BRAZILIAN CENTER FOR
INTERNATIONAL RELATIONS

INFRASTRUCTURE AND ENERGY PROGRAM,
I MEETING, YEAR III

INFRASTRUCTURE AND ENERGY PROGRAM

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RIO DE JANEIRO, FEBRUARY 21, 2019

Panelists: Marcelo Porto, Luis Antonio Lindau, Paul Antoine Matthieu and Hans van Ammers

Authors: Clarissa Lins and Bruna Mascotte

The role of cities in the energy transition

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The role of cities in the energy transition

Content: CATAVENTO

Sponsorship: Reino dos Países Baixos

INFRASTRUCTURE AND ENERGY
PROGRAM

This Program encourages the discussion on questions related to the energy and Oil & Gas (O&G) sectors and their global trends.

Its focus has been to investigate topics with the potential to enhance the insertion of the Brazilian industry into global chains and influence the formulation of public policies that create a competitive and attractive investment environment, such as technological innovations and their impacts on the sectors' competitiveness; the geopolitical impacts of the increasing relevance of renewable sources in the global energy mix; the identification of anchor sectors for fossil fuel demand in the long term; changes in the sectors' regulations, etc.

TRUSTEE

Jorge Camargo

President of the Brazilian Petroleum, Gas and Biofuels Institute (IBP) and senior advisor at McKinsey & Company. Previously, he worked for Statoil, as senior vice-president in Norway and later as president of Statoil in Brazil. He is also a member of the Board of Directors at Ultrapar Group and at Prumo Logistics.

SENIOR FELLOW

Clarissa Lins

Clarissa is a founding partner at Catavento, a consulting firm that specializes in strategy and sustainability. She is the executive director at the Brazilian Petroleum, Gas and Biofuels Institute (IBP) and a member of the Sustainability Committee at Vale. Clarissa has also worked for Petrobras and BNDES.

EXECUTIVE DIRECTOR

Julia Dias Leite

Julia is CEBRI's executive director since 2015. Previously, she worked for 10 years in the Brazil-China Business Council, where she occupied the position of executive secretary. Recently, she was chosen by the U.S. State Department to participate in the Young World Leaders program.

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PANELISTS

Mr. Drs. Paul Antoine Matthieu

Senior manager Area Development, project director Energy Transition,
Municipality of Nijmegen (Netherlands)

Throughout his whole career, Mr. Drs. Paul Antoine Matthieu has been involved in a wide variety of social, economic and political issues and projects at different large municipalities in the Netherlands. Currently, as senior manager for Area Development and project director for Energy Transition in Nijmegen, he is responsible for policymaking focused on energy transition and for projects related to sustainable energy supply for households, transition from natural gas to electric heat in buildings and development of a new sustainable train station in the city centre. The city has been awarded the “European Green Capital 2018” for medium and large sized cities by the European Commission. Previously, Mr. Drs. Paul Antoine Matthieu was P2 Managers Ltd founding partner (1997-2010), founder and director in Kasteel Kiekeboe day care (1994-2002), City councilor in the Municipality of Arnhem (1994-1998) and Education Director in the Municipality of Deventer (1987-1995). His experience as entrepreneur, supervisor, project manager, city councilor and board member in various settings has given him the opportunity to achieve a wide range of results, especially when coproduction is demanded between government parties and private investors. He also has a strong motivation to contribute to make cities vital, sustainable and ready for the future. He has a degree from the University of Groningen, Faculty of social science and Faculty of Law.

Mr. Drs. Hans van Ammers

Senior advisor on Climate Mitigation and Climate Adaptation,
Municipality of Arnhem (Netherlands)

During his career, Mr. Drs. Hans van Ammers has been involved in various policy areas aiming at improving the physical quality of the city and its surroundings: soil, green, water, environment and now climate policy. Currently, as senior advisor on Climate Mitigation and Climate Adaptation in the Municipality of Arnhem, he works to foster the transition towards a fossil fuel free society and a climate resilient city to live, work and recreate in. He believes climate mitigation is not only a technical and financial challenge, but also a social one, since we have to achieve a fair transition. He believes this can only be achieved with a tailor-made approach listening to stakeholders in order to build a strategy that is achievable, affordable and fair. Previously, he has been Senior policy advisor for soil pollution, Coordinator for city water management and Chief officer for public space in the Municipality of Arnhem (1992- current). He has also been project manager for soil contamination at ARGUS Milieukundig Ingenieursbureau: (1989-1992). Mr. Drs. Hans van Ammers has a degree in Physical Geography from the University of Utrecht.

Marcelo Porto

Vice President, IBM Cloud Latin America

Highly passionate about technology and innovation, Marcelo has worked in IBM for more than 30 years, being IBM Brazil CEO between 2015 and 2018. Previously, he was Enterprise Sales VP, responsible for clients around the country ranging from finance, insurance, retail, industry and others. In 2012, he spent the year in IBM headquarters in Armonk, New York, supporting the global CEO Ginni Rometti in project development with clients around the world. Among the leadership positions Marcelo occupied in strategic areas throughout his IBM career, one should highlight Software VP in IBM Brazil, Director for Small and Medium Size Companies Services in IBM Latam and Marketing Director. Porto has a degree in Systems Analysis from PUC-Rio.

Luis Antonio Lindau

Director, World Resources Institute (WRI) Cities

Ph.D in transportation, Mr Lindau is WRI Cities director in Brazil, where he leads and supplies technical orientation for the implementation of WRI's global strategy for sustainable cities. Lindau was one of ANPET' (Transportation Research and Teaching Association)'s founders, where he was the president between 2002 and 2006. In 1995, he implemented LASTRAN, UFRGS's Transportation System Lab. During the 80s, Lindau worked as a consultant for the Brazilian Company for Urban Transportation (EBTU). He was a member of the Transportation Committee for Developing Countries (ABE90) at the Transportation Research Board (TRB), and was part of the Board of the Nacional Public Transportation Association (ANTP). Luis Antonio Lindau holds a degree in Civil Engineering from UFRGS, a Ph.D in transportation from Southampton University and a post doctorate by the University College London.

THE ROLE OF CITIES IN THE ENERGY TRANSITION

The first event organized by the CEBRI Infrastructure and Energy Program in 2019 leveraged on the support of the Dutch Consulate in Rio de Janeiro, and focused on discussing the global trends that are reshaping cities and how they interact with the energy transition.

Starting with opening remarks by Jorge Camargo, CEBRI Trustee, the event relied on moderation by Clarissa Lins, Catavento Consultoria's founding partner and CEBRI senior fellow. The panel benefitted from insights presented by Marcelo Porto - Vice President at IBM Cloud Latin America -, Luis Antonio Lindau – Director at WRI Cities Brazil -, Paul Antoine Matthieu - project director for Energy Transition in Nijmegen, Netherlands – and Hans van Ammers - senior advisor on Climate Mitigation and Adaptation in Arnhem, Netherlands.

This paper consolidates the content presented by each participant, as well as the debate that followed, respecting the Chatham House rules usually applied to the events hosted by CEBRI's Infrastructure and Energy Program. It also includes additional insights provided by Catavento Consultoria.

EXECUTIVE SUMMARY

By concentrating people, economic activity, and infrastructure, cities offer unique opportunities to deliver greater prosperity, improve well-being and tackle climate change. Acting as nodes in global flows of capital, people and goods, cities generate 80% of the global GDP and more than 70% of global GHG emissions [1]. Rapid urbanization will lead to approximately 70% of the global population in cities by 2050, from 55% in 2018 [2]. At the same time, cities have been gathering increased relevance in the global climate action, while they are the most impacted by climate change and aging infrastructure.

The key strategic areas where cities should address climate change and energy transition are decarbonizing the electricity grid, optimizing energy efficiency in buildings, enabling next generation mobility and improving waste management.[3] Regarding the power generation grid, experts believe that, depending on local conditions, market and regulatory structure, renewables could account for 50-70% of power generation in urban centers by 2030.[4] At the same time, integrated mobility systems could produce benefits, such as improved safety and reduced pollution, worth up to $600 billion. [5] Buildings energy efficiency, smart waste management and climate resilience strategies also offer relevant room for opportunities in cities. Urban climate action can not only decrease air pollution-related deaths and mitigate climate impacts, but also generate jobs and investment opportunities that vary according to local characteristics and urban realities.

Technology can help cities handle an increasingly huge amount of available data in order to improve decision-making and the well-being of its citizens, while fostering a cleaner and more efficient livelihood. Connected applications put real-time, transparent information into the hands of users to help them make better choices. These tools can save lives, prevent crime, and reduce the disease burden. They can also save time, reduce waste, and even help boost social connectedness when safely and timely applied. Among the smart applications that can leverage the urban energy transition, we could highlight weather monitoring and forecasting, buildings' energy consumption trackers, smart streetlights, real-time transit information, autonomous and electric vehicles, predictive maintenance of infrastructure, intelligent traffic signals, digital tracking and payment for waste disposal. The application of these and other technologies could reduce commuting time in 15-20%, GHG emissions by 10-15%, unrecycled waste by 10-20% and water consumption by 20-30%,

1. 100RC. "Cities taking action in building urban resilience". 2017
2. UN. "World Urbanization Prospects 2018". 2018
3. C40. "Focused acceleration: A strategic approach to climate action in cities to 2030". 2017
4. C40. "Focused acceleration: A strategic approach to climate action in cities to 2030". 2017
5. McKinsey. "The futures of mobility - How cities can benefit". 2017

varying according to the specific urban scenario.[6] Although technology can be a potential powerful ally in the urban energy transition, some issues must be taken into account, such as cybersecurity and social inclusion.

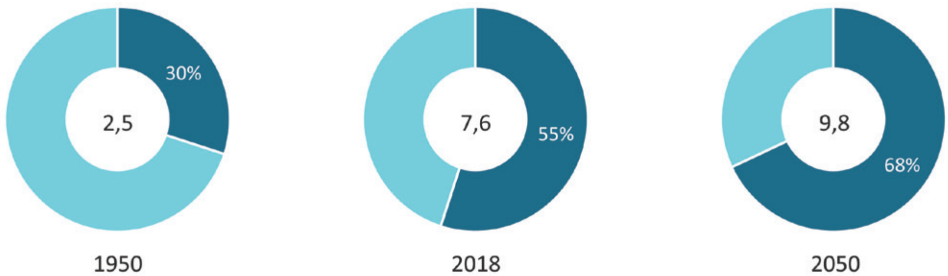
Brazil urban context is highly complex, but a comprehensive and robust city planning that integrates technology, climate and energy transition goals could help to foster cleaner, more efficient and inclusive cities. Brazilian cities face rapid population growth and inadequate infrastructure, leading to challenges that range from congestion, high levels of air pollution, low quality education and health services to lack of sanitation, and violence. How to reconcile climate change and energy transition with so many other pressing issues? Setting long-term goals could mitigate the current challenges, while integrated strategies for sustainable development can generate jobs, attract investments in low carbon economy and reduce poverty and inequality.

6. McKinsey. “Smart cities: Digital solutions for a more livable future”. 2018

INTRODUCTION: WHY CITIES?

Cities are at the center stage of the global discussion around energy transition, acting as nodes in global flows of capital, people and goods. In 1990, only 30% of the global population was urban. In 2018, this percentage accounted for 55% of the global population. Up to 2050, an additional 2.5 billion people will be living in cities worldwide, largely driven by Asian and African growth, representing almost 70% of the global population.[7] This accelerated trend means that urban areas are expected to increase in size by 80% between 2018 and 2030[8]. In this scenario, around US$ 700 billion will be needed annually for urban infrastructure projects in sectors such as transportation and energy [9].

Percentage of global population living in urban areas
billion people



Sources: Catavento analysis based on UN. "World Urbanization Prospects 2018". 2018

Cities are at the forefront of the challenges and opportunities of the 21st century. Understanding the implications of the way cities live, commute and access services such as electricity, connectivity and air conditioning is key to assess our footprint on natural resources. Urban centers are the driving force of the global economy, generating around 80% of the global GDP. Nonetheless, they are also responsible for more than 70% of global GHG emissions [10], mainly because of how citizens use energy, live and commute.

Currently, nearly a billion urban residents live in informal settlements mainly in developing countries, without access to adequate housing, secure tenure, or improved water and sanitation [11]. More mature cities, on the other side, are struggling with chronic congestion

7. UN. "World Urbanization Prospects 2018". 2018
8. WRI. "Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South". 2019
9. C40. "Focused acceleration - A strategic approach to climate action in cities to 2030". 2017
10. 100RC. "Cities taking action in building urban resilience". 2017
11. New Climate Economy. "New Climate Economy 2018 Report". 2018

and toxic air pollution, yet private car ownership is projected to increase by as much as 60% in developed countries and up to 500% outside the OECD by 2050 [12].

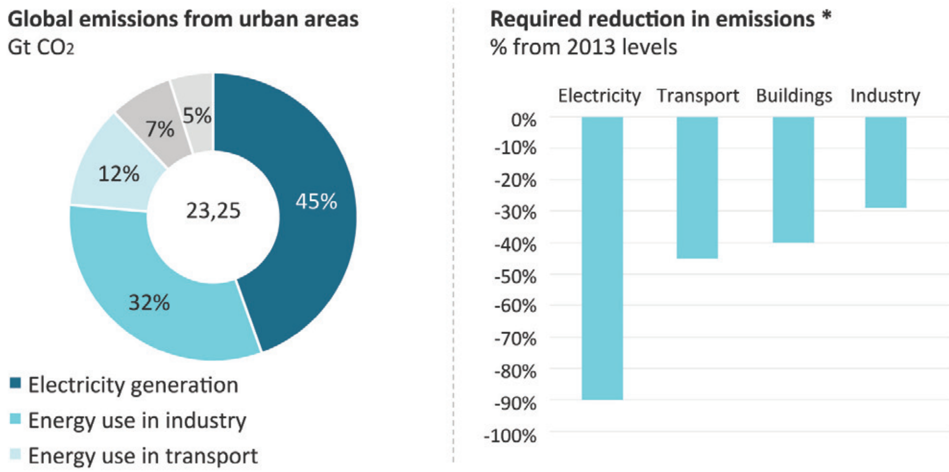
The impacts of climate change, aging infrastructure, population growth, mass migration, social and economic inequity are all disproportionately borne by urban centers.[13]

Since they are directly exposed to the consequences of resource stresses, cities are increasingly playing a leading role in global climate action. Some examples of actions taken relate to imposing congestion charges in urban centers, pushing for the next generation mobility or decarbonizing the power grid. At the same time, disruptive technologies have the potential to lead us through this transition, transforming the way cities operate and turning them smarter and more efficient.

12. OECD, ITF. “ITF Transport Outlook 2013: Funding Transport”. 2013
13. C40. “Focused acceleration - A strategic approach to climate action in cities to 2030”. 2017

CITIES ENERGY TRANSITION STRATEGIES

Cities all over the world are looking for increased sustainability, resilience and well-being. Global emissions from urban areas are concentrated in power generation and industry, while the greatest potential for emissions reduction come, respectively, from electricity, transport and buildings. Therefore, the priority areas for climate action and energy transition in cities are (i) decarbonization of power generation, (ii) adaptation to next generation mobility, (iii) optimization of buildings energy efficiency, (iv) waste management improvement and (v) climate adaptation and resilience.



** Emissions reductions needed to keep warming to up to 2°C, from 2013 levels.*
Sources: Catavento analysis based on C40 – "What the IPCC Special Report on Global Warming of 1.5°C means for cities", 2018; C40 – "Focused acceleration A strategic approach to climate action in cities to 2030", 2018

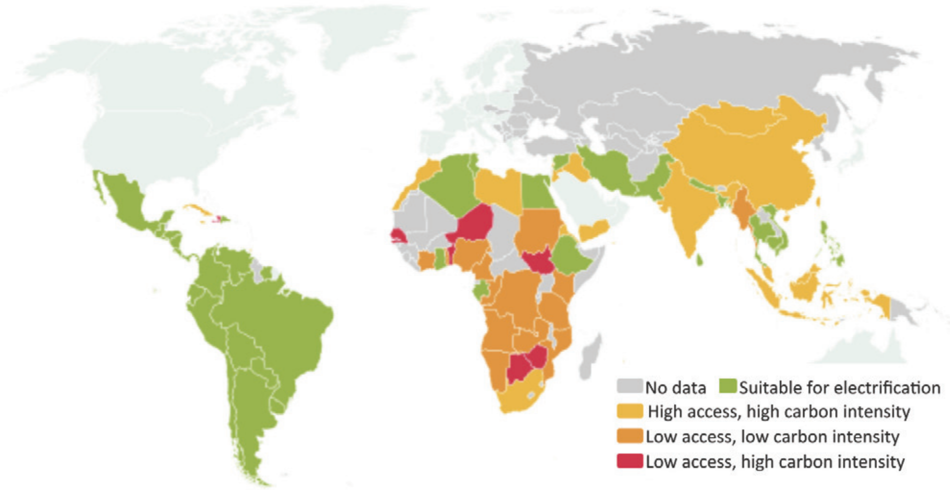
Decarbonizing the power generation grid requires a proper market and regulatory structure, in order to include renewable resources. Experts believe that renewables could account for 50-70% of power generation in urban centers by 2030.[14] While cities may believe they have little influence over the grid mix, in fact, they often represent a major portion of local electric utility's customers, potentially giving them significant leverage to shape the emissions profile of the electricity consumed within their metropolitan area. At the same time, utilities and regulators must play a central role in ensuring the overall mix of renewables is appropriately balanced and that components such as energy storage are in place to ensure grid reliability. Nevertheless, cities have an essential role to play by setting clear decarbonization goals, aggregating demand for renewables in either distributed or centralized systems, promoting energy efficiency, and shifting more urban energy consumption to electricity. If efficiently implemented, grid decarbonization could

14. C40. "Focused acceleration: A strategic approach to climate action in cities to 2030". 2017

account for 35-45 % of the total emissions reductions in cities needed by 2030 in order to be aligned with a 2°C warming of global temperatures. [15]

According to World Resources Institute (WRI), Brazil and its cities have a great potential to electrify their energy use. As seen in the map below, the Brazilian attractiveness relies on the high level of urban access to electricity and the low carbon intensity of electricity supply. [16]

Countries and cities in the global south suitable for electrification



Sources: World Resources Institute (WRI). "Shifting currents: opportunities for low-carbon electric cities in the global south". 2019

Promoting the next generation mobility would mean ensuring a variety of attractive and affordable low carbon options to citizens. The World Health Organization estimates that 1.25 million people died in road crashes in 2015 [17] and congestion is a serious issue in many cities, costing as much as 2-4% of national GDP, by measures such as lost time, wasted fuel, and increased cost of doing business [18]. Given this scenario, a McKinsey analysis indicates that in 50 metropolitan areas around the world, home to 500 million people, integrated mobility systems could produce benefits, such as improved safety and reduced pollution, worth up to $600 billion.[19] This requires remodeling cities that were initially shaped for cars.

According to the WRI, if cities simply electrified their whole fleet, this would lead to erroneous urban mobility concepts such as "clean congestion" and "low carbon fatalities"[20]. That is why WRI has a triple vision for mobility: zero fatalities, zero emissions and zero exclusions. This means fostering fleets of autonomous vehicles (AVs) that are shared and

15. C40. "Focused acceleration: A strategic approach to climate action in cities to 2030". 2017
16. World Resources Institute (WRI). "Shifting currents: opportunities for low-carbon electric cities in the global south". 2019
17. World Health Organization (WHO). "Global status report on road safety 2015". 2015
18. McKinsey. "Urban mobility at a tipping point". 2015
19. McKinsey. "The futures of mobility - How cities can benefit". 2017
20. WRI, Luis Antonio Lindau. "Changing the way cities move". 2019

electric, as well as sustainable urban planning, clean and smart public transportation. Cycling infrastructure, express bus lines (eg.: BRTs) and urban freight optimization are also among the initiatives that cities could promote.

This is not to say that the transition to the next generation mobility will have no drawbacks. There could be some social and labor impacts, as shifts in employment, for example, could occur as more autonomous and electric vehicles roll out, reducing the need for drivers and mechanics. Also, there is a potential fiscal revenue impact, as the extensive adoption of electric vehicles could reduce revenues from fuel taxes by 20% to 65% unless taxation systems are reconfigured. [21] On the other hand, connectivity and the Internet of Things (IoT) could be used to levy and collect new taxes for the use of infrastructure on a per-mile basis or for time spent driving in heavily traveled districts.

Globally, buildings energy efficiency is one of the key areas where local stakeholders have more influence to address, either through regulation, investments or partnerships. Buildings heating and cooling account for 35 - 60% of total energy demand around the world and, on average, produce nearly 40% of emissions. Cities' opportunities in this area include raising building standards for new construction, retrofitting building envelopes, upgrading heating, ventilation and air conditioning (HVAC) and water heating technologies, and implementing lighting, appliance, and automation improvements. While cities generally have more influence over this area than many others, progress will still require city leaders to work closely with building owners, both residential and commercial, real estate developers, and building occupants.[22]

Waste management is also one of the key areas where cities can foster the energy transition and climate mitigation, either through the promotion of a circular economy, or the application of new technologies to reduce emissions from waste. Methane emissions from waste have 28-36 times the near-term global warming potential of carbon dioxide[23] and reducing waste also has a negative impact on the full life cycle emissions of consumption.[24] Some cities are already using this methane generation from waste potential for cleaner and more efficient uses, such as Rio de Janeiro's waste to energy plant in Seropédica that processes 10,000 tons of waste daily in order to produce 20,000 cubic meters of purified gas per hour. The biogas is used for power generation and as an industrial raw material, leading to a reduction of 1,5 million tons of CO2eq and 70 million m^3 of methane emissions between 2011 and 2016.[25]

Finally, climate resilience is a complementary approach to emissions reduction, since it focuses on mitigating the unavoidable impacts of climate change. Urban resilience is defined as "the capacity of individuals, communities, institutions, businesses, and systems

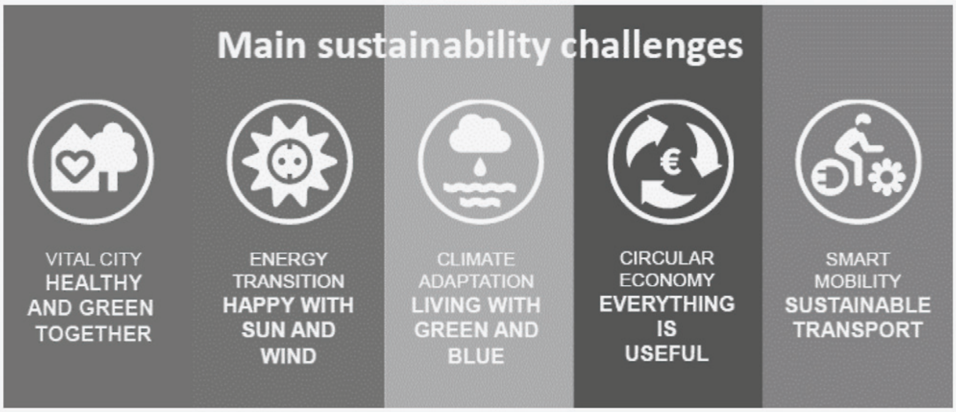
21. McKinsey. "The futures of mobility - How cities can benefit". 2017
22. C40. "Focused acceleration: A strategic approach to climate action in cities to 2030". 2017
23. USA Environmental Protection Agency (EPA). "GHG - Understanding Global Warming Potentials". 2019
24. C40. "Focused acceleration: A strategic approach to climate action in cities to 2030". 2017
25. Ciclus, Comlurb. "Apresentação Institucional". 2016; Reuters. "Rio de Janeiro hits the gas in push toward its zero carbon goal". 2019

within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience". Resilience intends to allow cities to prosper in the face of these challenges, helping them to prepare for both the expected and the as-yet unimagined[26]. In this context, the higher population densities of urban areas increase the exposure and vulnerability to climate change and fosters the need for risk-reducing infrastructure and services, such as drains, sewers, piped water, and paved roads. At the same time, an efficient and smart urban planning focused on increasing green and resilient areas can help reduce the impact of floods and other extreme weather events, on top of a timely use of technology appliances.

Some lessons from Dutch cities

Nijmegen and Arnhem are two cities located in central Netherlands, which together have little more than 300.000 inhabitants and are 17km apart. Due to this scenario, sustainability is fostered based on a "twin cities" approach, focusing on regional cooperation and integration. This partnership concept helps to catalyze sustainable action and could also be applied to large metropolitan areas with different municipalities around it, such as Rio de Janeiro and São Paulo.

Nijmegen and Arnhem: "twin cities" sustainability priorities



Source: Paul Matthieu and Hans van Ammers. "The role of Dutch cities in the energy transition". 2019

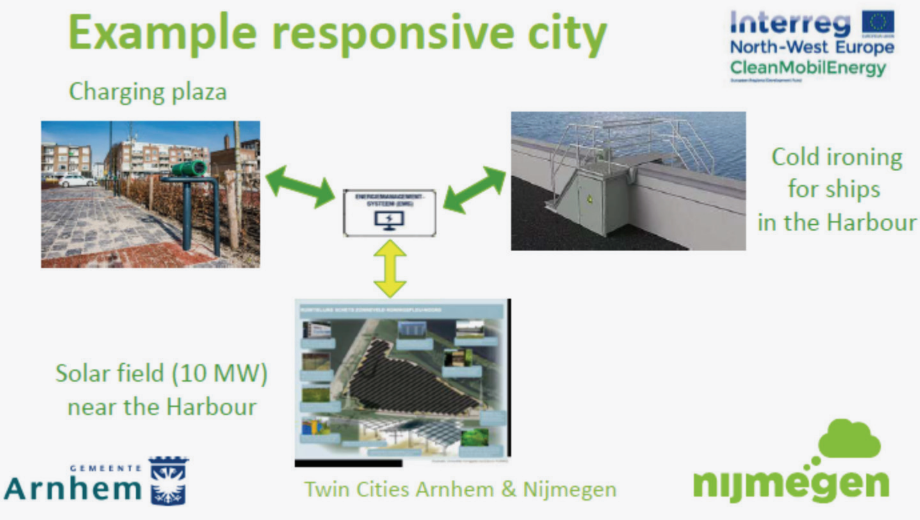
According to Nijmegen and Arnhem representatives, cities need to take an active role in the energy transition. Among the local governmental roles, one could highlight regulating, performing, cooperating and networking. Regulating relates to the governmental role of setting guidelines, laws and promoting checks and balances. A city performs by conducting its own governmental funded and led sustainable initiatives, such as those related to public transportation and power grid adaptation. On the cooperating and networking fronts, there is an increased relevance of fostering partnerships and engagement

26. 100RC. "Cities taking action in building urban resilience". 2017

with different stakeholders. This coordination and network should be fostered by a responsive government, that incentivizes citizens-led initiatives. One of the ways to conduct this is based on the so called "living labs", ecosystems or platforms that enable networking and the creation of pilots to solve sustainability challenges, by bringing together different players such as universities, citizens, companies and startups.[27]

These "living labs" would enable cities to start small, with pilots, in order to gain trust from citizens that the government can help them to scale up sustainable initiatives. They would also promote networking, foment partnerships and endorse both smaller and bigger projects focused on energy transition. For example, as highlighted in the image below, this local government responsiveness led to a partnership between three different sustainable projects, conducted by three different companies in the region. One of them wanted to build a solar energy plant, the other was focusing on e-mobile charging spots and the third one aimed at providing low carbon energy for ships in the regional harbor. The local governments, then, brought them together and managed for the projects to be leveraged, scaled and financed.

"Living labs" result



Source: Paul Matthieu and Hans van Ammers. "The role of Dutch cities in the energy transition". 2019

There is also an important role for local governments in setting long-term goals, in order to reduce political volatility risk and mitigate the lack of political will in tackling climate and energy transition issues. While the Netherlands are committed to have all public transport with zero emission by 2030, it is the role of cities to respond based on each regional context. Nijmegen, for example, is fomenting biogas from waste for public transportation, electric trolleys and cycling networks.

27. Paul Matthieu and Hans van Ammers. "The role of Dutch cities in the energy transition". 2019

Finally, a city energy transition strategy needs to consider the local context, including size, degree of economic development, education levels, priority issues, energy mix and availability of natural resources. Dutch cities lessons cannot simply be replicated into Brazilian cities. Small, high income, innovator cities around the world usually have slow-growing income and population, and significant local political power, with an extensive history of climate action. They usually rely on decarbonized grids with further low carbon push planned, as well as low solar radiation. On the mobility side, developed cities tend to rely on extensive transit systems with connections to walking, cycling and shared mobility services. Finally, they usually have advanced waste management and ultra-high efficiency standards for building construction and equipment.

On the other side, middle- or low-income mega cities have fast-growing populations and income, while climate action is often timid. They tend to rely on carbon intensive grids, with limited decarbonization planned, but high solar radiation. Some of them have invested on new and extensive transit systems, but car use and ownership are still expected to grow, as well as rapid growth in buildings with low efficiency and limited waste collection and emissions management.[28] These highly different contexts lead to a diverse set of opportunities when addressing energy transition, as can be summarized in the table below.

Small, high income, innovator city

- Focus on centralized renewables, reaching up to 90% of zero carbon power grid by 2030
- Cooling and heating upgrades in buildings
- Ultra high efficiency building standards, with 95% of post-2017 buildings being ultra high efficiency
- Mobility: next generation vehicles with extensive uptake of autonomous vehicles, with 100% of public transportation being net zero-emission and increased shared mobility

Middle or low income mega city

- Renewables accounting for 70-75% of power grid, either in centralized or distributed context, depending on regional scenario
- Ultra high efficiency standards in 65% of post-2017 buildings
- 80% of private buildings with retrofit
- 65% of waste diverted from land or incineration
- Mobility: infrastructure improvements, focus on cost effective solutions, little uptake of autonomous vehicles due to infrastructure quality but strong shift towards electricity

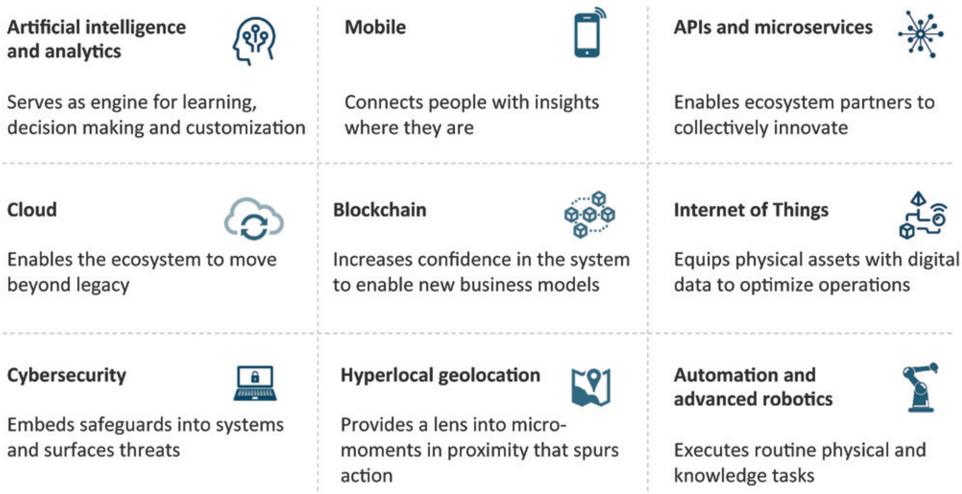
Source: Catavento analysis based on C40. "Focused acceleration A strategic approach to climate action in cities to 2030", 2017. McKinsey. "The futures of mobility - How cities can benefit". 2017;

28. McKinsey. "The futures of mobility - How cities can benefit". 2017; C40. "Focused acceleration: A strategic approach to climate action in cities to 2030". 2017

THE ROLE OF TECHNOLOGY: A SMARTER AND MORE EFFICIENT TRANSITION

Data is by some experts called the *natural resource* of the 21st century. It also holds some similarities with oil, since it becomes worthless if stakeholders are not able to extract actual value from it. Data is, therefore, redefining the future of business and entities in the global economy. According to IBM, 2.5 quintillion bytes of data are generated daily and, by getting it right, policy makers and businesses could generate up to $11.1 trillion a year in economic value by 2025 [29]. In the last 10 years, technology has already dramatically changed the way we live, consume, interact, get informed, work and do business, largely thanks to the cost reduction of cloud computing and its ability to host increasingly complex algorithms.[30]

New technologies accelerate business, industry and geopolitical disruptive forces. The fusion of multiple exponential technologies powers both disruption and tremendous opportunity, including for cities. Some examples of these disruptive technologies are summarized in IBM's framework below:

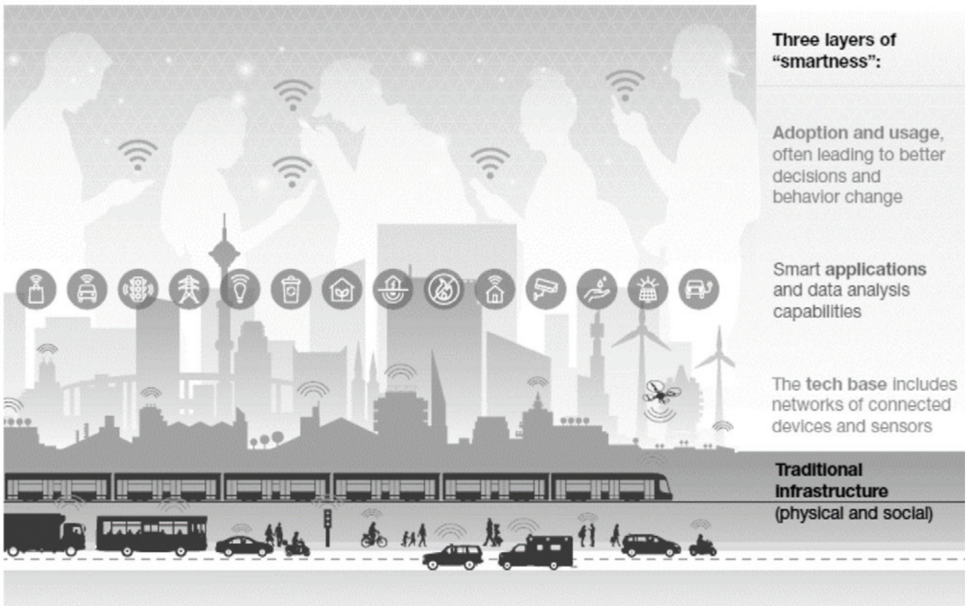


Source: IBM. "Let's put smart to work - Smarter Cities: Cognitive approaches to long-standing challenges". 2019

29. McKinsey. "Unlocking the potential of the Internet of Things". 2015
30. IBM. "Let's put smart to work - Smarter Cities: Cognitive approaches to long-standing challenges". 2019

How can cities handle this huge amount of available data in order to improve decision-making and the well-being of its citizens while fostering a cleaner and more efficient livelihood?

A 2018 McKinsey report analyzed dozens of current applications and found that cities could use them to improve some quality-of-life indicators by 10–30% [31]. Connected applications put real-time, transparent information into the hands of users to help them make better choices. These tools can save lives, prevent crime, and reduce the disease burden. They can also save time, reduce waste, and even help boost social connectedness. According to the report, three layers work together to make a smart city work. First, the technology, which includes smartphones and other sensors connected by high-speed communication networks, as well as open data portals. The second layer consists of specific applications. Translating raw data into alerts, insight, and action requires the right tools, and this is where technology providers and apps come in. The third layer is public usage, since many applications succeed only if they are widely adopted and manage to change behaviors.[32]



Source: McKinsey – "Smart Cities – Digital Solutions Towards a More Liveable Future", 2018

When it comes to **urban climate and energy transition challenges**, technology could be used to reduce impacts and improve efficiency, especially in the following areas:

i. Weather monitoring and forecasting, in order to better predict, prepare and develop action plans for ever more frequent extreme weather events, avoiding social

31. McKinsey. "Smart cities: Digital solutions for a more livable future". 2018
32. McKinsey. "Smart cities: Digital solutions for a more livable future". 2018

and economic costs. This could also include disaster early-warning systems (as can be seen in the box below);

ii. Building energy automation systems, energy consumption trackers, smart streetlights, dynamic electricity pricing and distributed automated systems;

iii. Urban mobility powered by technology, real-time transit information, digital public transportation payment, autonomous vehicles, predictive maintenance of infrastructure, intelligent traffic signals, smart parking, and dockless bike and scooter sharing platforms;

iv. Waste management, including digital tracking and payment for waste disposal and optimization of waste collection routes.

The application of these technologies in cities could reduce commuting time in 15-20%, crime incidents by 30-40%, GHG emissions by 10-15%, unrecycled waste by 10-20% and water consumption by 20-30%, depending on local variables [33].

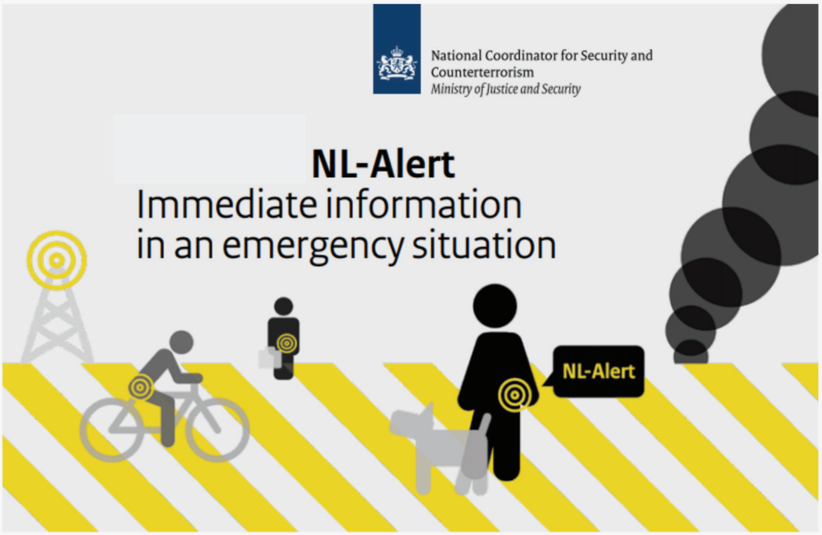
Using technology to prevent disasters: Dutch lessons

Only 50% of the Netherlands is more than a few feet above sea level, so over the centuries the Dutch have become experts at water management. However, they were caught short by crippling floods in the 1990s and have since then implemented vast flood prevention projects. Cities now use parks and public spaces as emergency reservoirs for floodwaters created by severe rainfall. For storm surges from the ocean, they are changing their approach from a purely defensive system to one that prepares for the failure of these systems.[34]

Dutch governments have also been using technology as a tool to prevent disasters and impacts from extreme weather for almost 7 years now. NL-Alert, for example, is a Cell Broadcast alarm system in use by the Dutch government to quickly alert and inform citizens of hazardous or dangerous situations. Using this system, authorities can send messages to users of mobile phones in specific areas of each city by using specific cell towers to alert phones within their reach. The emergency message is also displayed on a growing number of digital arrival signs at bus and tram stops and metro stations, while it describes the situation and advises people what to do at that moment. In late 2018, more than 11 million people were included in the service, representing 74% of the Dutch population. [35]

33. McKinsey. "Smart cities: Digital solutions for a more livable future". 2018
34. UN PRI. "The Netherlands, always vulnerable to floods, has a new approach to water management". 2017
35. Dutch Government. "Nationwide launch of emergency alert system NL-Alert". 2012

NL-Alert



Source: NL-Alert. "Factsheet NL-Alert: Immediate information in an emergency situation". 2018

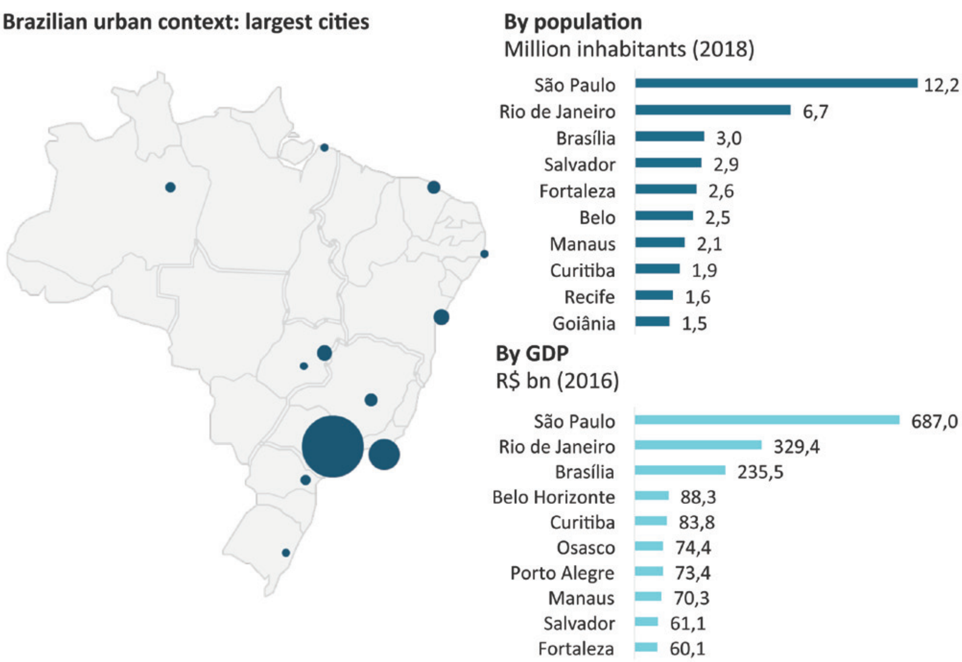
Although a vast number of opportunities arise from smart cities applications, two key challenges shall be considered: cybersecurity and inequality. Cybersecurity and data protection must be considered as a priority, with a need to identify the origin of data, the interests of those who are facilitating its flow and using it, and how these actors are dealing with privacy and personal security. Citizens will only increase usage of smart applications if companies and platforms are able to provide trust to its consumers. At the same time, using technology for the provision of public services has the potential to reproduce or worsen existing inequalities, even when aimed at increasing citizen participation in decision-making. For example, low income or older people without capabilities or resources to access services could be left behind.[36] Local governments should, therefore, have a robust long-term strategy to prepare its citizens for new technology applications, including training and education focused on vulnerable populations.

Finally, if well applied, technology and smartness can help cities foster a smoother and more efficient energy transition, helping it better manage extreme weather events, as the same time as reducing emissions.

36. Oxford Urbanists. "Being 'smart' about Smart Cities: Some elements for discussion". 2018

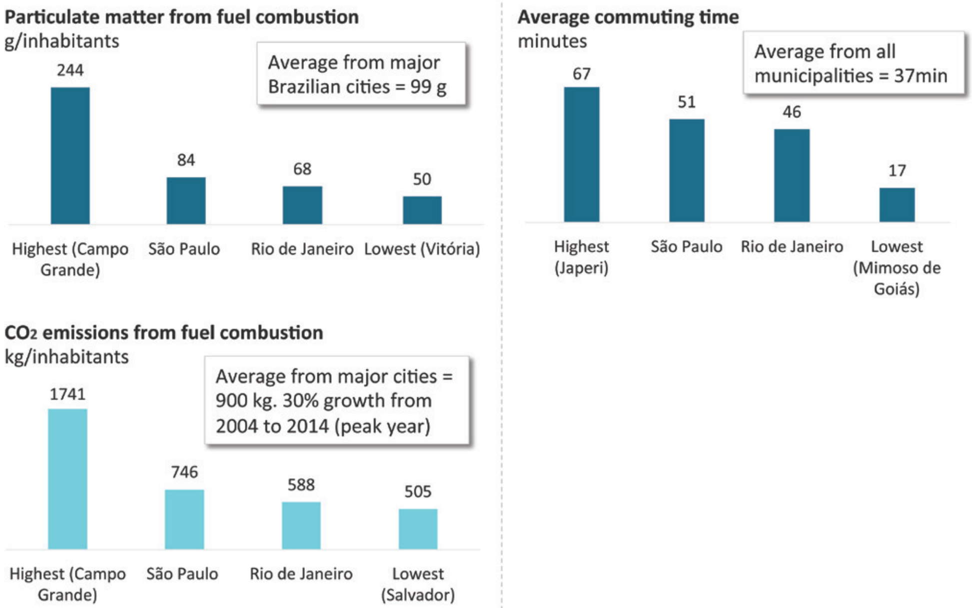
THE BRAZILIAN URBAN SCENARIO: CHALLENGES AND OPPORTUNITIES FOR ENERGY TRANSITION

Brazil currently hosts 5.570 municipalities, spread unevenly across the country, and varying from mega cities to small villages in the countryside, with less than one thousand inhabitants. Seventeen cities (0,3%) have more than 1 million citizens, concentrating 22% of the Brazilian population, while other twenty-nine cities (0,5%) have between 500.000 and 1 million inhabitants. More than half of the population lives in only 5,7% of the municipalities (317). São Paulo is by far Brazil's largest city, both in terms of population and GDP, followed by Rio de Janeiro and the capital Brasilia, as shown below.



Sources: Catavento analysis based on IBGE – "Brazilian resident population and federation units population estimates as from July 1st 2018". 2018; "Gross Domestic Product – municipalities". 2016"

Brazilian cities currently face a number of different challenges, ranging from air pollution and congestion to violence, lack of sanitation and extreme poverty. CO_2 emissions from fuel combustion grew 30% in Brazilian major cities from 2004 to 2014, currently holding an average of 900kg/inhabitants. Brazilian dependence on road transport, with low quality infrastructure leads not only to rising pollution and reduced air quality, but also to reduced well-being in cities. Brazilians take an average 37min to commute daily, while this can reach 46min in Rio de Janeiro, 51min in São Paulo and 67min in Japeri (a poor and violent municipality in Rio de Janeiro state). Commuting takes more than an hour for 31% of São Paulo and 25% of Rio de Janeiro citizens.[37]



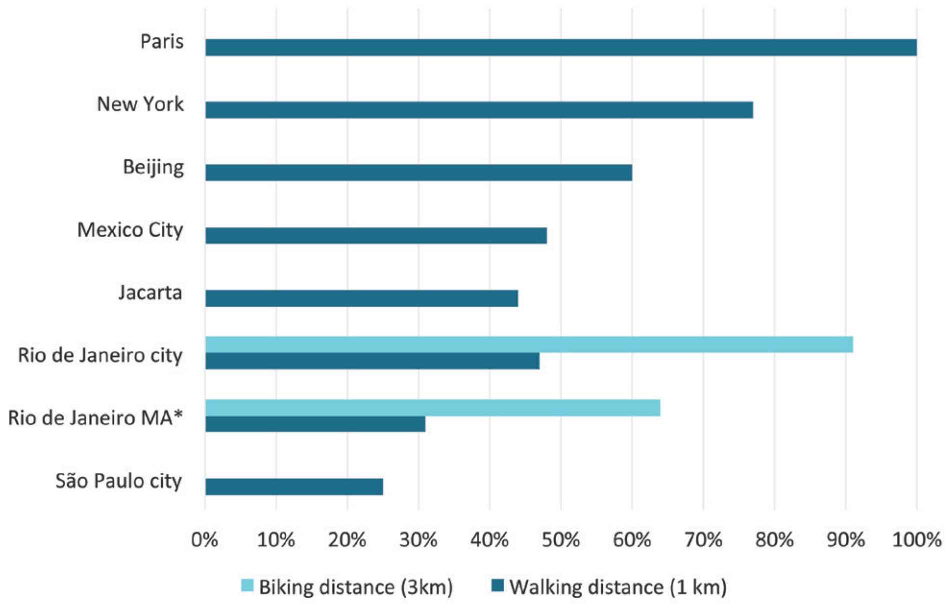
Sources: Catavento analysis based on ITDP – MobiliDADOS website and data base; WRI Cidades – "O que o retrato dos municípios brasileiros feito pelo IBGE pode ensinar", 2018

Mobility is a great challenge and a solid ground for opportunities in an energy transition context. Investments in different transport modals and congestion charges, for example, can help reduce emissions from fuel combustion, while at the same time improving air quality and well-being in cities. Congestion charges and low emission zones can help reduce the usage of cars in the city centers, such as the renowned London system. The English model charges not only those who drive in the city center during commercial hours, but also stablishes tighter exhaust emission standards.[38] The only Brazilian initiative that tries to discourage the usage of cars in cities is the São Paulo Cars Rotation, in place since 1997 and expanded in 2008, driven mainly by air pollution concerns.[39] On the opposite side, only 14,7% of Brazilian cities have bike lanes and 5,4% have bike stands, both concentrated in cities with more than 500.000 inhabitants [40]. At the same time, only 5% of capital cities' roads have priority bus lines. This means that Brazilian cities are still prioritizing private cars, a model that, as seen in the first chapter, favors congestion and reduced safety.

37. ITDP – MobiliDADOS website and data base. Disponível em: https://mobilidados.org.br/ Acesso em 04 de abril de 2019
38. Transport for London website. "Congestion Charge"; "Ultra Low Emission Zone". 2019
39. São Paulo City – CETSP. "Rodízio Municipal". 2019
40. IBGE. "Perfil dos Municípios Brasileiros". 2017

Brazilian cities should, therefore, improve urban and mobility planning, reducing commuting distances and investing in public transportation. Only 47% of the Rio de Janeiro citizens and 25% of São Paulo citizens live in a walking distance (1km) from a public transport station, while this compares to 44% in Jakarta, 48% in Mexico City, 60% in Beijing and 100% in Paris. At the same time, investments in job opportunities for the metropolitan area could reduce commuting demand in Brazilian cities. For example, the Rio de Janeiro municipality accounts for just over half of the total metropolitan area population, but for 74% of formal jobs. This scenario leads to high commuting times for citizens, since currently 68% of metropolitan area workers go to the Rio municipality daily and this tends to increase as the metropolitan area expands.[41] Brazilian cities should, therefore, focus on multimodal sustainable integration in metropolitan areas.

Percentage of population living close to public transport stations



Sources: Catavento analysis based on ITDP, WRI Brasil Cidades Sustentáveis – "Onde estão as pessoas e o transporte na cidade de São Paulo", 2016; ITDP – "Infográfico Rio Metropolitano - Mobilidade, desigualdade e os desafios de reequilibrar a metrópole", 2016

41. ITDP, WRI Brasil Cidades Sustentáveis – "Onde estão as pessoas e o transporte na cidade de São Paulo", 2016; ITDP – "Infográfico Rio Metropolitano - Mobilidade, desigualdade e os desafios de reequilibrar a metrópole", 2016

Examples of innovative mobility solutions across Brazil

A few Brazilian cities have been adopting initiatives focused on three main pillars for a next generation mobility: avoiding dislocations, switching modals and improving energy efficiency, air quality and emissions. Some of the initiatives are highlighted in the framework below, developed by ITDP.

Avoid	**Engage on an integrated urban planning, increasing occupation and population density around public transport corridors** • New construction code in the cities of Rio de Janeiro and São Paulo limit the number of parking spots in buildings located up to 800m from a medium to high capacity public transport station
Switch	**Promote the use of public transport, walking and cycling** • Recife has been collecting and analyzing data on origin and destiny of commuters, while Fortaleza leads the ranking on roads with special lines for buses, with more than 100km • Belo Horizonte has set targets for walking, cycling and public transportation as a percentage of commuting time for 2025 and 2030
Improve	**Improve energy efficiency, air quality and emissions based on technology and fuel substitution** • City of São Paulo set the target of reducing emissions from public transport and waste collection fleet by 100% in CO_2 emissions and 95% in particulate matter and NOx by 2028

Sources: ITDP – "Mobilidade de baixo carbono: Como as transformações necessárias na mobilidade urbana podem contribuir para mitigar os impactos das mudanças climáticas e para a melhoria na qualidade de vida das cidades brasileiras", 2019

On top of mobility, energy should be a priority in local climate strategies, not only focusing on new forms of transportation (including electricity and biofuels), but also fostering renewable and distributed power generation, as well as energy efficiency in buildings. As seen in the first chapter, although local municipalities sometimes do not have a greater role in defining the energy mix, it can set long-term goals for carbon emissions reductions, determine strict building efficiency standards and foment renewable energy by adopting it in public buildings and investments.

Brazilian cities shall, at the same time, better prepare for climate related extreme weather events, increasing resilience through greater planning. Between 2013 and 2017, 49% of the Brazilian municipalities were affected by droughts, 31% by floods and 27% by storms and land sliding. Still, in 2017, 59% of the Brazilian municipalities had no public instrument focused on disaster prevention and only 15% had a drought contingency or prevention plan.[42]

Although the Brazilian population is highly connected and usually early adopters of new technology, local governments have very little interest in leveraging technological innovations in order to solve urban challenges. Although only 58% of Brazilian homes have an internet connection, 65% of the population is connected to the internet and 62% use social networks, due to a high and exponential penetration of mobile smartphones.[43] According to experts, this connectivity could be used to leverage on smart applications to solve Brazilian cities challenges, such as weather alerts. At some level, it is already doing so by connecting low-income neighborhoods with mobility platform drivers, that can sometimes provide safer and more comfortable shared drives than public transportation. At the same time, local governments could connect their urban challenges with startups, promoting hackathons, for example.

Renowned experts believe that these issues should be tackled based on a holistic approach to city development, as well as long-term goals. Energy transition, technology and economic development should not be considered as disconnected themes, on the contrary, they should be increasingly handled in an integrated way. Governmental programs aimed at access to electricity since 1996 [44], for example, connected more than 3,3 million houses and establishments to electric power. This not only had a positive economic impact in the regions, but also in violence and gender. 7,5% of women started working and 9% went back to school. 82% of them acknowledged that they felt safer when staying home and walking around their neighborhoods. [45] The energy transition will create new investment opportunities, leading to job creation and a new climate economy.

42. IBGE. "Perfil dos Municípios Brasileiros (Munic)". 2017
43. IBGE. "Pesquisa Nacional por Amostra de Domicílios Contínua (Pnad C)". 2018; Hootsuite. "Digital in 2018: The Americas". 2018
44. Luz no Campo during Fernando Henrique Cardoso government and Luz Para Todos during Luis Inácio Lula da Silva government
45. Valor Econômico, Agnes da Costa. "Gênero e políticas públicas". 2019

FINAL REMARKS

Cities have an increasingly relevant role to play in the energy transition, working on the decarbonization of power generation, adaptation to next generation mobility, optimization of buildings energy efficiency, waste management improvement and climate adaptation and resilience. Technology can function as a transversal leverage to increase efficiency and decision making, while at the same time offer solutions also applicable to cities from developing countries.

Brazilian cities face a diverse set of complex challenges, but a few suggestions were highlighted throughout the report that local decision makers should keep in mind, such as:

i. Foster the adoption of renewable energy generation at the local level, either through the engagement with utilities and usage in public buildings;

ii. Incentivize the new generation of mobility and city planning, focused on reducing the need for dislocations, switching to shared, affordable and low carbon modals;

iii. Efficiently manage waste, adopting circular economy concepts for reduced waste generation and processing, including for energy generation;

iv. Set strict buildings energy efficiency standards, including for equipments such as air conditioning;

v. Promote long-term adaptation and resilience strategies, especially for low-income and vulnerable populations;

vi. Leverage on technology by allowing for the application of smart solutions, either focused on increased resilience or mitigation

At the same time, some key transversal lenses should be used throughout the adoption of the above initiatives. They include a holistic approach to economic development, usage of smart technologies and the application of long-term goals.

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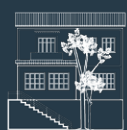

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