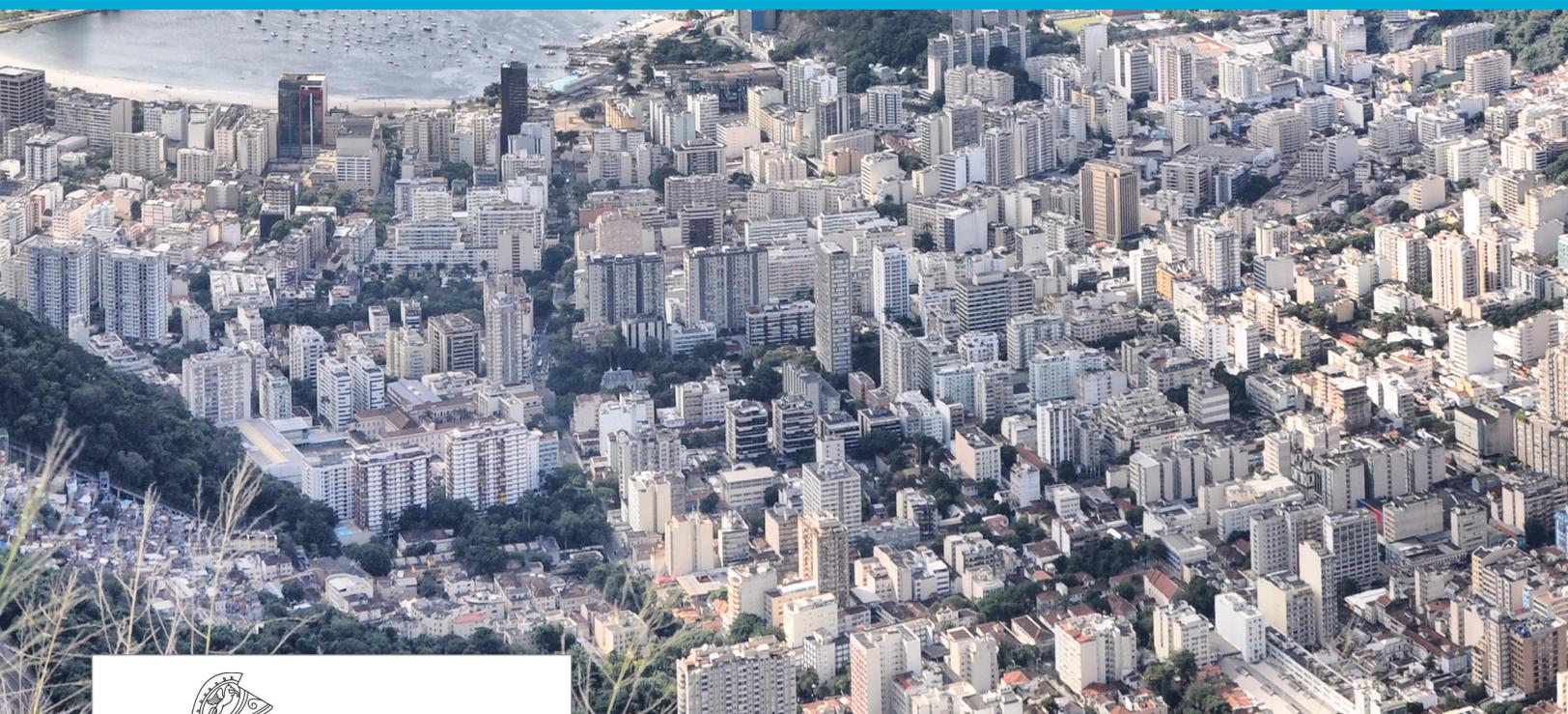




# The contribution of low-carbon cities to Brazil's greenhouse gas emissions reduction goals

Briefing on urban energy use and greenhouse gas emissions



**COPPE**  
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## EXECUTIVE SUMMARY

Cities around the world are growing almost twice as fast as the global population. More than half of people already live in urban areas, and each week this number increases by nearly 1.5 million. This fast-growing population will require new infrastructure, energy and transportation, all of which are important drivers of greenhouse gas emissions. Long-term planning and investment in low-emission alternatives will allow these rapidly growing cities to grow responsively and sustainably.

Brazil is ahead of these global trends. It has been majority-urban since the mid-1960s, and it is now about 85% urban, with one of the largest urban populations in the world, nearly 175 million people. Cities thus play a key role in Brazil. However, to date, Brazil's climate mitigation strategy has prioritized reducing emissions from deforestation and keeping a high percentage of renewables in the power supply. While this is understandable, particularly given the large share of Brazil's emissions associated with deforestation, engaging cities could greatly enhance mitigation ambition, particularly in the buildings, transportation and waste sectors.

Cities have limited policy instruments available to reduce GHG emissions. Many approaches, such as taxation, subsidies, regulations and standards, are primarily the responsibility of the federal government. Cities also compete with one another, and thus may be reluctant to adopt ambitious measures that might make them less economically competitive. At the same time, urban development is a key national priority, and national efforts to address poverty and equity will be focused in cities with the largest concentrations of poverty. Climate policies at the national and urban level will have to support these broader urban development aims.

Despite those challenges, this analysis identifies significant opportunities for urban GHG abatement in Brazilian cities, with the greatest potential in shifting modes of transportation, improving fuel efficiency of vehicles, increasing the energy efficiency of residential and commercial buildings and appliances, and improving waste management. For example:

- Brazil's national plan for improving urban mobility through infrastructure improvements and reducing reliance on personal vehicles is projected to reduce GHG emissions from passenger road transport by a total of 19.5 Mt CO<sub>2</sub>e by 2020 relative to business as usual.
- Energy use in urban residential and commercial buildings make up 50% of electricity use nationwide. New standards for new building construction, following the guidelines defined by the Brazilian Labelling Program, would achieve 50% energy savings for new buildings and 30% energy savings through building retrofits. By 2022, as a result of these energy efficiency measures, Brazil is expected to save 18,000 GWh of electricity in the residential sector and close to 7,000 GWh in the commercial sector, relative to business as usual.
- Waste management is a key priority in Brazil, with significant potential to reduce emissions and deliver development benefits. In Brazil, less than half of sewage is collected nationwide, and only 40% of what is collected is properly treated. The recently implemented National Policy for Solid Waste is expected to decrease waste generation, increase recycling and reuse, manage and dispose of solid waste properly, and provide universal basic sanitation.

These findings echo findings of SEI's global study in 2014. Yet few of these opportunities have been considered so far in discussions about Brazil's intended nationally determined contribution (INDC) in the lead-up to the Paris Climate Change Conference. It is also clear that cities in Brazil cannot realize this potential alone. Yet by tapping into cities' mitigation potential, the federal

government can more confidently raise the ambition of its international mitigation. In particular, we have identified the following key findings:

- Urban abatement is critical to reducing emission in Brazil over the long term. The national actions of reducing deforestation and clean energy generation have produced laudable near-term reductions; moving forward, cities can enhance the national climate strategy.
- Cities need support to maximize the effectiveness of their actions. Examples of national policies to support urban action include carbon pricing and support for distributed renewable energy production in urban areas by permitting integration into the national grid.
- The strongest tool Brazilian cities have for climate action is their political influence. This influence could be leveraged to strengthen the ambition of Brazil's national GHG emission reduction commitments.
- Cities have a responsibility to contribute to reduce emissions. Cities no longer have to choose between economic growth and emission reduction – they can do both.

## 1. GHG EMISSIONS AND DEVELOPMENT PRIORITIES IN BRAZIL

### **Brazil's national climate strategy to date has paid little attention to the role of cities.**

According to the National Inventory, in 2012 GHG emissions in Brazil were 1.25 Gt CO<sub>2</sub>e, a 41.1% decrease relative to 2005.<sup>1</sup> The largest contribution to this decrease was from the agriculture, forestry, and land use (AFOLU) sectors. Brazil was the first major developing country to set an emission reduction target, under the Copenhagen Accord. It was predicted that under a business-as-usual (BAU) scenario, the level of emissions would be of 2.7 Gt CO<sub>2</sub>e/yr by 2020. The government pledged to reduce emissions by 36.1–38.9% below BAU (Government of Brazil 2010).

Brazil has a broad federal regulatory framework related to climate change that defines governance structures, plans and tools, though many of the supporting regulations have yet to be issued. Studies<sup>2</sup> assessing the impacts of the GHG mitigation plan find that current government actions would reduce emissions to 1.2 Gt CO<sub>2</sub>e by 2020. Deforestation reduction measures make by far the largest contributions. However, the study finds significant potential to further reduce national emissions by adopting measures to incentivize energy efficiency, transport modal shifts, and low-carbon agriculture. If no further efforts are taken to control emissions, the study finds that emissions would actually rise between 2020 and 2030 due to the increased use of fossil fuels and increased emissions from livestock management.

Brazil is now preparing its intended nationally determined contribution (INDC) towards a post-2020 global climate agreement. In a joint statement with U.S. President Barack Obama on 30 June 2015, President Dilma Rousseff said Brazil would submit a “fair and ambitious” INDC “that represents its highest possible effort beyond its current actions”.<sup>3</sup> It is to be based on the implementation of broad policies in the forestry, land use, industrial and energy sectors, among others. The two leaders also launched a Joint Initiative on Climate Change, to be implemented through a high-level U.S.–Brazil Climate Change Working Group. The aim is to enhance bilateral cooperation on issues relating to sustainable land use, forest conservation and agriculture; clean energy, including renewables, energy efficiency, and innovative finance; and adaptation and resilience. Although the text does not explicitly mention cities, promoting building efficiency is a stated goal.

Within Brazil, several proposals have been made for the country's INDC. The Climate Observatory (Observatório do Clima), a civil society organization, has established several targets concerning land use, farming, electricity, transportation and fuel. It estimates that by 2030 Brazil should have an emissions limit of 1 Gt CO<sub>2</sub>e. The proposal includes specific sectoral targets and actions: recover 14 million hectares of preservation land, generate electricity at a level of 1,020 TWh/year, and expand public transportation through bus rapid transit (BRT), light rail, subways and trains. According to the OC, this target can be reached by propagating existing technologies and public policies that will push the country towards a low-emissions model.

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<sup>1</sup> See <http://www.mct.gov.br/clima>.

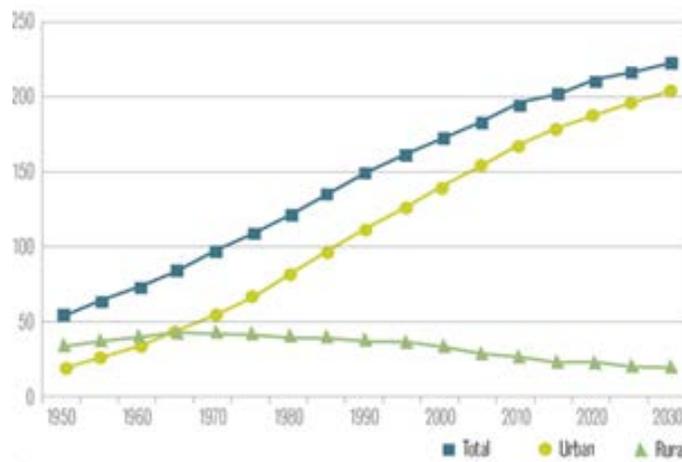
<sup>2</sup> Implicações Econômicas e Sociais para o Brasil (IES – Brazil); see <http://www.forumclima.org.br/pt.home>.

<sup>3</sup> See <https://www.whitehouse.gov/the-press-office/2015/06/30/us-brazil-joint-statement-climate-change>.

## Cities have a significant role in contributing to and mitigating Brazil's GHG emissions.

Brazil's population was estimated at 202.8 million in 2014, up 6.3% since the 2010 Census.<sup>4</sup> Most people live in mid-size cities, with populations between 100,000 and 500,000.

**Figure 1: Brazilian population and projections (in thousands)**



As shown in Figure 1, since the mid-1960s, the urban population has grown across Brazil, while rural population has declined. In 2010, an estimated 84.4% of the population lived in urban areas, with the highest observed rates of urbanization in the southeast. Brazil's urban population is expected to continue to grow, reaching 90% as soon as 2020, according to a United Nations Human Settlements Programme (UN-Habitat) report about Latin American and Caribbean cities. Overall, the report finds that Latin America and the Caribbean is the region with highest rate of urbanization globally.

Infrastructure choices made to support urban growth could significantly affect GHG emissions. Key materials required for infrastructure, such as concrete and steel, are very carbon-intensive, but more important, infrastructure is long-lived, often lasting several decades, so it is crucial to ensure that it does not “lock in” patterns of land use, transport, housing and overall behavior that drive up emissions (IPCC 2014). In developing countries, including Brazil, transportation infrastructure – existing and still to be built – is of particular concern. But Brazil's current transport infrastructure heavily favors road transport, with individuals driving their own cars. Although Brazil is a pioneer in biofuels production and use, it can still do better, and it needs to prioritize infrastructure that supports a shift to more sustainable transport modes, for both people and goods. Achieving such a shift will not be easy, as it requires changing people's habits, but it could yield multiple benefits beyond GHG emission reductions, such as improved air quality, less road congestion, and more connected, accessible and “livable” cities. For example, the adverse health impacts of air pollution in São Paulo have been estimated at US\$208 million per year, including respiratory and cardiovascular diseases and related mortality (Miraglia et al. 2005).

Building energy use is another area ripe for efficiency improvements. As noted above, the joint initiative with the U.S. includes work on energy efficiency, including the use of energy-efficient building materials. Creating a single methodology for assessment of thermal performance of buildings could help identify issues and solving them. For example, the Brazilian Panel for Climate Change suggests studies that correlate building type, geographical location and other variables with

<sup>4</sup> All data given here are from the Brazilian Institute of Geography and Statistics (IBGE): <http://www.ibge.gov.br>.

power consumption, as well as studies of building envelope-related energy savings.<sup>5</sup> As with efforts to drive shifts in transport mode, improving building efficiency may require overcoming economic, financial and also legal and institutional barriers.

### **Urban climate mitigation efforts must support Brazil's development priorities.**

Urban development in Brazil has been characterized by division and exclusion based on land, social class, and geography. Therefore, the federal government is focusing on increasing the accessibility and the integration of areas with little or no urban infrastructure with those with high levels of technology and infrastructure, through measures such as BRT and the widely known funicular to the Santa Marta favela in Rio de Janeiro. Several programs and institutions have been set up to foment these changes, including a National Secretariat of Urban Programs, which works on transportation, housing and sanitation.

Nationally, among the top priorities of the country are the eradication of hunger and poverty, and the provision of health care and security. The “Bolsa Família” program exemplifies these priorities, as it helps families that earn up to 25 US\$ per month per person or up to 50 US\$ per month per person if pregnant or with children younger than 18 years old. Today, “Bolsa Família” helps around 13.9 million families across the country to overcome difficulties and be integrated into society.

Brazil's Growth Acceleration Program (PAC) groups measures for improvement of social and urban infrastructure to encourage rapid but sustainable growth.<sup>6</sup> It includes projects to expand sewage collection and treatment, protect water sources, and reduce water pollution. Another important issue covered by this program is transportation, including construction of new roads and highways, railroads, airports, and waterways. For example, there are 107 projects involving airports expansion or construction across the country.

In addition, the government is trying to reduce barriers to economic growth, including through a reduction of the interest rate and the tax burden across the supply chain. Economic development in Brazil today depends on a mix of public- and private-sector investment, and the government has tried to incentivize private-sector investment. However, many of those policies, such as incentives for purchasing motor vehicles, have driven up GHG emissions with no benefits to the economy.

### ***Air quality***

The National Council on the Environment (Conselho Nacional do Meio Ambiente, or CONAMA) is responsible for implementing environmental policies and climate change mitigation actions. It has developed programs such as PROCONVE (Control Program of Air Pollution from Motor Vehicles) and PROMOT (Control Program of Air Pollution from Motor Vehicles and Similar Vehicles). Both initiatives are reducing emissions from vehicles by setting limits that become more and more restrictive over time.

In São Paulo and Rio de Janeiro, air quality is being monitored and controlled, especially concerning vehicle emissions. The situation is particularly challenging in São Paulo, which has the largest concentration of cars, with 40% of the country's automotive fleet.<sup>7</sup>

Several public information campaigns on air quality have been conducted in Rio, with a range of activities, from seminars to environmental tracking. Premature deaths from exposure to vehicle emissions are projected to decline by 50% in 2030 due to those programs to control vehicle

<sup>5</sup> See [http://www.pbmc.coppe.ufrj.br/documentos/pbmc\\_sumario\\_executivo\\_gt3](http://www.pbmc.coppe.ufrj.br/documentos/pbmc_sumario_executivo_gt3).

<sup>6</sup> See <http://www.pac.gov.br>.

<sup>7</sup> See <http://www.DENATRAN.gov.br/frota>.

emissions. These efforts are supported by the national Air Quality Standard (PQAr), established in 1990 through CONAMA Resolution No. 3/1190,<sup>8</sup> which sets limits for different pollutants. But if Brazil were to adopt best-practice control on vehicles and fuels, it could cut health impacts by an additional two thirds (Miller et al. 2013).

### ***Equity and housing***

Equity has always been an important subject on the national level, given the disparities that affect different aspects of life in Brazilian society. The juxtaposition of favelas and luxury condominiums brings these inequalities into stark relief, and the government has made it a priority to fight inequality. Programs such as “Minha Casa Minha Vida” (My House, My Life),<sup>9</sup> which offer affordable finance for low-income homebuyers, have helped decrease by 8% per year the housing shortage and are expected to reach 20,000 homes in 2024.

Observatório de Favelas (the Favela Observatory)<sup>10</sup> is a civil society organization with national scope that focuses on research and advocacy to formulate, advance and evaluate public policies related to slums, in order to improve living conditions and overcome social disparities. It works on urban policy, education, culture, communications and human rights.

On the government side, the Pereira Passos Institute (IPP) in Rio de Janeiro supports urban policy and planning and coordinates projects to improve quality of life and enhance public-sector efficiency. One of the major projects is “Rio+Social”, which promotes the full urban, social and economic integration of favelas by 2020.<sup>11</sup> So far, the project has helped to improve around 54,000 houses and funded projects for water supply networks, sewage, storm drainage, street lighting and paving. In addition, the project has relocated about 3,000 homes that were in zones that are highly exposed to natural hazards. Playgrounds and landscaping are also on the agenda.

### ***Economic development***

The federal government has adopted the slogan “Pátria educadora” (Educating Nation), to convey that economic development must be based on a knowledge economy. In this context, knowledge means not just basic schooling, but substantial skills, emphasizing the importance of education. Young people who drop out of school and fail to acquire these skills will be at higher risk of being excluded from the new Brazilian economy.

### ***Urban Infrastructure***

Infrastructure investment is well known to be crucial for economic growth – and a shift to a low-carbon economy will require investing in low-carbon infrastructure. Brazil’s economy, which had grown rapidly in recent years, is now stagnating, making it even more important to invest in the right kinds of infrastructure. Achieving this may be a challenge, however, because the current model for infrastructure development, based on concessions, does not provide the required incentives for projects to be launched. One promising initiative is a credit line set up by Caixa Econômica Federal to finance infrastructure projects linked to sanitation, energy, transport and logistics.<sup>12</sup> The government-owned bank has set aside R\$6 billion (about US\$1.6 billion) for this initiative.<sup>13</sup>

<sup>8</sup> See <http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=100>.

<sup>9</sup> See <http://www.caixa.gov.br/voce/habitacao/minha-casa-minha-vida/Paginas/default.aspx> (in Portuguese).

<sup>10</sup> See <http://of.org.br>.

<sup>11</sup> See <http://www.riomaisocial.org>.

<sup>12</sup> See <http://www.caixa.gov.br>.

<sup>13</sup> See <http://www.planalto.gov/CCivil>.

## 2. URBAN ABATEMENT POTENTIAL IN BRAZIL

### Cities have significant potential to contribute to climate mitigation in Brazil.

The greatest potential for emission reductions in Brazil's cities is in transportation, building energy efficiency, and waste management, as shown in the summary of GHG emission inventories of major Brazilian cities (Table 1). The main sources of emissions in these cities are energy (including transportation) and waste management. As an example, Table 2 summarizes the distribution of emissions in Rio de Janeiro.

**Table 1: Annual GHG emissions of major Brazilian cities<sup>14</sup>**

City	Emissions	Year of inventory
São Paulo	15 Mt CO <sub>2</sub> e	2009
Rio de Janeiro	22 Mt CO <sub>2</sub> e	2012
Curitiba	3 Mt CO <sub>2</sub> e	2008
Belo Horizonte	2 Mt CO <sub>2</sub> e	2007

Source: Prefeitura de São Paulo (2014), Prefeitura do Rio de Janeiro (2013), Prefeitura Curitiba (2012), and Prefeitura de Belo Horizonte (2009).

**Table 2: GHG emissions per sector in Rio de Janeiro, 2012**

Sector	% of GHG emissions
Energy	73%
Waste	21%
Industries	4%
Agriculture & land use	2%

Source: Rio de Janeiro's Climate Change Plan.

Most major cities in Brazil have set up councils to discuss climate action. They follow the guidelines of the National Plan for Climate Change Mitigation, but act on a local scale. Belo Horizonte, for example, has a Municipal Plan for Reduction of Greenhouse Gas Emissions acts with four pillars, each led by a work groups: mobility, sewerage, energy, sustainable procurement and adaptation. Similarly, Rio de Janeiro has a Forum for Climate Change and Sustainable Development, which discuss proposals and assesses environmental policies. Usually, these municipal entities are also responsible for preparing and presenting the cities' GHG emissions inventories.

Brazilian cities are also collaborating on climate action, both within Brazil and with partners worldwide. São Paulo is one of the megacities that founded the C40 Cities Climate Leadership Group in 2005, which has grown to more than 75 cities committed to actions that increase well-being in urban areas while mitigating climate change. Rio de Janeiro Mayor Eduardo Paes has been Chair of C40 since 2013, and Salvador and Curitiba are also members. C40 enables cities to exchange ideas and successful practices, and join forces to achieve greater results faster while creating synergies that decrease costs.

Following the C40 example, CB27 in Brazil brings together the Municipal Secretaries of the Environment of the 27 Brazilian state capitals, with the purpose of sharing experiences and

<sup>14</sup> Note the inventories were not all published in the same year; therefore, the comparisons between cities is limited.

collaborating. The aim is not only to discuss environment policies, but also to discuss successful projects that have already been implemented. CB27 has created a database with tools for measuring the performance of projects; it also documents the projects and analyzes their implementation.

In the transportation sector, Brazil has already created a program for improving urban mobility that would reduce GHG emissions by reducing dependence on personal vehicles. Table 3 shows the potential for users of personal cars, buses and other transport modes to shift to new, more efficient modes. Figures 2 and 3 show how ongoing investments in transport are expected to reduce GHG emissions through 2020 by inducing a shift to lower-carbon modes of transport.

**Table 3: Potential for modal shift by users of different transport modes**

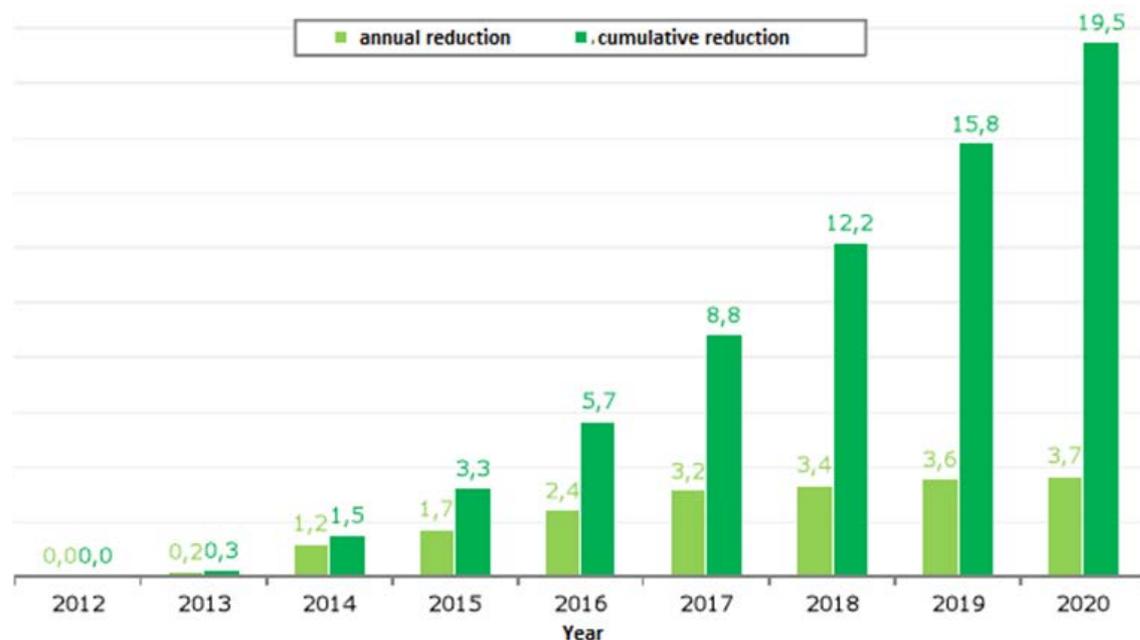
Mode	Bus	Own automobile	Others
BRT and VLT systems	69%	17%	14%
Metro and monorail systems	76%	14%	10%
Bus corridors	86%	-	14%

Source: Sectoral Plan for Mobility 2013.

**Figure 2: CO<sub>2</sub> direct emissions from road transport of passengers (Mt)**



Source: Sectoral Plan for Mobility 2013.

**Figure 3: Reduction of CO<sub>2</sub> direct emissions from road transport of passengers (Mt)**

Source: Sectoral Plan for Mobility 2013.

### **Increasing the energy efficiency of buildings (residential and commercial) and appliances has significant urban GHG abatement in Brazil.**

Electricity use in residential and commercial buildings accounts for about 50% of total power consumption in Brazil, and there is substantial potential for energy savings through efficiency improvements. New buildings constructed according to new standards set out in the Brazilian Labelling Program would use 50% as much energy as the average now, while refurbished older buildings could achieve savings of up to 30%.

Tables 4 and 5 present more data on energy efficiency in the residential sector. This is another area with substantial mitigation potential in Brazil's urban areas. Measures to improve home energy efficiency will contribute to the goals set by the government and institutions.

**Table 4: Increase in energy efficiency of home appliances over a decade**

Equipment	Annual gain (%)	Reasons
Air conditioning	0.5	Technological replacements and measures by manufacturer to improve efficiency
Refrigerator	0.5	
Freezer	0.5	
Washing machine	0.5	
TV	0.3	
Lamps	7.8	Replacement of incandescent lamps
Electric shower	-0.5	Tendency to purchase equipment with higher output

Source: EPE 2015.

**Table 5: Residential sector energy consumption and energy efficiency (urban and rural)**

<b>Consumption (GWh)</b>	<b>2013</b>	<b>2017</b>	<b>2022</b>
Consumption without conservation	122,831	153,655	196,718
Conserved energy	941	8 127	18 059
Conserved energy (%)	0.8	5.3	9.2
Consumption with conservation	121,890	145,528	178,659

Source: EPE 2015.

**Table 6: Commercial sector: Energy consumption and energy efficiency**

<b>Consumption (GWh)</b>	<b>2013</b>	<b>2017</b>	<b>2022</b>
Consumption without conservation	84,006	107,353	145,757
Conserved energy	776	2,966	6,779
Conserved energy (%)	0.9	2.8	4.7
Consumption with conservation	83,230	104,387	138,978

Source: EPE 2015.

The CO<sub>2</sub> avoided from residential and commercial energy conservation displayed in tables 5 and 6 depends on the carbon intensity of the electricity generation no longer needed. In recent years, the *average* carbon intensity of all electricity generation in Brazil has been about 0.1 t CO<sub>2</sub>/MWh. However, the carbon intensity of the new plants being built, and which might better represent the plants being avoided by energy efficiency, has averaged about 0.3 t CO<sub>2</sub>/MWh.<sup>15</sup> For example, and depending on whether the overall average or average *new* electricity source was being avoided, conserving 8,127 GWh of residential electricity in 2017 might represent a CO<sub>2</sub> savings of 0.8 to 2.4 Mt CO<sub>2</sub>.

Another area with significant potential is public lighting. Public lighting is essential for quality of life, to make urban areas safer and more enjoyable at night, for traffic safety, and to illuminate monuments, buildings and landscapes. Energy-efficient technologies such as LEDs make it possible to deliver these benefits while saving up to up to 30% on energy use; energy savings with traffic lights can be as high as 90%. Since 2000, more than 2.5 million public lighting units have been replaced by more efficient ones in more than 1,300 Brazilian cities, at a cost of about R\$500 million.

### **Improving waste management is a critical urban development need and urban GHG abatement opportunity for Brazil.**

The waste sector presents a major challenge for emission reductions. Brazil is ranked 112th among 200 countries worldwide for its sewage systems, scoring 0.581 in 2011 on the Sanitation Development Index. Brazil ranks not only below Europe and North America, but below other Latin American countries, such as Ecuador (0.719), Chile (0.707), Honduras (0.686) and Argentina (0.667). Less than half of the population is connected to sewage systems, and of the sewage collected, only 40% is treated. Similarly, around 40% of the solid waste produced in Brazil is not properly disposed of. With the recent implementation of a National Policy on Solid Waste, it is

<sup>15</sup> Electricity emissions factors reported here are drawn from "CO<sub>2</sub> emission factors for electricity generation in Brazil", <http://www.mct.gov.br/index.php/content/view/73318.html>

expected that the amount of waste generated will decrease, and there will be new incentives for reuse and recycling. Brazil is also aiming to provide universal access to basic sanitation.

### **There are several key institutions active on urban climate mitigation in Brazil.**

Institutions play an important role when it comes to identifying, planning and coordinating climate action at different scales. In Brazil, the National Plan on Climate Change includes both participation in global initiatives and national-level efforts. This plan has four main pillars: mitigation opportunities; impacts, vulnerability and adaptation; research and development; and education, training and communication. The plan also sets specific targets including: reducing Amazon deforestation by up to 80% by 2020, replacing 1 million old refrigerators each year over 10 years, and increasing recycling of solid waste by 20% by 2015. These actions are deployed and controlled by two main institutions:

**Comitê Interministerial sobre Mudança do Clima (CIM):** This committee, includes representatives of 16 Ministries as well as the Civil House (the Chief of Staff of the Presidency), guides the development, implementation, monitoring and evaluation of the National Plan.

**Grupo Executivo sobre Mudança do Clima (GEx):** This group works under the CIM to develop, implement, monitor and evaluate actions under the National Plan. It is composed of representatives of eight Ministries as well as the Brazilian Forum on Climate Change (FBMC)

Another key actor is the Brazilian Panel on Climate Change (PBMC), which is modeled on the structure of the Intergovernmental Panel on Climate Change (IPCC), is responsible for the research and development component of the National Plan. The goal is to provide scientific assessments on climate impacts, vulnerability, adaptation options, and climate actions. The panel's work is meant to inform public policy as well as the general public.

The Climate Observatory,<sup>16</sup> mentioned earlier, is a civil society organization that brings together specialists and social actors aiming to drive climate action. It works to hold the government accountable for meeting its commitments and to adopt further public policies on mitigation and adaptation. Many NGOs are members, including WWF Brazil, Greenpeace Brazil and Engajamundo.

### **Rio de Janeiro: A case study**

Rio de Janeiro is the capital of the state with the same name, located in southeast of Brazil. At 1,260 km<sup>2</sup>, it is the second-largest city in the country (after São Paulo). As noted earlier, Mayor Eduardo Paes is Chair of C40. The city's Secretary of Environment leads the CB27.

Rio de Janeiro faces multiple hazards related to climate change, including more frequent heavy rains, rising sea levels, storm surges, heavy winds, as well as increased waves (exacerbated by the urban heat island effect) and increases in diseases such as dengue that thrive in hot, wet conditions. Aiming to address these risks, Rio has taken several adaptation measures. The Sistema de Alerta Rio (Rio Warning System), for example, integrates data collected from weather radars, allowing the Civil Defense Agency to quickly alert communities of imminent landslide risks, so people can evacuate the area. There are around 165 sirens in 103 communities across the city. In late 2014, the city also created Alerta Dengue Rio, which sends out real-time alerts in the event of a dengue outbreak. Data are collected weekly (e.g. on mosquito concentrations) and disseminated to the public through social media and other venues.

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<sup>16</sup> See <http://www.observatoriodoclima.eco.br>.

The city is also working to reduce flood risks. For example, a project in the Jacarepaguá neighborhood has relocated people who were living on riverbanks that were highly polluted, silted, and at high risk of flood during heavy rains. The rivers are either canalized or restored by planting native vegetation on their banks. The project also protects the riparian habitats from further environmental degradation, creating the possibility of future waterway transportation, and providing a better environment for people, fauna and flora.

### ***Climate change mitigation measures***

The city has developed a Bus Rapid System (BRS) that provides dedicated lanes for buses and taxis during peak hours, allowing them to travel faster. It is also developing a Bus Rapid Transit (BRT)<sup>17</sup> system along dedicated corridors. Both actions improved traffic efficiency and are encouraging the use of public transit, which in turn improves air quality and reduces CO<sub>2</sub> emissions, among other benefits.

Rio is also encouraging the use of bicycles. It has prioritized the creation of 450 km of bike paths within the city, integrated with other transportation modes. The aim is to promote biking as a healthy alternative to automobiles. Supporting this same objective, Rio has also set up a bike sharing service, which now has around 200,000 users.

Reforestation is another significant aspect of Rio's climate-related efforts. The landscape of Rio is very particular, with almost all the remaining forested areas on steep hills that are often occupied by favelas. Replanting trees in these areas has multiple benefits: it protects the soil and prevents landslides, and it also lowers the temperature, increases air quality, helps avoid the spread of wildfires (especially in inhabited areas), and protects the fauna and flora. Rio's reforestation project aims to replant 150 hectares by 2016, and has already helped 150 communities, creating employment for around 800 people.

The program "Rio Green Capital" is another strategic plan for land use, which aims to consolidate 2,000 hectares of land that has already been reforested, in the region of Marapendi, Chico Mendes e Prainha. In addition, Rio also benefits from an urban afforestation program covering 170,000 m<sup>2</sup> of parks and squares. The latter aims to reforest 1,700 hectares between 2009 and 2016, and plant 500,000 new trees.

**Table 7: Actions in Rio's strategic plan for climate and emission reductions**

<b>Actions</b>	<b>Emission reduction by 2016 (tCO<sub>2</sub>e)</b>
Rio Green Capital project + Joint Forces for reforestation	-39,900
Reforestation of squares and parks	-9,800
<b>Total of removals</b>	<b>-49,700</b>

*Source: Rio de Janeiro's Climate Change Plan.*

### ***Mitigation potential for Rio de Janeiro***

The sector that represents the greatest reduction potential is transportation, which now accounts for the majority of emissions from energy use (see Table 2). As noted above, many actions have already been taken to maximize this potential, including improved public transit and cycling infrastructure. Introducing and encouraging the use of clean energy in this sector can also help decrease emissions.

<sup>17</sup> See <http://www.brtrio.com>.

Further reductions can be achieved by changing public perceptions of transit and better integrating transportation modes. The upcoming Olympic Games in 2016 will require further improvements to the public transit system, which 45% of Rio's population already relies on.<sup>18</sup> Ridership is expected to increase with the flow of tourists that the Olympic Games will bring. As a result, after implementation of the specific goals set by the government concerning transportation and mobility, GHG emissions are expected to be reduced by 20% by 2020. The share of people using high-capacity transportation systems such as trains and metro will reach 63% in 2016, compared with 18% in 2010 (before the inauguration of the first BRT). The BRT system alone is expected to avoid 96,624 tons of CO<sub>2</sub> emissions in 2015.

The waste sector accounts for up to 10% of Rio's emissions – 2 million tCO<sub>2</sub>e. As part of a broader effort to bring urban infrastructure and services to an additional 156,000 houses by 2016 (water, waste treatment, public lighting, etc.), recycling will be promoted, aiming to collect 25% the recyclable waste by 2016. Table 8 shows the summary of this potential.

**Table 8: Summary of GHG emissions reduction projections (tCO<sub>2</sub>e)**

<b>Actions</b>	<b>2016</b>	<b>2020</b>	<b>2025</b>
Capture and burning of biogas in Gramacho	329,000	-	-
Capture and burning of biogas in Seropédica	911,000	-	-
Reduced emissions/liquid effluents	-	-	-
<b>Total emission reductions, urban solid waste</b>	<b>1,240,000</b>	<b>--</b>	<b>--</b>

*Source: Rio de Janeiro's Climate Change Plan.*

The energy sector is another important consumer of energy. It is expected that, with the energy efficiency measures considered in Rio's strategic plan, the emissions will drop significantly. Table 9 summarizes estimates of potential reductions from different actions.

<sup>18</sup> See <http://www.pdtu.rj.gov.br/sobre-o-plano.html>.

**Table 9: Potential energy-related GHG emission reductions (tCO<sub>2</sub>e)**

Measure	2016	2020	2025
Reduced emissions/energy (fixed sources)	740	740	740
Installation of LED traffic lights (32,000 units)	640	640	640
My House, My Life project (1,000 units)	100	100	100
Reduced emissions/energy (fugitive emissions)	17,000	11,400	11,400
Replacement of gas network	17,000	11,400	11,400
Reduced emissions/energy (mobile source)	525,00	529,700	530,400
BRT - TransOeste (150,000 passengers/day)	15,500	19,200	19,300
BRT - TransCarioca (380,000 passengers/day)	48,200	48,700	48,900
BRT - 2nd phase TransCarioca (150,000 passengers/day)	19,000	19,200	19,300
BRT - TransOlimpica (100,000 passengers/day)	12,700	12,800	12,900
BRT- Transbrasil (900,000 passengers/day)	115,700	115,900	116,100
BRS Copacabana	17,600	17,600	17,300
Metro Jardim Oceanico (230,000 passengers/day)	85,500	85,500	85,500
Metro - new higher-capacity cars (+550,000 passengers/day)	204,400	204,400	204,400
Expansion of cycle path (300km)	640	640	640

Source: Rio de Janeiro's Climate Change Plan.

### 3. NEXT STEPS FOR URBAN ACTION IN BRAZIL

#### **There are opportunities to improve economic and social conditions while reducing GHGs.**

One major challenge faced by Brazil today concerns land use and how to align transportation policies with spatial planning in order to resolve accessibility and connectivity issues while reducing emissions. The latest IPCC report suggested that one strategy for climate mitigation would be to co-locate high-density residential areas with high-density employment areas. Mixed-use development increases accessibility and therefore reduces emissions. The integration of these areas with various transportation modes can also reduce the commuting distance, achieving further emissions savings in the long term.

An alternative solution to face the challenge of being a sustainable city is shared mobility. This is part of the broader “peer economy” – when owners make goods available to someone else when they are not using them (e.g. Couchsurfing, a website linking travelers to locals who will host them in their homes). This trend is growing every day due to increased access to technology, the spread of social media, and the increase of mobility, but also due to the rise of a “own less to use more” philosophy. Shared mobility can entail shared public services, such as car- and bike-sharing programs.

Shared mobility is already very popular in Europe and North America. In Brazil, although this trend is still maturing, the country already has more than 2,500 shared bikes and 600 shared cars. On the campus of the Federal University of Rio de Janeiro, there are projects being developed to make 600 shared bikes available and to implement an app so students can organize carpools among

themselves. This is expected to decrease the number of cars on campus, and the associated reductions in emissions and transportation mode shifts.

The city of Buzios has demonstrated the application of the Smart Cities concept, which combines sustainable technologies and efficient energy consumption. In Buzios, the power utility, Ampla, has set out to reduce energy consumption for public lighting by 60% by installing LED lamps. In addition, according to the firm, around 222 houses own smart meters, which gives information about their real-time energy consumption. The next step is to establish different pricing schemes that vary according to the time of the day, to encourage conservation during peak periods. Another next step is offering the opportunity for residential net-metering where consumers can generate energy (e.g. solar panels) that can be sold back to the power utility. Ultimately, the project estimates that the average consumer will decrease energy consumption by 30%.

Action for climate mitigation must be supported by government policies. Climate mitigation should be seen as part of a whole and integrated strategy, that delivers benefits for education, health and social services sectors, in order to maximize the synergies of co-benefits. Some policies in one sector can have benefits for another, and thus deliver co-benefits. For example, promoting the integration of land use and transportation planning and providing infrastructure for non-motorized and public transportation will have the co-benefit of increased the accessibility and affordability of travel. Reducing the cost of transportation by improving transportation networks can be a boost to trade and economic activity in the region. Vehicle efficiency regulation, like promoting use of alternative fuels and electric cars, can improve local air quality, which in turn can provide health benefits through the reduction of respiratory and cardiovascular diseases and reduce impacts on urban vegetation. Improvements to mass transportation can support general societal well-being by occupying less physical space than private automobiles and emitting less noise. In addition, financial incentives from governments to encourage the use of technologies can also result in a higher acceptance and affordability of the technology within society.

### **National policy changes are needed to realize urban abatement potential.**

Brazil has made major progress reducing CO<sub>2</sub> emissions in the last 10 years, mostly by achieving an 80% reduction in deforestation and fires. Intense reforestation as part of these efforts can balance eventual increases in emissions linked to the expansion of economic activities, and also help reduce uncertainty about water supply. This progress has led Brazil to argue that other countries have not matched its efforts to reduce emissions. However, Brazil acknowledges the need to have more ambitious goals and has recently made joint statements to that effect with China, the U.S. and Germany. The main pathway for decarbonizing the country economy remains to be further emission reduction in deforestation and clean energy.

One possible way in which Brazil could advance its climate goals is to adopt a carbon price, reflecting the social cost of carbon. Brazil took a step in this direction when it submitted, at the Lima Climate Change Conference in 2014, a proposal conceived by the civil society and directed by the government through the Congressional Commission on Climate Change that states the social and economic value of “carbon reduction”.

Another strategy that would further engage cities in the national effort is to promote the generation of renewable energy in distributed systems. In order to make this viable, the electric national agency (ANEEL), released a resolution in 2012 allowing small and medium generation systems to integrate their energy into the grid. Most of the systems that are being integrated involve solar energy.

Urban development and climate actions overall have the potential to achieve a substantial reduction of carbon emissions and simultaneously improve quality of life. The mayors of big cities should assume leadership of this important climate matter. The potential cumulative emission reductions in cities could help Brazil reduce its national emissions to 1 Gt CO<sub>2</sub> by 2020.

**Cities have a critical role to play in Brazil's national and international climate strategy.**

Several cities in Brazil are already undertaking ambitious climate action. By taking into account the large mitigation potential in urban areas, the national government should gain confidence to raise the ambition of national mitigation commitments. Moreover, city leaders can support the national government in pushing for a better international climate agreement, because cities are now playing a central role in policies and actions related to climate change impacts. Although cities in Brazil have very few economic tools to pursue a low-carbon pathway, since most revenue-raising instruments are their responsibility of federal government, their political influence is huge.

Cities have good reasons to engage in climate action, as they will be significantly affected by the impacts of climate change. Those impacts have a growing economic cost, and staying on a high-carbon pathway has high environmental costs. This means there is no longer a choice to be made between economic growth and emission reduction. Knowing their mitigation options and the benefits of those measures, cities will find it strategic to take action.

City organizations, including those such as C40, can use their leadership role to mobilize and engage Brazilian society to pursue solutions and influence the climate negotiations. Despite all the local-level initiatives under way around the world, a new global climate agreement is essential to advance and inspire greater international cooperation to achieve fair and ambitious action to address climate change.

## REFERENCES

- Boletim de Qualidade do Ar. 2015. Boletim de Qualidade do Ar. [ONLINE] Available at: <http://smac.infooper.net/smac/boletim>. [Accessed 17 July 2015]
- Clemente, W. (2015). Urbanização - Metrôpoles em movimento. [online] Ipea.gov.br. Available at: [http://www.ipea.gov.br/desafios/index.php?option=com\\_content&view=article&id=994:reportagens-materias&Itemid=39](http://www.ipea.gov.br/desafios/index.php?option=com_content&view=article&id=994:reportagens-materias&Itemid=39) [Accessed 6 Jul. 2015].
- Fórum Clima / IES Brasil. 2015. Fórum Clima / IES Brasil. [ONLINE] Available at: <http://www.forumclima.org.br/pt/home>. [Accessed 12 July 2015].
- Government of Brazil (2010). Letter including nationally appropriate mitigation actions. In *Copenhagen Accord, Appendix II: Nationally appropriate mitigation actions of developing country Parties*. [http://unfccc.int/files/meetings/cop\\_15/copenhagen\\_accord/application/pdf/brazilphaccord\\_app2.pdf](http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/brazilphaccord_app2.pdf).
- Inea.rj.gov.br, (2015). Inea - Portal. [online] Available at: [http://www.inea.rj.gov.br/Portal/MegaDropDown/ProgramaseProjetos/INEA\\_019766&lang=PT-BR#ad-image-0](http://www.inea.rj.gov.br/Portal/MegaDropDown/ProgramaseProjetos/INEA_019766&lang=PT-BR#ad-image-0) [Accessed 6 Jul. 2015].
- IPCC (2014). Summary for Policymakers. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, et al. (eds.). Cambridge University Press, Cambridge, UK, and New York. <https://www.ipcc.ch/report/ar5/wg3/>.
- Kahn Ribeiro, S. and Figueroa, M. (2015). Energy for road passenger transport and sustainable development: assessing policies and goals interactions. *Current Opinion*, 5(2), p.5.
- Miller, J., Façanha, C. and Minjares, R. (2013). *Impact of Standards on Premature Mortality and Emissions: Brazil*. ICCT briefing. International Council on Clean Transportation. <http://www.theicct.org/impact-standards-premature-mortality-and-emissions-brazil>.
- Ministério da Ciência, Tecnologia e Inovação, (2015). Estimativas Anuais de emissões de gases de efeito de estufa no Brasil. [online] Available at: [http://www.mct.gov.br/upd\\_blob/0235/235580.pdf](http://www.mct.gov.br/upd_blob/0235/235580.pdf) [Accessed 10 Jun. 2015].
- Ministério dos Transportes and Ministério das Cidades. (2013) Plano Setorial de Transporte e de Mobilidade Urbana para Mitigação e Adaptação à Mudança do Clima (Pstm) [Sectoral Plan for Mobility]. BRASÍLIA/DF. June 2013. Available at: [http://www.transportes.gov.br/images/ACOES\\_PROGRAMAS/Politica\\_MeioAmbiente.pdf](http://www.transportes.gov.br/images/ACOES_PROGRAMAS/Politica_MeioAmbiente.pdf)
- Miraglia, S. G. E. K., Saldiva, P. H. N. and Böhm, G. M. (2005). An Evaluation of Air Pollution Health Impacts and Costs in São Paulo, Brazil. *Environmental Management*, 35(5). 667–76. DOI:10.1007/s00267-004-0042-9.
- Observatoriodoclima.eco.br, (2015). Emissões da pecuária são tema de nova tira de Fernando Gonsales para o OC. [online] Available at: <http://www.observatoriodoclima.eco.br/> [Accessed 6 Jul. 2015].
- PBMC/Coppe, (2015). Sumário Executivo Mitigações das Mudanças Climáticas. [online] Available at: [http://www.pbmc.coppe.ufrj.br/documentos/pbmc\\_sumario\\_executivo\\_gt3.pdf](http://www.pbmc.coppe.ufrj.br/documentos/pbmc_sumario_executivo_gt3.pdf) [Accessed 15 Jun. 2015].
- Prefeitura Curitiba (2012). *Inventário de emissões de gases de efeito de estufa em Curitiba*. <http://multimidia.curitiba.pr.gov.br/2012/00118446.pdf>.
- Prefeitura de Belo Horizonte (2009). *Inventário de emissões de gases de efeito de estufa Belo Horizonte*. [http://www.pbh.gov.br/smpl/PUB\\_P015/Relat%C3%B3rio+Final+Gases+Estufa.pdf](http://www.pbh.gov.br/smpl/PUB_P015/Relat%C3%B3rio+Final+Gases+Estufa.pdf).

- Prefeitura de São Paulo (2014). *Inventário de emissões e remoções antrópicas de gases de efeito de estufa no município de São Paulo*.  
[http://www.antp.org.br/\\_5dotSystem/download/dcmDocument/2014/02/18/F4A437CC-081C-4D9E-A34D-2196CF4C7FE4.pdf](http://www.antp.org.br/_5dotSystem/download/dcmDocument/2014/02/18/F4A437CC-081C-4D9E-A34D-2196CF4C7FE4.pdf).
- Prefeitura do Rio de Janeiro (2013). *Greenhouse gas emission inventory for Rio de Janeiro 2012*.  
[http://www.rio.rj.gov.br/dlstatic/10112/1712030/4114527/CRJ\\_InventarioGEE2012\\_resumo\\_tecnicoINGLESFINAL1.pdf](http://www.rio.rj.gov.br/dlstatic/10112/1712030/4114527/CRJ_InventarioGEE2012_resumo_tecnicoINGLESFINAL1.pdf).
- Prefeitura do Rio de Janeiro, (2015). Vulnerabilidade à elevação do nível médio do mar na Região Metropolitana do Rio de Janeiro. [online] Available at:  
[http://portalgeo.rio.rj.gov.br/estudoscariocas/download%5C3207\\_\\_Vulnerabilidadeaelevacaodonivelmediodomarna\\_RMRJ.pdf](http://portalgeo.rio.rj.gov.br/estudoscariocas/download%5C3207__Vulnerabilidadeaelevacaodonivelmediodomarna_RMRJ.pdf) [Accessed 16 Jun. 2015].
- Riomaissocial.org, (2015). Rio+Social. [online] Available at: <http://www.riomaissocial.org/> [Accessed 6 Jul. 2015].
- Valor Econômico, (2015). FGV: Brasil precisa de R\$ 76 bi ao ano para zerar déficit habitacional. [online] Available at: <http://www.valor.com.br/brasil/3733244/fgv-brasil-precisa-de-r-76-bi-ao-ano-para-zerar-deficit-habitacional> [Accessed 8 Jun. 2015].
- Veicular.cetesb.sp.gov.br, (2015). Proconve | Emissão Veicular - Sistema Ambiental Paulista - Governo de SP. [online] Available at: <http://veicular.cetesb.sp.gov.br/proconve/> [Accessed 6 Jul. 2015].
- VELLOSO, J. P. D. R. E LEVY, J. V. F. Diante da nova revolução industrial
- Texto do livro: (VellosoLevy, [s.d.]
- Bibliografia: Velloso, J.; Levy, J. Diante da nova revolução industrial. Tradução .
- UN (2014). *World Urbanization Prospects: The 2014 Revision*. United Nations Department of Economic and Social Affairs, Population Division, New York. <http://esa.un.org/unpd/wup/>.