Urban Pathways

BRAZIL

POLICY ENVIRONMENT AND ADVICE PAPER

Wuppertal Institut

UN HABITAT FOR A BETTER URBAN FUTURE

UN environment programme

Author: Adriana Marchiori Silva, Urban Pathways team,Urban Electric Mobility Intiative/ UN-Habitat

This publication is part of the Urban Pathways project

Urban Pathways Secretariat

www.urban-pathways.org

Funded by

IKI INTERNATIONAL CLIMATE INITIATIVE

Federal Ministry for Economic Affairs and Climate Action

Urban Pathways

BRAZIL

POLICY ENVIRONMENT AND ADVICE PAPER

Wuppertal Institut

UN HABITAT FOR A BETTER URBAN FUTURE

UN environment programme

Urban Pathways

The Urban Pathways project helps delivering on the Paris Agreement and the NDCs in the context of the New Urban Agenda and the Sustainable Development Goals. It has established a facility in close cooperation with other organisations and networks active in this area to support national and local governments to develop action plans and concrete implementation measures to boost low-carbon urban development. This builds on UN-Habitat's role as "a focal point on sustainable urbanisation and human settlements including in the implementation and follow-up and review of the New Urban Agenda". The project develops national action plans and local implementation concepts in key emerging economies with a high mitigation potential. The local implementation concepts are being developed into bankable projects, focusing on the access to urban basic services to create a direct link between climate change mitigation and sustainable development goals.

Project concept

The project follows a structured approach to boost Low Carbon Plans for urban mobility, energy and waste management services that deliver on the Paris Agreement and the New Urban Agenda. The project works on concrete steps towards a maximum impact with regards to the contribution of urban basic services (mobility, energy and waste management) in cities to global climate change mitigation efforts and sustainable and inclusive urban development. This project makes an active contribution to achieve global climate change targets to a 1.5°C stabilisation pathway by unlocking the global emission reduction potential of urban energy, transport and resource sectors. The project will contribute to a direct emission reduction in the pilot and outreach countries, which will trigger a longer term emission reduction with the aim to replicate this regionally and globally to make a substantial contribution to the overall emission reduction potential.

Project aims

This project implements integrated urban services solutions as proposed in the New Urban Agenda providing access to jobs and public services in urban areas, contributing to equality and social coherence and deliver on the Paris Agreement and the Sustainable Development Goals.This is the first dedicated implementation action oriented project, led by UN-Habitat to deliver on inclusive, low-carbon urban services. Securing sustainability and multiplier effect, the project aims to leverage domestic and international funding for the implementation projects that will follow from this initiative

Urban Pathways

Urban Pathways Project and Replication Cities

CONTENTS

Urban Pathways

COUNTRY OVERVIEW

With a large and diversified economy, Brazil's GDP is the twelfth largest globally in 2022. The pandemic pushed Brazil into a recession in 2020, with GDP shrinking by 4.1%. The plunge followed years of middling economic performance with the economy having expanded just 1.5% per year from 2017-19. After a strong recovery by 5% in 2021, GDP growth is expected to slow significantly in 2022, to 0.6%, before picking up to 1.2% (OECD, 2022).

Brazil is considered an upper middle-income country and is Latin America's largest economy with a GDP of around USD 1.84 trillion in 2019 and a GDP per capita of around USD 8,700 (World Bank, 2021a). However, Brazil's GDP has been on a downward trend since it reached an all-time high at USD 2.6 trillion in 2011. Brazil's economic recession in 2014 to 2016 has accentuated the decline in GDP (World Bank, 2021b). Brazil has become one of the countries most affected by COVID-19 in the world, both in terms of the number of reported cases and the number of deaths (World Health Organization, 2021).

Brazil is the largest and most populous country in Latin America, with a population around 215.8 million, and national authorities project growth rates until 2050, when the country´s population might reach 230 million. Approximately 85% of the Brazilian population lives in urban areas. Brazil currently ranks 84th among 188 countries in the latest United Nations Human Development Index ranking. Brazilian figures regarding social development point to the need to ensure economic growth while promoting improvements in the life standards of its population.

Brazil occupies an outstanding position in the world´s agricultural production. According to data from the United States Department of Agriculture (USDA), the country is the main producer and exporter of orange juice, with a 57% share of the world production and 78.6% of exports, besides coffee and sugar, with 33.3% and 21% of production and 26.8% and 45.7% of exports, respectively. The sector is recognized within and outside the country as being globally competitive, and 2022 is expected to see continuing flows of capital into agriculture and agribusiness with a view to capturing future growth opportunities.

With a territory of over 8.5 million square kilometers, Brazil has equatorial, tropical, and subtropical climates, as well as six biomes, namely the Cerrado (savannah), the Amazon (equatorial rainforest), the Caatinga (semi-arid), the Atlantic Forest (tropical rainforest), the Pantanal (seasonal wetlands), and the Pampa (subtropical grasslands). Currently, 30% of the Brazilian territory is covered by protected areas, such as conservation units and indigenous lands.

NATIONALLY DETERMINED CONTRIBUTION (NDC)

The Brazilian contribution was presented to the General Meeting of the United Nations (UN) in September 2015, still with INDC (Intended Nationally Determined Contribution - given the character of intention it had at that time) status. This includes a reduction of 37% in Brazilian greenhouse gas emissions by 2025 (equivalent to the emission of 1.346 million tonnes of carbon equivalent - tCO2e), in addition to an indication of a reduction of 43% in National emissions by 2030 (equivalent to the emission of 1.208 million tCO2e), based on 2005 levels. It also presents commitments aimed at promoting adaptation to climate change. The commitment to reduce emissions assumed by Brazil is expressed in the National Policy on Climate Change (PNMC), formalized by Law No. 12.187/2009 and regulated by Presidential Decree No. 7.390/2010, which also presents the means to achieve this goal.

The perspective for achieving the Brazilian target in 2025 is based, above all, on a significant reduction in emissions from changing the land and forests use, a category that reached its peak in 2004 and historically concentrates the largest volume of GHG emissions in the country. It is expected that in 2030 GHG removals by forests have already exceeded emissions due to land-use change and deforestation, resulting in negative net emissions in this sector. The Forest Sector will have the central role in the development of a low carbon economy for Brazil. In order to make an effective reduction in deforestation, it will be necessary to control illegal practices in conjunction with the development of a production chain based on forest. The expansion of planted forest area, also expected to enable the achievement of the goals of the Industrial and Energy sectors, should bring the infrastructure required to increase the profitability of Sustainable Forest Management (MSF).

Among the points presented in the base document, it's important to highlight the strong relations between actions related to the forestry sector and low-carbon agriculture, which have the potential to transform the dynamics of land use in Brazil, based on the balance between production and conservation and sustained by the effective implementation of the Forest Code. Energy efficiency is also highlighted as a key issue for NDC's targets to be met. Its promotion in the industrial, energy generation and transportation sectors is, at the same time, a condition and opportunity for increasing the productivity and competitiveness of Brazilian companies. With regard to the agricultural sector, the achievement of targets in terms of pasture and Integration of Crops, Livestock and Forests (iLPF) recovery depends on overcoming bottlenecks such as insufficient rural extension, lack of skilled labor, restricted access to rural credit and the need to disseminate good agricultural practices among rural producers (IDB, 2016).

In 2015, Brazil submitted one of the most ambitious NDC targets among emerging markets. But it has yet to move to a net-zero approach. Due to the significant role of

hydropower, the power sector accounts for only around 7% of emissions, around half that of the transport sector (14%). Transport emissions have risen steadily and are the third largest source after 'land use, land-use change, and forestry' (LULUCF) (24%) and agriculture (36%). Brazil's NDC includes increasing the share of sustainable biofuels in the energy mix to 18% by 2030, expanding biofuel consumption, increasing ethanol supply, and raising the share of advanced biofuels and biodiesel in the mix.

On 9 December 2020, Brazil submitted its updated NDC, confirming its existing target for the year 2025 (a 37% reduction in emissions below 2005 levels), and committing to its previously indicative target for 2030 (a 43% reduction in emissions from 2005 levels). However, an increase in the base year emissions used as a reference means that Brazil can continue to increase its emissions and still meet its targets. The government has also dropped all reference to stopping illegal deforestation, restoring forests and enhancing native forest management in the NDC.

Brazil's NDC calls for receiving US$10 billion a year from 2021 to address its climate change-related challenges, including the conservation of its native vegetation, in particular the rainforest. However, it is not clear whether - and to what extent - Brazil's NDC targets are conditional on receiving such finance. With market trends already driving increased uptake of renewable energy, a sizeable portion of Brazil's mitigation needs should be affordable domestically, with international climate finance used to support mitigation in harder-to-abate sectors.

ENERGY SECTOR

Brazil is the Latin American country with the largest surface area and energy consumption. While 48% of the domestic energy supply in Brazil is provided by renewable resources, fossil fuels still dominate the energy mix (EPE, 2022). Brazil has one of the cleanest energy mixes in the world. In 2020, renewable sources accounted for 48.4% of the total demand for energy, three times the world average. In the electricity demand mix, the share of renewables accounted for 84.8%. As for the transport mix, it represents 25% of the sources. The production of biofuels for the transport sector has substantially increased due to RenovaBio, which uses market incentives to promote the decarbonisation of the sector and to incentivize these kinds of fuels. RenovaBio is a market driven incentive mechanism to the sustainable expansion of biofuels, based on efficiency. RenovaBio creates a "Carbon Credits" per unit of energy increasing efficiency in the production of biofuels, certified individually by producer. The use of hydropower to generate electricity accounts for 60% of the national installed capacity and has proven to be the best

available technology to compensate for the intermittency and seasonality that affect other sources of renewable sources, such as wind and solar energy, as well as biomass. Brazil has also made significant investments, nonetheless, in solar and wind energy and biomass, which already account for 20% of the countrys' energy mix and are experiencing rapid growth.

Due to a very high share of hydropower, Brazil has one of the highest shares of renewable energy globally (82% of the generation mix), leading to relatively low levels of emissions from the power sector (IEA, 2021; Timperley, 2018). This is also reflected in the latest Renewable Energy Country Attractiveness Index, in which Brazil moved up from 15th to 11th place of the world's most attractive markets for renewable energy (EY Global, 2020).

Brazil is currently one of the leaders in the use of renewable energy and has one of the least carbon intensive economies in the world. The country gets three-quarters of its energy from hydroelectric plants and about half of its vehicle fleet uses ethanol derived from sugar cane or uses fuels with alcohol blends in their composition. Despite this prospect, the country suffered prolonged power blackouts in 2001, due to low rainfall levels that resulted in a lack of capacity in the electric system and the implantation of gas-fired power stations (HORNER et al., 2016). Since 2021, droughts have been affecting reservoirs in the South and Southeast, increasing the risk of energy rationing at peak demand times. Among the repercussions of these crises is the increase in the volume of thermoelectric plants in the country, producing energy from the heat generated by burning fossil fuels (such as coal, oil, gas, among others).

Energy-related GHG emissions in Brazil can be divided into the following categories, from the highest to the lowest emitters: (1) transport (2) industry (3) power-generation sector (or simply power sector) (4) fuel production/ fuel transformation (also known as energy sector) (5) fugitive emissions (6) buildings (residential, public, and commercial), and (7) agriculture and livestock. According to the Energy Research Office (EPE in its Portuguese acronym), almost half of the energy related GHG emissions in Brazil come from the transportation sector (46%), followed by industry (22%), and the power generation sector (13%).

Taking into consideration the Brazilian government's forecast of population growth, Gross Domestic Product (GDP) and the influence of energy efficiency improvements, it is estimated that energy consumption (electricity and fuel) will increase from the current 3.200 terawatt hours (TWh) to 7.000 – 8.800 TWh by 2050. The government's study shows that Brazil has enough potential to supply its demand with renewable resources. Solar power and biomass are fundamental resources which, together, could meet 75% of future energy requirements.

In wind, Brazil's installed onshore capacity totalled 16.5 gigawatts as of May 2020. Yet experts say its potential could be 30 times greater, as much as 500 gigawatts. Solar energy also shows big promise. In 2019, about five terawatt-hours of power from the sun's rays were injected into the national energy grid. Studies suggest that by developing just its sunniest regions, Brazil's output could hit 500 terawatt-hours a year, enough to meet 90% of its 2019 power demand. Finally, natural gas output is surging, too (McKinsey, 2021). The competitive agricultural sector already produces biomass for energetic purposes and shall become more efficient, without interfering in rainforest areas. The enormous amount of agroindustry residues could generate additional energy.

The Ministry of Mines and Energy (MME), through Normative Ordinance n. 2/2021, approved the 2030 Ten-Year Energy Expansion Plan (PDE 2030, in the Portuguese acronym). Jointly developed by MME and the Brazilian Energy Research Company (EPE), PDE 2030 provides the ten-year (2021-2030) projected expansion for the energy sector, covering the projected national energy demand; the expected scenarios for generation, transmission and distribution; the expected developments in supply and demand for each energy source; and social and environmental analyses. The federal decision-making process on energy policy in the next ten years will be guided by PDE 2030, as well as by the 2050 National Energy Plan (PNE 2050, in the Portuguese acronym), launched in December 2020.

The PNE 2030 is the first study of integrated planning of energy resources held within the Brazilian government, and prepared by the Ministry of Mines and Energy of Brazil (MME). It proposes a strategic direction for expansion of energy supply. The PNE is composed of a series of studies that seek to provide inputs to formulate energy policies according to an integrated view of available resources. As a contribution to meeting that future estimated demand, the MME proposes 164GW as the country's exploitable, but as yet unrealised hydropower potential. Of that 164GW, the MME says that 90% (about 147GW) is in the Amazon region. If realised, this figure would amount to more than a doubling of the total installed national electricity generation capacity in Brazil (from all generation sources). According to the PNE 2030, energy efficiency policy will be built in aiming at guiding a set of priority projects. The formulation of effective regulatory mechanisms and instruments for inspection will involve the regulatory agencies in the energy sector.

The PNE 2050 replaces PNE 2030. It is a set of studies that support the government's long-term strategy design in regarding the expansion of the energy sector. The strategy, in turn, consists of a set of recommendations and guidelines to be followed in defining the actions and initiatives to be implemented throughout the 2050 horizon. These, in turn, need to be defined in an Action Plan to be prepared following the approval of the PNE 2050. The document notably prioritises the expansion of hydropower capacity, of oil and gas production, the analysis of promotion mechanisms for a range of renewables, research and development, and increased efficiency.

TRANSPORT SECTOR

Road transport stands out as the main element of the Brazilian transport matrix, especially in the case of passenger transport. Although changes in transport patterns towards more energy efficient modes caused a decrease in the share of road transport from 93% in 2005 to 84% in 2050, this mode of transport is still far superior to air, rail and water transport (with 8.5%, 6.9% and 0.1% by 2050). In the Brazilian case, the infrastructure-related costs for expanding the metro and metropolitan railways are major impediments to increase rail activity.

Brazil's productivity, regional integration and international trade are also dependent on the quality of infrastructure. According to the World Economic Forum, in 2019 Brazil ranked 85th out of 141 economies in terms of overall quality of transport infrastructure. Despite an improvement compared to previous years, the current transport matrix results in high transport costs, equivalent to more than 6% of the national GDP. Approximately 65% of the country's cargo is transported by road, with a smaller percentage transported by rail, waterways, cabotage, pipelines and planes.

Transport makes up a large share of Brazil's energy sector emissions: according to the latest World Energy Outlook (2019), the transport sector accounted for 48% of energy-related CO2 emissions in Brazil in 2018. Transport emissions have been increasing over recent decades, mainly due to increased vehicle ownership. Brazil is currently the world's second largest producer and consumer of biofuels. In 2017, the country produced an estimated 27.7 billion litres of ethanol and 4.2 billion litres of biodiesel (Berk & Barros, 2017).

In many Brazilian urban areas, public transportation systems do not adequately meet the population's needs, either in terms of capillarity (e.g., non-existent or intermittent coverage of peripheral regions) or quality (e.g., overcrowding, poor conservation, frequent delays). (ITDP, 2021)

Brazil identifies the Sectoral Transport and Urban Mobility Plan for the Mitigation and Adaptation to Climate Change (PSTM) as its key policy to tackle transport sector emissions (Ministry of Science Technology and Innovation of Brazil, 2016b). This Plan aims at contributing to mitigating GHG emissions through initiatives that lead to the expansion of cargo transport infrastructure and using more energy-efficient modes; and in the sector of urban mobility, increasing the use of efficient systems of public passenger transportation. The Resolution Number 5 of June 2018 approved the annual national emissions intensity targets under RenovaBio, a new national biofuels policy (Conselho nacional de política energética, 2018). The policy aims to increase the use of all biofuels in Brazil, including ethanol, biodiesel and biomethane, aiming to increase energy security and reduce GHG emissions.

RenovaBio, Brazil's national biofuel policy, came into force in 2020. It establishes annual decarbonization targets for fossil fuel

suppliers, targeting a 10% reduction in carbon emissions by 2028. It classifies biofuels by their greenhouse gas emissions profiles, and introduces a carbon credit system. The tradable carbon credits (Cbios) represent the equivalent of a one metric ton reduction of CO2 versus fossil fuel emissions, and create a cost advantage for biofuels over fossil fuels. Presented in 2015 by the Brazilian government, the National Logistics Plan (PNL) is divided up by mode for the reference year, handling a total of 2.4 Freight Tonnes Kilometre (FTK), in addition to simulations for the 2025 scenario. The PNL presents strategic planning for fine-tuning cargo transport, taking into consideration the potential of each mode of transport. According to data released in 2020 by the Logistics and Supply Chain Institute – ILOS for volumes transported in Brazil, 61% of cargoes are hauled along highways, 21% are carried by rail, 12% by cabotage, 4% by pipelines, 2% by waterways and less than 1% by air.

The NLP is part of the concept of Integrated Transport Planning, which harmonises and integrates different instruments so that the levels of strategic, tactical, and operational decisions are conducted as a self-dependent chain, reducing the likelihood of conflicts and inconsistencies, and with a focus on the aid of initiatives, programs or actions also integrated. The Ministry of Infrastructure has been announcing major projects, many of them begun during the pandemic, with the government targets of BRL 30 billion in public investments and BRL 250 billion in federal concessions, during the next two years, as well as BRL 40 billion for railways and BRL 1.9 billion for upgrading road access to the Port of Santos. The main expectation of the Brazilian Government is to forge ahead with port privatisation, in order to streamline the shipment of goods and commodities, while doubling the rail share in the Transport Matrix and thus reducing free charges for the logistics market. During the next two years, the Brazilian Government intends to conduct 24 port lease auctions, signing 54 private terminal adherents agreements, increasing Brazil's cargo fleet by 40%, while preparing the country for a massive upsurge in rail transport.

Ordinance Nº 123, of August 21, 2020, from the Ministry of Infrastructure, established the Integrated Transport Planning, which includes the road transport, railway, waterway, and airway federal subsystems, as well as the road network and logistical connections between these subsystems and of these with the road systems of municipalities, states, and the Federal District. In turn, Ordinance Nº 792 of July 1, 2021, from the Ministry of Infrastructure, complemented the elements of the Integrated Transport Planning by instituting the Public Action Plan.

On transport, while biofuels have contributed significantly to improve the emissions intensity of the road transport sector in Brazil, full decarbonisation of the transport sector will require a fast uptake of electric vehicles (EVs). In terms of EVs, Brazil is a laggard, with a very small penetration rate and without a clear strategy to substantially increase the adoption of this technology. Despite the

international trend on electromobility and the Rota 2030 program (Brazilian automotive industrial policy for the next 15 years), Brazil does not advance in this area at the pace of the main international players, such as China and Europe. Nonetheless, significant advances in energy use derived from biomass reduce national dependence on diesel (from 51% in 2005 to 44% in 2050), which may improve energy security.

WASTE SECTOR

According to the solid waste outlook of the Brazilian Association of Public Cleaning and Special Waste Companies (Abrelpe), 82 million tons of urban solid waste were produced in 2021 (390 kg/inhabitant/year) — a significant increase from the previous year. Of this total, 92% (76.1 million) was collected. In Brazil, per capita municipal solid waste (MSW) generation has been increasing in the last years. This situation, combined with inadequate MSW management, provides a disturbing scenario in the Brazilian States.

It is estimated that 30% of the collected wastes in Brazil are recyclables. On the other side, the recycling rate of municipal solid waste is estimated at 13% only (SILVA, 2017). In Brazil, over 90% of the materials that are eventually recycled are collected by more than one million recyclable materials collectors. According to the "Brazilian Corporate Commitment to Recycling" (CEMPRE), Brazil has 858 recycling industries (22 aluminium centres, 27 paper recycling facilities, and 809 plastic recycling companies) (data of 2017). The Brazilian recycling companies produced 1.28 M t/y of recycled products and had annual sales of 590 M BRL (ca. 114 M USD) in 2019. The same study shows that recyclable waste collection systems have not yet been established in most Brazilian cities. Brazil has 5570 municipalities in total. Of the 3468 municipalities surveyed, only 1322 (38.1%) offer some sort of selective collection. In contrast, 2146 municipalities (61.9%) do not offer this service. Second, recycling initiatives are centralised in the South (42.7%) and South–east (42.8%) regions. Together, the poorer regions of the country, i.e., North and North–east, account for 8.6% of selective collection systems.

In Brazil, there were more than 20 years of discussion thus far until the establishment of a nationwide policy related to waste, 29 years after the launch of the National Policy on the Environment – PNMA (Law no. 6938/1981) and the creation of the National System on the Environment – SISNAMA and of the National Council on the Environment – CONAMA. Thus, the Federal Government has approved in 2010 the National Policy on Solid Waste - PNRS (Law no. 12305/2010), in conjunction with the National Policy on the Environment-PNMA and the National Policy on Environmental Education (Law no. 11445/2006), in order to establish guidelines for the integrated management and solid waste management (including hazardous).

The Law no. 12305/2010 (PNRS) sets forth the principles, objectives and instruments, guidelines, goals and actions adopted by the Federal Government, either alone or in cooperation with States, Federal District, municipalities or individuals, with a view at the integrated management and solid waste management (including hazardous), the responsibilities of generators and public authorities, and the relevant economic instruments. Additionally, demonstrates the concern about the disposal of waste, providing guidelines for the collection, treatment and final disposal, as well as ways to reduce the production of such waste. However, despite the need for its consolida-

tion, its existence has not yet proved enough to be able to effectively influence, in the short term, a change in the reality of Brazilian municipalities. One of the pillars of the PNRS is the streamlining of recycling, which serves to generate employment and income for recyclable materials collectors. Recycling is an industrial sector that grows 12% per year on average. This sector's market takes the shape of an oligopsony—that is, a few large buyers and many small sellers.

Reverse logistics was introduced as a legal mechanism in Brazil by the National Policy on Solid Waste. In 2015, a Sectorial Agreement was signed, according to which industries must ensure the proper final destination of post-consumption packaging: reuse, recycling, treatment, and disposal. Although the PNRS established the requirement for the structuring and implementation of reverse logistics systems independent of the public urban sanitation services for certain products in Article 33 (Brazil, 2010a), some of these systems were previously regulated and had to be adapted to the new guidelines, as was the case with tyres and motor oil, which led to a discussion of the sectorial agreement draft. Thus, for the implementation of these systems, the PNRS defines three different instruments: regulation, sectorial agreement, and commitment terms. The Brazilian government also created a steering committee for the implementation of reverse logistics systems in 2010 via decree 7.404. This committee was composed of five Ministers of State (Environment, Health, Agriculture and Livestock, Finance, and Industry and Commerce) to establish the priorities in the implementation of the reverse logistics systems and accompany the implementation (Brazil, 2010b; Oliveira and Galvão Junior, 2016). This decision enabled negotiation between the public and business sectors to identify bottlenecks, obstacles, and expectations to seek joint solutions.

In 2020, Brazil approved the Federal Law No. 14,026/2020 (new sanitation regulatory framework). As a result, municipalities could create a fee for waste management. Currently, 53% of Brazilian municipalities do not have a tax collection system to support their waste management infrastructure. It is expected that the creation of a disposal tax may also contribute to the promotion of waste reduction and reuse, which should be prioritised in the waste management hierarchy. The Ministry of Environment launched the new Solid Waste Management Plus National Information System (SINIR+) tool, which provides government agencies, investors, and citizens with 3-D maps, interactive panels and granular data on waste management. The tool was rolled out to partner with the private sector to drive sustainability by supplying it with information such as locations with potential for investment in waste collection or recycling services.

On April 14, 2022, the Brazilian government approved the National Solid Waste Plan previously foreseen by the National Solid Waste Policy of 2010. Their main objective is to support solid waste management and planning in federal, state, and municipal spheres. With-

in its 20 years' timeframe, the National Solid Waste Plan is divided into phases. Initially, the urban waste is diagnosed nationally, contemplating the national and international best practices addressing the issue. New mechanisms are supporting the compilation of information and population awareness. This is the case of the National Information System on Solid Waste Management (SNIR), displaying legal text, regulations, waste generation characteristics, reverse logistics schemes (Extended Producer Responsibility - EPR), reports, and on. Among the main goals, the following are highlighted:

- The elimination of dumping places until 2024;
- Until 2040, recover at least 48% of the generated mass (recycling, energy, and biologic waste);
- Until 2040, 95% of municipalities will offer a formal contract for cooperative and waste collectors;
- Recover 50% of all packing material through reverse logistics in 2040;
- Highly improve energy generation on varied decomposing waste sources, benefiting more than 27 million households;
- Recycling 25% of waste from civil construction until 2040.

The National Solid Waste Plan will be updated every four years to assess progress in diverse sectors and evaluate investment gaps.

On April 14, 2022, Decree No. 11,044 was issued by Brazilian government, instituting the Recycling Credit Certificate ("Recicla+") program, which will issue credit to public or private entities in connection with solid waste reverse logistics systems. The objectives of Recicla+ are to improve physical and logistic infrastructure implementation and operation; providing economies of scale; enable collaboration between reverse logistics systems; adopt measures to prevent or reduce the generation of solid waste and materials waste within the lifecycle of products; promote the use/reuse of solid waste also in production chains (including forms of energy recovery); encourage the use of inputs with less environmental impact; and encourage the development, production and consumption of products derived from recycled and recyclable materials.

With the institution of Planares and creation of Recicla+, the objective is to improve the management of solid waste in a proper, transparent and efficient way in the country, reducing the costs of companies subject to reverse logistics and providing income gain to others involved in the chain in benefit of higher waste recycling and preservation of the environment.

POLICY RECOMMENDATIONS

In the energy sector, a clear cause for concern is Brazil's energy infrastructure planning, which unnecessarily continues to incorporate fossil fuels, including coal and gas. On a more positive note, market trends for renewable power generation are heading in the right direction, with a steady increase in wind and solar capacity (IRENA, 2021).

The future energy matrix should take into consideration the seasonality of renewable sources, in order to build a solid energy supply in Brazil. Storage capacity, strong integration and the development of high efficiency transmission lines will be equally necessary. The future energy matrix will set the consumption characteristics. Electricity will perform a central role and the transport system shall be adapted accordingly. Thus, Brazilian mobility by electric vehicles will be a relevant issue. Unfortunately, the current energy policy in Brazil points in an opposite direction. The imminent electricity blackout, which is contingent upon the water supply, leads to thermal power generation, mainly supplied by fossil fuels, and the consideration of expanding nuclear power. On the other hand, investments in renewables decreased in the last years and the potential of bioenergy, solar and wind power remains overlooked.

Diversify and optimise the energy system, given the steady decline in costs, wind farms already have the lowest levelized cost of energy, and solar will exceed that level in three to four years. But in boosting the share of renewables, grid operators must also invest in solutions that can better balance the volatility of renewable power.

Brazil loses about 18% of the power it generates within its transmission and distribution grids. The country should strive to reduce grid losses in an effort to decrease end-customers' tariffs, especially commercial ones, and to increase the competitiveness of Brazil's companies.

According to energy-efficiency index ODEX, Brazil's residential sector improved its energy efficiency by 21% from 2005 to 2018, and the transport sector improved 18%, whereas the industrial sector increased only 7%. Investments in initiatives to accelerate the industrial sector's energy efficiency include improving recycling, expanding the use of energy management systems, and investing in professionals' development to help them identify energy-efficiency opportunities.

Brazil is on the right path to decarbonize its logistics and transport sector, but there are still opportunities for improvement so that this transformation is even more sustainable. Integrating sustainability into logistics and transport planning, integrating climate risk and mobilising investments for sustainable infrastructure are a step in that direction. In a post-pandemic scenario, reconstruction and construction guided by the ESG agenda become even more relevant for economic recovery.

In the Third National Communication, Brazil identifies the Sectoral Transport and Urban Mobility Plan for the Mitigation and Adaptation to Climate Change (PSTM) as its key policy to tackle transport sector emissions (Ministry of Science Technology and Innovation of Brazil, 2016b). This Plan aims at contributing to mitigating GHG emissions through initiatives that lead to the expansion of cargo transport infrastructure and using more energy-efficient modes; and in the sector of urban mobility, increasing the use of efficient systems of public passenger transportation.

Brazil has had a limited expansion of its road and rail networks in recent years. Efficiency gains from improved inter-modal coordination could amount to 0.7% of GDP annually, more than double current public investments in the sector. Improved planning, regulation and integration would also allow additional objectives such as low carbon transport and road safety to be reflected in the policy agenda. To attract new investments and improve services in roads, railways and waterways, it should be considered the following:

- Improving the regulatory framework;
- Integrating policy across transport modalities and responsible agencies;
- Improving or creating standards and regulations for new technologies and business models: new standards for charging infrastructure, distributed storage, disposal or reuse of batteries and electric vehicle components, etc. Flexibility for the construction and operation of new electrified freight railways;
- New business models and public transport concessions, revising tariff modalities with government financial support: business models focused on charging infrastructure (charging stations, energy distribution, distributed and semi-distributed storage), electric vehicle sharing, etc. Concession models that require the expansion of the electric bus fleet in cities, with government subsidies for fares.

The infrastructure and services in Brazil need to take advantage of the technologies potential to maintain international competitiveness. Another set of technologies have significant perspectives of impact on logistics and national transport, such as the digital transformation in logistics, which includes the use of IoT, Big Dada, AI, and Advanced Analytics to increase logistics efficiency from the planning to execution of transport. It is estimated that this set of applied technologies should raise vehicle utilisation rates by 3.2% in the road transport mode and 5% in other modes, reduce vehicle maintenance costs by 18.9% in the road transport mode and 30% in other modes of transport, and a reduction of up to 5% of the cost of road transport through more efficient routing. The applications and platforms of vehicle capacity sharing can also drive cost reductions, especially in freight road transport, and with greater impact on autonomous truck drivers, with the prospect of a further 3.2% reduction in total logistics costs.

If, on the one hand, waste generation accounts

for 4% of total greenhouse gas emissions in the country, the sector has an important role in mitigating these emissions. ISWA estimates that the simple adoption of appropriate waste disposal systems has the potential to mitigate emissions of 5-10% of the total. Actions to reduce waste generation, recycling and energy recovery can contribute with an additional reduction of 5-10%, leading to a total mitigation potential of about 20% of global GHG emissions, not to mention the many benefits for the environment, public health and the economy.

In 2010, Brazil adopted a forward-looking waste management policy. Implementation is still incomplete and greenhouse gas (GHG) emissions in the waste sector are still rising. The reduction targets for the waste sector are not yet defined for the Nationally Determined Contributions (NDCs) of the Paris Agreement. Municipalities still face technical and institutional challenges in implementing solid waste management plans and more than 2,000 dumps still have to be closed. Considering the potential for sustainable waste management in Brazil, it makes sense to align this with the National Plan on Climate Change. This would highlight the waste sector as a GHG mitigator. The future recycling scenario includes the formatting of innovative and robust business models and sustainable solutions in industries challenges, the replacement of extensive transportation of post-consumption materials over long distances with intermediate storage, depots, and material reserves can play a decisive role. Moreover, Brazil should diversify the transport modal, invest in automation and failure prevention. Besides, more innovative logistics systems enabled by Internet of Things (IoT), satellite technology, and artificial intelligence could save time, energy, and resource during recyclables management.

The reallocation of the investment portfolio is also necessary to promote the decentralisation of Brazil's recycling installation. Recycling initiatives, that is, selective collection, cooperatives, scrap brokers, and recovery facilities are centralised in the South and South-east regions. The scarcity of recycling systems favours the mismanagement of recyclable materials. There is no doubt that in the recycling chain, the infrastructure plays a decisive role. The construction of roads to flow the recyclable materials and MRFs to recover them could enable the return of post-consumption products to industries and manufacturers. Hence, it would be possible to increase the recycling rate in the country. Finally, the Government must set strict regulations to promote reverse logistics and expand this system to other goods chains. Clear laws and strict regulations to avoid the recycling materials' mismanagement could help to sustain the reverse logistics in Brazil.

Waste pickers are a fundamental actor at Brazilian recycling scheme, however most work informally. Municipality should be a key actor, within a regional framework. The intrinsic value of material is not enough to promote social inclusion – Social inclusion is a separate objective than increasing recycling. On that matter there is a need to:

- Assume social inclusion as a Public Policy objective;
- Promote an effort to organisation and regularisation/ register in cooperatives;
- Discuss and implement EPR financing;
- Facilitate the direct sales to industry, avoiding intermediaries;
- Provide training, equipment, technical support, etc;
- Mitigate price volatility.

The development of sound strategic planning for waste management represents an important opportunity for governments at all levels to establish the foundations and resources necessary to create integrated, sustainable, and resilient waste management systems, not only for municipal solid waste, but also for construction and demolition waste, health care waste, and other waste streams.

REFERENCES

Almeida, R., de Souza, R.G. & Campos, J.C. Lessons and challenges for the recycling sector of Brazil from the pandemic outbreak of COVID-19. Waste Dispos. Sustain. Energy 3, 145–154 (2021). https://doi.org/10.1007/s42768-021-00075-y

ANTAQ. Anuário Estatístico. 2019. Available at: http://portal.antaq.gov.br/wp-content/uploads/2020/02/ Anu%C3%A1rio-2019-vFinal.pdf.

Anuário CNT de Transportes. Estatísticas Consolidadas. 2019. Available at: https:// anuariodotransporte.cnt.org.br/2019/Referencias.

DNIT. Departamento Nacional de Infraestrutura de Transportes. Atlas Ferroviário. Available at: https:// www.gov.br/dnit/pt-br/assuntos/ferrovias/AtlasFerrovirioVersoFinal.pdf

EPL (2018), Relatório Executivo PNL 2025, available at https://www.epl.gov.br/plano-nacional-delogistica-pnl

Hannah Ritchie, Max Roser and Pablo Rosado (2020) - "Energy". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/energy'

IPEA - Brasil Pós Covid-19 Contribuições do Instituto de Pesquisa Econômica Aplicada (IPEA), Brasília, 2020.

ILOS. Matriz de Transportes a Espera de Investimentos. Available at: https://www.ilos.com.br/web/ tag/matriz-de-transportes/

Nascimento, V.F., Sobral, A.C., Fehr, M., Yesiller, N., Andrade, P.R. and Ometto, J.P.H.B. (2019) 'Municipal solid waste disposal in Brazil: improvements and challenges', Int. J. Environment and Waste Management, Vol. 23, No. 3, pp.300–318.

Rebehy PCPW, Andrade Dos Santos Lima S, Novi JC, Salgado AP Jr. Reverse logistics systems in Brazil: Comparative study and interest of multistakeholders. J Environ Manage. 2019 Nov 15;250:109223. doi: 10.1016/j.jenvman.2019.06.124. Epub 2019 Sep 17. PMID: 31545173.

https://transportes.fgv.br/sites/transportes.fgv.br/files/artigos/innovation_norway_-_relatorio_reduzido_-_23-12-2020.pdf

https://www.epe.gov.br/sites-en/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-237/Atlas2021_EN_2022_02_04.pdf

https://ekosbrasil.org/wp-content/uploads/2017/08/EKOS_Brazil_2050.pdf

https://www.climate-transparency.org/wp-content/uploads/2019/02/Brazil-Policy-Paper-Energy-Transition-FINAL.pdf

https://www.wribrasil.org.br/sites/default/files/bridging-the-gap-energy-climate-brazil.pdf

https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-brazil-can-optimize-its-cost-of-energy

https://cebds.org/wp-content/uploads/2017/06/CEBDS_NDC_SUMEX_ING_navegavel.pdf

https://www.worldbank.org/en/country/brazil/brief/brazil-policy-notes

https://portal.apexbrasil.com.br/regulatory_report/the-ministry-of-mines-and-energy-mme-and-the-brazilian-energy-research-company-epe-launched-the-2030-ten-year-energy-expansion-plan-pde-2030-in-the-portuguese-acronym-it-will-support-federal-d/

https://www.climate-laws.org/geographies/brazil/policies/national-energy-plans-2030-and-2050-pne

https://www.oecd.org/environment/waste/Session_2-Part_1-From-informal-to-providers-Flavio-de-Miranda-Ribeiro-CETESB-Brazil.pdf

https://ontl.epl.gov.br/wp-content/uploads/2022/05/PNL-English-version.pdf

https://www.climate-transparency.org/wp-content/uploads/2021/02/Transport_Energy-Transition-in-Brazil.pdf

URBAN PATHWAYS

Urban Pathways

Urban Living Lab CENTER

UN HABITAT FOR A BETTER URBAN FUTURE

Wuppertal Institut

Technische Universität Berlin

MITei MIT Energy Initiative

More information about the
Urban Pathways project can be found at:

WWW.URBAN-PATHWAYS.ORG