1. **Sustainable Infrastructure**

Climate change has caused severe social and economic losses in the last decades leading to an urgent need for planning infrastructure and incorporating climate aspects into national and subnational budget frameworks. Mitigation and adaptation policies have gradually started to become part of government plans just as sustainability elements into the development of climate resilient infrastructure. Around US$ 90 trillion worth investment will be needed over the next 15 years for sustainable infrastructure, and two thirds of that amount will account for the global South. In order to leverage this level of investment, structural changes such as tackling price distortions, strengthening investment policy frameworks, transforming financial systems and boosting clean technology through R&D are imperative[[1]](#footnote-1).

Brazil as the world’s ninth largest economy possess a unique pipeline for low carbon investments in energy, transport, buildings, water and sanitation which are all under the responsibility of cities. Municipal and state governments must be encouraged to take action locally and design mitigation and adaptation plans, given that climate change has imposed serious damages to local infrastructure. In 2016, 30% of Brazilian cities were in a state of emergency due to natural disasters[[2]](#footnote-2), imposing heavy costs that could have been avoided if projected in the city planning framework.

Natural disasters hinder infrastructure development, especially in developing countries such as Brazil. To increase the resilience of cities, it is fundamental to jointly work with governments, bilateral and multilateral finance institutions and the private sector to scale up investments. Therefore, it is important that local governments are prepared to engage with these sectors to assess the impacts of climate change on their municipalities and develop a sustainable infrastructure strategy. Hence, developing a common framework for understanding what constitutes sustainable infrastructure will help clarify end goals and give a valuable basis for analysis to identify key actions, including roles and responsibilities, at different stages across the whole project life cycle. In this regard, an agreed framework will also help measure advances toward sustainability[[3]](#footnote-3).

Having a clear shared understanding of sustainable infrastructure ensures that all sectors are heading towards the same objectives, resulting in efficient projects that could be replicated in other countries (IDB, 2018). Identifying and promoting innovative solutions to be available in the short term, while capitalizing on long term investment is essential to meet Brazil’s adequate infrastructure needs. Technology R&D have the potential to reduce costs and enhance accessibility to infrastructure sectors that may create jobs and boost the GDP.

1. **Brazil’s Climate Commitments**

The main Brazilian national policy under the UNFCCC is the National Policy for Climate Change (PNMC) foreseeing the sustainable development in country aligned with economic growth to establish a pathway to a low carbon economy. The PNMC sets targets for reducing GHG emissions, thus focusing on mitigation and presenting opportunities for change and technological substitutions that may foster innovative models for energy, transport, buildings, industry, waste management and agribusiness. Nevertheless, the National Plan for Adaption (PNA) complements the PNMC in the sense that it was created to reduce the country's vulnerability to climate change, as well as implement risk management strategies associated with these phenomena.

Brazil is the largest GHG emitter in Latin America having a very bold National Determined Contribution (NDC) under the Paris Agreement, which aims to reduce emissions by 37% from 2005 levels by 2025. To fulfill this commitment, Brazil will need to promote a new approach in the way to conceive, build, finance, and use its infrastructure.

For a country like Brazil, huge adaptation challenges and vast mitigation opportunities exist, particularly for its infrastructure needs. Indeed, it has been estimated that Brazil will need between USD278 billion to USD296 billion[[4]](#footnote-4) to achieve the targets laid out in its Nationally Determined Contribution (NDC), under the UNFCCC COP21. To implement the NDC targets, the country has set a series of measures, which covers areas among energy efficiency, transport, basic infrastructure and sanitation:

Mitigation[[5]](#footnote-5)

* Achieve **10% efficiency gains** in the electricity sector by 2030.
* Promote efficiency measures and improve **transport infrastructure** and **public transportation** in urban areas.

Adaptation

* **Basic infrastructure** and **sanitation**, constitute key areas for adaptation policies.

This project addresses these three priority areas for Brazilian government, supporting the delivery of the country’s climate commitments by creating investment conditions for more resilient municipal infrastructure. Cities are currently responsible for two-thirds of global energy consumption and 70% of CO2 emissions, highlighting the need to shift their growth towards a low carbon pathway. Therefore, transforming energy, transport, sanitation and urban planning will be fundamental to reduce emissions and vulnerability to climate change in Brazil.

1. **Sectorial Opportunities**

***Transport***

The transport sector is the second green-house-gas emitter in Brazil, after land use and land use change. In addition, emission from cars and motorcycles have increased 192% in 2016[[6]](#footnote-6). Brazilian primary transportation infrastructure faces many challenges. According to the World Economic Forum, Brazil ranks 107th out of 144 countries, regarding the level of development of its infrastructure. Given that transport is a long-lasting infrastructure arrange with a high deployment cost, it is important to understand how climate change will affect investment in the coming decades. Therefore, strategic planning and its periodic review is increasingly necessary.

Climate alterations impact road infrastructure in various ways. For pavements, large temperature variations due to heat waves can lead to an unexpected expansion and retraction behavior. On the other hand, changes in the rainfall patters generate flooding and trigger mass movements, such as landslides, debris flow, mud run, rock falls, among others. These events become even more serious when they cause traffic disruptions on escape routes, which may be the only option to evacuate areas hit by natural disasters. Roads need to be upgraded, as the most common method of cargo transportation is trucks –via roads, due to a limited rail network[[7]](#footnote-7). The infrastructure of urban mass transportation in Brazil, relies mostly on large privately-owned bus fleets and could be decarbonized with the expansion of urban and suburban trains.

Decisions over the impacts of climate change on transport systems and urban mobility infrastructure can be taken from a mitigation or an adaptation approach. The mitigation approach seeks to reduce emissions of GHG, responsible for the acceleration of global temperature rise, as for the adaptation approach, measures are related to improving resilience on both road infrastructure and operational structure of the various means of transport, due to extreme natural changes rendering climate risks. Increasing the resilience of the public transport services is especially necessary in the poorest countries, which are lacking in resources, and therefore have a poor response capacity. In these regions, climate change tends to accentuate the risks associated with existing hazards.

Lloyd’s (2017) recommends the following actions to transition to a resilient transport infrastructure:

It is worth mentioning that investments in resilience in the road infrastructure and in the operational structure of the public transport systems is key for a sustainable socioeconomic development in Brazil, benefitting:

1. The Public Administration itself, with savings in resources, avoiding waste and thus safeguarding the capacity for new investments;
2. The population benefiting from public services enhancing their life quality and consequently reducing the demand for services and expenses from the government;
3. Private investors and entrepreneurs for the quality and resilience of transport infrastructure, enabling new investments in all sectors of the economy even during disasters;
4. International investment agencies for social and technological development. Also, national and foreign bodies to promote the integrated progress of Latin American countries, for the results obtained and guarantee of return of resources applied.

The transport sector is responsible for 46% of the Brazilian energy sector’s GHG emissions. At city level, it represents 73% of GHG emissions. An existing challenge is the restricted capacity of municipal governments to mobilize and access resources for transport infrastructure and urban mobility projects. Thus, by providing credit lines for Brazilian municipalities this project directly addresses existing investment gaps to deliver low carbon transport in the country. Projections from COPPE suggest that 19.5 Mt CO2e could be reduced by 2020 just through improvements on urban mobility and transport infrastructure. Therefore, it is important to support measures that enable low carbon transport systems, infrastructure and supply chains.

***Energy***

The main enabling conditions for achieving green growth in the energy sector relate to channeling investments into energy efficiency, renewable energy and well-designed infrastructure (e.g., for the production, delivery and distribution of electricity)[[8]](#footnote-8). Energy efficiency is one of the most cost-effective ways to mitigate emissions. Different alternatives have been identified to increase energy savings in Brazil, including clean technology standards for industry and a new national action plan. Within recognized solutions are the need to create credit lines to direct investments towards energy efficiency measures and increase energy efficiency in public lighting and buildings. All addressed in the project’s energy component.

Public lighting is responsible for 4% of Brazil’s overall energy consumption and for a significant slice of municipalities budget, who since 2014 have been responsible for all public lighting assets, formerly run by utilities. A recent study by the World Bank, concluded that energy efficient public lighting could contribute to meet one fifth of the country’s energy efficiency NDC target. This could be achieved by through the adoption of more efficient technologies as LEDs lamps; 40-60% more effective than current technology. Nevertheless, there are budgetary and financial constraints for Brazilian municipalities to implement this.

Increasing energy efficiency in buildings is another important measure for Brazil. Latest available figures for the country, indicate buildings were responsible for 19% of the country’s electricity consumption in 2012, with future projections pointing to a further increase. Over the past 30 years, Brazil has implemented a variety of voluntary programs to promote energy efficiency in buildings as the PROCEL and PBE *Edifica* labels. There has been specific focus on public buildings, as labelling for this sector became mandatory in 2014, increasing the impact of energy efficiency measures, which may be later be replicated by the residential and commercial sectors. While there is no information available the contribution to Brazil’s energy efficiency NDC target, this is aligned with Brazilian government energy efficiency strategies and plans.

Some of the policies that can accelerate the transition include pricing mechanisms (e.g., the phasing out of subsides for fossil fuels, a carbon tax or a cap and trade system), incentives (e.g., feed-in tariffs for distributed generation) and support for levering private investments (e.g., advantageous loans). Capacity building is also important, and the main elements to it are the identification of skill gaps, the establishment of demonstration projects, and investments in both R&D and training (IISD, 2017).

***Sanitation***

Sanitation is one of the greatest challenges for Brazil. According to the annual Diagnosis of the National System of Information on Sanitation in 2014, the average access to sewage treatment in urban areas is 57.6%, while the total population’s access reaches up to 49.8%. Moreover, only 40.8% of the total sewage generated is treated. This means that more than 100 million Brazilians do not have access to this service. In addition to facing sanitation problems, Brazilian cities are marked by deep social inequalities that are reflected in the development of illegal settlements in risky areas (favelas). As a result, the garbage produced in these zones is discarded on hillsides, rivers, canals and farms, directly affecting urban drainage during extreme precipitation events[[9]](#footnote-9).

Approximately 176.4 thousand tons of waste are produced by Brazilian households and this is not adequately disposed of, raising environmental impacts in cities, particularly in water. In 2015, less than half of the sewage produced by the country was collected and of that total, less than half was properly treated. While the National Policy for Solid Waste was introduced to address part of this issue, considerable efforts are needed to address existing barriers. Climate change related events are increasingly impacting urban infrastructure, including water availability and quality. Therefore, to increase city level resilience in the country it is vital to adapt water systems to deal with waste treatment, water loss and water supply.

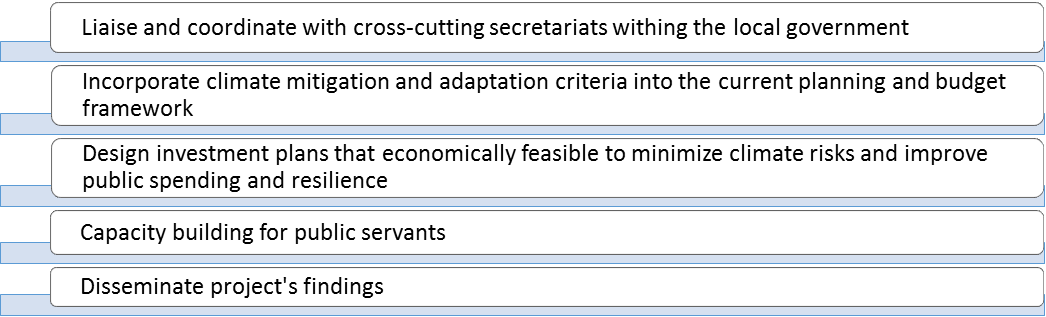
The intensification of extreme precipitation events driven by climate alterations may increase the risk of flooding of effluent treatment plants, especially those closest to the receiving bodies, as well as generating overloads in the sewage and drainage network. Sewage systems have different capacities to respond to the stresses of climate change impacts. The effects of flooding due to the instantaneous flow of the dammed water volume pose a high risk to the safety of level dams, whose disruption can generate interruptions in supply and environmental accidents (PBMC, 2016). City planning, monitoring and evaluation is critical to build resilience for sanitation, therefore recommendations are:

* Climate risk scenarios include disease outbreaks during floods calling for an urgent improvement on sanitation systems and sewers.
* Design tools for climate alterations scenarios, considering weather forecasts in order to have a consistent data base to plan ahead dam projects.
* Sanitation infrastructure expansion entails a larger demand for energy to charge pumping mechanisms and for system overloads, therefore the costs have to be considered in the city’s budget allocation.

This project aims to support the adaptation component of Brazil's NDC by increasing municipal resilience through sanitation projects, to improve water quality; water supply management, to ensure availability and access to potable water; and landfill creation, to reduce the volume of waste in urban centers, including renewable generation by transforming waste to energy.

***Public Management Improvement***

To successfully increase the resilience of Brazilian municipalities, it is necessary to integrate climate change mitigation and adaptation into the planning and budget frameworks. Climate risks can be measured to support public planning strategies that reduce uncertainty and improve the resource allocation by analyzing locations that are more vulnerable to natural disasters. Brazil has spent over 50 billion USD between 1995 and 2014 to recover regions affected by climate alterations, therefore indicating the urgent need to incorporate climate risks and sustainability measures into government planning to enhance public spending strategies. Recommendations are:



Upstreaming institutional strengthening is fundamental to transition to a low carbon economy, since the majority of the government in Brazil prioritize infrastructure without considering the sustainable aspects linked to its development. Policy, legislation and regulation must be ensured through capacity building to local governments, assuring systemic and long-lasting changes, leading to quality infrastructure project pipelines and better delivery of infrastructure services (IDB,2018).

1. **Final Considerations**

Almost 85 percent of Brazil’s 208 million citizens live in urban centers, offering climate-smart investment opportunities to develop and refresh city infrastructure[[10]](#footnote-10). The adoption of a systemic and permanent approach by the national and sub-national government that addresses current climate issues and anticipate future risks, will allow the protection of public services against the impacts of climate change saving resources that may be invested in sustainable infrastructure projects.

Thus, climate change brings forth the need to develop innovative frameworks and policies in a technological and operational point of view. On the other hand, the implementation of these innovations in the public sector require capacity building for human resources that are able to work in this new context. Building resilience to climate risks is fundamental in guaranteeing the reporting principles of the public administration, mainly, continuity and efficiency even in adverse climatic conditions. For this reason, the international cooperation and investment agencies in the development of Latin American countries will be able to coordinate actions towards the reduction of regional inequalities.

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2. [EBC, 2016.](http://agenciabrasil.ebc.com.br/geral/noticia/2016-02/cidades-tem-papel-de-destaque-no-combate-mudanca-do-clima-diz-especialista) [↑](#footnote-ref-2)
3. [What is Sustainable Infrastructure, IDB/IDB-Invest, 2018.](https://publications.iadb.org/bitstream/handle/11319/8798/What-is-Sustainable-Infrastructure-A-Framework-to-Guide-Sustainability-Across-%20the-Project-Cycle.pdf?sequence=1&isAllowed=y) [↑](#footnote-ref-3)
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5. UNFCC, Brazil’s NDC 2016 [↑](#footnote-ref-5)
6. <http://epoca.globo.com/> [↑](#footnote-ref-6)
7. <https://www.export.gov/apex/article2?id=Brazil-Transportation> [↑](#footnote-ref-7)
8. [Sustainable Asset Valuation Tool: Energy Infrastructure, IISD, 2017.](https://www.iisd.org/sites/default/files/publications/sustainable-asset-valuation-tool-energy.pdf) [↑](#footnote-ref-8)
9. [Mudanças Climáticas e Cidades, Painel Brasileiro de Mudanças Climáticas, 2016.](http://www.pbmc.coppe.ufrj.br/documentos/Relatorio_UM_v10-2017-1.pdf) [↑](#footnote-ref-9)
10. [Climate Investment Opportunities in Emerging Markets, IFC/World Bank, 2016](https://www.ifc.org/wps/wcm/connect/51183b2d-c82e-443e-bb9b-68d9572dd48d/3503-IFC-Climate_Investment_Opportunity-Report-Dec-FINAL.pdf?MOD=AJPERES). [↑](#footnote-ref-10)