara, Jørgen Villy Fenhann, and Marco Christian Schletz, "Zero Carbon Latin America - A Pathway for Net Decarbonisation of the Regional Economy by Mid-Century," UNEP DTU Partnership (2015), p. 29 http://orbit.dtu.dk/files/123115955/Zero_Carbon_Latin_America_rev.pdf (accessed July 5, 2017).

6. Walter Vergara, Jørgen Villy Fenhann, and Marco Christian Schletz, "Zero Carbon Latin America - A Pathway for Net Decarbonisation of the Regional Economy by Mid-Century," UNEP DTU Partnership (2015), p. 70 http://orbit.dtu.dk/files/123115955/Zero_Carbon_Latin_America_rev.pdf (accessed July 5, 2017).

7. Suzanne Duryea and Marcos Robles, "Social Pulse in Latin America and the Caribbean 2016: Realities & Perspectives" Inter-American Development Bank (October 5, 2016), p. 15 (accessed July 10, 2017).

Table 1: Latin America's Vehicle Fleet

Country	Light-Duty Vehicle Fleet, 2015	Annual Rate of Light Vehicle Fleet Growth (%), 2010-2020	Heavy-Duty Vehicle Fleet, 2012	Total vehicles/1000 inhabitants, 2012
Brazil	30,708,965	4.2	7,619,436	383.8
Mexico	14,310,339	3.0	380,342	281.5
Argentina	10,387,029	3.4	593,476	279.1
Chile	2,907,383	5.2	201,531	226.0
Colombia	2,149,446	7.9	306,012	196.5
Venezuela	2,016,744	3.3	914,985	N/A
Peru	1,346,450	9.5	106,151	70.2
Dominican Republic	638,258	4.4	363,439	285.0
Costa Rica	518,407	5.3	195,784	237.2
Uruguay	498,828	4.5	53,762	502.9
Ecuador	413,303	3.8	128,874**	112.0
Panama	330,367	7.6	21,912	127.0
Bolivia	299,084	5.5	98,688	108.0
Paraguay	222,174	5.3	242,257**	166.1
El Salvador	212,753	4.4	61,046	94.0
Honduras	143,905	4.7	59,151*	134.2
Nicaragua	71,261	4.5	42,721	85.5

Source: United Nations Environment Program, 2016 Inter-American Development Bank "Freight Transport and Logistics" 2015. Note: Guatemala not included *Data corresponds to 2010 ** Data based on extrapolation from 2008-2011

daily basis.[8] The region also has the highest per capita bus use in the world.[9] Many cities in the region—like Bogotá, Medellín, Lima, and Quito—rely on public transportation for more than half of passenger trips in a typical workday and others—like Mexico City and Panama City—rely on public transportation for more than 70 percent of passenger trips in a typical workday.[10] By com-

8. Union Internationale des Transports Publics, "Metro Latin America—Prospects and Trends," (October 2016), p. 2 http://www.latinamerica.uitp.org/sites/default/files/Relat%C3%B3rio%20Metr%C3%B4s_UITP%20Am%C3%A9rica%20Latina_ENG.pdf (accessed July 18, 2017).

9. UNEP, "Movilidad Eléctrica," p. 10.

10. "Compare Systems Indicators," *Global BRT Data*, *BRTData.org* (2017) http://brtdata.org/panorama/systems (accessed July 15, 2017).

parison, private transportation makes up between 78 and 94 percent of passengers trips in a typical workday in Los Angeles and Miami, respectively, and public transport represents just 5 and 3 percent respectively.[11]

However, as the middle class continues to grow and larger numbers of people enjoy more purchasing power, motorization rates and the number of automobiles in circulation are climbing in cities across the region that are already facing serious urban congestion, emissions, and air quality problems. In Mexico City, the motorization rate grew from 308 vehicles to 593 vehicles per 1000 inhabitants between 2005 and 2015.[12] Over the same period, the number of registered vehicles in circulation nearly doubled to 4.9 million.[13] In 2030, Mexico and Brazil—the two largest automobile markets in the region—are projected to represent 5 percent of global light-duty vehicle sales.[14]

Freight transportation is another growing source of vehicles on the road. In Latin America, freight is dominated by diesel-fueled road transport due to insufficient infrastructure to move most goods by rail, air, and marine transport. The number of light, medium, and heavy-duty freight trucks in the region has grown rapidly over the past 15 years along with GDP. In addition to its growing stock of vehicles, Latin America's road freight fleet is also traveling more total kilometers every year as demand for freight transport increases. The region's total vehicle-kilometers—a unit measuring total annual distance covered by a given fleet—for road freight transport nearly doubled between 2000 and 2015.[15] The share of freight transport by rail in Latin America is very small but growing. Brazil, Mexico, and Colombia represent 90 percent of freight by rail in the region, and 62 percent of freight rail transport is dedicated to mining projects.[16] Freight transport by rail is

11. Vergara et al., "Zero Carbon Latin America," p. 28.

12. Instituto Nacional de Estadística y Geografía, "Transporte—Índice de Motorización por entidad federativa, 2000 a 2015," Dirección de Estadísticas del Medio Ambiente con base en: Dirección de Estadísticas (July 5, 2017) http://www3.inegi.org.mx/sistemas/sisept/default.aspx?t=mamb137&s=est&c=21690 (accessed July 12, 2017).

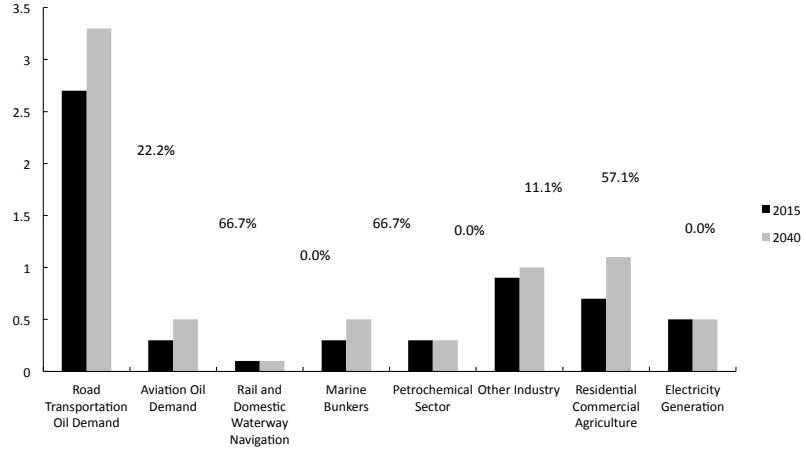
13. Instituto Nacional de Estadística y Geografía, "Transporte—Automóviles registrados en circulación por entidad federativa, 2005 a 2015," Estadísticas económicas: Estadística de vehículos de motor registrados en circulación (July 5, 2017) http://www3.inegi.org.mx/sistemas/sisept/default.aspx?t=mamb373&s=est&c=35939 (accessed July 12, 2017).

14. Global Fuel Economy Initiative, "Fuel Economy State of the World 2016—Time for global action" (2016), p. 34 https://www.globalfueleconomy.org/media/203446/gfei-state-of-the-world-report-2016.pdf (accessed July 10, 2017).

15. International Energy Agency, "The Future of Trucks—Implications for Energy and the Environment" (2017), p. 26https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheTheFutureof.pdf (accessed July 12, 2017).

16. Vergara et al., "Zero Carbon Latin America," p. 33.

Figure 1: Oil Demand by Subsector in Latin America and the Caribbean, 2015 & 2040



Source: Organization of Petroleum Exporting Countries.

much more carbon efficient than road-based freight transportation. Air transport is also used for small amounts of domestic freight transport, and the region's international freight transfers also include small percentages of air and marine transport.

Energy Demand for Transportation

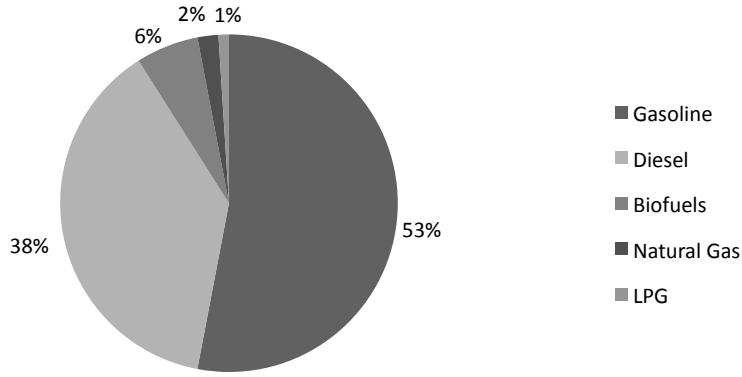
As the number of vehicles on the road grows, the demand for fuel grows as well. Globally, the transport sector is responsible for more than half of all oil demand and is growing more quickly than all other energy demand sectors, at about 2 percent per year.[17]

Latin America is the third fastest-growing region for oil demand after Asia and the Middle East, currently representing about 9.2 percent of the world total, or 9.2 million b/d.[18] Road transportation fuels, particularly gasoline and diesel, make up the lion's share of Latin American oil demand, with the Organization of Petroleum Exporting Countries (OPEC) projecting a 22 percent increase in Latin America between 2015 and 2040, compared to a

17. IEA, "The Future of Trucks" p. 11.

18. Barragan, Ricardo, "Latin America: Petroleum Product Demand Forecast" (September 13, 2017) https://stratasadvisors.com/Insights/091317-GRP-Petroleum-Demand-Latin-America (accessed September 29, 2017).

Figure 2: Breakdown of Fuels Used in the Transport Sector in Latin America and the Caribbean



Source: Vergara et al., "Zero Carbon Latin America," p. 34.

15 percent global average increase for this subsector. The aviation and marine bunker subsectors in Latin America will see even larger growth rates over the period but are starting from a very low base and will remain a relatively small source of oil demand (See Figure 1).[19]

Gasoline, the primary fuel used for passenger cars in Latin America, makes up the largest share of the region's transport sector fuels with 53 percent, followed by diesel, commonly used for freight trucks, with 38 percent, and smaller amounts of biofuels, natural gas, and liquid petroleum gas (see Figure 2).[20] Biofuels use is most ubiquitous in Brazil where it represents 17 percent of energy demand for transportation. [21] Gasoline demand in Brazil and Mexico alone represents almost 2 million b/d, or about 30 percent of regional refined product demand.[22] In countries like Colombia and Argentina,

19. Organization of the Petroleum Exporting Countries (OPEC), "2016 World Oil Outlook: Oil supply and demand Outlook to 2040" (2016) https://woo.opec.org/index.php/oil-supply-and-demand-outlook-2040/data-download (accessed September 28, 2017).

20. Enerdata (2015), cited in Vergara et al., "Zero Carbon Latin America," p. 34.

21. Olivia Brajterman, "Introdução de veículos elétricos e impactos sobre o setor energético brasileiro" (March 2016) http://www.ppe.ufrj.br/ppe/production/tesis/brajterman.pdf (accessed September 27, 2017).

22. Barragan, Ricardo, "Latin America: Petroleum Product Demand Forecast" (September 13, 2017) https://stratasadvisors.com/Insights/091317-GRP-Petroleum-Demand-Latin-America (accessed September 29, 2017).

liquid petroleum gas and compressed natural gas also supply an important part of transportation fuels.

Latin America imports a large share of its oil products due to inadequate refining capacity. In 2016, the region imported 730,000 b/d of middle distillate and 830,000 b/d of motor gasoline, half of which went to just three countries: Mexico, Colombia and Brazil.[23]

Impact on GHG Emissions, Pollution and Congestion

Booming oil demand is leading to higher emissions. Latin America overall still has low per capita emissions from the transport sector compared to developed countries due mainly to lower per capita car ownership, as most of the region's inhabitants continue to use public transportation. While Latin America has an average of almost 200 cars per 1,000 inhabitants, Europe and North America have 600 and 800 cars per 1,000 inhabitants, respectively.[24] But as private transportation use increases, so do emissions. The transport sector made up 15 percent of Latin America and the Caribbean's 2013 GHG emissions with 586.56 $MtCO_2e$—a 60 percent increase from a decade earlier.[25] As the largest countries in the region Brazil and Mexico have the highest transport-related emissions. However, Venezuela and Argentina, which each have smaller populations than Colombia, have higher emissions due to higher rates of car ownership and, particularly in the case of Venezuela, the use of less fuel-efficient cars (see Figure 3).

Transport sector carbon dioxide (CO_2) emissions are heavily concentrated in road transport (73 percent) with smaller amounts from international and domestic marine, and air transport, and just 1 percent from rail (see Figure 4).[26] Within road transport, freight and passenger transport are each responsible for about half of emissions. Heavy-duty trucks are particularly carbon intensive, contributing 28 percent of road emissions with only 2.5 million vehicles (see Table 2). In the passenger segment, private automobiles are

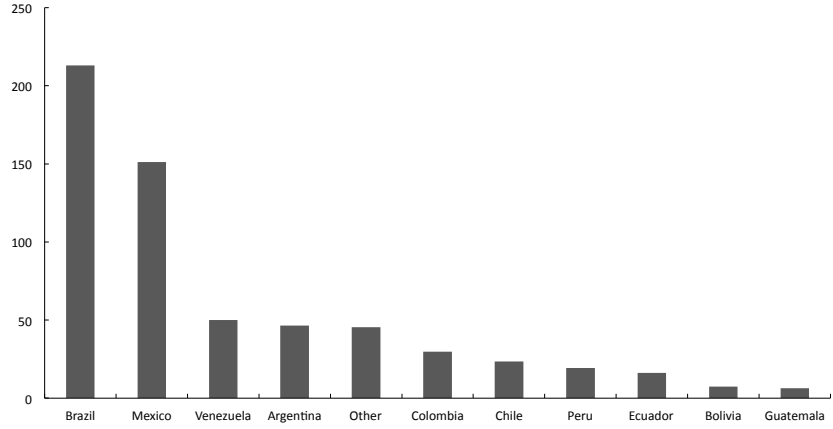
23. Barragan, Ricardo, "Latin America: Petroleum Product Demand Forecast" (September 13, 2017) https://stratasadvisors.com/Insights/091317-GRP-Petroleum-Demand-Latin-America (accessed September 29, 2017).

24. Vergara et al., "Zero Carbon Latin America," p. 29.

25. "CAIT Climate Data Explorer—Historical Emissions," *World Resources Institute* (2017) http://cait.wri.org/historical (accessed July 13, 2017). Note: Includes emissions from land use change. GHG emissions include carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).

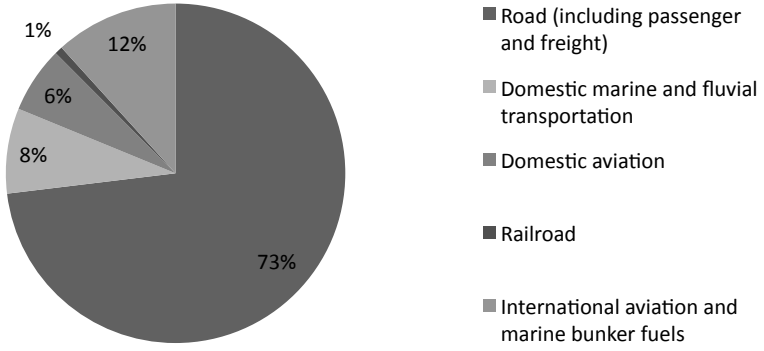
26. Vergara et al., "Zero Carbon Latin America," pp. 26–27.

Figure 3: Transportation Sector CO_2 Emissions from Fuel Combustion by Country, 2014 (mn tons)



Source: OECD/International Energy Agency, "World CO_2 Emissions from Fuel Combustion Database Documentation" (2016). Note: "Other " includes: Dominican Republic, Costa Rica, Paraguay, Panama, Uruguay, Honduras, Trinidad and Tobago, El Salvador, Nicaragua, Jamaica, Cuba, Haiti, Curaçao, Suriname and "other non-OECD Americas"

Figure 4: Latin America's CO_2 Emissions from the Transport Sector (2010)



Source: ANTF (2011), CAIT (2015), EPA (2015) and IEA (2015), cited in Vergara et al., "Zero Carbon Latin America," p. 27.

Table 2: Estimated size and emissions from the domestic road fleet in Latin America

Mode	Number of vehicles (millions)	Kilometers per year (thousands)	Fuel efficiency (kilometers per liter)	Metric tons of CO_2 equivalent ($MtCO_2e$)
Private autos	59.4	12	11	150
Taxis	2.2	60	11	27
Motorcycles	10.7	12		5
Standard buses	0.6	40	3.8	12
Articulated buses	0.02	60	3.8	1
Minibuses	1.0	40	2.8	33
Light trucks	5	13	3.2	47
Medium duty trucks	5.4	22	2.7	77
Heavy duty trucks	2.5	50	2.5	134
Total	86.8			486

Source: CAF (2010), CEPROEC (2015), Barbero (2014) and EPA (2015), cited in Vergara et al., "Zero Carbon Latin America," p. 27.

by far the largest source of emissions, while the region's bus fleet accounts for less than 10 percent of road transport emissions.

Left unchecked, emissions from the transport sector will increase dramatically. Globally, the transport sector is the fastest growing source of emissions, with a projected 70 percent increase by 2050.[27] In Latin America, emissions from the transport sector are projected to grow by 114 percent in a business-as-usual scenario by 2050, with total regional emissions reaching nearly 7 gigatons of CO_2 equivalent ($GtCO_2e$) by 2050 (see Table 3).[28] Although the region's transport sector emissions are growing from a smaller base, they are projected to grow more than 1.5 times as fast as global transport sector emissions.

27. UNEP, "Movilidad Eléctrica," p. 4.

28. Walter Vergara, Ana R. Rios, Galindo Paliza, Luis Miguel, Pablo Gutman, Paul Isbell, Paul Hugo Suding, and Jose Luis Samaniego, "El desafío climático y de desarrollo en América Latina y el Caribe: Opciones para un desarrollo resiliente al clima y bajo en carbono," Inter-American Development Bank (2013) pp. 14–15 https://publications.iadb.org/bitstream/handle/11319/456/Libro%20Final%20Dic%209%202014.pdf?sequence=4&isAllowed=y (accessed July 6, 2017).

Table 3: Projected business-as-usual emissions by sector,* Latin America and the Caribbean (Gt, %)

Sector	2010	2050	Percent change	Main cause(s)
Business as usual emissions trajectory	4.73	6.73	+42	
Electricity	0.24	0.54	+125	Carbonization
Industry	0.33	0.66	+100	Economic growth
Industrial Products	0.11	0.23	+109	Economic growth
Residential/Commercial	0.18	0.21	+17	Economic growth
Transport	0.56	1.2	+114	Motorization, urbanization
Land Use	1.6	0.67	-58	Decrease in deforestation
Total CO2 emissions	3.3	4.56	+38	Energy demand
CH4	1	1.5	+50	Livestock, agriculture
N2O	0.34	0.63	+85	Fertilizer use

*Vergara et al.'s business as usual scenario is based on the Latin America and the Caribbean regional projections in the International Institute for Applied Systems Analysis' (IIASA) Global Energy Assessment (GEA) Database. The BAU scenario is based on the GEA's MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact), which is a "hypothetical no-policy baseline describing the evolution of the energy system in the absence of any transformational policies for the demand- or supply-side of the energy system." Gt = gigaton.

Source: CAF (2010), CEPROEC (2015), Barbero (2014) and EPA (2015), cited in Vergara et al., "Zero Carbon Latin America," p. 47–49.

In addition to the global impacts of Latin America's transport emissions on climate change, pollution from vehicles also causes severe health problems for local populations, particularly in urban areas. Many Latin American cities regularly declare emergency levels of pollution. Smog—visible air pollution created when emissions combine with atmospheric conditions like sunlight and heat—is prevalent in cities across the region like Mexico City, where 90 percent of the city's smog comes from the transportation sector.[29] Mexico's *Hoy no circula* program limits the days and hours vehicles in Mexico City and the neighboring State of Mexico can be on the road based

29. Institute for Transportation and Development Policy, "Sustainable Transport—Santiago, Chile, Putting Pedestrians First," (Winter 2017) N. 28, p. 4 https://3gozaa3xxbpb499ejp30lxc8-wpengine.netdna-ssl.com/wp-content/uploads/2017/01/ST28.12.28.pdf (accessed July 14, 2017).

on each vehicle's emissions level. In April 2016, smog in the city reached its highest levels in decades, requiring emergency measures to further restrict vehicles. Santiago has a similar program, which restricts vehicles on a rotating basis based on the last digit of their license plates. Santiago also has a serious air quality problem and frequently issues advisories at the "alert," "pre-emergency," and "emergency" levels. The transport sector contributes more than a third of Santiago's GHG emissions and 40 percent of its pollution.[30] On an annual basis, according to Plume Labs' index, Santiago has an average of 119 days with moderate pollution, 135 with high pollution, 88 with very high pollution, 6 with excessive pollution, and just 16 with fresh air.[31] Certain vehicles in each city—like electric and hybrid vehicles—are exempt from such restrictions. São Paulo, Bogotá, and Quito also have similar programs.

The amount and type of pollution each vehicle emits depends on both its vehicle emissions standard and the fuel it uses. Compared to gasoline, diesel provides better fuel economy and lower overall GHG emissions.[32] But diesel emits more nitrogen oxides (NO_x) and particulate matter, two important contributors to smog formation. Diesel-powered vehicles also emit more black carbon than gasoline vehicles, though both are a significant source of the pollutant.

Air pollution—largely from the transport sector—has important and costly impacts on human health, such as increased risk of stroke, heart disease, chronic and acute respiratory diseases like asthma, and lung cancer. Emissions from the transport sector include both long-lived climate pollutants like CO_2 and short-lived climate pollutants like black carbon and ozone. While long-lived climate pollutants are more often the target of national emissions reductions goals and policies because of their role in longer-term climate change, short-lived climate pollutants have more immediate impacts on human health.

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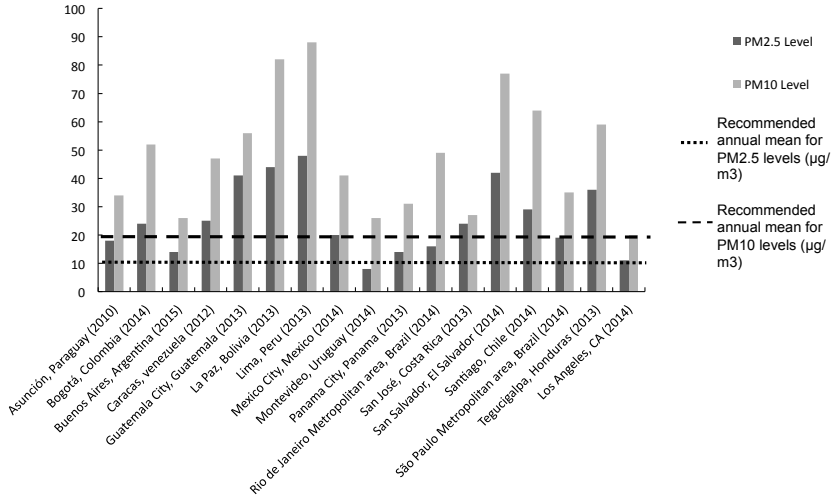
30. Camila Albertini, "Amplían Etiquetado de Eficiencia Energética a Vehículos Comerciales, Eléctricos e Híbridos," *Publimetro Chile* (June 28, 2017) https://www.publimetro.cl/cl/noticias/2017/06/28/autos-mas-eficientes-segun-etiquetado.html (accessed July 18, 2017).

31. "Live Pollution and Air Quality Forecasts," *Santiago Air Report*, *Plume Labs* (2017) https://air.plumelabs.com/en/year/santiago (accessed July 18, 2017).

32. Thomas Klier and Joshua Linn, "Comparing US and EU Approaches to Regulating Automotive Emissions and Fuel Economy," Policy Brief No. 16-03, Resources for the Future (April 2016), p. 2 http://www.rff.org/files/document/file/RFF-PB-16-03.pdf (accessed July 14, 2017).

Figure 5: Ambient Air Quality Levels & Guidelines



Source: "Global Ambient Air Pollution," *World Health Organization* (2017) http://maps.who.int/airpollution/ (accessed July 19, 2017).

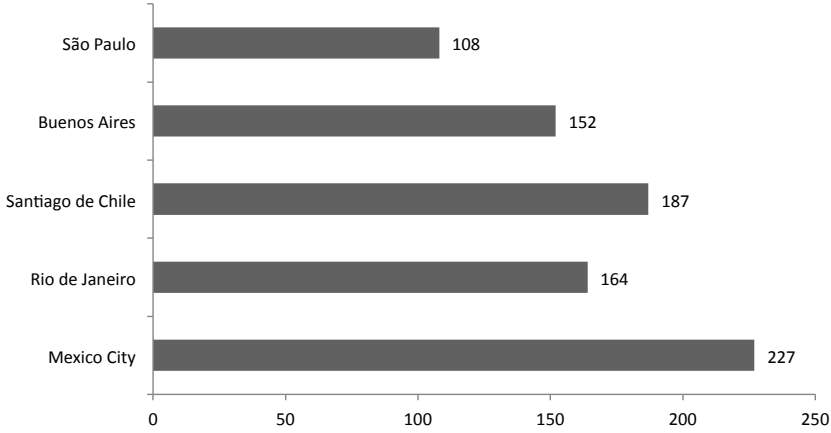
A recent United Nations Environment Program (UNEP) report estimates that air pollution causes at least 50,000 premature deaths per year in Latin America.[33] Almost every capital city in Latin America exceeds the recommended annual limits for $PM_{2.5}$ and PM_{10} emissions (see Figure 5). Air pollution also imposes enormous monetary costs on Latin American economies; UNEP estimates that Mexico alone spends US$40 billion in pollution-related health costs, half of which can be directly attributed to the transport sector.[34]

Reducing short-lived climate pollutants from the transport sector can be a particularly attractive public policy option, as it can improve local health outcomes with direct benefits for communities while contributing to achieving national climate commitments. Stricter fuel efficiency and vehicle emissions standards, for example, reduce short-lived climate pollutants, improving air quality with associated health benefits while lowering CO_2 levels. Mexico's 2013 fuel economy standards are expected to yield more

33. UNEP, "Movilidad Eléctrica," p. 3; World Health Organization, "Reducing Global Health Risks through Mitigation of Short-Lived Climate Pollutants—Scoping Report for Policymakers" (2015), p. 1 http://www.who.int/phe/publications/climate-reducing-health-risks/en/ (accessed July 11, 2017)

34. UNEP, "Movilidad Eléctrica," p. 3.

Figure 6: Extra Hours per Year Spent in Traffic (based on 230 days of commuting)



Source: "TomTom Traffic Index," *TomTom International BV* (2017) https://www.tomtom.com/en_gb/trafficindex/ (accessed July 15, 2017).

than US$2 billion in cost savings from health benefits by 2032.[35] Increased use of mass transportation also has similar co-benefits. Fuel quality improvements—like ultra-low-sulfur diesel use with diesel particle filters—have an important impact on short-lived climate pollutants and improve air quality, but do not have the associated CO_2 reduction benefit.

Latin America's transportation challenge is in many ways exacerbated by high levels of urbanization. In some countries—like Brazil, Venezuela, Chile, and Argentina—the percentage of the population living in cities is even higher than the regional average of 80 percent. 67 cities in the region are home to more than one million inhabitants, with many more expected to surpass this threshold in the next decade.[36] As a result of this population density and insufficient infrastructure to support it, many of the region's cities are extremely congested, with commuters spending hours sitting in traffic every day (See Figure 6). Mexico City and Bogotá often rank among the most congested cities in the world.

35. International Council on Clean Transportation, "Policy Update: Mexico's LDV CO_2 and Fuel Economy Standards," (July 2013), p. 3 http://www.theicct.org/sites/default/files/publications/ICCTupdate_Mexico_LDVstandards_july2013.pdf (accessed July 18, 2017).

36. United Nations, "The World's Cities in 2016: Data Booklet," (2016), p. 5 http://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf (accessed July 18, 2017).

Weak Standards and Enforcement

Latin America has very weak standards for vehicle emissions, fuel quality, and fuel economy, meaning that each vehicle has higher levels of emissions than the average vehicle in developed countries, which generally have stricter standards. Mexico is currently the only country in Latin America with mandatory fuel economy regulations in place. Approximately 83 percent of the global car market had fuel economy regulations in place as of 2016, but the remaining 17 percent of the market is largely in Latin America and Southeast Asia, regions expected to see some of the most rapid growth in car ownership in the coming years.[37]

Fuel economy regulations create standards for manufacturers on how efficiently vehicle fleets must use fuel. Countries can apply standards per vehicle or per manufacturer (or both), though manufacturer level standards are most common worldwide. For example, the newest Corporate Average Fuel Economy (CAFE) Standards in the United States—released in November 2016—established a minimum fleet-wide average fuel economy of 36 miles per gallon for all cars and light trucks by 2025.[38] Mexico's standards, first published in 2013 for vehicle model years 2014-2016, are based on the United States' CAFE standards but are slightly less stringent—requiring 1 percent less efficiency for cars and 2 percent less for light trucks—with an average fuel economy of 14.6 kilometers/liter.[39] Though the establishment of these standards is an important step, weak enforcement mechanisms that rely on self-reporting from manufacturers limit their impact.

Though no other country in the region has mandatory fuel economy standards in place, Brazil and Chile have economic incentives to encourage consumers to purchase more efficient vehicles. In 2013, Chile instituted a mandatory labeling system—the first of its kind in the region—to provide consumers with more information about city and highway vehicle mileage as well as CO_2 emissions. In 2014, Chile instituted an even stronger incentive: a progressive tax on new vehicle purchases calculated in relation to fuel efficiency and NO_x emissions. Brazil's INOVAR AUTO program, approved in 2012, incentivizes the production of more fuel-efficient vehicles by providing a 30 percent reduction on Brazil's IPI tax on industrialized products.

37. GFEI, "Fuel Economy State of the World 2016," p. 31.

38. Ben Wolfgang, "EPA Locks in Fuel Economy Standards through 2025, Calls for 36 Miles per Gallon," *The Washington Times,* January 13, 2017 http://www.washingtontimes.com/news/2017/jan/13/epa-locks-fuel-economy-standards-through-2025/ (accessed July 11, 2017).

39. ICCT, "Policy Update," p. 1.

Table 4: Emissions Standards in Latin America

Country	Light-duty vehicles	Heavy-duty vehicles
Chile	Euro 5	Euro V
Argentina	Euro 5	Euro V
Mexico	Euro 4	Euro IV
Colombia	Euro 4	Euro IV
Peru	Euro 3	Euro III
Uruguay	Euro 3	Euro III
Ecuador	Euro 1	Euro II
Costa Rica	Euro 1	Euro I

Source: Natural Resource Defense Council, 2014 United Nations Environment Program, "Status of Fuel Quality and Vehicle Emission Standards—Latin America and the Caribbean," (November 2016), http://staging.unep.org/transport/New/PCFV/pdf/Maps_Matrices/LAC/matrix/LAC_FuelsVeh_November2016.pdf (accessed July 18, 2017) "Propuesta para actualización de normas de emisión para vehículos pesados en la región latinoamericana," Centro Mario Molina Chile (April 27, 2017) http://portal.mma.gob.cl/wp-content/uploads/2016/11/Gianni-Lopez-Recomendaciones-para-avanzar-con-la-normativa-de-vehiculos-pesados-en-la-region-latinoamericana.pdf (accessed July 18, 2017) Natural Resource Defense Council, "Dumping Dirty Diesels in Latin America: Reducing Black Carbon and Air Pollution from Diesel Engines in Latin American Countries," (November 2014), p. 9 https://www.nrdc.org/sites/default/files/latin-america-diesel-pollution-report.pdf (accessed July 18, 2017).

Many countries in the region have standards regulating vehicle emissions of local air pollutants, but these are also lagging. Instead of regulating how efficiently cars must run, vehicle emissions standards regulate maximum amounts of pollutants—like CO_2, particulate matter, and NO_x—that are permitted in tailpipe emissions from diesel and gasoline vehicles. Chile and Argentina have the most ambitious emissions standards in place, but none of the countries in the region have implemented Euro 6/VI standards[40]—the most recent of the European Union emissions standards, which are used to measure vehicle emissions in many parts of the world (See Table 4). Successive Euro emissions standards permit lower amounts of CO_2, NO_x, and particulate matter. Many countries in the region are considering stricter standards, and some already have stricter sub-national regulations to combat air

40. Light-duty vehicle emissions standards are generally referred to with Arabic numerals, while heavy-duty vehicle emissions standards are generally referred to with Roman numerals.

pollution. For example, Santiago mandates Euro VI standards for heavy-duty vehicles.

Fuel quality standards are closely linked to vehicle emissions standards. At both a global and regional level, fuel quality regulations for diesel and gasoline focus on lowering sulfur content, which generally requires refinery upgrades. To a lesser extent, other gasoline regulations focus on octane, benzene, aromatics and olefins and other diesel regulations focus on cetane, density, lubricity, polyaromatics and cold flow. In Latin America, existing and planned sulfur content regulations vary widely for both gasoline and diesel. Chile and Ecuador are currently the most ambitious, with restrictions allowing only 0-10 parts per million (ppm) of sulfur in gasoline and 10-15ppm of sulfur in diesel. Venezuela and Peru are among the least stringent, allowing 501-2500ppm in gasoline and >2000ppm in diesel.[41]

Used car imports are still prevalent throughout the region, exacerbating the problem of low fuel economy and vehicle emissions standards. A growing number of countries—Argentina (with some exceptions), Brazil, Chile, Colombia, Ecuador, Uruguay, and Venezuela—have banned the practice, but others have much less stringent restrictions on used car imports, or none at all.

Latin America's truck fleet is also very old and, as a result, has low fuel efficiency and fuel economy standards and high levels of emissions. Chile has the youngest truck fleet in the region, with an average age of 10 years, while Nicaragua has the oldest, with an average age of 23 years.[42] Because of limited access to finance, developing countries typically have lower levels of truck scrappage, or removal of the oldest vehicles from the fleet, though rapid increases in sales in recent years have driven down the average fleet age.

Clean Transport Pathways in Latin America

Climate Commitments for the Transport Sector

The Paris Agreement, adopted in December 2015 at the 21st United Nations Framework Convention on Climate Change (UNFCCC) conference of the parties (COP21), is the most ambitious global pact to limit GHG emis-

41. Stratas Advisors, "Global Fuel Quality Developments," (June 6–7, 2016), pp. 11 and 15 http://staging.unep.org/Transport/new/PCFV/pdf/11gpm/11gpm_PCFV_HuimingLi.pdf (accessed July 18, 2017).

42. "Freight Transport and Logistics Statistics Yearbook," *Inter-American Development Bank* (April, 2015) https://publications.iadb.org/handle/11319/6885 (accessed July 18, 2017).

sions to date. The agreement, which had been signed by 195 countries and ratified by 166 as of September 2017, establishes the goal of limiting the increase in global average temperature to "well below 2 degrees Celsius (2°C) above pre-industrial levels and [pursuing] efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."[43] Though the agreement itself notes that even if every country fulfilled its non-binding nationally determined contribution (NDC) warming would still exceed 2°C, the NDCs are meant to be evaluated and intensified every five years. Notably, the agreement also established a minimum US$100 billion/year goal in climate finance for developing countries.

As a region, Latin America is extremely supportive of efforts to combat climate change. Three quarters of Latin American citizens—more than in most parts of the world—consider climate change to be a very serious problem that is now harming people.[44] Of the Latin American countries that signed the accord, 15 of 18 have already ratified it. The region's NDCs are relatively ambitious, pledging to reduce emissions across all sectors through a wide array of measures, including increasing renewable energy generation, expanding energy efficiency, reducing deforestation, and introducing cleaner forms of transportation. However, only Costa Rica's NDC ranks as "2°C compatible", according to the Climate Action Tracker.[45] Brazil, Mexico and Peru's NDCs are considered "insufficient," or inconsistent with limiting global warming below 2°C as they would require comparably greater reductions on the part of other countries, while Argentina's NDC is ranked as "highly insufficient" and Chile's is "critically insufficient."[46]

The transport sector receives specific mention in almost every one of Latin America's NDCs—proposed measures include the establishment of

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43. United Nations Framework Convention on Climate Change, "Adoption of the Paris Agreement," (November–December 2015), p. 21 https://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf (accessed September 27, 2017).

44. Bruce Stokes, Richard Wike and Jill Carle, "Global Concern about Climate Change, Broad Support for Limiting Emissions—U.S., China Less Worried; Partisan Divides in Key Countries," *Pew Research Center—Global Attitudes and Trends* (November 5, 2015) http://www.pewglobal.org/2015/11/05/global-concern-about-climate-change-broad-support-for-limiting-emissions/# (accessed July 15, 2017).

45. "Climate Action Tracker," *Climate Action Tracker Partners* (2017) http://climateactiontracker.org/countries.html (accessed September 28, 2017).

46. Ibid. Note: The Climate Action Tracker rates (I)NDCs, long-term targets and current policies against whether they are consistent with a country's fair share effort to achieve the Paris Agreement 1.5°C temperature goal. For more detail on methodology, see: http://climateactiontracker.org/methodology.html.

taxes on vehicle imports, incentives for purchasing electric and hybrid vehicles and using cleaner fuels, and transportation network planning. For example, Chile highlights the contribution of diesel-fueled transport to black carbon and $PM_{2.5}$ emissions in Chilean cities as a priority for mitigation in its NDC. Guatemala includes creating fiscal incentives and subsidies focused on clean energy use in public and private transport as one of its intended mitigation actions.

The transport sector is also the focus of many nationally appropriate mitigation actions (NAMAs). Also part of the UNFCCC framework, NAMAs are policy instruments or implementation tools that translate goals into country-specific action plans. In Brazil, the city of Belo Horizonte has a Comprehensive Mobility Plan NAMA–*planmobBH*—which focuses on creating a more sustainable urban transportation system. The NAMA includes plans to improve public transportation, fare integration, and infrastructure for the promotion of non-motorized transportation across the metro area. This would lead to a cumulative estimated GHG emissions savings of 9 $MtCO_2e$ between 2008 and 2030, a 39 percent reduction in particulate matter by 2030, and a 50 percent reduction in travel time by 2030.[47] In Peru's TRANSPerú Sustainable Urban Transport NAMA—which is expected to reduce GHG emissions by 5.6 to 9.9 $MtCO_2e$ between 2016 and 2025—focuses on developing better fuel economy standards and fuel efficiency standards for light vehicles, developing integrated public mass transport systems, modernizing the public transport fleet, improving urban transport management, and improving non-motorized transportation in Lima and Callao.[48] One of Mexico's NAMAs focuses on the renewal of its car fleet, with the goal of reducing the average age of the country's fleet from 14.8 years to 11.2 years by substituting 500,000 vehicles aged 15 years or older.[49] The NAMA is expected to reduce GHG emissions by 2.63 $MtCO_2e$ per year.[50]

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47. Transport NAMA Database, "Comprehensive mobility plan for Belo Horizonte (Brazil)," *GIZ* (2010) http://www.transport-namadatabase.org/comprehensive-mobility-plan-for-belo-horizonte-brasil/ (accessed July 18, 2017).

48. Deutsche Gesellschaft für Internationale Zusammenarbeit, "TRANSPerú—Sustainable Urban Transport NAMA Peru," (2015), p. 48 http://transferproject.org/wp-content/uploads/2015/12/GIZ-TRANSfer_Full-NAMA-Concept-Doc-TRANSPeru-EN-online.pdf (accessed July 18, 2017).

49. Transport NAMA Database, "Car fleet renewal in Mexico," *GIZ* (2014) http://www.transport-namadatabase.org/car-fleet-renewal-in-mexico-2/ (accessed July 18, 2017).

50. United Nations Framework Convention on Climate Change, "NS-162 - Car Fleet Renewal in Mexico," Public NAMA (2014) http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/NamaSeekingSupportForPreparation.aspx?ID=95&viewOnly=1 (accessed July 27, 2017).

Globally, the transport sector receives specific mention in three quarters of NDCs.[51] In order to limit warming to 2°C by 2025, projections from the International Energy Agency (IEA) indicate 23 percent of reductions must come from the transport sector.[52] At a global level, the costs of meeting additional demand under a 2 degree Celsius scenario can actually be lower than under a 6 degree Celsius business-as-usual scenario, according to the IEA.[53] Urban areas are the focus of most emissions reductions measures, as they can deliver 40 percent of emissions reductions from the transport sector under the 2 degree Celsius scenario.[54]

Reducing emissions from the transport sector requires an integrated approach that combines increasing the use of mass public transportation and non-motorized transportation, improving energy efficiency and vehicle technology, and using cleaner or zero-carbon fuels. These same three approaches should be applied to Latin America to reduce GHG emissions. Many of these measures will also generate improvements in air pollution, human health, and urban congestion.

Increasing the Use of Mass Public Transportation and Non-Motorized Transportation

As Latin America looks to meet increasing demand for transportation while reducing emissions, expanding mass public transportation and non-motorized transportation is crucial. The region's public transportation systems already move large numbers of people every day, but additional investment to expand and improve existing infrastructure is necessary to meet growing demand, provide a practical and convenient alternative to private transportation, and reduce emissions. Latin America's population is

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51. Ernesto Monter, "Supporting Decarbonization Efforts in the Transport Sector in Latin America and the Caribbean," presented at *Energy and Transportation in the Atlantic Basin, Jean Monnet Network on Atlantic Studies* (July 20, 2017) http://jeanmonnetnetwork.com.br/wp-content/uploads/2017/08/Ernesto-Monter-Supporting-Decarbonization-Efforts-in-LAC-Transportation-Sectors.pdf.

52. International Energy Agency, "Energy Technology Perspectives 2015—Mobilising Innovation to Accelerate Climate Action," (2015), p. 73 http://www.iea.org/publications/freepublications/publication/ETP2015.pdf (accessed July 21, 2017).

53. International Energy Agency, "Energy Technology Perspectives 2016—Towards Sustainable Urban Energy Systems, Executive Summary" (2016), p. 3 https://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2016_ExecutiveSummary_EnglishVersion.pdf (accessed July 27, 2017).

54. Ibid., pp. 7–8.

Table 5: Bus Rapid Transit Statistics by Region

Regions	Passengers per Day	Number of Cities
Africa	468,178 (1.46%)	4 (2.43%)
Asia	9,293,372 (29%)	42 (25.6%)
Europe	1,566,580 (4.88%)	44 (26.82%)
Latin America	19,470,072 (60.75%)	54 (32.92%)
Northern America	810,513 (2.52%)	16 (9.75%)
Oceania	436,200 (1.36%)	4 (2.43%)
Total	32,044,915	164

Source: "Compare Systems Indicators," Global BRT Data, BRTData.org (2017) http://brtdata.org/panorama/systems (accessed September 27, 2017).

projected to grow by 23.6 percent between 2015 and 2050[55], adding to demand for both public and private transportation.

Bus Rapid Transit (BRT)

BRT systems are one of the most important forms of public transportation in the region. These systems combine dedicated lanes for bus transportation with off-board fare collection to provide quick and effective mass transportation, but require a much smaller infrastructure investment than metro or urban rail systems. BRTs in Latin America move almost 20 million passengers per day across 54 cities—60.75 percent of the daily worldwide BRT passenger total (see Table 5).[56]

Many of Latin America's BRT systems are among the most advanced in the world. Belo Horizonte's MOVE and Bogotá's TransMilenio, for example, are reference points for international best practices in the Institute for Transportation and Development Policy's BRT Standard, which evaluates systems based on criteria like frequency of service, corridor location, and integration with other forms of public transportation.[57] Belo Horizonte's MOVE BRT—which received the highest "gold" classification—provides high capacity service along high demand corridors and makes good use of scarce space

55. The World Bank, "Population Dashboard" in *Health, Nutrition and Population* (2015) http://datatopics.worldbank.org/health/population (accessed September 27, 2017).

56. "Compare Systems Indicators," Global BRT Data, BRTData.org (2017) http://brtdata.org/panorama/systems (accessed September 27, 2017).

57. "About the BRT Standard," *Institute for Transportation and Development Policy* (2016) https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/about-the-brt-standard/ (accessed July 14, 2017).

in the city center. Bogotá's TransMilenio—also classified as "gold"—has been among the most successful BRT systems, moving passengers equal to or better than many metro systems. BRT corridors in Curitiba, Rio de Janeiro, Medellín, Guadalajara, and Lima also received the premier "gold" score. However, many of these systems suffer from overcrowding and need to increase the network and service frequency and introduce off-board fare collection and express service.

In addition to these improvements to existing BRTs, there is appetite for new BRT corridors in the region. Though the rate of urbanization in Latin American cities has slowed, urban populations are still growing every year, putting additional stress on already heavily strained urban transportation systems. The region's Rapid Transit to Resident Ratios (RTR)—an Institute for Transportation and Development Policy metric which compares the length of rapid transit lines (metro, rail, and BRT) with a country's urban population (a higher RTR indicates more kilometers of transit per urban resident)—are still relatively low. Chile and Ecuador have the highest RTRs in the region (between 20 and 30).[58] Between 2004 and 2014, Brazil's RTR increased from 8.3 to 10.7, as rapid transit growth outpaced urban population growth and Colombia's RTR grew from 0 to 10.1 between 1994 and 2014. Mexico also saw important RTR growth from about 5.5 to 8.4 over the same period.[59] The rest of the region has an RTR of less than 10. By comparison, the United States' RTR is 14.3 and Germany's is 81.6.

In addition to reducing GHG emissions from the transport sector, the introduction of BRT systems has also been shown to improve road safety and air quality. In TransMilenio's first two years of operation, traffic collisions, pedestrian accidents, and related deaths along Bogotá's main BRT corridor fell by 94 percent.[60] In the year after TransMilenio was rolled out, Bogotá also saw a 44 percent reduction in sulfur dioxide, a 24 percent reduction in PM_{10}, and a 7 percent reduction in NO_2.[61]

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58. "Infographic: Rapid Transit to Resident Ratio (RTR)," *Institute for Transportation and Development Policy* (January 29, 2016) https://www.itdp.org/wp-content/uploads/2016/01/2015-itdp-infographic-spread-1206.pdf (accessed July 19, 2017).

59. Walter Hook, Colin Hughes and Jacob Mason, "Best Practice in National Support for Urban Transportation," *Institute for Transportation and Development Policy* (February 2015), p. 5-6 https://3gozaa3xxbpb499ejp30lxc8-wpengine.netdna-ssl.com/wp-content/uploads/2014/05/Best-Practices-in-National-Support-for-Urban-Transport_ITDP.pdf (accessed September 29, 2017).

60. "C40 Cities in Action: How Bike-Share and BRT Are Accelerating across the World," Sustainability Management Capstone, Earth Institute, Columbia University (2013), p. 10 http://sustainability.ei.columbia.edu/files/2014/01/C40-CITIES-IN-ACTION_Fall-2013-.pdf (accessed July 19, 2017).

61. Ibid., p. 39

Latin American countries are working on developing and rolling out a number of new BRT systems in the coming years. BRT Transbrasil will be Rio de Janeiro's fourth BRT, adding 28 stations, 4 terminals and 15 pedestrian walkways spanning 32 kilometers at a cost of US$416 million.[62] The Transbrasil corridor will be integrated into the city's Transcarioca bus system and will serve about 900,000 passengers per day. Asunción, Paraguay is developing an 18.4 kilometer BRT system, which will connect the capital with the cities of Fernando de la Mora and San Lorenzo. The system—financed with a loan from the Inter-American Development Bank—includes 26 stations and electric-powered buses with an estimated cost of US$167 million and will have a capacity of 300,000 passengers per day.[63]

Metro and Light Rail Systems

A number of cities in the region also rely heavily on metro systems, which carry 20 million people per day in 22 cities across ten countries.[64] Mexico City's metro system ranks among the ten largest in the world and serves approximately 6 million passengers per day—almost one third of the city's metro area population.[65] São Paulo's metro system, the second largest, moves more than 4.5 million passengers per day.[66] Santiago and Caracas also see both high volumes and high rates of metro use. By 2021, the region's metro ridership is expected to grow by almost 5 million passengers per day.[67]

Latin American countries are working to build new metro systems and expand existing metro and light rail systems. Quito is in the process of building its first metro line, which will cover 23 kilometers and include 15 stations, 6 of which will be connected to the existing bus network. The project—which will have a 369,000 passenger per day capacity—will cost an estimated US$1.7 billion and will save US$14 million per year in fuel costs.[68] Lima's Metro Line 2, an ongoing project with an estimated cost of US$5.8 billion, will include 35 kilometers of new urban rail and will integrate with the city's

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62. "BRT Transbrasil," *Business News Americas*, 2017 https://www.bnamericas.com/project-profile/en/btr-transbrasil-btr-transbrasil (accessed July 21, 2017).

63. "Bus rapid transit (BRT) Metrobus Asunción stretches No. 2 and No. 3," *Business News Americas*, 2017 https://www.bnamericas.com/project-profile/en/btr-transbrasil-btr-transbrasil (accessed July 21, 2017).

64. UITP, "Metro Latin America," p. 2.

65. "Subways," *Metropolitan Transportation Authority* (2017) http://web.mta.info/nyct/facts/ ffsubway.htm (accessed July 11, 2017); UITP, "Metro Latin America," pp. 1–2.

66. UITP, "Metro Latin America," pp. 1–2.

67. Ibid., p. 5.

68. "Quito Metro Line 1," *The World Bank Group* (2017) http://projects.worldbank.org/P144489/ecuador-quito-metro-line-one?lang=en&tab=overview (accessed July 21, 2017).

existing Line 1 and BRT system, reducing public transport travel times for passengers by up to 75 minutes.[69] São Paulo, Santiago, and Panama City are also in the process of adding lines to their existing metro systems.

When building new mass transit systems, cities have many factors to consider. BRT systems are much less costly to build than metro and light rail systems and take less time to implement; they can generally be deployed in five years or less, while metro systems can take decades. But metro and light rail systems can carry more passengers—typically 35,000 per hour per direction compared to 2,000-10,000 on BRT—and have a lower per-passenger operation and maintenance cost.[70] Rail systems are also generally entirely electric, which provides an advantage in terms of emissions reductions, especially in Latin America where electricity is largely generated from hydropower.

Non-Motorized Transport

In addition, increasing access to and convenience of non-motorized transport is an important part of sustainable urban mobility plans. Many cities in the region have made important investments in this space in recent years. When compared to other forms of transportation, cycling infrastructure and bicycle-sharing programs are much less costly, require less space, have no emissions, and can be deployed in a matter of months. Bicycle-sharing programs range in cost from less than US$5 million in cities like in Toronto, Portland and Istanbul to US$40 million in New York City and US$140 million in Paris.[71]

More than 12 cities in Latin America have adopted bicycle-sharing programs in recent years, including Mexico City, Rio de Janeiro, São Paulo, and Buenos Aires.[72] Mexico's ECOBICI program is very popular and demand is growing quickly. The program began operation in February 2010 with 84 stations and 1,200 bicycles and by 2016 had grown to 452 stations and more than 6,000 bicycles.[73] The program regularly sees more than

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69. "Peru Lima Metro Line 2 Project," *The World Bank Group* (2017) http://projects.worldbank.org/P145610?lang=en (accessed July 21, 2017).

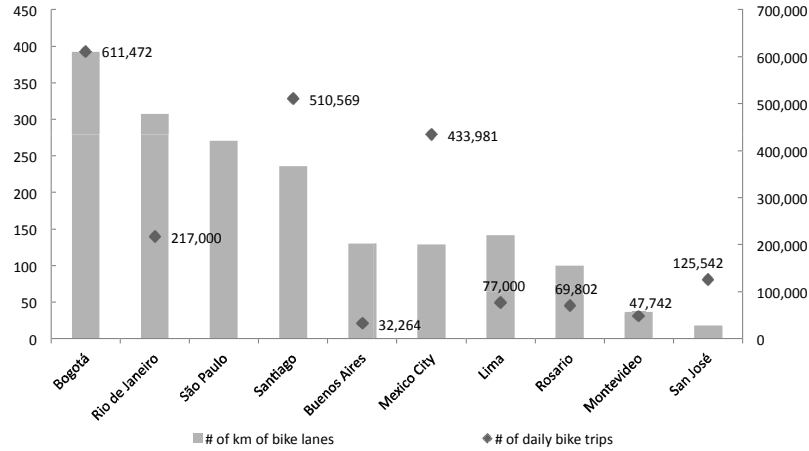
70. Jacques Drouin, "Why Latin America's Urban Transport Is on Track," *World Economic Forum* (May 6, 2015) https://www.weforum.org/agenda/2015/05/why-latin-americas-urban-transport-is-on-track/ (accessed July 21, 2017).

71. "C40 Cities in Action," Columbia University, p. 9.

72. "Cycling Gains Ground on Latin American Streets," *The World Bank Group* (June 24, 2015) http://www.worldbank.org/en/news/feature/2015/06/24/el-pedaleo-gana-espacio-en-las-calles-latinoamericanas (accessed July 21, 2017).

73. "¿Qué es ECOBICI?" *CMS CDMX, Oficialía Mayor de la Ciudad de México* (2016) https://www.ecobici.cdmx.gob.mx/es/informacion-del-servicio/que-es-ecobici (accessed July 21, 2017).

Figure 7: Daily Bicycle Use in Latin America, 2015



Source: Inter-American Development Bank, "Ciclo-inclusión en América Latina y el Caribe: Guía para impulsar el uso de la bicicleta" (February 2015), p. 3 https://publications.iadb.org/handle/11319/6808 (accessed July 19, 2017).

30,000 rides per weekday, sometimes reaching almost 40,000, and users span 43 *colonias* (neighborhoods) and 3 *delegaciones* (boroughs) covering 35km^2.[74] Rio de Janeiro's bicycle-sharing system—Bike Rio—began operating in 2011 with 60 stations and expanded to 260 stations with 2,600 bicycles covering more of the city in 2014.[75] The city has 450 kilometers of cycling lanes—the second largest in Latin America (after Bogotá) (see Figure 7).[76] Rio recently announced it will modernize its entire bicycle fleet and all 260 stations with more modern technology, including a new payment interface that will accept the *Bilhete Único Carioca*, the city's bus and metro payment system. Investments in cycling infrastructure to create more space for cyclists have also paid off in Santiago, where the number of cyclists on

74. "¿Qué es ECOBICI?" *Oficialía Mayor de la Ciudad de México*; "Estadísticas de ECOBICI" *CMS CDMX, Oficialía Mayor de la Ciudad de México* (2017) https://www.ecobici.cdmx.gob.mx/es/informacion-del-servicio/que-es-ecobici (accessed July 21, 2017).

75. Gustavo Ribeiro, "Bike Rio passará por recauchutagem," *O Dia*, June 18, 2017 http://odia.ig.com.br/rio-de-janeiro/observatorio/2017-06-18/bike-rio-passara-por-recauchutagem.html (accessed July 26, 2017).

76. "Biking in Rio," *Rio.com LLC* (2017) http://www.rio.com/practical-rio/biking-rio (accessed July 27, 2017).

the road has grown by up to 25 percent a year in the past decade and now accounts for 6 percent of all journeys.[77]

Investments in pedestrian-friendly infrastructure like sidewalks and lighting also encourage non-motorized transport. Over the past 12 years, Mexico City's government has converted five kilometers—approximately 30 streets—into pedestrian-only or pedestrian-priority streets. These investments will continue in 2017 with updates to make three major roadways more pedestrian and bicycle friendly with an investment of more than US$2 million.

Improving Energy Efficiency and Vehicle Technology

Improving fuel economy, vehicle emissions, and fuel quality standards is also crucial for Latin America, both to reduce GHG emissions and to improve air quality in cities.

Between 2014 and 2015, non-OECD countries have seen faster fuel economy improvements than OECD countries, as improvement trends slowed in the United States (from 2.3 percent to 0.5 percent) and reversed in Japan (worsened by 4.5 percent) while large non-OECD markets like Brazil, China and Malaysia saw improvements.[78] Mandatory fuel economy standards can yield enormous results. Mexico's environment ministry estimates that its standards, implemented in 2013, will save 710 million barrels of fuel and avoid 265 million tons of CO_2 emissions by 2032.[79] Fuel economy standards for heavy-duty vehicles lag particularly far behind, both in Latin America and globally. Only four countries in the world—Canada, China, Japan, and the United States—have fuel economy regulations for heavy-duty vehicles.[80] Mexico is considering implementing heavy-duty fuel economy regulations. More stringent fuel economy standards can raise vehicle prices, but they also generate cost savings for owners as a result of having to use less fuel. Analyses of proposed regulations typically include information about this "payback period"—how long it takes for savings in fuel costs to compensate

77. Gideon Long, "'Get yourself a bike, perico!': how cycling is challenging Santiago's social barriers," *The Guardian*, July 21, 2016 https://www.theguardian.com/cities/2016/jul/21/cycling-challenging-santiago-chile-social-barriers (accessed July 15, 2017).

78. Global Fuel Economy Initiative, "International Comparison of Light-Duty Vehicle Fuel Economy 2005-2015: Ten Years of Fuel Economy Benchmarking" (2017), p.19 https://www.globalfueleconomy.org/media/418761/wp15-ldv-comparison.pdf (accessed September 27, 2017).

79. ICCT, "Policy Update," p. 3.

80. International Energy Agency, "Global EV Outlook 2017," (2017), p. 12.

for the higher upfront cost.[81] Fuel economy standards can sometimes inadvertently encourage consumers to choose private transportation over public transportation because of the low cost of fuel. To avoid this, fuel economy standards can be accompanied by stronger fuel taxes.

Beyond establishing fuel economy regulations, enforcement and verification mechanisms must also be considered. At a global level, some countries have independent certification and inspection systems, some are reliant on manufacturers to self-police, some rely on import statistics, and others have no inspection criteria at all. Vehicle certification processes in Latin America lag far behind, with the notable exception of Chile, according to UNEP.[82] Many countries depend on information from tests developed by vehicle manufacturers themselves, and in some countries, only a sworn declaration by an importer's legal representative is required with no further inspection. Though Mexico's fuel economy standards are the most stringent in the region, they lack incentives for enforcement and, like the United States CAFE standards, rely heavily on self-reporting.

There are also a host of economic incentives for vehicle efficiency that countries can implement. A feebate—like Chile's progressive tax based on fuel efficiency and NO_x emissions—defines a 'pivot point' in emissions levels and taxes vehicles above the pivot point while providing monetary incentives to those below the pivot point.[83] Feebates have the advantage of being fiscally neutral, as payments to low-carbon vehicle owners are financed with taxes on high-carbon vehicle owners. France has applied this policy since 2008 with success.

Countries may also choose to implement a labeling system with different levels depending on efficiency and emissions standards with clear benefits for each level. Labeling systems simplify the application of a feebate and can also be used to exempt vehicles from circulation restrictions. For example, vehicles with Chile's *sello verde*, or green seal, are exempt from Santiago's vehicle restriction program and vehicles in Mexico with a zero or double zero label as well as EVs are exempt from the *Hoy no circula* program.

A vehicle registration tax that corresponds to vehicle emissions levels can also incentivize consumers to purchase more efficient vehicles. Offering incentives for taxi owners to buy newer models with a rebate dependent on

81. GFEI, "Fuel Economy State of the World 2016," p. 34.

82. UNEP, "Movilidad Eléctrica," p 31.

83. Ibid., p. 59.

the vehicle's fuel efficiency can also pay dividends in converting this high-use vehicle fleet. Some countries—like Chile and Mexico—employ a combination of these options.

Secondhand car imports will continue to be problematic for reducing emissions from the transport sector and for improving air quality, especially in countries with developing economies. Globally, an estimated 25-35 million light-duty vehicles move internationally as secondhand vehicles every year.[84] By 2030, the volume of secondhand vehicle trade will equal new car sales in the European Union and China combined.[85] Though many Latin American countries have banned used car imports, many others still allow it. Costa Rica, for example, has made several attempts to ban used car imports but the measures have not passed Congress. As a result, 80 percent of the fleet is more than ten years old.[86]

Countries in the region should also consider implementing stricter emissions requirements for new vehicles, though in countries that continue to import used cars, these emissions restrictions will not have as significant an impact. Vehicle emissions regulations should be developed considering the significant difference between laboratory and real-world conditions. The International Council on Clean Transportation estimates that in 2014, CO_2 emissions from vehicles were on average 40 percent higher than testing condition estimates.[87] In recent years, portable emissions monitoring systems (PEMS), which allow real-time measurement of hydrocarbon, CO, CO_2, NO_x, and particulate matter emissions, have gained traction for producing more accurate results. In fact, Euro VI standards require PEMS for heavy-duty vehicles.

Fuel quality standards are also making strides in the region. Though some countries plan to progressively lower sulfur content or leave regulations untouched, a few have chosen to "leapfrog" to a much more rigorous standard. For example, by 2020 Peru will tighten its gasoline sulfur content

84. Roger Gorham, "Prospects for 'Decarbonization' of African Transport," presented at *Energy and Transportation in the Atlantic Basin, Jean Monnet Network on Atlantic Studies* (July 20, 2017) http://jeanmonnetnetwork.com.br/wp-content/uploads/2017/08/Gorham-Prospects-for-Decarbonization-of-African-Transportation.pdf.

85. Roger Gorham, "Prospects for 'Decarbonization' of African Transport," presented at Energy and Transportation in the Atlantic Basin, Jean Monnet Network on Atlantic Studies (July 20, 2017) http://jeanmonnetnetwork.com.br/wp-content/uploads/2017/08/Gorham-Prospects-for-Decarbonization-of-African-Transportation.pdf.

86. UNEP, "Status of Fuel Quality."

87. ICCT, "From laboratory to road: A 2015 update," (2015) cited in UNEP, "Movilidad Eléctrica," p. 58.

restrictions from 501-2500ppm to 31-50ppm and its diesel sulfur content restrictions from >2000ppm to 10-15ppm. Mexico will also significantly restrict sulfur limits in diesel, moving from 351-500ppm to 10-15ppm by 2020. Several countries around the world, including Brazil, also have stricter sub-national regulations.

Using Cleaner or Zero-Carbon Fuels

Electric Vehicles

In the longer term, however, to decarbonize the transport sector Latin America will need to vastly expand alternative vehicles markets, particularly EVs. As Latin America's vehicle fleet continues to grow rapidly—with the IEA projecting the fleet will triple by 2050[88]—EV expansion is vital to avoid huge increases in demand for fossil fuels and emissions from the transport sector. UNEP estimates that an accelerated rollout of electric mobility in the region would result in emissions reductions of 1.4 Gt of CO_2 and fuel cost savings of US$85 billion between 2016 and 2050.[89] With about half of its electricity coming from renewable sources, Latin America is particularly well positioned to gain from widespread EV adoption. Even in countries where fossil fuels still make up a large source of electricity generation, EVs can offer huge benefits in terms of urban air quality. As electricity generation from intermittent renewable energy sources like wind and solar grows, EVs can also offer an important form of energy storage as vehicle-to-grid technology—when electricity is stored in EV batteries and later fed back to the grid—is further developed.

EV markets are still in a very early stage, and strong policy incentives are needed to promote widespread adoption. The global stock of electric cars surpassed 2 million vehicles in 2016, growing from 1.26 million in 2015 and just 180,000 in 2012.[90] Ten countries make up 95 percent of electric car sales; China and the United States are the two largest markets, followed by Norway, the United Kingdom, France, Germany, the Netherlands, and Sweden (see Chapter Three). Electric cars represent more than 1 percent of market share in just six countries—Norway (29 percent), the

88. UNEP, "Movilidad Eléctrica," p. 3.

89. Ibid., p. 3.

90. International Energy Agency, "Global EV Outlook 2017," (2017), p. 5 https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf (accessed July 24, 2017).

Netherlands (6.4 percent), Sweden (3.4 percent), France (~1.5 percent), the United Kingdom (~1.5 percent) and China (~1.5 percent).[91]

Latin America faces many barriers to increasing EV uptake with few of the incentives that have spurred sales in other regions (see Table 6). High upfront costs and a lack of public charging infrastructure are the foremost obstacles, although the price difference between electric and conventional vehicles is expected to decrease dramatically in the coming years as lithium-ion battery costs fall and the price of conventional vehicles rises with increasingly strict fuel economy demands. Lithium-ion battery costs have dropped drastically in recent years—from US$1,000 per kilowatt hour (kWh) in 2010 to US$273/kWh in 2016—and are projected to continue falling.[92] Estimates suggest prices will fall to just US$73/kWh by 2030.[93] Stricter fuel economy and vehicle emissions standards are also necessary for EVs to compete successfully with conventional vehicles as they incentivize manufacturers to invest in EV technologies. Concerns about grid reliability, competition from other industries, and fuel subsidies also continue to pose significant challenges for EV uptake in the region.

Fuel subsidies have been particularly problematic in Venezuela, Mexico, Ecuador, Argentina, and Colombia (in 2017 Mexico changed its fuel pricing policies to align domestic fuel prices with international oil prices). These five countries spent US$29 billion on gasoline and diesel subsidies in 2013—26 percent of global fuel subsidy spending.[94] When fuel subsidies are in place, the cost per kilometer driven falls, encouraging consumers to choose private transportation over public transportation and preventing the development of alternative vehicles markets. In countries with large fuel subsidies like Mexico, cost per kilometer for conventional vehicles is about US$0.05, while countries like Uruguay which tax fossil fuels have a cost of more than US$0.11 per kilometer, according to UNEP.[95] EV costs per kilometer can be as low as US$0.008, depending on the cost of electricity. In countries like Mexico and Argentina with generous electricity subsidies, EV cost per

91. Ibid., p. 12.

92. "The Long-Term Outlook for Electric Vehicle Adoption," *Bloomberg Finance*, August 2, 2017 https://bloomberg.cwebcast.com/ses/yHxPvxgMWCQhQn-GScF7pA~~?ek=26664507-22b1-402c-8798-d8ad89681bad (accessed July 27, 2017).

93. Ibid.

94. CEPAL (2014) cited in UNEP, "Movilidad Eléctrica," p. 60. ICCT, "From laboratory to road: A 2015 update," cited in UNEP, "Movilidad Eléctrica," p. 58.

95. Centro de Estudio de la Regulación Económica de los Servicios Públicos Universidad de Belgrano (2016), cited in UNEP, "Movilidad Eléctrica," p. 61.

kilometer is less than US$0.01. In countries with high electricity costs like Uruguay, the cost is around US$0.03 per kilometer.

Many countries in the region have fiscal and non-fiscal incentives in place to encourage the purchase of EVs, though they have not yet been sufficient to meaningfully expand the market. These include a range of measures like tax exemptions or reductions, exemptions from vehicle circulation restrictions, separate electricity metering and lower tariffs for residential vehicle recharging, and access to preferential parking and driving lanes.

Brazil is the region's most important market with almost 4,800 EVs and hybrid EVs (just 300 are 100 percent electric),[96] though expansion has been slow and faces many obstacles. The industry faces strong opposition from Brazil's powerful ethanol lobby and a limited charging network that has expanded slowly due to regulations that prevent power sales by third parties. In Rio de Janeiro, the country's second largest city, there are less than five public EV charging stations. A bill in Brazil's lower house of Congress aims to expand this network by requiring electric utilities to install EV charging stations on public roads as well as in residential and commercial areas. But despite its large size and some promising developments in recent years, like expanded electric bus fleets and more EV brands available for retail purchase, projections for the next ten years show timid growth. Furthermore, unlike in Europe, where battery electric vehicles (BEVs) offer the greatest prospects for emissions reductions (see Chapter 3), analysis suggests that in Brazil conventional hybrid vehicles would do more to lower emissions than all-electric vehicles. A recent study found that although large-scale BEV penetration (82 percent of sales in 2050) would reduce total primary energy demand, it would increase GHG emissions because the use of ethanol would decline considerably and Brazil would have to increase coal-fired power generation to meet additional electricity demand for cars.[97]

Latin America's second largest country, Mexico, is also a large potential market for EVs with the domestic car market projected to reach seventy million vehicles by 2030.[98] Most of the major EV brands, such as Tesla, Nissan

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96. "Carro elétrico: o futuro já está entre nós," *Associação Brasileira do Veículo Elétrico* (July 14, 2017) http://www.abve.org.br/noticias/carro-eletrico-o-futuro-ja-esta-entre-nos (accessed July 19, 2017).

97. Olivia Brajterman, "Introdução de veículos elétricos e impactos sobre o setor energético brasileiro" (March 2016) http://www.ppe.ufrj.br/ppe/production/tesis/brajterman.pdf (accessed September 27, 2017).

98. Estefanía Marchán and Lisa Viscidi, "Green Transportation—The Outlook for Electric Vehicles in Latin America," *The Inter-American Dialogue* (October, 2015), p. 7

LEAF, and the BMW i3 and i8, are available for purchase there, though the current fleet remains small with about five hundred EVs.[99] Mexico offers some incentives to purchase EVs, such as exemption from a new vehicle tax, differentiated electricity tariffs for home charging, and exemption from traffic restrictions. However, for the most part, these incentives are not enough to compensate for the high upfront cost of EVs, limited network of public charging infrastructure, and high and unpredictable cost of electricity.

Costa Rica, the most ambitious Latin American country in terms of GHG emissions reduction goals, is an emerging leader in Latin America in electric mobility. Aiming to reach zero net emissions by 2085, Costa Rica is increasingly focusing on cutting emissions from the transportation sector given that about 80 percent of installed capacity already comes from renewable energy. Its NDC specifically mentions plans to increase electric transportation. A new law that has been proposed for debate in congress would lower the cost of EVs up to 44 percent by reducing the sales tax, consumption tax, and import tax on a sliding scale depending on the price of the vehicle for a period of five years.[100] Costa Rica's electric utility, the Costa Rican Electricity Institute (ICE) recently announced it would purchase a fleet of one hundred EVs and one hundred charging stations to incentivize EV use in the public sector.[101]

There is also potential for electric motorcycle, bicycle, and bus growth in the region. Latin America currently has a fleet of 16 million conventional motorcycles, 5 percent of the global market.[102] Electrifying the region's bus fleet is an opportunity to reduce both GHG emissions and short-lived climate pollutants from high-use vehicles. The global stock of electric buses is just 345,000, the vast majority of which are found in China.[103] However, many

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http://www.thedialogue.org/wp-content/uploads/2015/10/Green-Transportation-The-Outlook-for-Electric-Vehicles-in-Latin-America.pdf (accessed July 24, 2017).

99. "Alto costo y falta de incentivos limitan compra de autos eléctricos," *El Informador*, *Unión Editorialista*, September 10, 2016 http://www.informador.com.mx/tecnologia/2016/681425/6/alto-costo-y-falta-de-incentivos-limitan-compra-de-autos-electricos.htm (accessed July 27, 2017).

100. "Costa Rica: costo de vehículos eléctricos podría bajar casi a la mitad," *Estrategia y Negocios* (magazine), *OPSA Honduras*, May 22, 2017 http://www.estrategiaynegocios.net/lasclavesdeldia/1073216-330/costa-rica-costo-de-veh%C3%ADculos-el%C3%A9ctricos-podr%C3%ADa-bajar-casi-a-la-mitad (accessed July 27, 2017).

101. "Empresa estatal de Costa Rica usará 100 autos eléctricos para fomentar su uso," *Elpais.Cr*, May 5, 2017 http://www.elpais.cr/2017/05/05/empresa-estatal-de-costa-rica-usara-100-autos-electricos-para-fomentar-su-uso/ (accessed July 24, 2017).

102. UNEP, "Movilidad Eléctrica," p. 15.

103. International Energy Agency, "Global EV Outlook 2017," (2017), p. 28.

Table 6: Benchmarking Electric Vehicle Conditions in Latin America

Country	Low-Carbon Power Generation	Emissions Reduction Targets	Road Access Incentives	Financial Incentives	Extensive Public Charging Infrastructure	Electricity Incentives	Fuel Economy Economic Incentives
Colombia	Yes	Yes	Yes	Yes			
Mexico		Yes	Yes	Yes		Yes	Yes
Brazil	Yes	Yes	Yes	Yes			Yes
Chile		Yes	Yes	Yes			Yes
Costa Rica	Yes	Yes	Yes				

Source: Estefanía Marchán and Lisa Viscidi, "Green Transportation—The Outlook for Electric Vehicles in Latin America," The Inter-American Dialogue (October, 2015), p. 11 http://www.thedialogue.org/wp-content/uploads/2015/10/Green-Transportation-The-Outlook-for-Electric-Vehicles-in-Latin-America.pdf (accessed July 24, 2017) and own elaboration.

Latin American cities—like Bogotá, Medellín, and Mexico City—have begun electric bus pilot projects, and studies based on Quito and Santiago show that electric buses are less costly over their life cycle than hybrid or conventional diesel buses.[104]

Biofuels

Biofuels can also be cost-competitive alternative fuel options for long-distance transport, though they still represent an extremely small share of transport sector fuels in the region. In Latin America and the Caribbean, biofuels make up just 6 percent of transport sector fuels,[105] though they are widely used in Brazil. As a result of the country's Pro-Álcool Program, developed in 1975 to reduce dependence on oil imports, more than 70 percent of Brazil's light vehicle fleet is made up of hydrous ethanol and flex-fuel vehicles.[106] Even Brazil's gasoline has a high level of ethanol; the current requirement is a 27 percent ethanol blend.[107] Brazil also mandates biodiesel blending, though on a smaller scale. Due to its widespread use of ethanol,

104. UNEP, "Movilidad Eléctrica," pp. 21–22.

105. Enerdata (2015), cited in Vergara et al., "Zero Carbon Latin America," p. 34.

106. USDA Foreign Agricultural Service, "Brazil Biofuels Annual—Annual Report 2016" (August 12, 2016), p. 16 https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Sao%20Paulo%20ATO_Brazil_8-12-2016.pdf (accessed July 25, 2017).

107. Ibid., p. 1.

Table 7: CO2 Emissions Factors by Fuel

Fuel	CO2 emissions factor
Gasoline "A" (27 percent anhydrous ethanol)	2.269 kg/L
Anhydrous ethanol	1.233 kg/L
Hydrous ethanol	1.178 kg/L
Diesel	2.671 kg/L
Natural gas	1.999 kg/m^3

Source: Ministério do Meio Ambiente (Brasil) - Secretaria de Mudanças Climáticas e Qualidade Ambiental, "1º Inventário Nacional de Emissões Atmosféricas por Veículos Automotores Rodoviários," (January 2011), p. 35 http://www.anp.gov.br/wwwanp/images/Emissoes-Atmosfericas-1Inventariodeemissoes.pdf (accessed July 24, 2017).

Brazil's oil demand is much lower than average for the size of its economy and population. Argentina, Colombia, Ecuador, Panama, Paraguay, and Peru also have ethanol blend mandates, biodiesel blend mandates or both. Other countries in the region, like Chile, have blending targets but not mandatory blending levels.

Biofuels provide reductions in vehicle emissions and resulting health benefits—a recent study by the Getulio Vargas Foundation estimates that biodiesel emits 57 percent less pollutants and a 5 percent biodiesel blend avoids about two thousand premature respiratory disease deaths per year.[108] Yet there is disagreement as to whether biofuels lower net GHG emissions. While emissions per liter of fuel are much lower (see Table 7), when emissions from land use change are taken into account some studies find that GHG emissions nearly double over thirty years from using corn-based ethanol.[109] Others find as much as a 48 percent reduction in lifecycle GHG emissions from corn-based ethanol.[110] Sugarcane and canola-based ethanol, more commonly used in Latin America, are much more efficient, offering greater emissions reductions. Cellulosic materials like switchgrass and agricultural waste offer even greater efficiency and lower emissions, though the process of converting them into fuel is more difficult and costly.

108. Danielle Nogueira, "Biodiesel emite 57% menos gases poluentes, diz FGV," O Globo, September 16, 2012 https://oglobo.globo.com/economia/biodiesel-emite-57-menos-gases-poluentes-diz-fgv-6096296 (accessed July 24, 2017).

109. Vergara et al., "Zero Carbon Latin America," p. 34.

110. "Ethanol Vehicle Emissions," *Alternative Fuels Data Center, US Department of Energy* (March 16, 2017) https://www.afdc.energy.gov/vehicles/flexible_fuel_emissions.html (accessed July 24, 2017).

Natural Gas Vehicles

Natural gas vehicles also offer significant CO_2 reductions, though they may result in a net increase if fugitive emissions (leaks) are significant. Compared to gasoline, estimates indicate that natural gas offers 6-11 percent lower lifecycle GHG emissions.[111] GHG emissions from CNG and LNG are very similar, but CNG offers a slight benefit in terms of emissions reductions as its production uses less petroleum.

In Latin America, natural gas represents just 2 percent of transport sector fuels, though Argentina and Brazil have sizable fleets and Bolivia's fleet is growing rapidly.[112] Argentina has about 1.7 million natural gas vehicles in circulation with approximately 2,500 natural gas service stations and an average of 15,000 vehicles per year are converted from gasoline to compressed natural gas (CNG).[113] As Argentina has reduced longstanding fossil fuel subsidies and the gap between natural gas and gasoline prices has narrowed, the country has seen a drop-off in vehicle conversions. To compete, natural gas prices need to be about one third the price of gasoline as they require more frequent fueling and an upfront investment for conversion.[114] Further scheduled natural gas price increases in Argentina leave little room for this market to expand in the near term. Although Bolivia's fleet remains small, its free natural gas conversion program has led to rapid growth. Between 2006 and 2016, the country's fleet grew to 350,000 vehicles using CNG as a primary fuel—a 722 percent increase.[115]

Conclusion

Providing adequate transportation is one of the greatest policy challenges facing most Latin American countries. Transportation — from individuals commuting to work to trucks carrying goods across the country for export—

111. "Natural Gas Vehicle Emissions," *Alternative Fuels Data Center, US Department of Energy* (April 12, 2017) https://www.afdc.energy.gov/vehicles/natural_gas_emissions.html (accessed July 24, 2017).

112. Enerdata (2015), cited in Vergara et al., "Zero Carbon Latin America," p. 34.

113. Carlos Arbia, "Posible quita de subsidios pone en riesgo la continuidad del GNC para autos particulares," *Infobae*, May 10, 2017 http://www.infobae.com/economia/2017/05/10/el-gobierno-eliminaria-la-utlizacion-de-gnc-en-los-autos-particualres/ (accessed July 25, 2017).

114. Ibid.

115. "EEC-GNV Reports Continued Success with Bolivia's CNG Vehicle Conversions," NGV Global News, May 3, 2016 http://www.ngvglobal.com/blog/eec-gnv-reports-continued-success-with-bolivias-cng-vehicle-conversions-0503 (accessed July 25, 2017).

underpins economic growth across the region. Yet transportation systems in Latin America are increasingly inadequate for the region's growing economies. Booming demand for transportation from private citizens, the public sector, and industry is currently on track to generate a significant increase in GHG emissions. Thus, establishing policies that encourage low-carbon transportation is critical to ensuring green growth in Latin America.

The most important area for expansion is in electric mobility, as it offers the only viable pathway to zero emissions. Natural gas vehicles lower emissions in the short term but still rely on fossil fuel energy. Biofuels for transport also generate emissions and are not viable on a large scale in most Latin American countries outside of Brazil. Improving fuel efficiency and expanding mass public transportation also help reduce CO_2 and local air pollutants but cannot alone achieve zero emissions.

In the near-term, Latin American countries should significantly increase their efforts to electrify high-use vehicles such as taxis, buses, and metros. The benefits of electrifying high-use vehicles are twofold: this approach has a greater impact on emissions because the vehicles travel many kilometers throughout the day while private cars sit idle the vast majority of the time. At the same time, electrifying high-use vehicles provides exposure for many people to the unfamiliar technology. While prioritizing high-use vehicles, governments also need to develop plans and establish specific targets for mass use of private electric vehicles in order to move towards zero emissions. Policies to promote electric mobility should be coupled with efforts to encourage electricity generation from renewable sources. This approach alone will ensure that Latin American countries achieve the goals of the Paris climate accord to which every country in the region has signed on.