BRAZIL

ROAD TRANSPORTATION

Stabilization of road transport emissions in the country of ethanol

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Brazil's attenuation target is a 37% reduction in national GHG emissions by 2025 and 43% by 2030 compared to the 2005 baseline. While the country's main efforts are focused on increasing the share of renewable energies in the energy matrix, achieving zero deforestation and recovering 12 million hectares of forests in the Amazon, the challenge is also important in the transport sector: diesel and petrol account for 75% of the energy consumption of the sector and forecasts predict that transport-related GHG emissions will be 45% of the national total in 2025 (Waycarbon, 2018). This chapter analyses the factors explaining the evolution of emissions in the transport sector and the various actions in progress.

Head editor • **GHISLAIN FAVÉ** • *Consultant*

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1 • RECENT STABILISATION OF EMISSIONS

Driven by the reduction in illegal deforestation, Brazil has seen a 28% reduction in its emissions over the 2008-2014 period (see Figure 1). However, in 2015 and 2016, GHG emissions increased by 12.3%, driven by the resumption of illegal deforestation. **Transport sector emissions increased by 40% over the 2008-2014 period and stabilised in 2015 and 2016 at around 190 million tonnes of CO_2eq, i.e. the same level as in 2012.**

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Transport domestique (hors aérien)	144	150	147	164	179	196	203	209	193	194
Total national	2,682	2,807	2,003	1,925	1,927	1,947	2,107	2,022	2,091	2,278

FIGURE 1. EVOLUTION OF CO_2EQ EMISSIONS IN TOTAL AND IN THE TRANSPORT SECTOR IN BRAZIL (MILLIONS OF TONNES).

Source : From the databases of the SEEG (System for Estimates of Emissions and Removal of Greenhouse Gases), 2018

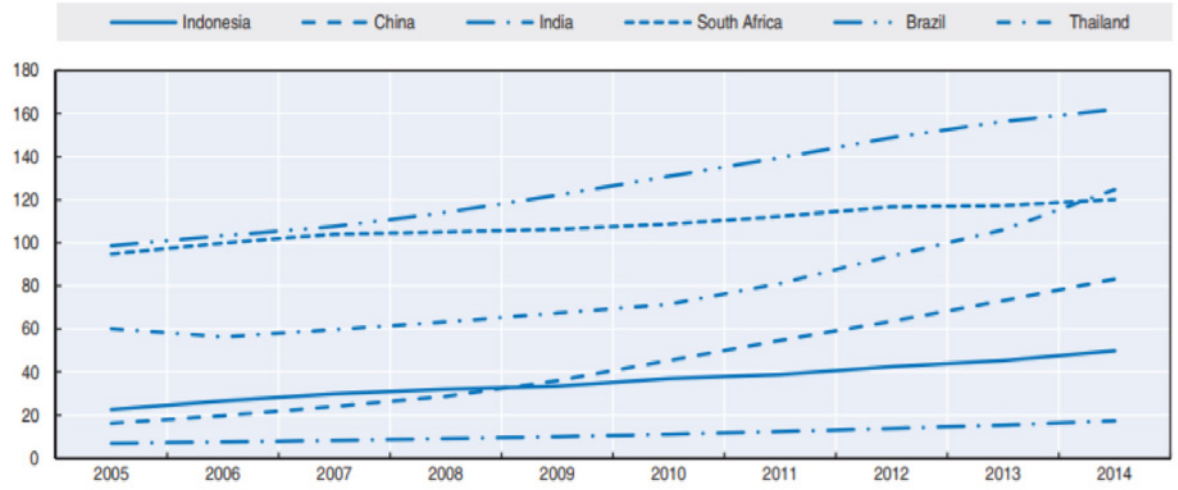

FIGURE 2. EVOLUTION OF THE RATE OF MOTORISATION IN SELECTED DEVELOPING COUNTRIES

Source : ITF Transport Outlook, 2017

Strong economic growth rates in emerging economies have led to a rapid rise in motorisation rates, and it is no different in Brazil, with growth of 60% between 2005 and 2014 (see Figure 2). This has been particularly significant in Brazil where economic growth between 2001 and 2015 led to a large part of the population on low incomes moving up into the middle class. In addition, this dynamic has been reinforced by the encouragement of the Brazilian government for the motorisation of households to support the automotive industry, which is important for the country's economy. Thus, in 2008, during the global financial crisis, the state reduced taxes on industrialised products (IPI); this measure was renewed in 2012. Other factors, such as easier access for households to credit and financing for new cars, also contributed to this growth in individual motorisation. According to the production and sales statistics released by the ANFAVEA (National Association of Motor Vehicle Manufacturers), the total volume of sales of new vehicles in Brazil increased from 1.4 million vehicles in 2002 to 3.8 million in 2012, a growth rate of 11.5% per year (ANFAVEA, 2015). These elements make it possible to understand the major increase in GHG emissions from the transport sector between 2008 and 2014, from 150 to 209 million tonnes of CO_2eq (see Figure 1).

The economic crisis that Brazil has been experiencing since 2015 largely explains the recent stabilisation of emissions in the transport sector. Thus, GDP fell by 3.8% in 2015 and 3.6% in 2016,

which is reflected in the GHG emissions of the Brazilian energy sector: over this 2015-2016 period, emissions in the energy sector fell 7.3% (SEEG, 2016). Further proof of the effect of the current crisis on transport sector emissions is the 30% drop in new car sales between 2012 and 2015 (PwC, 2016).

If the recent stabilisation of transport sector emissions appears above all cyclical, we should try to analyse the main drivers of these and identify the strengths and weaknesses of the sector in Brazil.

2 • URBAN MOBILITY UNDERGOING TRANSFORMATION

• THE CRISIS OF PUBLIC TRANSPORT • Brazil's economic growth since the 1950s has been accompanied by rapid urbanisation: while only 45% of Brazil's population was urban in 1960, more than 80% of Brazilians were living in cities in 2010 (IBGE, 2010). This rapid urban growth has been shaped by automobiles and structured along major highways. The ex-nihilo creation of the federal capital Brasilia in 1960 is the perfect example: its ambitious urban plan was conceived based on the car, as a symbol of this era when the car was presented as the only solution to urban travel.

This powerful urbanisation was accompanied by a rise in property prices and property speculation, which pushed the poorest populations in marginal areas further and further away, all the more so as informal housing was increasing. Transport infrastructures struggled to keep pace with this urban sprawl and transport times became considerably delayed, prompting people to turn increasingly to individual methods of motorisation to cope with their travel needs.

The response from municipal, regional and federal governments is, in most cases, investment in infrastructure, which may include an ever-growing car fleet, to the detriment of public transport, which is confirmed by analysis of the evolution of the index of passengers per kilometre on the urban bus network. **The figures provided by the Associação Nacional das Empresas de Transporte Urbano on the cities of Belo Horizonte, Curitiba, Fortaleza, Goiânia, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo, show a 38% drop in this index between 1994 and 2015, a reflection of a public transport system that can no longer attract Brazilians.**

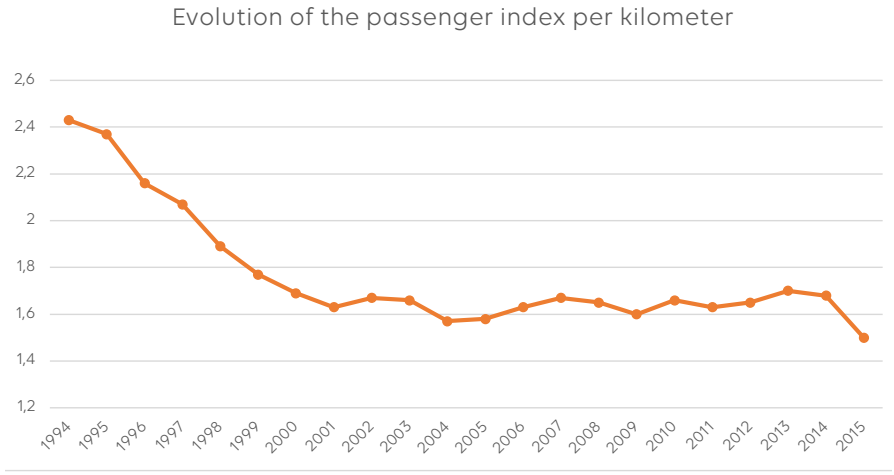

FIGURE 3. EVOLUTION OF PASSENGER INDEX PER KILOMETRE BETWEEN 1994 AND 2015 IN THE CITIES OF BELO HORIZONTE, CURITIBA, FORTALEZA, GOIÂNIA, PORTO ALEGRE, RECIFE, RIO DE JANEIRO, SALVADOR AND SÃO PAULO.

SOURCE: Based on data from the Associação Nacional das Empresas de Transporte Urbano (NTU)

Alternate traffic in São Paulo

São Paulo, a megalopolis of more than 12 million inhabitants and the economic heart of Brazil, is frequently plagued by traffic jams. According to a study by the specialised firm INRIX, the inhabitants of São Paulo spent an average of 86 hours per year in traffic jams in 2017, i.e. the 4th city in this study, which covers 1360 cities. On average, traffic congestion totals 300km per day in this metropolis, at an estimated cost of 69.4 billion reais or 7.8% of local GDP, according to a technical study published in July 2014 by Firjan.

In order to improve the situation and especially to reduce air pollution, from 1997 the city introduced restrictions on traffic in the extensive centre of the city: the rodizio. Every working day, based on the last number on their number plate, traffic is prohibited between 7am and 10am and between 5pm and 8pm in the city centre. The rodizio, by removing 20% of the vehicles from traffic, initially led to lower congestion and atmospheric pollution. The results are now more mixed: the vehicle fleet has grown by 40% since the establishment of this measure, especially because many people have acquired a second car with a different registration, to escape the rodizio.

TEXT BOX 1

One of the consequences of this crisis in the demand for urban public transport and the increase in the motorisation rate is the deterioration of urban air quality, and high GHG emissions linked to the transport sector in Brazilian cities. Thus, urban transport represents 68.2% of the emissions of the city of São Paulo (municipal inventory 2011), 57.6% in Belo Horizonte (municipal inventory 2015) and 54.5% in Recife (2015). By comparison, the transport sector accounts for around 26% of GHG emissions in European cities (Covenant of Mayors in Figures: 8-year assessment, 2017). This greater share in Brazilian cities is also linked to the low carbon intensity of the electrical energy consumed in Brazil and, consequently, to the lower share of the energy sector in municipal emissions. Even though the car ownership rate is still growing strongly and is much lower than in other countries, the trend is towards growth of urban transport in GHG emissions, which represents the biggest challenge in terms of mitigation for Brazilian cities: the city of Recife predicts that emissions associated with transport will account for 75% of the city's emissions in 2040, if the current trend continues.

Mobilisation of civil society

At the beginning of 2013, following the announcement of an increase in bus fares, demonstrations broke out at the call of the Movimento Passe Livre, a movement calling for free public transport. Soon, these events spread to the whole of Brazil, mobilising up to one million people and the demands extended to education and health, along with criticism of the expenses related to the organisation of the 2014 World Cup. Following this unprecedented mobilisation, urban mobility became the symbol of these public policies that struggle to meet the expectations of the population.

TEXT BOX 2

• URBAN MOBILITY PLANS, INSTRUMENTS OF LOW-CARBON MOBILITY • In April 2012, the law establishing the Política Nacional de Mobilidade Urbana (National Urban Mobility Policy - PNMU) came into force. It stipulates that towns with more than 20,000 inhabitants must produce their Urban Mobility Plan (UMP), in way that is integrated with their master plan, within three years. Previously, only cities with more than 500,000 inhabitants were under this obligation; with this new law, there are now 1663 municipalities that must submit a UMP, otherwise they will no longer be able to receive federal funds intended for urban mobility (CODATU, 2015).

The PNMU defines public transport and active modes as priorities for cities, instead of individual motorised transport. It provides guidelines for sustainable urban development: the development of cycle lane networks and bus lanes, restriction of vehicle traffic at certain times, pricing of public parking, etc. To fight against air pollution and against GHG emissions, the law also provides for the control of the level of emissions, the introduction of pollutant emission limits, and traffic restrictions if thresholds are exceeded. This law, contrary to the reduction in vehicle taxes renewed in 2012 by the federal government, stimulated the transformation of urban mobility in Brazil.

Fortaleza, the latest Brazilian example of sustainable mobility

Fortaleza, the 5th largest city in Brazil with a population of almost 3 million, has been transforming urban mobility since 2014: prioritising active modes and public transport (development of 108km of bus lanes, modernisation of bus terminals, refurbishment of the fleet with air conditioning and wifi), 225km of cycle paths (240% growth in the last 5 years), a shared bike programme integrated with the public transport system, the launch of a pilot programme of shared electric cars and traffic calming initiatives. **The results are already measurable: road mortality has been reduced from 14.66 per 100,000 in 2014 to 9.71 in 2017, the shared bike system is now the most used in Brazil, and on some bus routes, journey times have been halved.** With these actions, the city aims to reduce its emissions by 20% in 2030 compared to developments if current trends continue. These achievements have brought international recognition to Fortaleza, with the "Sustainable Transport Award" being awarded to the city in 2018 by the ITDP.

TEXT BOX 3

TransCarioca, the heritage of the Rio de Janeiro Olympics

As a result of Rio's commitment to hosting the FIFA World Cup and the Olympic Games (2014 and 2016 respectively), the city has been the focus of major investments in transport infrastructure, including the development of a network of 150km of BRT (Bus Rapid Transit) lines. The TransCarioca, a 39km line inaugurated shortly before the World Cup, is the main legacy of these events. With a cost of about $550 million and 75% funding from the BNDES, the national development bank, the TransCarioca connects Barra da Tijuca district, where most of the sports facilities of the Olympics were concentrated, in the southern districts of the city, with Rio International Airport.

FIGURE 4. MAP OF THE BRT TRANSCARIOCA

SOURCE: Rio de Janeiro City Councilo

Today, approximately 320,000 passengers use the line every day and nearly 500 buses have been removed from traffic, reducing travel times, congestion and GHG emissions. This line crosses many more disadvantaged neighborhoods of the northern area of the city and provides a major development opportunity for this region.

TEXT BOX 4

3 • FUELS: BETWEEN SUCCESSES AND CHALLENGES

• ETHANOL FUEL: THE BRAZILIAN MODEL • The production of ethanol, from the fermentation of sugar contained in sugar plants such as sugar cane, has been developed in Brazil for many years, but it is since the oil shocks of the 1970s that its use as a substitute to gasoline has intensified. In response to the rise in oil prices, Brazil, then increasingly dependent on oil imports, implemented in 1975 the Programa Nacional do Álcool (National Alcohol Programme) - PROALCOOL. Support measures for the production of fuel ethanol were taken: enhanced credit for investments and price setting. **The sector benefited from the very strong responsiveness of economic actors with massive investments in fuel ethanol production units and the launch of hydrated alcohol vehicles**

(operating only with ethanol) by all car manufacturers. The programme was very successful with the production of 5.6 million ethanol vehicles between 1975 and 2000. It is estimated that this programme prevented the emission of 110 million tonnes of carbon equivalent over the same period (EPE, PNE 2030).

The early 2000s saw the emergence of productivity gains in both the agricultural and industrial sectors, as well as the emergence of flex-fuel engines that work equally well with gasoline, ethanol, or a mixture of both (in 2003, the first flex-fuel model, the Volkswagen Gol flex-fuel). Today, all car manufacturers offer flex fuel models, which accounted for almost 90% of light vehicle sales in 2015 (EPE, 2015). These factors led to a sharp increase in fuel ethanol consumption between 2003 and 2009, reaching a peak in 2009 of more than 100 million tonnes of oil equivalent (MMA, 2014). Over the 2009-2012 period, ethanol fuel lost market shares: it was more profitable to produce sugar than ethanol, investments in the means of production were reduced, and the price of petrol fell and became more competitive. In fact, over these three years, the share of fuel ethanol in the energy matrix of passenger transport declined from 33% to 22% (SEEG, 2018). The increase in the compulsory fraction of anhydrous alcohol in petrol (now 26%) has helped recover consumption growth and in 2016, ethanol accounted for 29% of energy consumption in the passenger transport sector (SEEG, 2018).

With this success, is Brazil continuing to develop its fuel ethanol sector and is now resisting the electrification of its car fleet: **despite the enormous potential for reducing emissions that this technology represents, especially since the electrical matrix in Brazil is clean with more than 68% hydropower (EPE, 2018), ethanol is defended by the entire productive chain and the federal government.** The Transport and Urban Mobility Sector Plan for climate change mitigation plans for a penetration of only 3% of hybrid gasoline vehicles in 2021, while the consumption of fuel ethanol would reach 52 billion litres in the same year.

Biofuels are often criticised for their environmental impacts, mainly due to land use changes induced by their production. In some regions, for example, growing production accelerates deforestation and increases the price of food. Attentive to maintaining the forest-fuel-food balance, the Brazilian government established the zoning of sugar cane in 2009, delineating 70 million hectares for its cultivation. The northern region of Brazil is excluded from this zoning as the planting of sugar cane in the Amazon basin is prohibited. Brazil does not lack space to develop a sustainable ethanol sector, the demarcated area being 10 times larger than the area needed for production in 2020. The largest production areas are concentrated in the Centre-South region and their growth does not threaten the Amazon rainforest. In these areas, expansion of sugar cane cultivation is

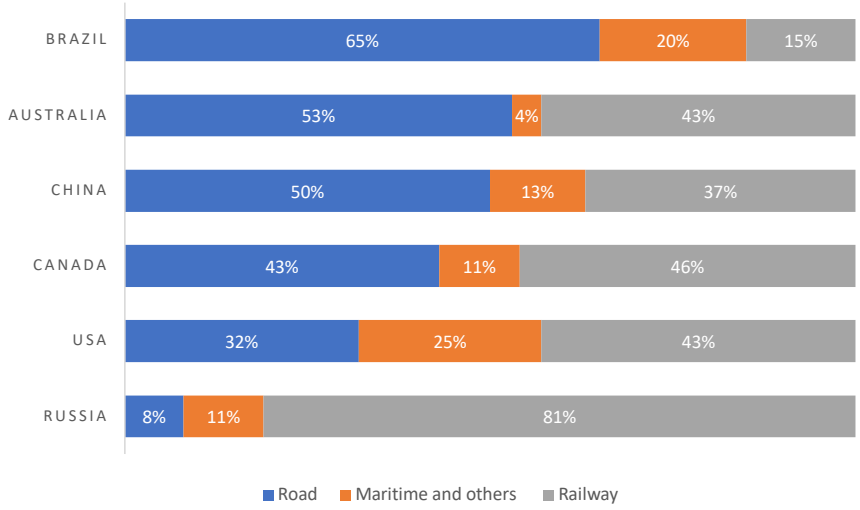

FIGURE 5. MODAL DIVISION OF FREIGHT TRANSPORT IN CONTINENTAL-SIZED COUNTRIES IN 2015.

Source : SEEG, 2018.

mainly on degraded or abandoned pastures and does not compete with food production. On the other hand, the remarkable Cerrado and Mata Atlântica biomes could be subject to strong agricultural pressure (Feres et al., 2011).

• DEPENDENCE ON THE ROAD FREIGHT AND ON DIESEL • While the rail network was developed at the beginning of the 20th century, it was gradually replaced by a road network during the post-war period, partly to promote the growth of the car industry. **The transport of goods is today heavily dependent on road transport, which accounted for 65% of freight in 2015, much more than in other continental-sized countries like Brazil (see Figure 5).**

Trucks are essential for regional freight transport in Brazil and diesel is the most consumed fossil fuel, accounting for 53% of transport sector consumption in 2005 (PNE 2030, 2007). As a result, freight transportation is a major source of GHG emissions, not only in the transportation sector but throughout the energy sector. According to SEEG's analysis, in 2016, road transport emitted 101.9 $MtCO_2eq$, i.e. half of the emissions from the transportation sector and one-fifth of the emissions associated with the energy sector, more than the total emitted by power plants in the same year (54.2 $MtCO_2eq$).

In addition to this environmental cost, this predominance of road transport represents a high economic cost for the Brazilian production chain. The National Logistics Plan (2007) thus designates the transport of goods as one of the main factors limiting the country's competitiveness, as the current matrix prioritises the highest cost modes. A better balance of freight transport modes is therefore needed.

The Plano Nacional de Mudança do Clima (National Climate Change Plan or PNMC) emphasises the importance of reducing the volume of transport by HGV and of a shift towards less carbon-intensive modes such as rail and river transport. Despite this understanding, this modal shift requires major investments and the migration will be slow: roads in Brazil will remain the dominant mode in the transportation of goods. Between 1999 and 2008, the truck fleet increased three-fold (ANFAVEA, 2009) and the National Energy Plan 2030 forecasts a growth of 3.5% per year of diesel consumption over the 2005-2030 period.

Mobilisation of truck drivers and the diesel crisis

From 2011 to 2015, the Brazilian government artificially controlled the price of petrol and diesel fuel at the pump, with the main aim of controlling inflation and avoiding consumer price instability caused by high volatility of international tariffs. This policy heavily indebted Petrobras, the national oil company, and therefore ceased in 2016. Petrobras began to index its prices on those of oil and the dollar. Following the rise in the price of a barrel and the rise of the dollar against the Brazilian real, the price of diesel at the pump increased significantly in 2018, provoking the anger of truck drivers who went on strike in May 2018. The country, which is highly dependent on road transport, was paralysed as many cities faced shortages of food and fuel. Faced with the difficulty of transporting goods, some international airports were affected, and cancelled flights due to a lack of kerosene. A state of emergency was declared in many cities and the army received the order to free up the highways. After 11 days of strike action – the biggest strike in the sector in the history of Brazil – the Temer government yielded, announcing an immediate reduction of 0.46 reais in the price of a litre of diesel, based on a reduction in taxes on diesel at 0.10 reais per litre as well as direct subsidies in the amount of 0.30 reais per litre. The government estimates that these two measures will respectively represent a shortfall of 4.01 billion reais in 2018 and a cost of 9.5 billion reais.

TEXT BOX 5

• EMERGENCE OF BIODIESEL • Si l'éthanol biocarburant est fortement implanté au Brésil, les débuts du biodiesel sont plus timides. La compagnie nationale Petrobras, après avoir investi dans des usines biodiesel, n'a jamais atteint le seuil de rentabilité et a même enregistré des pertes record entre mai et juin 2015, totalisant 304 millions de réais. En 2016, elle a annoncé son retrait progressif de l'activité, fermant l'une de ses principales unités de production.

L'augmentation de la part de biodiesel dans le diesel a un potentiel de réduction des émissions considérable et est l'une des stratégies du Brésil pour atteindre ses objectifs d'atténuation. Dans le document *"Fundamentos para a elaboração da Pretendida Contribuição Nacionalmente Determinada (iNDC) do Brasil no contexto do Acordo de Paris sob a UNFCCC"*, le Ministère de l'environnement définit l'objectif d'une fraction de 10 % de biodiesel dans le diesel (diesel B10) d'ici 2030.

Cities invest in low-emission buses

Beyond this government objective, cities and manufacturers are already undertaking a more ambitious transformation, starting notably with low-GHG urban bus programmes. In 2012, the city of Rio launched a pilot programme of urban buses running on 30% biodiesel. São Paulo has also initiated a B20 bus project called "Ecofrota" (a mixture of 20% biodiesel). The most ambitious programme comes from the city of Curitiba which, in partnership with Volvo and the Swedish government, is being equipped with hybrid buses with biodiesel engines.

TEXT BOX 6

CONCLUSION

The recent stabilisation of transport sector emissions at the 2012 level is more the result of the current economic crisis in Brazil than of pro-climate actions. It will be interesting to observe the evolution of the sector's GHG emissions as the country recovers economic growth. Many initiatives are under way to decarbonise transport, at the federal level in terms of biofuel, but also at the municipal and civil society level; will these actions reverse the emissions curve?

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