

## **Guidelines for the formulation of a National Roadmap towards the Circular Economy in Brazil**

**Project:** Assessment of the current status of the Circular Economy for developing a Roadmap for Brazil, Chile, Mexico and Uruguay

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**Work Elaborated by:**

Alexandre Gobbo Fernandes, National Consultant Brazil (CEP-Americas/ASDF)

**Specialist Team:**

Hernán Carlino, National Consultant Uruguay (FACTOR Ideas)

Mauricio Zenteno , National Consultant Mexico (CEP-Americas/ASDF)

Irina Reyes , National Consultant Chile (CEP-Americas/ASDF)

Carmelo Angulo, Expert in Innovation Industry 4.0 (FACTOR Ideas)

Kenneth Alston, Expert in International Circular Economy Policies and international  
benchmarks (CEP-Americas/ASDF)

Mauricio Zenteno, Circular Economy Indicator Matrix (CEP-Americas/ASDF)

**Management Team:**

Iker Larrea, Project Manager Director (FACTOR Ideas)

Kevin De Cuba, Project Leader (CEP-Americas/ASDF)

Elena Aguirre Martin/Christina García, Project Manager (FACTOR Ideas)

María de los Ángeles Franco/Claudia Lorena García, Project Manager (CEP-  
Americas/ASDF)

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## ACRONYMS

ABC Low-Carbon Agriculture	
AFOLU Agriculture, Forestry and Other Land Use	
APL local productive Arrangements	
BNF Biological Nitrogen Fixation	
CE Circular Economy	
CETEM Center for Mineral Technology	
CNI National Confederation of Industry	
CTI Information Technology Center	
Embrapa Brazilian Enterprise for Agricultural Research	
ERA-MIN 2 Research & Innovation Program on Raw Materials to Foster Circular Economy	

E4CB Hub de Economia Circular,  
FINEP Funding Authority for Studies and Projects  
IBICT Brazilian Institute of Information in Science and Technology  
ICT Information and Communication Technologies  
iLPF Crop-Livestock-Forestry Integration  
LCA Life Cycle Assessment  
LCI Life Cycle Inventories  
MAPA Ministry of Agriculture, Livestock and Supply  
MCTI Ministry of Science and Technology and Innovations  
MDR Ministry of Regional Development  
MME Ministry of Mines and Energy  
NCRE Non-Conventional Renewable Energies  
NDC Nationally Determined Contribution  
NGO Non-Governmental Organizations  
PACTI Science Technology and Innovation Action Plan  
PNDR National Policy for Regional Development  
PNRS Waste Management National Policy  
PPA Regional and Territorial Development  
RC4CE Research Center for Circular Economy  
R&D+I Research and Development plus Innovation  
SAFs Agroforestry Systems  
SDG Sustainable Development Goals  
SPD Direct Planting System  
STIAP Science Technology and Innovation Action Plan  
TAP Technology Action Plan  
TNA Technology Needs Assessment  
UN United Nations

## Part I: Summary of the main project results

Part I of this document contains the summary of the process and most relevant results contained in all reports from the "Assessment of the current status of the Circular Economy for developing a Roadmap for Brazil, Chile, Mexico and Uruguay" project promoted by the Climate Technology Centre and Network (CTCN). The work led to the circular economy roadmap draft to Brazil, presented in Part II of this document.

Circular economy is an economical and industrial regenerative model by design, which aims to keep resources in use and circulation for longer periods of time avoiding the loss of the value of materials, while sustaining the natural ecosystems bio-capacity. This requires the inclusion of new production and consumption systems - such as reuse, re-design, reutilization, recycling, remanufacturing - and disruptive business models - like product-as-service, shared models and extended life cycle systems.

To address these challenges, the CTCN has promoted a technical assistance, technical assistance to assess the status of the circularity of four Latin American countries' economies, including Brazil, Chile, Mexico and Uruguay.

This technical assistance aimed "to lay the foundations for the development of a roadmap to create a general circular economy strategy that generates an economic, social, institutional and environmental impact through the identification of players and territories that have favorable conditions for the development of a circular model, improving the competitiveness and efficiency of local businesses, enterprises and organizations that operate in these three sectors" <sup>1</sup>.

### 1. Methodology

The work was organized in six main outputs with specific activities. Figure 1 shows the steps of the methodology adopted.

**Figure 1. Methodological approach for this project**

Output 1. Development of implementation planning and communication documents			
Activity 1. Development of work plan			
Output 2. Diagnosis of key stakeholders and current initiatives related to circular economy in each country			
Activity 2.1. Kick-off meeting		Activity 2.2. Exploration and diagnosis of actors and initiatives	
Output 3. Identification of circular economy value and definition of benefits, weaknesses, opportunities and challenges in each country			
Activity 3.1. diagnosis of perceived benefits	Activity 3.2. Diagnosis of strengths and opportunities	Activity 3.3. Diagnosis of weaknesses and barriers	Activity 3.4. Development of indicator matrix

<sup>1</sup> Technical Assistance Response Plan - Terms of Reference. Analysis of the current situation of the circular economy for the development of a road map for each requesting country.

Output 4. Review of international experiences on circular economy		
Activity 4.1. Benchmarking of international success stories	Activity 4.2. Diagnosis of the conditions and opportunities of international cases	Activity 4.3. Design of comparative matrix of experiences
Output 5. Mapping of successful cases of application of industry 4.0 which benefit circular economy		
Activity 5.1. Analysis of technologies, benefits and opportunities of the forth industrial revolution	Activity 5.2. Diagnosis of the potential benefits of applying industry 4.0 to circular economy models	
Output 6. Identification of potential projects in circular economy prioritized in specific territories		
Activity 6.1 Definition of Pilot Projects	Activity 6.2. Executive Summary and Guidelines for the Circular Economy National Roadmap	6.3. Organization of final event

## 2. Main results of the assessment of the status of the circular economy in Brazil

### 2.1. Diagnosis of key stakeholders and current initiatives in Brazil

To launch the project in Brazil, an open kick-off meeting to present the work plan to local actors interested in circular economy and the National Designated Entity (NDE) was organized by the Brazilian national designated entity with the support of the national consultant. This enabled the establishment of an initial database of key stakeholders and provided to the technical team a clearer view about the overall expectations.

One of the main goals of this technical assistance was the engagement of actors into a future collaborative and cooperative process, encouraging the exploration of previously unseen possibilities for the necessary innovations to the effective implementation of a circular economy in Brazil.

After this launch, a survey was carried out with more than 100 different organizations distinguishing between five categories: (a) government/public sector; (b) companies; (c) civil society organizations; (d) academia and (e) entrepreneurs, as a first step to identify the profile of potential key actors in the country. In addition, an interview process was held with nine key actors from organizations recognized by their role in local initiatives related to circular economy.

The reports from Output 2 presents information about all the players that were identified and participated in this assessment. This process resulted in an updated map of relevant actors and organizations for this project as well as policy instruments, institutional frameworks and public-private partnerships, to better understand the profile of the local circular economy initiatives in the country.

Considering that circular economy is still in the early stages of development in the country, this assessment for circular economy in Brazil allowed the recognition of many

players engaged in a broad range of initiatives in circular economy as well as the presence of key actors with potential leadership role.

From this analysis it was possible to identify some important strategic areas of intervention in a national scale, that could potentially impact the implementation of the circular economy value chains in the country, and contribute to GHG mitigation as well as to the sustainable development goals of 2030 Agenda.

The strategic areas for intervention that were identified related to the circular economy in Brazil are presented below.

1. **Bioeconomy** - Having the circular economy associated with bioeconomy has relevance to drive the sustainable use of natural resources from ecosystems to the development of circular economy value chains to industry and agriculture. Thus, the bioeconomy activities have the potential to contribute to water security and conservation and sustainable use of land and underwater biodiversity, particularly concerning protected areas.
2. **Urban infrastructure, productive inclusion and regional sustainable development** - The implementation of circular economy value chains in urbanized territories can contribute to the responsible use of materials and products and more sustainable patterns of development in cities. This has great relevance to the more urbanized regions where most of the industrial production and consumption systems are located and more than 85% of population are living in.
3. **Circular Manufacturing and Supply Chains** - Capacitation and engagement in the circular economy business models and technical knowledge is key to the development of technological and systems innovation and infrastructures to build circular economy value chains. These can bring solutions based on a more sustainable production and consumption, to generate economic growth and more opportunities of decent work.
4. **Life Cycle Assessment and Inventory** - Broader adopting of Life Cycle Inventories for circular economy products and processes can support for more sustainable innovations in responsible consumption and production, and for collaboration and partnerships across sectors which are key for the development of circular economy value chains.
5. **Research, Development and Innovation for industry and Low-Carbon Agriculture** - The circular economy value chains are pushing R&D+I advancements towards a more sustainable use of resources in industry and agriculture, which impacts to the increase in the adoption of more sustainable technologies and systems and drive improvements in production, logistics, infrastructure, machinery, information systems and other efforts.
6. **Bioenergy** Going towards a 100% renewable energy matrix is one of the most important contributions of circular economy value chains. Circular economy systems are pushing forward energy supply systems sustained from bio-based resources, which have great impact in climate change mitigation and natural ecosystems conservation.

The most relevant stakeholders identified during this technical assistance and their initiatives in the country are presented in Table 5. The selection of the actors was based on their strategic value for the circular economy implementation in Brazil.



**Table 5: Key Initiatives identified for the implementation of the circular economy in Brazil**

<b>Key Stakeholder</b>	<b>Ministry of Science, Technology Innovations (MCTI)</b>
<b>Initiatives</b>	<p>The <b>Bioeconomy Science Technology and Innovation Action Plan (PACTI Bioeconomy)</b> fits into a larger context, finding the convergence of national initiatives with the Sustainable Development Goals (SDGs) of the UN 2030 Agenda. In addition, given the transversal nature of the bioeconomy, this Plan relates to other Action Plans on Science, Technology and Innovation, PACTIs, with emphasis on sustainable agriculture and renewable energy. The Bioeconomy STI Action Plan aims to support efforts in scientific and technological development as well as innovative solutions and new business models.</p> <p>The Bioeconomy STI Action Plan aims to produce and apply scientific and technological knowledge to promote social, economic and environmental benefits, filling essential knowledge gaps, fostering innovation and providing conditions for the strategic insertion of the Brazilian bioeconomy within the global scenario.</p>
<b>Key Stakeholder</b>	<b>Brazilian Institute of Information in Science and Technology (IBICT)</b>
<b>Initiatives</b>	<p>The <b>Life Cycle Assessment Project</b> is an initiative of the Brazilian Institute of Information in Science and Technology (IBICT) to foster the development and adoption of LCA methodology in Brazil, through an information infrastructure that serves industry, academia and society in general.</p> <p>The Life Cycle Assessment Project is dedicated to promoting the development of Life Cycle Inventories (LCI) and the dissemination and production of content on Life Cycle Thinking through the integration of partners from industry, government, research institutions and academia that have the common interest in LCA in Brazil.</p>
<b>Key Stakeholder</b>	<b>Ministry of Agriculture, Livestock and Supply (MAPA)</b>
<b>Initiatives</b>	<p>The Sectorial <b>Plan for Adaptation to Climate Change and Low Carbon Emission in Agriculture towards Sustainable Development (2020-2030) - Strategic Vision for a New Cycle</b> is the global strategy for 2020 to 2030 Climate Change Adaptation Plan and Low Carbon Emission in Agriculture (ABC +), for consolidating a national agriculture based on sustainable, resilient and productive systems.</p> <p>The ABC+ Plan (Ministry of Agriculture, Livestock and Supply, MAPA) is composed of seven areas dedicated to research, technology transfer, technical assistance and capacity-building to support the implementation of the ABC Plan, and overcome limitations related to improvement of infrastructure and logistics and access to funding.</p> <p>The ABC Plan aims to stimulate and monitor the adoption of low GHG emissions actions to agriculture and build resilience combining conservation and economic results through climate change adaptation and mitigation technologies.</p>

Key Stakeholder	The Funding Authority for Studies and Projects (FINEP)
Initiatives	<p><b>ERA-MIN 2 consortium</b> for Research &amp; Innovation Program on Raw Materials to Foster Circular Economy. The purpose of the ERA-MIN 2 s to provide financial support through grants for transnational research and development and innovation projects that are jointly developed by companies and ICTs in the non-energy raw materials and non-agricultural sectors, including metallic, construction, and industrial minerals sub-sectors. The focus of these themes is on sustainable sourcing, production, consumption, reuse and recycling of raw materials in a circular economy.</p> <p><b>FINEP-startup program</b> aims to support innovation in nascent knowledge-intensive companies, covering the support and financing gap that exists between investments made by acceleration programs, angel investors and crowdfunding tools and investments made by Seed Money and Venture Capital.</p>
Key Stakeholder	National Confederation of Industry (CNI)
Initiatives	<p>The National Confederation of Industry, CNI, has been dedicating efforts for the circular economy delivering studies, seeking trends, making proposals to solve bottlenecks and creating a strategic vision for the Brazilian industry, including a recent publication "<b>Strategic industry map for the circular economy in Brazil</b>" in 2019.</p> <p>The report "Circular Economy: Strategic Path for Brazilian Industry" is a diagnosis of where Brazil stands in relation to the circular economy and of actions that could lead to the transition, led by companies and industry associations and federations. The results are presented in terms of educational, marketing, public policy, financing and research and technological development actions</p>
Key Stakeholder	Ministry of Regional Development (MDR)
Initiatives	<p>In pursuit of the achievement of the objectives of the <b>National Policy for Regional Development</b>, the Ministry of National Integration, established the <b>National Integration Routes</b> as a strategy for regional development and productive inclusion. The Routes Program promote the coordination of public and private actions in selected industrial productive chains, through the sharing of information and the use of collective synergies.</p> <p>The 'National Integration Routes' are part of the '2029 Program' for Regional and Territorial Development (PPA 2016-2019), aiming to promote productive activities, local productive arrangements and integration routes for regional and territorial development. The 'Routes' are networks of local productive arrangements (APL), associated with strategic supply chains capable of promoting the productive inclusion and sustainable development for Brazilian regions prioritized by the National Policy for Regional Development - PNDR. The 'Circular Economy Routes' are an initiative within this program seeking to promote innovation, differentiation, competitiveness and profitability of associated enterprises regarding circular economy products, services and business models.</p>

<b>Key Stakeholder</b>	<b>Ministry of Mines and Energy (MME)</b>
<b>Initiatives</b>	An effort from the Ministry of Mines and Energy, MME, <b>Renovabio Program</b> , part of the <b>National Biofuels Policy</b> , aims to establish support mechanisms for investments in renewable biofuels, with the objective of placing Brazil among the countries a clean energy matrix.
<b>Other Initiatives</b>	
<b>RC4CE</b> (Research Center for Circular Economy, USP)	The RC4CE Research Center for Circular Economy at University of São Paulo is bringing many industrial sectors together, partnering with CNI, developing the capacitation and finding opportunities in circular economy initiatives for companies. RENNEN and HP / Sinctronics are the first of the companies that have made efforts in this direction.
<b>Hub-EC</b> (Hub de Economia Circular, E4CB)	Multi-sectoral ecosystem that aims to accelerate the Circular Economy in the country through structural changes, education and practical actions. Has developed 3 webinar and several meetings gathering public and private organizations dedicated to circular economy in the country.
<b>CETEM</b> (Center for Mineral Technology, MCTI)	Boost strategic partnerships between government, academia and technology centers to increase investments and mitigate investment risk. R&D+I to solutions, e.g. urban mining, etc. for the recovery of valuable elements (ores, rare earths, etc.) from waste, or urban mining, stored in large urban centers. Main sources being electro-electronic waste, construction and demolition waste, ashes, effluents.
<b>CTI Renato Archer</b> (Information Technology Center, MCTI)	It works in partnerships between the private sector, academia and the government to promote innovations in processes and products, strengthening the national industry. Rematronic project - Recover strategic materials from electronic waste, focus on the circular supply of materials, using mechanical, hydro-metallurgical and bio-metallurgical processes. The project is part of the Ambientronic program, together with main entities in the electronics industry. LicoBat Project - Technologies for the recovery of strategic materials from Li-ion batteries, focus on the circular supply of materials. Projeto LICOBAT conducts a socioeconomic study for reverse logistics for batteries, both in Europe and in Brazil, to learn about the current situation and propose alternatives that guarantee the sustainability of recycling activities.

## 2.2. Identification of circular economy value and definition of benefits, weaknesses, opportunities and challenges

For a broader understanding of the many potential areas of impact to build circular economy value chains in the country, an analysis of benefits, weaknesses, opportunities and challenges for the implementation of a circular economy in Brazil was conducted. The information of this analysis was gathered from actors that participated in the survey and interviews complemented by a desk research assessing relevant data about the national context and from the systematization of the potential economic, social and environmental general benefits of the circular economy to the country.

Seven main perceived benefits were identified regarding the implementation of a circular economy in Brazil:

**1. Guide innovations to leapfrog current models towards sustainable development**

There is a huge room for investments and gains from circular economy technological and systems innovations and the promotion of productive inclusion. Also, there is a window of opportunity to “leapfrog” the current recycling linear approach going directly to implementation of more sustainable production and consumption patterns. This provides an opportunity to contribute to reaching the Paris agreement goals, as well as many of the UN 2030 Agenda Sustainable Development Goals (SDG).

**2. Expand the access to essential products and urban services for more people**

Brazilian social-cultural context may be a very fruitful environment to explore commercial circular economy product-service models like reuse, share, resale, maintenance, refurbishment, and redistribution. Product-service systems and shared business models on circular economy can improve the access to better quality products (like housing, basic infrastructure for health, sanitation and transportation) for a broader range of people and foster changes in use patterns to urban infrastructures, such as for water, sewage, energy and buildings.

**3. Stand out in the emerging global trends of bioeconomy and ecological regeneration**

Brazil is well positioned to become a relevant nation and global player to explore bioeconomy and develop innovative solutions to the industry, agriculture and cities. Circular economy interdependence of factors is essential to enhance actions towards a more sustainable industry and agriculture production and consumption relationships.

Developing the circular economy bio-cycle can drive innovations in many sectors and bring about many environmental benefits through adoption of biomaterials, to strengthen Brazil's competitiveness and sustainability globally, specially by improving the “regenerative potential” to support ecosystems services, water, food, energy, and biodiversity. Initiatives around small-scale and urban food production, agri-ecology systems can add value through preserving biodiversity in association with social development.

**4. Promote the adoption of renewable energy and a low-carbon, resilient practices**

Circular economy can also be a driver for investments in increasing renewable energy production and help manufacturers to adopt circular economy design principles to stimulate R&D+I and the deployment the next generation of technologies, like for Industry 4.0 solutions. Circular economy value chains could boost the renewable energy production from organic solid waste and effluents to support advances in biofuels and benefits from the circular economy biological cycle to innovations for a low-carbon and resilient agriculture.

**5. Impact of innovation trends for sustainability in productions and consumption patterns**

There are many potential benefits of the circular economy approach to design products and packaging being observed by many sectors of the industry in Brazil: for

electronics, paper and cellulose, textile and cement, plastics and steel, among others. A supply industry of recovered materials, from biological and technological sources, can be created and help Brazilian cities to build more interlinked beneficial resources management for the urban and rural systems, such as for energy and water supply, sewage treatment and food.

Implementing circular economy can enable the connection of service providers and users for purchasing the service of product, which will demand many socio-institutional systemic changes together with innovation in products and technologies. It is expected that these circular economy models will boost global trends, such as for food and the plastics environmental issues, and specially in cities as the places with power to mobilize collaboration between multiple actors, with the greatest concentration of materials and nutrients.

## **6. Updating legislation for new business and job opportunities**

New specific circular economy policy proposals can be built upon existing regulatory framework in the country. For example, improving and expanding waste management regulations to support circular economy business models and industrial symbiosis is a significant opportunity for the circular economy in the "National Solid Waste Policy Law 12.305 / 2010", which already recognizes the potential of waste management as a resource as an economic and social development tool for the country. Potentially, by deploying circular economy innovations, the expenditure in waste management by the government with tax money could be reduced and new businesses and jobs creation could be triggered.

## **7. Gender equality embedded in the circular economy transition**

Although the circular economy approach is not directly linked with the gender equality agenda in the country, it can also contribute to this by the involvement of female entrepreneurship and to strengthen women's leadership position in recycling activities, craftsmanship, community entrepreneurship, and solidarity economy activities in which women are the majority of the workers.

Several perceived **weaknesses and barriers** were identified addressing seven particular aspects:

### **1. Regulatory aspects identified:**

- Currently, the taxation models make difficult the commercialization of recycled materials and undermine the creation of a strong market on secondary materials and products.
- Policy makers need guidance to update regulations to enable circular economy cross-sector collaboration.
- Due to highly different contexts of the Brazilian regions, policies would need to be adapted to each regional context to enable the development of nation-wide circular economy value chains.
- A mobilization of multiple actors in different sectors will be needed to allow the change of regulations that restraint the deployment of innovations for circular economy.

## 2. Market aspects identified:

- Most of relevant industrial sectors for circular economy in Brazil still have a 'linear' approach for management resources and materials.
- Important sectors to the national economy are dependent on extractive activities, such as mining, oil, wood and agri-business monoculture and cattle.
- Products and business models Innovations for circular economy will need a much more favorable financial, technical and regulatory environment to succeed.
- The circular economy demands a complex collaboration system and knowledge sharing between multiple actors from diverse areas of interest in cross-sector value chains.
- Professional capacitation and consumer behavior change are needed to develop the skills and improve the perception towards the adoption of a circular economy practices in marketing products and using of resources.

## 3. Cultural aspects identified:

- The mindset of policy makers, business managers and consumers are still framed in the linear economy approach to make decisions.
- A more sustainable management of resources depends on culture change in the 'business as usual' attitude by current 'linear business management' practices.
- To create the necessary articulation and coordination of actors in Brazil, a long-term shared vision of the advantages of a circular economic model to the local context is required.
- Technologies and systems innovation for the circular economy requires new knowledge and management practices not yet internalized in many professional areas.
- Sectoral agreements are still complex and there are many conflicts between actors to establish the reverse logistics for products and materials, to comply with waste management shared responsibility.
- More engagement on shared responsibility schema for reverse logistics to recover products and materials as resources is much dependent on consumer behavior change.
- The necessary improvements in consumption, materials management and policies needs a coordinated mobilization of actors from multiple sectors to influence social and cultural changes.
- A large part of the business sectors still faces considerable challenges to implement their sustainable practices, on collaboration along the supply chain, building a culture for innovation, improve systemic and long-term business vision, comply with international regulations and update resource efficiency methods.

## 4. Entrepreneurship aspects identified:

- The competitive behavior in business management needs to open space for a more collaborative mindset.

- Circular economy new business models, which rely on establishing partnerships and articulating shared interests from different business, will need a different fiscal, regulatory and technological environment capable of supporting business collaboration.
- Financial support to startups before they reach competitiveness in the market is key to enable and accelerate technological and systems advancements needed for many circular economy innovative products and business models.
- Expand and facilitate long-term investments to scale-up the innovative initiatives from SMEs is crucial, especially to the national level.
- More examples of innovation projects in association with recycling cooperatives are needed to demonstrate the circular economy profitability and its potential for social inclusion.
- Demonstrating results from real cases that shows the strategic value of the circular economy is key to mobilize actor's engagement, especially business managers and consumers.

#### **5. Financing and capital aspects identified:**

- Costs associated with R&D+i, updating technology and logistics to the implementation of circular economy supply chains in the territory requires strong mechanisms of risk-taking long-term financing to the industry.
- Tax system adaptation and specific public policies will be needed to encourage the development of technological innovation to support the circular economy market in Brazil.
- In practice, financing mechanisms for innovations has not yet internalized the sustainability mindset for long-term returns, which may hinder funding of circular economy models.

#### **6. Industrial and technological aspects identified:**

- Industry 4.0 technologies associated to circular economy are a new approach for many companies in the country, which may struggle to implement it.
- It is possible to learn from European circular economy solutions but, in most cases, the implementation requirements are different to the Brazilian context.
- Innovation projects need to present tangible results to engage more companies in technology innovation practices.
- To develop circular economy practices, the extractive sectors will demand a great effort to change and innovate in the way they operate.
- Industrial symbiosis for the circular economy relies on platforms for materials and products circulation in complex cross-sectoral relationships and within industrial clusters.
- The development of circular economy industrial systems needs a well-structured databases at the national level to monitor and evaluate the use and processing of resources and control the generation, treatment and disposal of waste by the industry.



- Many technological upgrades are needed to enable the scale-up of sustainable production practices in agriculture in a circular economy approach.
- Many communities in Brazil lack of sewage systems infrastructure, especially in rural areas and urban poorest regions. Centralized, large-scale, 'linear approach' sanitation systems are, in most of these cases, not cost-effective to be implemented.
- Improving transportation infrastructures and logistics systems is critical to enable resource management and circular economy business models in the Brazilian continental territory.

## **7. Material and product recovery logistics, collection, repair and manufacturing aspects identified:**

- Common waste management initiatives that are currently being implemented are mostly focused on 'linear' improvements to minimize waste negative impact with an "end-of-pipe solutions" approach.
- Dedicated systems for manage the huge amount of organic waste in Brazilian cities are missing and there is a lack of monitoring regarding collection and utilization of organic nutrients from waste as resources.
- Planning and assessing the implementation of circular economy in the country will need a well-structured monitoring and evaluation system both for technical materials and biological materials.
- To improve the value of their services to the market, recycling cooperatives will need capacity building in circular economy approaches and business models.

The perceived **strengths and opportunities** for the implementation of a circular economy in Brazil can be summarized in four main circular economy strategic approaches:

### **1. Developing circular economy biological cycles**

- Circular economy projects can capture international funds and investments for industry and agriculture innovation, especially thrones with impact in global circular economy supply chains.
- The development of innovations and new solutions for urban-rural circular economy supply networks, can associate biotechnologies, bioenergy and food production with sustainable nutrient cycling, biodiversity and ecosystem services regeneration.
- Innovative approaches regarding biomaterials cycling can expand the adoption of new sustainable practices by the industry, such as industrial symbiosis, low-carbon agriculture, biofuels production from organic waste and sanitary treatment facilities for biogas production, that can be associated with actions for restoration and good management of natural ecosystems and support climate mitigation.
- The ultimate goal of circular economy is to change production and consumption patterns in order to reduce the extraction of natural resources to reach sustainable levels and increase the regenerative effects to ecosystems services capacity.



## 2. Developing circular economy technical cycles

- Circular economy can bring an improved approach for waste management and sectoral agreements for reverse logistics, and promote better cooperation and coordination among actors in managing materials as resources for industry.
- Brazilian products manufacturers such as textiles and apparel, packaging, household appliances, electronics, are already part of global supply chains that are adopting circular economy product-service models, specially related to reuse, share, resale, maintenance, refurbishment, and redistribution of products.
- Currently available Life Cycle Assessment (LCA) methodologies and Life Cycle Inventories (LCI) in the local context can provide the tools for measuring and monitoring products and processes and improve data for national information databases for a circular economy. This would impact competitiveness by improving materials and products management, connecting local and global circular economy supply chains.
- Circular economy approach can also boost shared responsibility agreements for products, opening new partnership opportunities for Brazilian manufacturers, importers, distributors, traders and recycling cooperatives for waste reduction, materials management and reverse logistics for co-products and products — and even for urban mining in the future — for many industrial sectors, such as paper, plastics, glass, metals, electronics, packaging and the construction in cities.
- Local productive arrangements can benefit from circular economy in regional development by increasing opportunities for productive inclusion and creation of decent jobs<sup>2</sup>. This is also true for the development of cities and in metropolitan areas in a more sustainable way, also accounting the different social and economic contexts in Brazil.

## 3. Developing circular economy services

- Circular economy cross-sector value chains could leverage the engagement of industry, commerce, service providers, distributors and consumers in partnerships for innovation in commercial product-service systems, which can be a powerful tool for regional development.
- The socio-cultural context in Brazilian cities have great potential for setting up product-services systems and other circular business models that are labor-intensive activities.
- The inclusion of recyclers cooperatives in projects adopting the circular economy product-service approach is important also to demonstrate its potential to deliver beneficial social impacts.
- The implementation of programs for professional capacity building on technologies and systems applied to circular economy product-service business models, especially for the adoption and integration of industry 4.0 technologies, is key to the national industry compete and thrive globally.

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<sup>2</sup> Schroeder et al., Circular Economy and SDGs. The Relevance of Circular Economy Practices to the Sustainable Development Goals. Journal of Industrial Ecology, 2018.

It is also important to **identify risks** of systemic unintended effects in deploying new technologies and socio-institutional innovations for circular business models, for example:

- Recycling processes that mix materials and reduce their quality preventing secondary materials from having high value as a resource and restricting applications only to lower quality requirements (also known as “downcycling”).
- Production, logistics or materials recover systems that require large amounts of energy from non-renewable sources, and/or rely on activities that generate pollution to water, air or soil.
- Product-service business models that facilitate the access to non-sustainable products or increase the demand for products that have no commitment to eco-friendly or social-fairness practices (for example, intensifying more rides in fossil-fuel cars through car-sharing systems, or sharing clothes made in regions with problematic labor conditions).

### 2.3. Review of international experiences on circular economy

The review of international experiences for the implementation of circular economy roadmaps and projects in the European Union, as an economic region that is leading the circular economy transition, included the analysis of 5 countries - Denmark, Finland, France, Netherlands and Spain, as well as the regional approach of the EU Circular Economy Action Plan. Countries in the European region have been the first ones that have initiated piloting circular economy approaches and creating circular economy roadmaps. European Union countries have already funds dedicated to the Circular Economy to test new innovations and business models.

These international roadmap initiatives are a valuable source of potential pre-identified and often pre-tested opportunities for sectors. The analysis provided an overview of the most instructive and relevant learnings that are leading initiatives for circular economy implementation globally, identifying the approaches for developing roadmaps, plans and projects. The Central approach of some of these circular economy roadmaps are presented in Table 2.

**Table 2: Central approach of each of the circular economy roadmaps in the five International countries**

**The Dutch circular economy roadmap "A Circular Economy by 2050"** is in essence focused on selection or prioritization of strategic sectors for the country, in a more 'thematic approach'.

**The Finnish circular economy roadmap "Leading the Cycle to a Circular Economy 2016-2025"** is structured based on biological and technical loops cycles, with particular focus on how to move materials through the economy (transport and logistics).

**The French circular economy roadmap "50 Measures for 100% Circular Economy"**, with a differing approach than the others, puts much focus on how to mobilize actors' engagement. In essence, it is structured on the general value chain or materials flow through their economy.

**The Spanish circular economy roadmap "Circular Spain 2030"** approach includes both the focus on resources efficiency, sustainability and low-carbon economy, as well as the participation of the entire society in the transition to a circular economy.

**The Danish circular economy roadmap "Strategy for a Circular Economy"** approach focuses on enterprises as the driving force for the transition, as well as the need for more harmonized standards for circular economy throughout the country and within the region.

**The European Union's regional circular economy "Circular Economy Action Plan"** approach recognizes the global, cross-border scale of implementation, as well as the requirements of multi-lateral and international agreements and the need of collaboration with all actors from economic sectors and civil society organizations. In this direction it focuses the goals on promoting a climate neutral and resource efficient, competitive economy.

This analysis also identified the conditions and opportunities that influenced the process of implementation of these circular economy initiatives at regional, national and sectoral level. It was considered the main relevant challenges and barriers and the policies and incentives or conditions taken for their implementation.

This assessment intended to be useful across different contexts, rather than grounded in specific scenarios or cases. Although the roadmaps are mainly derived from the European Union experience, which is different from Brazilian context, the identified pre-conditions can be important for enabling the effort for the Americas as a region toward circular economy.

Based on the assessment of the international circular economy roadmaps and case studies analyzed, ten key recommendations were highlighted as relevant to Latin American countries are presented in Table 3.

**Table 3: Recommendations from the review of the benchmarks of circular economy implementation:**

1. The circular economy is often applied as a transformational concept
2. Circular economy implementation mostly relies on international economic relations and global supply chains
3. There are common circular economy approaches that are being used by all countries
4. Governmental support is necessary to the transition to a circular economy, especially by leading and enabling policies and financial incentives through legislation and regulations
5. Multi-stakeholder groups are needed to deal collectively with the complexity of the circular economy

6. The social reality in Latin America will demand a different circular economy approach than that seen in developed countries
7. There are great potential opportunities for cooperations and partnerships for circular economy in common sectors among different countries
8. Circular economy plans often expects to contribute positively to Sustainable Development Goals and Climate Change mitigation
9. Circular economy plans often expects to provide new employment opportunities
10. Pilot Projects are seen as the way to experiment and find the solutions to implement the circular economy and to provide knowledge to the creation of future specific sectoral plans.

The selection of priority sectors and focus areas most relevant to its economy is a critical first step for the planning of the implementation of circular economy projects in a country. To this aim, a comparative matrix gathered all the economic activities and initiatives prioritized by the five national roadmap case studies in Finland, Netherlands, France, Denmark and Spain, plus the economic activities and initiatives identified as the most relevant to the circular economy in the national context in the four countries of this technical assistance — Brazil, Chile, Mexico and Uruguay<sup>3</sup>, summarized in Table 4.

**Table 4: Comparative matrix gathered all the economic activities and initiatives prioritized by Country**

Sectors or initiatives	Mentions	countries studied									
		F I	NL	FR	DK	ES	BR	CH	MX	UY	
Infrastructure and Construction	9										
Production and Manufacturing Industry	8										
Consumer Goods and Procurement	7										
Food and Agriculture	7										
Forestry, Biomass Technologies and Bioeconomy	7										
Digitalization and Industry 4.0	6										
Waste Management	6										

<sup>3</sup> The selection of projects and initiatives summarized have the focus on the direct relation to the Circular Economy, although the studied countries have many initiatives on other important topics associated with economic and social development and climate mitigation and adaptation that were not considered for this analysis.

Bio- and Renewable Energy	6									
Financial	6									
Education and R&D	5									
Transport and Logistics	4									
Plastics	4									
Taxes and Regulations	3									
Textile and Garment	3									
Mining and Raw Materials	2									
Water Management	2									
Tourism	1									
Transversal initiatives enabling the circular economy	6									

The comparison matrix shows geographical particularities that are based on the specific context of a country or region, arising from cultural, economic or certain sustainable development changes desired by the countries, allowing:

- To see the economic sectors and focus areas that are common between the countries and identify potentialities for opportunities in regional south to south and/or broader cooperation with countries leading the implementation of the circular economy in Europe.
- To look at the priority sectors that have been identified by several other countries and see when these sectors also fit with the economic priorities of Brazil and then learn and apply lessons from what has already been done elsewhere.
- To make use of this comparative matrix to extract information from the other countries that can have similar or complementary priority sectors of interest to their own, and find opportunities of partnerships, funding and cooperation in the region or in global initiatives.

#### 2.4.Mapping of successful cases of application of industry 4.0 which benefit circular economy

The technologies of Industry 4.0 are oriented towards implementation of advanced manufacturing, integrating value chains and connecting consumers with the production process and business model. All digital technologies can be applied to a greater or lesser degree of complexity to all business models proposed from the perspective of the circular economy.

The Industry 4.0 is capable of applications in manufacturing and also in primary and services sectors. It is especially critical for competitive value propositions in sectors with a strong focus on international trade, such as mining, agriculture and livestock and fisheries.

The most promising approach to this aim is to align the technologies used in Industry 4.0 with the three main processes underlying the design of every circular business model:

- The production process
- Reducing time-to-market
- Value proposition design

The application of the technology and production models implicit within Industry 4.0 are supported by the capacity for innovation of regions and organizations. This requires a cultural context, integrated collaboration processes across the entire value chain and public-private partnerships. A national strategy must consist of initiatives from various sectors that should be assessed using homogeneous criteria. Thus, the quality of governance and institutional structure are one fundamental and crucial aspect. It is also important to attract foreign investment and collaboration agreements with countries that are more advanced in 4.0 technologies.

Thus, considering the technological capacity and strategy of different regions and organizations, the potential for implementing 4.0 technologies to circular economy will primarily depend on four factors:

- The quality of governance and institutional structure
- The robustness of the existing structure of production
- Its technological potential
- Consumers' awareness and preferences

The analysis conducted has identified some indicators to assess the readiness for change in countries' production structures, for the assessment of the dynamism of technological transformation and the levers of change that are likely to catalyze Industry 4.0, which could represent a country dynamism to address the paradigm shift. The proposed indicators that can be seen in detail in Output 5, were grouped on four areas:

- Country's readiness for change
- Business capacity for innovation
- Quality of national human capital
- Quality of governance of the country

From this, an assessment of industry 4.0 has identified some aspects of the country's general position, the adoption of the 4.0 paradigm by different agents and the adoption of 4.0 technologies. Based on the analysis some important results that are more relevant to the Brazilian context are:

1. Internationally, Brazil stands in an intermediate position in terms of its readiness for Industry 4.0. The relative weight in the value added of medium and intensive hi-tech companies in the overall manufacturing sector corresponds to a 35.2%. This represents a potential for a good uplift of Industry 4.0 in the international ranking.
2. Globally, Brazil faces the risk of being squeezed between two groups of countries: the group represented by technology frontrunners with ever-increasing capacity to

offer advanced manufacturing and that represented by smaller countries with a competitive cost advantage.

3. In Brazil, the main perceived barriers to the incorporation of 4.0 technologies are the investment costs and the lack of clear guidelines for calculating the return on investment. Other important issues include organizational culture, a lack of skilled workers, weak telecommunications infrastructure in the country, difficulties identifying collaborating partners and a lack of funding lines.
4. The quality of its institutional structure is one of the most important weakness to the incorporation of 4.0 technologies in the country.
5. Because of their size and diversity, in Brazil the productivity ratios of the manufacturing sector vary considerably by region, sector and company size. This makes it difficult to generate general roadmaps for all these economies, which need specific ones.
6. One of the keys for technological development in Brazil is expected to be the need to institutionalize participatory approaches in which the various stakeholders work towards a definition of industrial policies, in particular public-private collaboration, and the essential shared leadership and coordination between different ministries.

Finally, some recommendations for public-private collaboration, shared leadership, and the coordination between governmental ministries towards a circular economy and industry 4.0 are:

1. Develop inter-ministerially coordinated public policies, which declare the commitment of the government to develop a paradigm shift based on the joint implementation of circular economy and Industry 4.0.
2. Develop sectoral circular economy and Industry 4.0 strategies channelled through public-private collaboration organizations. These would have the role of combining the interests of the regions and specific sectors within them to give impetus to innovation.
3. The creation of public funds to support investment in innovation for this kind of initiatives. Each innovation project, understood from the perspective of the circular economy, must respond to the demand for improving the efficiency and environmental impact of the value chain as a whole and must also be an evident source of social benefit.
4. Development of integrated and homogeneous management models with the capacity to evaluate the implementation of Industry 4.0 technologies under the principles of the circular economy in organizations. It is understood that the circular economy must be expressed in a strategy not only at the national, but also at sectoral and even company levels.
5. Creating spaces for pooling knowledge between the public sector, business, universities and research centers to lead on research, and the creation of strategic guidelines for circular and technological development.



6. Coordination of intra-governmental and regional legislation in terms of policy, regulation and incentives, and consistency in the regulatory and fiscal protection of sustainable business management settings. The goal is to eliminate barriers to the development of competitive circular economy strategies.

Circular economy models supported by smart technology involve designing efficient collaborative processes between internal departments, between different companies and with government and the world of knowledge, impacting on major changes to the relationships with stakeholders and the internal organization processes. Six pillars are identified as necessary to implement this new technological paradigm:

1. Increased technological training, required for professionals
2. The quality of the universities and their involvement in the development of guidelines for working in collaboration with companies
3. National and international cooperation needed to design financially-viable innovation projects
4. The gender-equal participation of professionals
5. Alignment with international climate change mitigation and with the other Sustainable Development Goals
6. The effective implementation of a culture of innovation and transparency in respect of the strategies for stakeholders

In addition, the development of combined initiatives based on circular economy models and smart technology must be also an ethical revolution based on the principles of sustainability. Three key factors were identified as key to underpin the competitiveness of the country and business aligned with sustainability principles:

1. The degree of leadership, on the part of the government, which needs to be able to create an environment for public-private partnership;
2. The quality of institutions, based on high legal certainty and low complexity of the conditions required for the creation of new businesses;
3. The existence of a roadmap agreed with key stakeholders that sets out the staging and prioritization of initiatives in line with the country's competitive position.

## **2.5. Identification of potential projects in circular economy prioritized**

With the aim of taking most of the potential of the opportunities in the circular economy model for the Brazilian context, it was envisioned a platform for knowledge sharing to enable a systematic support in the development and deployment of demonstration projects on circular economy in the country.

It is expected that, by creating a dynamic network for knowledge sharing and supporting actor's collaboration in circular economy solutions, this platform could enable socio-technical innovations to respond to economic, environmental and social pressures in different levels.

The result was an initial work to be developed as a future proposal, and serve as the basis for discussion with key stakeholders engaged in the circular economy in Brazil for the development of a Brazilian Circular Economy Platform.



The general aim of this Platform is to promote the development of innovative solutions and technologies to accelerate the adoption of more sustainable production and consumption systems, with more responsible use of resources in products design and industrial processes. To be able to perform in this context toward this bold mission, the Brazilian Circular Economy Platform will base its actions in five main pillars:

1. Systemic and sustainability innovations
2. Cross-sectoral governance
3. Funding projects and supporting partnerships
4. Knowledge exchange and capacity building
5. Advocacy for enabling infrastructures

The general objectives to the Brazilian Circular Economy Platform and the expected outputs of its performance are related to the main barriers to be addressed and targets the critical issues previously identified in this technical assistance. The following set of general objectives is proposed:

1. Build a national shared vision about the benefits of a circular economy to the country
2. Create a more systemic relationship between actors
3. Support continuous innovation in a broad range of relevant areas
4. Provide means to explore the most effective circular economy solutions
5. Integrate technologies with positive social and environmental impacts;

To this aim, a set of nine essential outputs were proposed to guide the performance of the Brazilian Circular Economy Platform:

1. Act as a knowledge and advocacy center for the circular economy.
2. Foster R&D+I and technological development to strengthen the connection between specialists in circular economy with other emergent areas.
3. Search and establish means to finance and support circular economy demonstration projects specifically for opportunities in the Brazilian context.
4. Support more systemic relations between rural and urban systems of production and consumption.
5. Promote the circular economy perspective to the Waste Management National Policy (PNRS) benefits for business.
6. Support the development of the "technical cycle" approach for value chains for recovering non-renewable materials back to industry.
7. Support the development of technologies and systems innovations in the "biological cycle" value chains, to boost the use of bio-based materials and renewable sources.
8. Support the implementation of new circular economy business models in product-service systems and shared economy commercial systems.

9. Support the adoption of 4.0 embedded technology for tracking products and control assets considering the whole product life cycle.

Finally, an implementation approach presented a summary of the main activities, also indicating the profile of potential executing entities and implementing partners. In order to establish a basic operating structure for the Brazilian Circular Economy Platform, four main steps organize the activities within planning, deployment and implementing the platform and the assistance to the development of the circular economy demonstration projects, to be carried out in the Setup and Operational phases.

## Part II: Guidelines for the formulation of a Roadmap towards the Circular Economy

This second part of the document outlines the elements that constitute the structure for the formulation of a roadmap to implement a circular economy in Brazil based on the findings from this technical assistance.

This technical assistance aims "to lay the foundations for the development of a roadmap to create a general circular economy strategy that generates an economic, social, institutional and environmental impact through the identification of players and territories that have favorable conditions for the development of a circular model, improving the competitiveness and efficiency of local businesses, enterprises and organizations that operate in these three sectors" <sup>4</sup>

The guidelines presented in this document are a methodological input to contribute to the processes of development of the general roadmap to the national level, to enable it to fit in different contexts depending on states of advancement, local institutional and political will and other factors that may influence the adoption of the circular economy, also considering the country's great difference of local and regional contexts.

To this aim, a general roadmap framework was conceived in a way to offer flexibility and adaptation to embrace the wide range of scopes from a diversity of actors that will be engaged in circular economy initiatives in the country and to enable future improvements and updates to the roadmap.

In general, the Circular Economy Roadmap for Brazil should be a representation of a consensual strategy among all the actors enrolled, about the opportunity to improve and boost the competitiveness of the Brazilian economy in terms of a national focus, with objectives and goals reflected. Thus, the roadmap may seek to support integrated and focused planning of products, technologies and processes for a circular economy.

### 1. The value of a Roadmap towards the Circular Economy

This roadmap draft is a document organized in a framework that presents a high-level overview of the areas of intervention and objectives to the implementation of the circular economy in Brazil.

This document should facilitate the consolidation of a shared vision and common goals for what is identified as a general national strategy for implementing the circular economy in the country. This document should be also a tool to support the development of more comprehensive circular economy policies and for the assessment of impacts of actions planned.

The information presented here should be recognized by stakeholders from business, academic, government and civil society organizations as a useful for guidance to detail and consolidate the Circular Economy Roadmap in Brazil.

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<sup>4</sup> Technical Assistance Response Plan - Terms of Reference. Analysis of the current situation of the circular economy for the development of a road map for each requesting country.

Instead of presenting a detailed description of implementation activities, this general roadmap is designed to be a simple and flexible tool for managing stakeholder expectations, for communicating the steps and coordinating the resources.

From the future process of developing and implementing the Circular Economy Roadmap in Brazil, different milestones, possible risks identified and potential dependencies concerning objectives will influence modifications and improvements to this frame.

### **1.1.Relationship between the Circular Economy and Climate Change**

The interface between circular economy and GHG mitigation efforts is still a relatively new field of study. Future advancements in research will allow to understand and quantify all the potential of the Circular Economy in the contribution to GHG mitigation from specific economic sectors adopting the circular economy.

The circular economy approach goes beyond the focus of GHG emissions on the 'production side', bringing into the debate the socioeconomic practices that create GHG emissions from the 'demand side', and its great potential for mitigations <sup>5</sup>. A circular economy also brings a perspective through "GHGs cycling" beyond just reducing GHGs, by promoting the use of recovered carbon as a resource or inputs for production processes or other solutions.

Specially by improving the "regenerative potential" of ecological systems for water, food, energy, and biodiversity improvement, the circular economy approach can support advances to deliver positive impacts to climate change mitigation efforts from sectors like biofuels, low carbon agriculture, forestry restoration and reforestation, and management of ecosystems services from protected areas.

The circular economy design principles can be a driver for investments in products and systems design, to stimulate R&D+I and the deployment the next generation of technologies for sustainability. New systems for a circular economy may positively push changes for more sustainable production and consumption patterns, for products and urban infrastructures for water, sewage, energy and buildings circularity, and push innovations for cities sustainability on key areas like housing, health, sanitation and transportation.

The implementation of a circular economy approach for production processes may also pull the demand for renewable energy, as this is a basic condition to consider a sustainable circular economy system.

### **1.2.Relevance and value of the Circular Economy for Brazil**

From the perceived benefits assessed in this study, for the adoption of a circular economy to the Brazilian context, the recommended six guidelines for the implementation of a circular economy at the national level are presented on Table 8.

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<sup>5</sup> <https://www.circle-economy.com/news/5-opportunities-for-the-circular-economy-to-strengthen-the-paris-agreement>

**Table 8: Guidelines for the implementation of a circular economy at the national level**

### 1. Increase the competitiveness in global markets committed with local development

Industry and agriculture are economic sectors of most importance for the country. To maintain and improve competitiveness in global markets, investments oriented to innovation in technology, infrastructures and systems will be needed, as well as fostering capacity building, support to entrepreneurship and professional capacitation locally.

Business managers, policymakers and investors should receive strong signals to orient their focus to new circular economy processes, products, and business models by developing a circular economy model that integrates the industry and agriculture value chains, to gain competitiveness through more sustainable production systems that favours local development.

### 2. Support R&D+I and technical capacitation committed to the complete life cycle of resources

New circular economy value chains will demand R&D+I advancements to bring solutions to production processes for more sustainable use of resources. As a feedback, the improvements of technologies and systems may drive wider adoption of circular economy in production, logistics, infrastructure, machinery, information systems and business models.

The development of circular economy value chains will demand an increase in knowledge sharing, partnerships and collaboration across governmental, business and academic sectors to play an important role to attract global investments for innovations initiatives in the country.

To this aim, circular economy Life Cycle Inventories for products and processes are key to support monitoring and assessing the performance of materials, products and systems innovations and also to guide improvements in consumption and production towards more responsible and sustainable patterns.

### 3. Foster economic development decoupled from the negative impacts to natural ecosystems

Biotechnologies and bio-based innovations are strategic to drive the economic development associated with conservation of natural ecosystems, impacting positively to climate change mitigation, water security, soil regeneration, healthy clean air, the conservation of biodiversity and other key environmental issues.

Implementing the circular economy model associated to the development of bioeconomy may drive the development of more interdependence between rural and urban value chains to make more sustainable use of inputs from biological sources. This can also guide more solutions to support production and consumption patterns that are more responsible for the conservation of ecosystems.

#### **4. Foster an urban and regional planning that integrates economic, social and environmental development**

More than 85% of population in Brazil are living in urbanized regions, where most of the industrial production and consumption systems are located and most of the valuable materials and nutrients are wasted.

A circular economy model can be designed to support shared responsibility agreements for products and materials recovery in urban areas, and improve the dialogue between business, government and citizens for their engagement, and contribute with behavior change to maximize the responsible use of materials.

The implementation of circular economy solutions for sustainable sanitation and public health systems may also contribute to more a sustainable urban development planning committed with environment and social fairness in urbanized areas.

A more sustainable production and consumption model based on circular economy may also help to guide cross-sector local productive arrangements (APLs) and, thus, generate economic growth associated with more local opportunities for creation of decent jobs and productive inclusion.

#### **5. Mainstreaming the adoption of clean and renewable energy sources in production processes**

Going towards a 100% renewable energy matrix is one of the most important goals for the climate change mitigation. The circular economy model should be associated with commitments to accelerate the supply chains adoption of clean and renewable energy sources, specially with clean energy generation systems from bio-based resources.

The circular economy approach to renewable energy may also be key to Brazil's long-term global leadership in the field of biofuels and biogas technologies associated with agriculture biomass and urban organic waste.

#### **6. Integrating water, air, soil and materials management for a more sustainable and beneficial flow of resources**

For the biological cycle of the circular economy, applying this approach to build integration systems between industrial and agricultural sectors can support local productive arrangements (APL) for regional development and productive inclusion in cities and metropolitan areas. Circular economy innovations on biomaterials and biotechnologies can associate food, materials, beauty and pharmaceutical sectors with biodiversity and ecosystem services regeneration. In addition, renewable energy, specially biogas production, can benefit from circular economy models for the recovery of high quality organic substrates from industrial, agriculture and sanitary activities.

For the technological cycle of the circular economy, applying this approach for materials management to the shared responsibility principle of the national waste management policy (PNRS) can benefit multiple actors by establishing effective reverse logistics programs and partnerships including recycling cooperatives.

This can benefit from industry cross-sector circular economy partnerships that can cooperate to improve product design to allow materials recover in higher quality inputs, specially redesigning packaging to allow more effective collection and recycling of steel, aluminum, plastics and paper. Combining this with industry 4.0 technologies in reverse logistics systems can update the urban waste management, especially for construction products and electronics sectoral agreements to the next level of circularity, including urban mining.

The socio-cultural context in Brazil may also be good for setting up innovative commercial product-services systems to create more business opportunities in reuse, share, resale, maintenance, refurbishment and redistribution of products, which are labor intensive activities and can create decent jobs opportunities.

## 2. Structure of the roadmap

The framework in Table 9 describes the structure and the relevant information that defines the circular economy roadmap draft.

**Table 9: Framework of relevant information for the circular economy roadmap in Brazil**

CIRCULAR ECONOMY ROADMAP (framework)						
<b>Long-term Vision</b>	Set the shared vision statement to communicate the aspirations aimed at bringing benefits and improvements to the country in the future.					
<b>Guiding Principles</b>	Set the principles aimed to support all actors when making a decision for circular economy initiatives in Brazil					
<b>Strategic area of intervention</b>	<b>Leadership</b>	<b>Key Stakeholders</b>	<b>Objectives</b>	<b>Indicators</b>	<b>CE Transition Short to Mid-term</b>	<b>CE implementation Mid to Long-term</b>
Give a short name for the strategic area of intervention	List the leader(s) organization(s) in this area of intervention	list the key stakeholders willing to engage on the initiatives in this area of intervention	Define the general objective for the initiatives in this area of intervention	Define the set of indicators to monitor and evaluate the initiatives in this area	Set Micro-level Actions and Goals	Set Micro-level Actions and Goals
					Set Meso-level Actions and Goals	Set Meso-level Actions and Goals
					Set Macro-level Actions and Goals	Set Macro-level Actions and Goals

### 2.1. Vision Statement

Setting a vision statement for the circular economy roadmap is critical to communicate shared aspirations which motivates actors from governmental, academic, business and civil society organizations through an inspiring message leading to changes.

An effective vision statement is forward-looking aimed at envisioning shared benefits and improvements to the country in the future. It defines the intention for the roadmap and where it is heading reflecting cultural beliefs and core local values.

The proposed statement is an inspirational vision of an idealistic future describing the intentions for the impact of the circular economy to be experienced collectively on a broader context for Brazil:

**"Implement a circular economy model for the country by establishing strong foundations to change the future production and consumption patterns to deliver a more sustainable and responsible development for the Brazilian region."**

## 2.2.Guiding principles

The guiding principles intend to encompass the actors' common beliefs and values regarding the circular economy implementation in Brazil. It is aimed to create a basis for all actors – from government, business, academy and civil society organizations – to understand what is more relevant for the country.

By establishing guiding principles, it is possible to define the foundations for the development of a roadmap to build an effective circular economy implementation strategy.

It should guide all individuals and organizations to put efforts and cooperate in different circumstances, across all goals, strategies and for activities in all levels. This is the basis for the long-term vision, and serves as a means of guiding and setting time-based targets and objectives for the process of implementing a circular economy in Brazil.

The proposed guiding principles for implementing the circular economy in Brazil are presented in the table 10.

**Table 10: Guiding principles of the circular economy Roadmap for Brazil**

1. Economic development associated with conservation and restoration of natural ecosystems;
2. Industry and agriculture competitiveness in global supply chains committed to local sustainable development;
3. R&D + innovation and professional capacitation considering resources complete life cycles impacts;
4. Urban and regional planning integrating the economic, social and environmental dimensions of development for all;
5. Broader adoption of clean and renewable energy in production and commercialization processes;
6. Integrated management for a more sustainable and beneficial circulation flows of the resources and waste: water, air, soil and materials.



## 2.3. Areas of intervention and Objectives

This technical assistance has identified seven specific areas in Brazil that have favorable conditions to explore the potential of a circular economy in the context of the country. The roadmap for the implementation of a circular economy in Brazil recommends these areas of intervention by its comprehensive impact considering the whole territory in an integrated and multi-dimensional approach.

Organizing the actors and the initiatives in these seven areas of intervention with clear objectives to move towards a circular economy in Brazil may improve collaboration efforts and coordination of the different necessary actions at the level of public policy, regulatory framework, (pilot) projects, financing mechanisms, capacitation programs, awareness campaigns, and others.

Table 11 shows the seven areas of intervention and the related objectives recommended for the orientation of circular economy initiatives in the context of Brazil.

**Table 11: Areas of intervention and the related objectives for the circular economy initiatives in Brazil**

<b>1. Bioeconomy</b>
Foster policies and articulate with governmental players on science, technology, innovations for bioeconomy and climate change national plans.
<b>2. Urban infrastructure, productive inclusion and regional development</b>
Develop public policies for urban infrastructure and promotion of regional and productive development and facilitate the governance for clusters and supply chain for productive inclusion and gender equality.
<b>3. Bioenergy: biogas, biofuels</b>
Establish support mechanisms for investments in renewable biofuels for a clean energy matrix.
<b>4. Industry and Supply chains engagement and capacitation</b>
Bring together state industry federations, industry associations and business representatives to diagnose and think of strategies and draft proposals for technological improvement and international competitiveness.
<b>5. Research, Development and innovation for Industrial sector</b>
Provide financial support through grants for national and transnational R&D+I, including 4.0 technologies, to companies, universities, technological institutes and other public or private institutions.
<b>6. Research, Development and innovation for Agriculture Sector</b>
Promote the adoption of sustainable low-carbon production technologies, including 4.0 technologies, responding to GHG mitigation in the agricultural sector.
<b>7. Life Cycle Assessment, and National Bank of Life Cycle Inventories</b>
Foster the development and adoption of LCA methodology and the development of Life Cycle Inventories (LCI), and an information infrastructure that serves industry, academia and society.

## 2.4.Indicators

It is recommended that the framework should be based on seven key fundamental elements for the implementation of Sustainable Circular Economy strategies, as a reference to locate potential indicators to monitor the transition to a circular economy:

- a. Sustainability
- b. Climate change
- c. Materials
- d. Energy
- e. Water
- f. Biodiversity
- g. Community

Based on the experience in other countries where the Circular Economy is being implemented, the indicators in this framework reference are grouped in three focus areas:

- 1. Resource Inputs:** Assess the origin of each flows (materials, energy, and water) to visualize the inputs of all resources at the different scales (micro, meso, and macro) and evaluate the effectiveness of the circular economy implementation.
- 2. Impacts and Outputs:** Assess the socio and environmental impacts, the degree of socio-economic development and the progress of the Sustainable Development Agenda and climate change mitigation and adaptation.
- 3. Enabling Mechanisms:** Assess the mechanisms that block or enable the circular economy initiatives, the orientation of resources invested in innovation, technology, support of companies and new businesses, as well as public policies.

The proposed framework designed for the development of indicators for measuring and monitoring the initiatives for the implementation of a circular economy in Brazil is presented in Table 12.

**Table 12: Framework for measuring and monitoring indicators of a circular economy implementation in Brazil**

1. RESOURCES INPUTS:	
Materials input	% of total technical and biological materials that is reused as valuable resource in production processes.
Energy input	% of total national energy matrix that is produced from clean and renewable resources.
Water input	% of total water used that is reused or reincorporated clean and safe to the environment

2. IMPACTS OUTPUTS:	
Non-renewable resources maintenance and recovery benefits	# of economic, social and environmental related initiatives dedicated to the recovery and maintenance of non-renewable resources
Renewable resources and ecosystems services regeneration benefits	# of economic, social and environmental related initiatives dedicated to the recovery of renewable resources and regeneration of ecosystems services
Product services systems benefits	# of economic, social and environmental related initiatives dedicated to product services systems
3. ENABLING MECHANISMS	
Entrepreneurship in CE activities	% of the total number of new business
Innovation in CE technologies	% of total number of patents
Industry 4.0 applied to CE systems	% of total number of 4.0 products and services
Professional Capacitation on CE	% of total number of educational courses
Consumer behavior change for CE	% from total consumers awareness campaign
Implementation of CE Regulations	# of new regulations related to CE
Implementation of CE tax schemes	# of new tax schemes related to CE
Implementation of CE policies	# of new policies dedicated to CE

This reference framework considers three groups of factors and seven perspectives that are recommended for monitoring the progress of implementation of a circular economy.

#### Factors:

**1. Technological Factors:** assess the evolution in technological development, in the production of raw materials through value-added to resources recovered from a specific industry.

**2. Socio-institutional Factors:** assess the technology role as an enabler in support of circular economy business models, for example in transactions associated with the exchange of resources through electronic platforms.

**3. Sharing Economy Factors:** assess the degree to which actors establish collaborative links that modify the dynamics of production and consumption towards a circular economy model, by the supply and purchase of recovered materials, products and/or services under a shared economy.

#### Perspectives:

**1. Raw Materials:** the origin of the raw materials used in production, measure and monitor the materials flows, the degree of dependency of virgin raw materials and the level of impact of mechanisms that enables technical and biological cycles.

**2. Product and Services Design:** the solutions and products or services designed, focused on the re-incorporation of the resources used in new economic cycles.

**3. Production and Consumption:** the reduction of discarded resources and evaluation of the flows of materials, energy, and water, to close cycles, re-defining the consumer markets and the relationship producer-consumer.

**4. Management of discarded Resources:** the flows of discarded resources that are revalued as resources.

**5. Competitiveness and Innovation:** the contribution of a circular economy initiative for jobs creation, technological development, and economic growth.

**6. Gender Perspective:** the social equity prioritized in terms of education or employment opportunities, and regarding empowerment of women and socially vulnerable groups.

**7. Risks and Impacts:** the potential risk and impacts by the occurrence of natural disasters.

These reference indicators should be revised during the processes of development and validation of the roadmap. Updates to the set of indicators could also be done during the entire process of transition and at the stage of implementation of the circular economy in Brazil, and when data are available to feed more advanced indicators.

Additionally, milestones and targets should be established and assessed considering the different time stages and levels of scale of the initiatives:

#### Time stages:

**1. Circular Economy Transition Stage (2020 - 2030):** planning and development of the circular economy roadmap.

**2. Circular Economy Implementation Stage (2030-2050):** measure and monitor the long-term goals of circular economy initiatives progress and results.

At the Micro level individual companies seek for consumers behavior change and sustainable product design, higher efficiency, and cleaner production. In the meso level, established industrial parks and clustered or chained industries seek to circulate resources efficiently within the production system in local industry and adopt more effective actions for environmental protection and regeneration. Most important, at the regional macro level circular economy adds a strong social and economic dimension through investment in new ventures and job creation by integrating different production and consumption systems safe to the environment, by means of management systems for material flows throughout urban, sub-urban and rural areas to

products and resources circulate safely and efficiently across producers and the communities.

#### Levels of scale:

- 1. Micro Level:** improvements on products, services and patterns of production and consumption characterized, supplied by companies and organizations that offer solutions to the market.
- 2. Meso Level:** performance results of economic sectors, production chains, and industrial parks in specific areas of influence and its impacts in the territory.
- 3. Macro Level:** management of materials, energy, and water within regions and nationally, including import-export flows of raw materials and products as well as socio-economic development and climate change mitigation and adaptation.

### 2.5.Actions and Goals

The circular economy model encompasses different levels of actions and the circular economy opens opportunities for both domestic and foreign enterprises<sup>6</sup>. Establishing general goals contributes to translate into a more tangible plan the way to reach the vision and principles of a roadmap. In the Table 13, general goals recommended for the actions to the transition and implementation of a circular economy in Brazil are presented.

**Table 13: General goals for the implementation of a circular economy in Brazil**

1. Design a national development strategy for circular economy that is shared among actors in all sectors.
2. Build the knowledge about the circular economy potentials considering territory differences and local contexts of the country.
3. Create national policies and regulations for circular economy that favors more responsible and sustainable production and consumption.
4. Create financial mechanisms and improve enabling Infrastructures that supports circular economy initiatives in all levels and scales.
5. Prioritize to support circular economy R&D oriented to systemic, cross-sector, socio-technical innovation processes.

By having these general goals in agreement among all the actors enrolled, it should be able to influence the development and selection of initiatives that are determined to the roadmap execution. Oriented towards these goals, some recommended actions are listed in the table below, considering the transitional phase (short to medium-term) and implementation phase (medium to long-term) of a circular economy.

<sup>6</sup> Ernest Lowe, Economic Solutions. in Environmental Solutions, 2005

The actions that are being recommended are based on the perceived barriers on seven spheres for the development of circular economy in Brazil, presented in Table 14.

**Table 14: Actions in seven relevant matters considering the transitional phase and Implementation phase for the development of circular economy in Brazil**

## 1. Regulatory

### Transition phase

- a. Revise taxation models that undermine the creation of a strong market on secondary materials and products.
- b. Revise regulations that may impose restraints to the deployment of innovations for circular economy.

### Implementation phase

- a. Adapt policies to the diverse regional contexts in the country.
- b. Create regulations to enable cross-sector collaboration.

## 2. Market

### Transition phase

- a. Raise awareness from the industrial sectors that keep 'linear' practices for the management of resources.
- b. Dialogue with sectors to the national economy that are dependent on extractive activities which are highly related to GHG emissions.
- c. Promote professionals and the public skills training and behavior change campaigns.

### Implementation phase

- a. Support innovation programs to advance in products and business models development.
- b. Facilitate collaboration systems that enable knowledge sharing between multiple actors.

## 3. Cultural and Educational

### Transition phase

- a. Promote the introduction of new professional knowledge and management practices.
- b. Build a strong long-term shared vision that embraces the specific local contexts.
- c. Internalize the new mindset for most of policy makers, business managers and consumers that are still framed in the linear economy.
- d. Facilitate more coordinated mobilization from multiple actors to influence social and cultural changes.

### Implementation phase

- a. Mediate complex sectoral agreements in the many points of conflict between the actors.
- b. Enforce actors' engagement in shared responsibility schema for reverse logistics of products and materials.
- c. Support the industrial sector that still faces important challenges in management for sustainability.

## 4. Entrepreneurship

### Transition phase

- a. Engage business community in a more collaborative mindset.
- b. Incentivize demonstrations of circular economy profitability and its potential for productive inclusion with social impact.
- c. Develop pilot cases to demonstrate results that supports the strategic value of the circular economy.

### Implementation phase

- a. Facilitate new business models that rely on articulating shared interests and establishing partnerships from different companies.
- b. Support startups with substantial financial support before they reach competitiveness in the market.
- c. Support scaling-up innovative initiatives with expanded and facilitated long-term investments.

## 5. Financing and capital aspects

### Transition phase

- a. Create strong mechanisms of risk-taking long-term financing.
- b. Adapt tax system to support the recycled materials market.

### Implementation phase

- a. Expand funding for technological innovation for circular and sustainable use of natural resources.

## 6. Industrial and technological aspects

### Transition phase

- a. Understand and adapt from circular economy solutions in Europe that are different to the Brazilian context.
- b. Facilitate industrial symbiosis for a circular economy which relies on platforms for materials and products circulation in complex cross-sectoral relationships.
- c. Organize structured databases that are needed at the national level for monitoring and evaluating the use and processing of resources by the industry.
- d. Promote the association of 4.0 technologies with circular economy, which is a new approach for many companies.

### Implementation phase

- a. Engage extractive sectors which perform 'linear' activities that will struggle to change and innovate.
- b. Support sustainable production innovative practices in agriculture to be scaled-up.
- c. Promote the change in the implementation of 'linear approach' sanitation systems that are, in most cases, not cost-effective to be implemented.
- d. Build nationwide transportation infrastructures and logistics systems that are critical to enable circular economy.

## 7. Materials and products recovery logistics, collection, repair and manufacturing aspects

### Transition phase

- Increase monitoring collection and utilization of organic nutrients from waste as resources.
- Promote the change of the focus that are still on 'linear' improvements with "end-of-pipe solutions" approach to minimize waste negative impact.
- Support recycling cooperatives improvements in capacitation in circular economy approaches and business models.

### Implementation phase

- Create monitoring and evaluation systems for resource use and waste generation by industrial activities.

## 2.6. Key stakeholders

The most relevant key stakeholders identified during this technical assistance and their initiatives in the country are presented in the Table 15. The selection of the actors was based on their strategic value for the circular economy implementation in Brazil.

**Table 15: Key stakeholders for the implementation of the circular economy in Brazil**

Ministry of Science, Technology Innovations (MCTI)	
<b>Description</b>	The Ministry of Science, Technology and Innovations of Brazil is an organ of the direct federal administration which coordinates science, technology, and innovation activities in the country. It has the role of promoting strategic areas and bringing the industrial sector closer to scientific knowledge to stimulate technological development and innovation. The General Coordination of Climate Science and Sustainability of MCTI is the Brazilian National Designated Entity for the Climate Technology Centre and Network.
<b>Objectives</b>	Development and improvement of technological innovation on production systems based on bioeconomy and industry 4.0.
Brazilian Institute of Information in Science and Technology (IBICT)	
<b>Description</b>	The research unit of the Ministry of Science, Technology and Innovation (MCTI), the Brazilian Institute of Information in Science and Technology (Ibict) is the national information agency that conducts studies in the field of information science and related topics. The Institute monitors and internalizes new information and communication technologies, stimulating entrepreneurship and innovation. It has a role to aggregate and integrate scientific and technological information initiatives in the country.
<b>Objectives</b>	Life Cycle Thinking, LCA, LCI, information science and related topics.



Ministry of Agriculture, Livestock and Supply (MAPA)	
<b>Description</b>	<p>The Ministry of Agriculture, Livestock and Supply (MAPA) is responsible for the management of public policies to encourage agriculture, for the promotion of agribusiness and for the regulation and standardization of services linked to the sector. It brings together activities to supply goods and services to agriculture, agricultural production, processing, transformation and distribution of agricultural products from small, medium and large rural producers to the final consumer.</p> <p>The Brazilian Agricultural Research Corporation - Embrapa, is a state-owned research corporation affiliated with the Brazilian Ministry of Agriculture, Livestock and Supply, dedicated to developing technologies, knowledge and technical-scientific information aimed at Brazilian agriculture, including livestock. Its mission is to "develop research, development and innovation solutions for the sustainability of agriculture, for the benefit of Brazilian society".</p>
<b>Objectives</b>	Promotion of sustainable agriculture on a regional-level under an integrated landscape approach for technological innovation on food production systems.
The Funding Authority for Studies and Projects (FINEP)	
<b>Description</b>	The Funding Authority for Studies and Projects (FINEP) is an public organization for financing R&D and innovation from the Brazilian federal government devoted to funding of science and technology in the country, under the Ministry of Science of Technology. It operates throughout the innovation chain, focusing on strategic actions, structuring and impacting for the sustainable development in the country. Has the mission to promote economic and social development by supporting science, technology and innovation initiatives for companies, universities, technological institutes and other public or private institutions.
<b>Objectives</b>	Support ICT development and cross-sector innovation projects in the production processes and the value chain;
National Confederation of Industry, CNI	
<b>Description</b>	The National Confederation of Industry (CNI) is the main organization representing the Brazilian industry to foster public policies that favors entrepreneurship and industrial production and the increase of Brazilian industry competitiveness. It engages in policy dialogue to with the federal government and various entities and bodies in Brazil and abroad.
<b>Objectives</b>	Foster adoption of circular economy and Industry 4.0 practices by industrial sectors and value chains.
Ministry of Regional Development, MDR	
<b>Description</b>	The Ministry of Regional Development is a federal ministry in Brazil, working in regional and urban development to reduce the inequalities caused by the growth of cities. It is dedicated to housing, emergency management, water resources, urban mobility and development, fostering the integration and development of the Brazilian regions.
<b>Objectives</b>	Support local productive arrangements (APL); regional and territorial integration; productive inclusion; regional sustainable development.

Ministry of Mines and Energy, MME	
<b>Description</b>	The Ministry of Mines and Energy (MME) is a Brazilian federal ministry that fosters investments in mining and energy-related activities, funds research and sets out government policies. The MME has four secretariats: the Secretary of Petroleum, Natural Gas and Biofuels; the Secretariat of Geology, Mining and Mineral Transformation; the Secretariat of Electric Energy; and the Secretariat of Energy Planning and Development.
<b>Objectives</b>	Promote expansion of biofuels and bioenergy in energy matrix; Implement offset emissions mechanisms.

## 2.7. Leadership

The process of preparation, planning and execution of the Circular Economy Roadmap in Brazil, requires institutions that act together to lead the coordination, validation, implementation, monitoring and updating activities.

In Table 16, the main institutions identified by their strategic area of activity related to the circular economy and their potential strategic role of collaborating in the implementation of the circular economy roadmap in Brazil are suggested.

**Table 16: key institutions suggested to lead the implementation of the circular economy roadmap**

Key Institution	Strategic areas of action	Strategic role
<b>Ministry of Science, Technology Innovations (MCTI)</b>	(1) Bioeconomy	Foster policies on Circular Economy to science, technology and innovations within the bioeconomy national plan and articulate with governmental players.
<b>Ministry of Regional Development (MDR)</b>	(2) Urban infrastructure, productive inclusion, and regional development	Develop public policies on Circular Economy initiatives on urban infrastructure and promotion of regional and productive development and facilitate the governance for clusters and supply chain for productive inclusion.
<b>Ministry of Agriculture, Livestock and Supply (MAPA)</b>	(6) Research, Development and innovation for Agriculture Sector	Promote the adoption on Circular Economy initiatives on sustainable low-carbon production technologies responding to GHG mitigation in the agricultural sector.
<b>Funding Authority for Studies and Projects (FINEP)</b>	(5) Research, Development and innovation funding for Industrial sector	Provide financial support on Circular Economy initiatives on national and transnational R&D+I to companies, universities, technological institutes and other public or private institutions.

<b>National Confederation of Industry (CNI)</b>	<i>(4) Industry and Supply chains engagement and capacitation</i>	Bring together players on Circular Economy from state industry federations, industry associations and business representatives to diagnose and think of Circular Economy proposals for technological improvement and international competitiveness.
<b>Brazilian Institute of Information in Science and Technology (IBICT)</b>	<i>(7) Information infrastructure for LCA, and National Bank of LCIs</i>	Foster the development and adoption on Circular Economy Life Cycle Assessment methodology and the development of Life Cycle Inventories (LCI), through an information infrastructure that serves industry, academia and society.
<b>Ministry of Mining and Energy (MME)</b>	<i>(3) Bioenergy: biogas, biofuels</i>	Establish support mechanisms for investments in on Circular Economy initiatives for renewable biofuels, with the objective of placing a clean energy matrix in the country.

## Annex: Draft framework for the Circular Economy Roadmap in Brazil

### ANNEX - Draft format for the implementation of the Circular Economy Roadmap in Brazil

BRAZIL CIRCULAR ECONOMY ROADMAP DRAFT	
Long-term Vision	"Implement a circular economy model for the country establishing strong foundations to drive the future of production and consumption patterns that delivers a more sustainable and responsible development for the Brazilian region."
Guiding Principles	<ul style="list-style-type: none"> <li>(1) Economic development associated with conservation and restoration of natural ecosystems;</li> <li>(2) Industry and agriculture competitiveness in global supply chains committed with local sustainable development;</li> <li>(3) R&amp;D + innovation and professional capacitation considering resources complete life-cycles impacts;</li> <li>(4) Urban and regional planning integrating the economic, social and environmental dimensions of development for all;</li> <li>(5) Broader adoption of clean and renewable energy in production and commercialization processes;</li> <li>(6) Integrated management for a more sustainable and beneficial circulation flows of the resources and waste: water, air, soil and materials.</li> </ul>
General Goals	<ul style="list-style-type: none"> <li>(1) Design a national development strategy for circular economy that is shared among actors in all sectors;</li> <li>(2) Build the knowledge about the circular economy potentials considering territory differences and local contexts of the country;</li> <li>(3) Create national policies and regulations for circular economy that favor more responsible and sustainable production and consumption;</li> <li>(4) Create financial mechanisms and improve enabling infrastructures that support circular economy initiatives in all levels and scales;</li> <li>(5) Prioritize to support circular economy R&amp;D oriented to systemic, cross-sector, socio-technical innovation processes;</li> </ul>

Strategic area of intervention	Leadership	Stakeholders (to be indicated)	Objectives	Indicators Monitor and Evaluate	CE Transition Short to Mid-term (Micro, Meso & Macro level)	CE implementation Mid to Long-term (Micro, Meso & Macro level)
Bioeconomy	MCTI (Ministry of Science, Technology Innovations)	Governmental Business Academic Civil society organizations	Foster policies on Circular Economy to science, technology and innovations within the bioeconomy and climate change national plans and articulate with governmental players.	(1) Indicators for resources input: Materials input; Energy input; Water input.	(1) <b>Regulatory:</b> Revise taxation models that undermine the creation of a strong market on secondary materials and products; Revise regulations that may impose restraints to the deployment of innovations for circular economy;	(1) <b>Regulatory:</b> Adapt policies to the highly diverse regional contexts in the country; Create regulations to enable cross-sector collaboration.
			Develop public policies on Circular Economy initiatives on urban infrastructure and promotion of regional and productive development and facilitate the governance for clusters and supply chain for productive inclusion.		(2) <b>Market:</b> Raise awareness from the industrial sectors that keep 'linear' practices for management of resources; Dialogue with sectors to the national economy that are dependent on extractive activities which are highly related to GHG emissions; Promote professionals and the general public skills training and behavior change campaigns.	(2) <b>Market:</b> Support innovation programs to advance in products and business models development; Facilitate collaboration systems that enable knowledge sharing between multiple actors;
Urban infrastructure, productive inclusion and regional development	MDR (Ministry of Regional Development)	Governmental Business Academic Civil society organizations				

<b>Bioenergy: biogas, biofuels and Carbon Market</b>	MME (Ministry of Mines and Energy)	Governmental	Establish support mechanisms for investments in Circular Economy initiatives for renewable biofuels, creating a bold carbon credit market, with the objective of planning a clean energy matrix in the country.	<b>(2) Indicators for Impacts and outputs:</b> Contribution to SDGs targets; Contribution to NDCs targets; Contribution to competitiveness and productivity; Impact on non-renewable resources maintenance and recovery;	<b>(3) Cultural and Educational:</b> Promote the introduction of new professional knowledge and management practices; Build a strong long-term shared vision that embraces the specific local contexts; Internalize the new mindset for most of policy makers, business managers and consumers that are still framed in the linear economy; Facilitate more coordinated mobilization from multiple actors to influence social and cultural changes;	<b>(3) Cultural and Educational:</b> Mediate complex sectoral agreements in the many points of conflict between actors; Enforce actors' engagement in shared responsibility schema for reverse logistics of products and materials; Support the industrial sector that still have important challenges in management for sustainability.
		Business Academic Civil society organizations	Bring together players on Circular Economy from state industry federations, industry associations and business representatives to diagnose and think of Circular Economy proposals for technological improvement and international competitiveness.	Impact on renewable resources and ecosystems services regeneration.	<b>(4) Entrepreneurship:</b> Transition phase Engage business community in a more collaborative mindset; Incentivize demonstrations of circular economy profitability and its potential for productive inclusion with social impact; Develop pilot cases to demonstrate results that support the strategic value of the circular economy.	<b>(4) Entrepreneurship:</b> Facilitate new business models that rely on articulating shared interests and establishing partnerships from different companies; Support startups with substantial financial support before they reach competitiveness in the market; Support scaling-up innovative initiatives with expanded and facilitated long-term investments;

R&D + innovation for Industry sector	FINEP (Public Financing Organization for R&D+I)	Governmental Business Academic Civil society organizations	Provide financial support on Circular Economy initiatives on national and transnational R&D+I to companies, universities, technological institutes and other public or private institutions.	(3) Indicators for enabling mechanisms:  Entrepreneurship in CE activities;  Innovation in CE technologies;  Industry 4.0 applied to CE;	(5) Financing and capital aspects:  Create strong mechanisms of risk-taking long-term financing;  Adapt tax system to support the recycled materials market;	(5) Financing and capital aspects:  Expand funding for technological innovation for circular and sustainable use of natural resources.
R&D + innovation for Agriculture Sector	MAPA (Ministry of Agriculture, Livestock and Supply)	Governmental Business Academic Civil society organizations	Promote the adoption on Circular Economy initiatives on sustainable low-carbon production technologies responding to GHG mitigation in the agricultural sector.	Professional Capacitation on CE;  Consumer behavior change for CE;  Implementation of CE regulations;  Implementation of CE taxes;  Implementation of CE policies.	(6) Industrial and technological aspects:  Understand and adapt from circular economy solutions in Europe that are different to the Brazilian context.  Facilitate industrial symbiosis for a circular economy which relies on platforms for materials and products circulation in complex cross-sectoral relationships;  Organize structured databases needed at the national level, for monitoring and evaluating the use and processing of resources by the industry;  Promote the association of 4.0 technologies with circular economy that are a new approach for many companies;	(6) Industrial and technological aspects:  Engage extractive sectors that perform 'linear' activities that will struggle to change and innovate;  Support sustainable production innovative practices in agriculture to be scaled-up;  Promote the change in the implementation of 'linear approach' sanitation systems that are, in most cases, not cost-effective to be implemented;  Build nationwide transportation infrastructures and logistics systems that are critical to enable circular economy.



<b>LCA and National LCI</b>	<b>IBICT</b> (Brazilian Institute of Information Science and Technology)					<b>(7) Materials and products recovery logistics, collection, repair and manufacturing aspects:</b> Increase monitoring collection and utilization of organic nutrients from waste as resources.  Promote the change of the focus that are still on 'linear' improvements with "end-of-pipe solutions" approach to minimize waste negative impact;  Support recycling cooperatives improvements in capacity in circular economy approaches and business models;	<b>(7) Materials and products recovery logistics, collection, repair and manufacturing aspects:</b> Create monitoring and evaluation systems for resource use and waste generation by industrial activities;
	Governmental						
	Business						
	Academic						
					Foster the development and adoption on Circular Economy Life Cycle Assessment methodology and the development of Life Cycle Inventories (LCI), through an information infrastructure that serves industry, academia and society.		
					Civil society organizations		



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