

Pictures of Transformation: a vision of Brazil in 2035

SIEMENS







Sustainability and digitalization are the two great transformation imperatives of our time.





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Table of Contents

Foreword by the CEO of Siemens Brazil 4

About this Project 6

Drivers of Transformation 10

Overview of Brazil 16

Analysis: Energy 22

- Safe Energy Transition in the Electricity Sector 22
- Data Integrity for the Regulated Carbon Market 23
- Electrical System Digitalization, Innovation for a Sustainable Future 24
- Biofuels in Energy Transition 26
- Carbon Capture, Storage and Utilization in Brazil 27

Analysis: Efficient and Resilient Infrastructure 28

- Robust Transportation and Logistics Infrastructure Networks 28
- Integrated Energy Management and Port Operations 30
- Airport and Aviation Safety and Efficiency 32
- Low Carbon Urban Mobility 33
- Energy Efficiency, Loss Minimization and Water Quality Assurance 34

Analysis: Sustainable Industries and Specific Sectors 36

- Applied Technologies for Sustainable Food Systems 36
- Impact Reducing Technologies in the Mining Sector 38
- Efficiency and Circular Economy in the Metal Industry 39
- Digital Technologies for the Petrochemical Sector 40
- Digitalization in Operational Optimization of the Automotive Sector 42
- Digitalization to Improve Processes in the Pulp and Paper Sector 43

Our Contribution 44

References 46

"This document seeks to provide a comprehensive and strategic vision to guide the actions and decisions of the different stakeholders involved in Brazil's development. Our goal is to inspire and encourage reflection on the necessary transformations to achieve a sustainable, inclusive, and prosperous future."



Transforming everyday life to create a better tomorrow

Dear readers,

This document is Siemen's attempt at outlining future scenarios for Brazil, highlighting the importance of technological transformations that will address the challenges of decarbonization, inclusion, and the country's growth.

Brazil finds itself in a highly favorable context: it will host the G20 in 2024 and COP30 in 2025. Moreover, the country offers numerous opportunities through its natural resources and the diversity of its people, and it has positive prospects for the energy sector. This, in combination with the government program Nova Indústria Brasil (New Industry Brazil) and the growing global demand for sustainable industrialization, results in an extremely favorable scenario for the carrying out of this work.

This 'Picture of Brazil in 2035' seeks to explore how Brazil may transform over the next decade through a comprehensive analysis of public data, global and local trends, and interviews with experts from various fields. Over an eight-month period, trends in key sectors and areas of potential transformation were identified, aiming at creating a likely and inspiring scenario for the country's future. The initiative was supported by the Brazilian Center for International Relations (CEBRI).

The validation of the content by specialized consulting firms and the technical review conducted by Fábio Scarano, Chair at UFRJ and curator of the Museu do Amanhã (Museum of Tomorrow), enhance the reliability of the presented forecasts, even though they are estimates based on the best available information.

By combining the knowledge and experiences of Siemens and the engaged experts, this document aims to provide a comprehensive and strategic vision to guide the actions and decisions of various stakeholders involved in Brazil's development. Our goal is to inspire and encourage reflection on the necessary transformations to achieve a sustainable, inclusive, and prosperous future.

Pablo Fava
CEO of Siemens Brazil

How will Brazil look in 2035?

Brazil's leadership in the climate, digitalization, and social inclusion agendas will drive significant transformations in the country over the next decade. The deep-dives performed for this project provide a medium-term perspective on the importance of technologies as part of the solutions to make the country a sustainable and inclusive economic powerhouse.



Sustainable natural resources are the foundation of Brazil's prosperity, positioning the country as a leader in combating climate change. As a major exporter of commodities, Brazil must reduce socio-environmental impacts and increase its efficiency, making the nation more competitive in the global market. With an innovative, low-emission energy matrix, Brazil can boost its economy and stand out in international supply chains.

The success of this vision for the future requires the coordinated effort of public, private, and societal agents to implement the necessary transformations. Sustainability and digitalization are the two great transformation imperatives of our time. Part of the global challenge is finding synergy between these two megatrends, which will present a significant window of opportunity for Brazil.

Disclaimer: Unforeseeable Events

The global economy will be shaped by various challenges in the coming decade. Some will still exist in 2035 – and new ones will emerge. This report is based on current and developing knowledge and expectations, as hoped and desired

Methodology

Picture of Transformation: a vision of Brazil in 2035 is a document that outlines a possible future for Brazil's development over the next decade. It is based on four drivers that could drive transformation over the next 10 years: decarbonization, circularity, society, and technology with purpose.

Between December 2023 and August 2024, several Siemens professionals were involved in a task force consisting of one coordinator and 12 professionals, guided by a methodology developed by Siemens AG. This team gathered public and market data and interviewed 51 economists and internal and external experts on technological solutions applied to the sectors addressed in this document. Every two weeks, the task force held workshops to update data and interviews, as well as receive guidance from the coordinator to advance the project. The transformation areas identified by the team were presented in two meetings to a steering committee composed of six members of Siemens Brazil's senior management, for deliberation on the topics discussed. For verification, review, and supplementation of the content and sources used, Siemens partnered with the Brazilian Center for International Relations (CEBRI) and researcher Dr. Fabio Rubio Scarano. The results were once again evaluated by Siemens and external experts in their respective fields of expertise.

opportunities that technology can provide. This document does not take into account the impacts of potential political or geopolitical uncertainties, such as new pandemics, unrest or acts of war, and other events.



Agenda

Addressing the natural crisis requires a critical shift toward being nature-positive. The 2020 World Economic Forum study, which estimates the global cost of transitioning in this direction, identified three key investment areas:

- food systems, land and ocean use;
- infrastructure and built environment;
- and extractives and energy.

By aligning this study with the four drivers of transformation (decarbonization, circularity, society, and technology with purpose) and the findings from research and interviews conducted, we identified the following areas of transformation:

- Energy;
- Efficient and Resilient Infrastructure;
- Sustainable Industries.

The goal of the document is to encourage discussions on prudent actions to seize opportunities for greater international integration, ensuring sustainable and inclusive prosperity.

Opportunities for a prosperous and sustainable Brazil

This is not a utopian vision.
We balance our challenges with the existing potential to present a likely scenario – provided we tackle current challenges with determination.

The need for a successful transformation has never been greater. If we don't act now, it could simply be too late. Prudent actions taken today will create opportunities for a more prosperous, inclusive, and sustainable society, transforming Brazil into a global reference.

It is human nature to aspire, invent, and evolve our societies. Brazil's diversity of people and its natural wealth are the key differentiators that can drive this country's socioeconomic development. In this publication, we outline a vision of the future based on expert knowledge.

Let's make it happen!

"According to CEBRI, technological transformation should foster the country's socioeconomic and sustainable development. The Brazil of 2035 is built on a green economy, enhancing its global competitiveness and the social inclusion of its citizens through energy transition and digitalization, supported by robust and diverse partnerships and sustainable business models. At CEBRI, we are proud to contribute to mapping and shaping this path, promoting innovative policy solutions and connecting strategic stakeholders for a more efficient and decarbonized future."
Julia Dias Leite, CEO of the Brazilian Center for International Relations.

"Picture of Transformation is a future-back exercise that helps us envision the Brazil we want for the next ten years and identify what is needed to get there. This strategic approach allows us to reimagine the country's future and explore pathways for sustainable and integrated development, focusing on the megatrends that will influence the industry, infrastructure, and energy transition."
Luis Mosquera, Vice President of Legal, Government Relations and Sustainability at Siemens Brazil.


DEM E PROGRESSO

A Holistic Vision for 2035

This vision illustrates Brazil in 2035: how major digital and sustainability transformations will impact all areas and people, shaping cities and our daily lives.




27°
GLOBAL
LOCAL

Drivers of Transformation

We live in increasingly complex and challenging times. An immediate reduction in greenhouse gas emissions is necessary, while society pushes further, demanding more flexible, integrated, and healthy ways of living. In this context, a strong drive for technological innovation is the starting point for improving the world of tomorrow. In the following pages, you will find the main drivers of transformation we identified in the development of this project, “Picture of Transformation: A Vision of Brazil in 2035.”





Decarbonization

We can no longer wait. The world is already experiencing a state of climate emergency, including Brazil, which has been feeling the effects of environmental disasters.

Currently, more than 45% of emissions in Brazil come from deforestation, with 80% of that total resulting from illegal activities. Additionally, around 27% of emissions are concentrated in agriculture. If legislation is strictly enforced and illegal deforestation is curbed, the productive sector will have time to develop technological solutions to promote an efficient energy transition. Such innovative solutions in the technological field must occur simultaneously with reducing biodiversity loss to achieve a net-zero or positive greenhouse gas emission balance.

Brazil has all the potential to be a leader and example in combating climate change. Integrating smart solutions into the renewable energy mix and electrifying various sectors are prerequisites for decarbonization and energy reliability in the economy. However, this leads to a shift in consumption for energy-intensive industries and consumer empowerment, with the adoption of more efficient and sustainable technologies, as well as investments in renewable sources. Low-carbon energy transition requires immediate collaborative action from public institutions and private companies. This results in a major push for solutions and technologies that can help manage this unprecedented transformation.



Circularity

The recently launched National Circular Economy Strategy proposes instruments for fostering and financing the efficient use of natural resources and sustainable practices throughout the entire production chain. The decree-law promotes innovation, culture, education, and skill development to reduce, reuse, and redesign production in a circular way.

The goal is to go beyond recycling, focusing on circular design and the productive regeneration of nature, ensuring a just transition that includes workers in the circular economy in markets such as remanufacturing, reuse, maintenance, and recycling. It also ensures the participation of rural workers and the protection of natural ecosystems.

Circularity begins with conceptual design, with sustainability as a fundamental pillar, taking into account the life cycle from the outset. In the supply chain, a collaborative platform supported by horizontal data governance is necessary. Detailed design is optimized using digital twins and Artificial Intelligence (AI), and the validation of new materials and processes occurs digitally, minimizing environmental impact before production.

This is an opportunity to integrate Brazil's strategy into global processes of economic and technological transformation. To advance this agenda, it is essential to transform innovation into efficient business models that accelerate the creation of new markets, with large-scale, competitive circular initiatives becoming part of the individual and collective choices of our society.

Drivers of Transformation

Society – Education and Capacity Building

Education is the foundation for societal progress, directly linked to the competitiveness and growth of all economic sectors. Digitalization and new work models can only partially bridge this inextricable connection. The smart and autonomous networks of the future still need to be developed, built, and maintained by highly skilled individuals. The shortage of specialists and data science professionals could hinder progress, but an education policy aligned with industry needs makes education and skill enhancement key factors in establishing a resilient and highly adaptable labor market. Skilled workers are needed at all educational levels, across all economic sectors of different sizes, and from diverse age groups.



To keep up with social and technological changes, it is necessary to revise curricula, invest in infrastructure, innovation, and continuous teacher training, making education both resilient and empowering. Investment in Basic Education is crucial for sustainable long-term development, while Professional and Higher Education, aligned with market needs, along with the promotion of management techniques and Industry 4.0 technologies, are pressing demands. STEAM professionals (Science, Technology, Engineering, Arts, and Mathematics) drive new technologies and processes, boosting competitiveness and productivity. Learning programs that enhance youth employability reduce generational inequality and positively impact mental health, increasing the sense of belonging and productivity. Thus, prioritizing education and creating opportunities in the domestic labor market will position Brazil as a global competitor, ready for challenges and opportunities, investing in the future and modernizing the country.

We must bring everyone along on this journey of a just transition to avoid creating a new form of inequality and social division in the future. Public policies must focus on long-term challenges so that our obstacles do not become even more critical. Society must seek a balance between the present and the future, enabling Brazil to build a lasting and virtuous circle toward productivity, inclusion, and sustainability.



Technology with Purpose

Acknowledging digital connectivity as a key element for leveraging technological innovations to support the Sustainable Development Goals of the 2030 Agenda, the United Nations has set targets to achieve universal, inclusive, and ethical connectivity.

The Brazilian industry is becoming more technological with the widespread adoption of digital technologies, resulting in greater efficiency and the creation of new products. Digitalization is becoming essential, deeply impacting production processes, supply chains, and sales. New business models are crucial for this transformation: with the mass collection of data through sensors, new platform approaches and connectivity solutions are reorganizing various aspects of our daily lives. These innovations combine efficiency and convenience in the design, production, and distribution of goods and services. Artificial Intelligence (AI), virtual reality, and automation are driving forces in creating a more efficient industrial sector. However, due to growing public concern, their implementation must be accompanied by a strong regulatory framework that ensures cybersecurity, human rights, and consumer trust. By 2025, it will be essential to monitor the AI bill in Brazil, which can make the country a pioneer in the region. Additionally, collaboration between the European Union and Latin America through the Digital Alliance may influence regional AI regulation.

The first significant step toward transformation is digital inclusion, which involves enabling access to quality digital infrastructure, digital resources, and digital literacy for both individuals and Micro, Small, and Medium Enterprises (MSMEs), which are the backbone of the economy and essential for the competitiveness of the supply chain. Mechanisms established by the Brazilian government for 5G spectrum licensing should, among other goals, provide 5G coverage to all 5,570 Brazilian municipalities by 2029, facilitating and expanding access to digital infrastructure.

While digital technologies bring many benefits to society, their application must be ethical and responsible. The protection of individuals and organizations is becoming increasingly relevant. We must responsibly promote the transformative power of Artificial Intelligence, while allowing for innovation and development, harmonizing cybersecurity and data protection standards, and coordinating international cybersecurity efforts.

Drivers of Transformation

Decarbonization
To mitigate and adapt the effects of climate change

Circularity
To Accelerate the creation of new markets

Education and Capacity Building
As the foundation of societal progress

Technology with Purpose
To transform the Future

Society and Economy

Brazil has significant economic potential, thanks to its abundant natural resources, large population, and robust domestic market. Spanning 8.5 million km², it is home to multiple ecosystems, reflecting pronounced diversity in race, history, culture, and industry. The country is undergoing a transformation to outline a new development model that reconciles strong economic growth and social change with environmental protection.

Territory
8.5 million km²

+ 210
million
people

GDP growth rate of
1,5% ~ 3%
per year
in the next
few years



Internet access



60% Legal Amazon





10th
World
Economy

Ecological Transition with Social Justice

Integrating strategies that include Artificial Intelligence for data analysis and preventive monitoring is crucial for Brazil's role in the global energy transition. However, the country faces significant global challenges, such as balancing efficient agricultural production with environmental preservation and ensuring the reliable provision of ecosystem services. Small and medium-sized producers, who are most vulnerable to climate change, need access to credit, technology, and markets, as well as improvements in basic services such as healthcare and education.

As a major food producer and the primary guardian of the Amazon (holding 60% of the region's territory), Brazil must lead the sustainable transformation of agro-food systems, integrating food security with the conservation of biomes. Mining, essential for energy transition, requires a careful strategy to mitigate environmental and social risks. Despite Brazil's vast potential in renewable energy, the country will still rely—though increasingly less—on oil during the energy transition until it achieves a Human Development Index (HDI) comparable to that of industrialized countries. Brazil's focus is on achieving an almost entirely clean and renewable energy mix by 2040.

By 2030, changes in land use will be crucial for food, water, and climate security, in addition to preserving ecosystem services. Although Brazil faces challenges like corruption, social inequalities, and inadequate infrastructure, it can become a global powerhouse with the right policies and strategic investments, particularly in education.

The engagement of civil society and the strengthening of Non-Governmental Organizations (NGOs) and social movements have promoted policies aimed at equal opportunities, reducing social and economic disparities, and ensuring equitable access to the benefits of the ecological transition. The representation and active participation of affected communities in decision-making are essential to meeting their needs, protecting human rights, adapting to climate change, and strengthening the resilience of vulnerable communities.



Growth and Demand for Infrastructure

With over 210 million inhabitants and an annual GDP growth rate projected between 1.5% and 3% in the coming years, Brazil depends on structural reforms and economic stability. CNI's strategic map for 2032 highlights the urgent need for actions to provide adequate infrastructure and enhance the competitiveness of manufacturing in the global market.

The expansion of digital infrastructure is a foundation for leveraging Brazil's technological, social, and economic development and strengthening the industry's global positioning. Currently, a significant portion of industrial processes relies on quality internet networks, but challenges remain in coverage, broadband, and service levels. A 2022 survey from TIC Domicílios shows that 36 million people lack internet access.

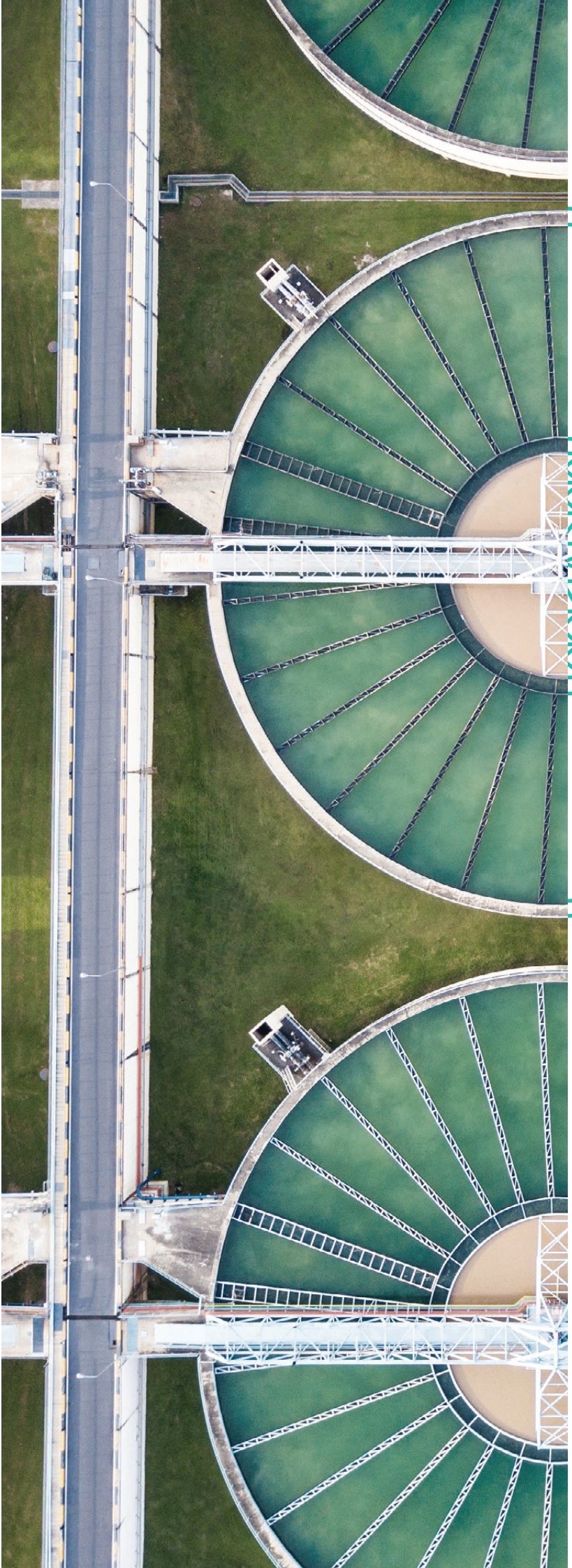
Solutions include expanding 4G and 5G networks, adapting regulations, and reducing reliance on foreign satellites to improve logistics, security, and telecommunications. Telecommunication regulations must promote incentives for continuous investment, enabling new technologies and broadband expansion. Partnerships with science and technology institutions are critical for the sector's growth. According to the Inter-American Development Bank (IDB), closing the digital infrastructure gap with the OECD could boost GDP by 6.5% and productivity by 5.4%.

Large urban centers face significant challenges due to population growth, requiring investments in efficient transportation, potable water, sanitation, and sustainable energy. In recent years, Brazil's infrastructure has lagged behind desired standards. Investments in transportation and logistics have made minimal progress towards their goals. Execution capacity for investments by dock companies in public ports remains low. Brazil's logistics have improved in customs procedures, infrastructure, international maritime traffic, quality and logistical competence, and traceability. However, progress in providing potable water and sewage services has been slow, jeopardizing the goal of universal coverage by 2033. Low investment levels and inefficiency, evidenced by high water loss in distribution, continue to be significant issues.

New regulatory frameworks for railways, coastal shipping, and basic sanitation, along with tax reform, promise to attract substantial investments.

Advanced technologies for intelligent transportation and more investments in high-speed telecommunications and urban management are needed to improve quality of life and operational efficiency. Expanding and modernizing potable water systems to increase energy efficiency and reduce losses is essential. Basic sanitation must ensure universal access to vital services, improving public health.

Investing more in infrastructure is crucial to reducing inequalities, lowering industrial production costs, enhancing supply chain efficiency, driving innovation, and, consequently, strengthening Brazil's industrial competitiveness.



Investing more in infrastructure is crucial to reduce inequalities, lower industrial production costs, and enhance supply chain efficiency, driving innovation, and, consequently, strengthening Brazil's industrial competitiveness.

Challenges and Opportunities for the Sustainable Growth of a Diversified Industry

Brazil's diversified industry encompasses sectors such as automotive, agribusiness, food and beverages, oil and gas, mining, metallurgy, chemicals, paper and pulp, and technology, contributing to GDP growth, job creation, and making the economy more resilient to external fluctuations.

In addition to digitalization and innovation, the industry must adopt environmentally sustainable practices, not only to meet environmental targets but also to add value to Brazilian products in the global market. It is essential for the industry to take an integrated approach across the entire value chain, from production to distribution, improving logistics, optimizing resources, and fostering strategic partnerships to increase efficiency and reduce costs. To strengthen economic resilience, Brazil needs to diversify its export markets, build stronger ties with emerging economies, and explore new opportunities in traditional markets, such as the European Union and the United States.

Achieving higher levels of productivity and sustainable development remains a key challenge that has become even more urgent and will require bolder actions. Therefore, promoting policies that drive competitiveness, innovation, and sustainability is crucial for continuous growth.



Tax reforms that simplify the tax system, reduce taxes and risks, and incentivize private sector innovation and sustainability are vital for a competitive business environment that attracts foreign investment.

Strategic investments and structural reforms can expand and diversify the industrial base, strengthening Brazil's global position. This will require investments in information technology, Artificial Intelligence, the Internet of Things (IoT), and digitalization, enhancing efficiency and competitiveness. Education will also continue to be a priority, especially in developing digital skills.

Building a Robust and Resilient Innovation Ecosystem

In 2023, Brazil climbed five positions in the Global Innovation Index (GII) compared to the 2022 ranking, reaching 49th place among 132 countries and becoming the top-ranked country in Latin America.

One highlight is the value of its 16 unicorns (ranked 22nd), which represented 1.9% of the national GDP in 2023. Compared to other upper-middle-income countries in the index, Brazil performs above average in indicators such as knowledge and technology outputs, creative outputs, business sophistication, market sophistication, human capital, and research. Despite this sustained upward trend for the third consecutive year, Brazil, the world's 10th largest economy, has significant potential for further advancement.

Brazil has a historic opportunity to become a global green leader, with a higher share of green patents compared to major economies, though this share has been declining. According to GII organizers, Brazil needs to foster a culture of eco-innovation, which involves increasing companies' willingness to take risks and enhancing governmental support for green innovation. Promising innovative capabilities exist in areas such as waste management, energy conservation, alternative energy, and transportation within the Brazilian industry.

Creativity and innovation are standout characteristics, especially in entrepreneurship and the creative economy. The Brazilian Association of Startups has mapped 2,593 startups, many of which utilize Artificial Intelligence. Brazil is preparing to boost its innovation capacity and resilience, focusing on strategic sectors like information technology, cybersecurity, biotechnology, industrial automation, and renewable energy. This aims not only to enhance operational efficiency but also to create innovative and sustainable products with global appeal. Major urban centers are startup incubators, benefiting from government support and private investment to strengthen the entrepreneurial ecosystem. The adoption of advanced Industry 4.0 technologies, such as automation and Artificial Intelligence, serves to modernize industrial processes and enhance competitiveness on a global scale.

Increasing private investment in innovation remains a challenge that can be addressed through greater risk-sharing. Decentralizing technological development can stimulate growth in less developed regions. Productive development policies centered on science, technology, and innovation are essential to boost competitiveness and accelerate technological transformations, balancing economic growth with adaptation to emerging trends like climate change. Public and private efforts in this field could increase the productivity of the Brazilian economy by 18% until 2032, enhancing competitiveness and delivering broad socioeconomic benefits.









Safe Energy Transition in the Electricity Sector

Storing electrical energy is essential for managing the variations of intermittent energy sources, which will impact all areas and people, shaping cities and our daily lives.

Picture of 2035

To address the intermittency of renewable sources, technological and intelligent solutions enable the decarbonization of the sector through the integration and management of various renewable sources, with fossil thermal power plants still being activated in emergency and transitional situations. This allows the country to play a leadership role in global geopolitics concerning the worldwide strategy for reducing greenhouse gas emissions. Bioelectricity is generated near energy consumption centers, reducing system losses. In addition to being non-intermittent, it complements hydroelectric generation. It is also worth noting that the production of green hydrogen, using electrolysis powered by renewable energy, reduces dependency on fossil fuels. Furthermore, the integration of smart grids allows for real-time monitoring and control of energy distribution, optimizing resource use and preventing failures.

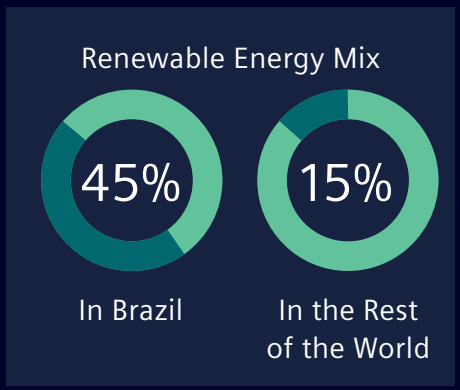
Today

With an annual growth forecast of 12.8% until 2040, the energy storage market is expected to add up to 7.2 gigawatts (GW) of installed capacity in Brazil. Specific policies for the technology, along with incentives and targets to promote the integration of batteries into the energy generation, transmission, and distribution infrastructure, could increase this capacity to 18.5 GW.

Brazil's energy mix relies on more renewable sources (>45%) compared to the rest of the world (15%). Specifically, the Brazilian electricity mix generates a large portion from hydroelectric plants (56%*) and wind and solar energy sources (23%). By 2031, the share of Hydroelectric Power Plants (UHE), Wind Farms (EOL), and Photovoltaic Plants (UFV) is expected to reach 51% and 15%, respectively. Both wind and solar energy are intermittent, meaning that thermal power plants still need to be activated to meet demand during peak times.

Without energy storage, the projected energy supply in the coming years will exceed demand (281 GW of capacity versus 111 GW of demand by 2027, according to ONS). Storing electrical energy is crucial to manage variations from intermittent energy sources.

In 2023, bioelectricity generation for the grid was 21 terawatt-hours (TWh), meeting the needs of 10.8 million residential consumer units.



56%
Hydroelectric Power Plants

23%
Wind and Solar Energy

10.8 million
residential consumer units serviced with bioelectricity

*Note: The drought in 2024 impacted the electricity mix, reducing the performance of hydroelectric plants and increasing the use of thermal power plants.

Data Integrity for the regulated Carbon Market

Picture of 2035

Specific and standardized protocols, along with verification by external entities using clear eligibility criteria, have become a reality and are essential for the success of the system. Technologies such as satellites, drones, Artificial Intelligence, blockchain encryption, and smart sensors automate data collection, analysis, and validation, providing more reliable information in less time. This reduces costs and, most importantly, makes more accurate and consistent data available for the verification and issuance of carbon credits.



Today

Bill 3961/20 currently under discussion in the National Congress, declares a climate emergency in Brazil and prohibits the reallocation of environmental resources during the emergency. Additionally, it mandates the transition to a sustainable and emissions-neutral economy by 2050. Development policies and plans must include responses to the climate emergency. A carbon market for the national industry is strategic to accelerate the transition to a low-carbon economy and promote competitiveness in the sector. The regulated carbon market, whose bill is also under review in the National Congress, requires a robust Measurement, Reporting, and Verification (MRV) system capable of providing data that is accurate, complete, transparent, and consistent. Implementing MRV systems strengthens control over the carbon credit market by measuring the volume of emissions capture or reduction in specific activities, facilitating third-party verification and ensuring the integrity of emissions transactions.

The Bill (PL 412/2022), which regulates the Brazilian Emissions Trading System (SBCE), aims to encourage emissions reduction in compliance with the National Policy on Climate Change (Act 12.187, 2009) and international agreements signed by Brazil. The regulation of the carbon market focuses on reducing greenhouse gas emissions and promoting low-carbon technological innovations.



There are already cases in Brazil using Artificial Intelligence to analyze satellite data, collecting near real-time information on deforestation and land-use changes. These insights help monitor and fight deforestation, though they remain costly.

Electrical System Digitalization, innovation for a Sustainable Future



Picture of 2035

Brazil has made significant progress in transitioning from a centralized, vertically integrated system to a distributed, intermittent, networked, and bidirectional system. Prosumers (producers + consumers) are key players in this energy transition, driven by digital technologies that manage the entire system. Demand management, energy transition, the increasing digitalization of many consumers, the pursuit of sustainability, and the expansion of the open energy market have become drivers for the development of new smart grid technologies. Digitalization, including the Internet of Things (IoT), Artificial Intelligence, Big Data systems, and Digital Twins, has transformed the energy sector by maximizing energy efficiency and enabling new business models. Energy storage has provided a backup for intermittent sources like solar and wind. The integration of these sources into the national grid, combined with intelligent management, automation, and real-time data analysis, allows the electrical system to operate more efficiently and reliably, reducing costs and optimizing resource management.

Smart cities have evolved into interconnected ecosystems where technology and sustainability go hand in hand. In this context, smart buildings use the data they generate to respond to changing needs and conditions. The integration of sensors and data analysis allows for even more precise and efficient control of various aspects of buildings and urban infrastructure. Sensors distributed throughout the city monitor energy consumption, air quality, and traffic in real time. Analyzing this data enables resource optimization, reducing waste and promoting a more sustainable environment. Urban mobility has also been transformed, with autonomous vehicles and intelligent public transport systems that adapt to citizens' needs in real time, reducing traffic congestion and pollutant emissions.

The Energy as a Service (EaaS) business model has become established in the energy and utilities sector (covering essential services such as water, gas, and energy). Both sectors have been driven by decentralization, digitalization, and decarbonization, aiming to democratize the use of renewable energy and accelerate the energy transition process across Brazil. In addition to using renewable energy sources, the model employs cutting-edge technologies to ensure energy quality and efficiency, potentially incorporating energy storage technologies as well.

"Smart infrastructure is focused on the safety and comfort of people. It adapts to meet new challenges and the demands of its users, such as those imposed by climate change. Digitalization and technology are essential for scaling the impact on resilience, availability, and sustainability."

William Pereira, Vice President of Smart Infrastructure.



Today

Decarbonization, digitalization, and decentralization are considered the main drivers of the global energy system transition, and Brazil is no exception to this universal trend. The adoption of new technologies, such as Distributed Generation (DG), Distributed System Management (DSM), electric vehicles, and cities with smart grids, likely occurs not only due to direct financial gains for consumers but also considering the preference for behavioral and sociocultural factors.

By delegating energy management, companies can focus on their core activities, directing financial and human capital to other areas critical to business growth. This ensures cost reduction, economies of scale, and sustainability, given the growing emphasis on good ESG (Environmental, Social, and Governance) practices. The Energy as a Service model has already been gaining traction in the market. In Brazil, there are cases of industries, farms, utilities, and even isolated communities that have implemented 100% renewable microgrids with intelligent control management systems, optimizing energy dispatch.

The future of smart cities plays a central role in combating climate change, integrating digital technologies to create sustainable, efficient, and pleasant urban environments for living, working, and learning. These cities use real-time data to optimize public services, improve urban mobility, and reduce environmental impact.

Smart grids represent a revolution in consumer empowerment and energy commercialization, connecting producers and consumers. With smart grids, energy distribution can offer customized services, enable remote reading and supply control, and reduce theft. However, it is crucial to regulate technologies and security applications to protect industrial networks, critical infrastructures, and consumers from cyberattacks.

> "Digitalization will be key to integrating renewable sources into the grid, accelerating the path to Net Zero, increasing reliability and resilience of the electric sector, and reducing electricity costs, ensuring a more efficient and seamless energy transition."
>
> Rui Chammas, CEO of Isa-Cteep.

Biofuels in Energy Transition

Picture of 2035

To achieve increased productivity and energy efficiency, cost reduction, and ensure international competitiveness, there is a demand for automation and digital simulation (digital twin) to model and optimize factory operations.

Brazil has grown due to its strategic relevance in the energy transition, driven by the commitments of the Paris Agreement until 2030 and the Renovabio Program. Additionally, agricultural productivity, genetic improvement, second-generation ethanol, and new fuels such as biogas have also contributed to this growth.

"Brazil has the potential to establish competitive advantages in various sectors. We have a clean energy mix, high potential in biofuels, and a wealth of talent. Digital Transformation enhances these attributes, generates efficiency, and addresses bottlenecks, increasing our capacity to offer high value-added products and services."

Fernando Cestari of Rizzo,
Chair of the B20 Digital Transformation task force and CEO of Tupy.

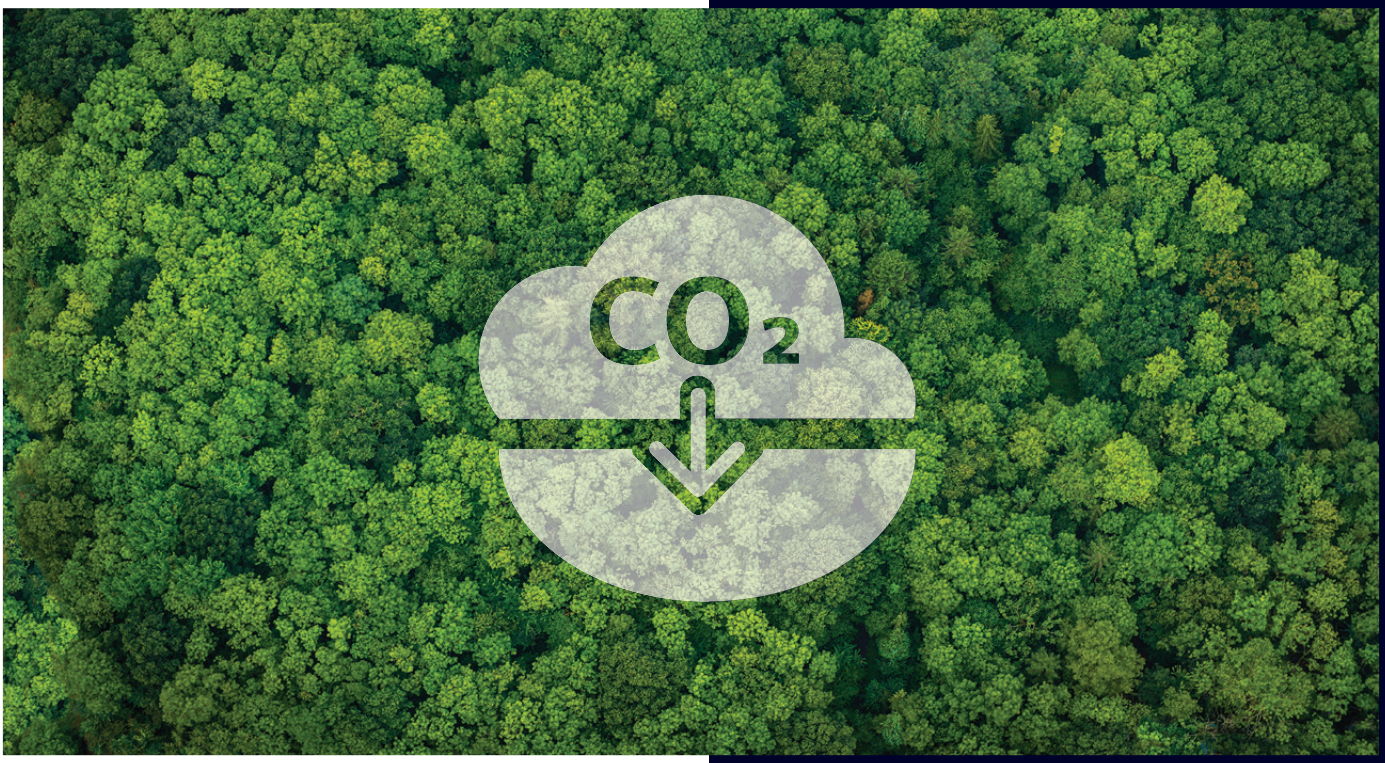
Today

Brazil is one of the leaders in ethanol production, with 34 billion liters produced, supporting the transition to a low-carbon energy system in the transportation sector. Ethanol accounts for about 41.3% of the energy consumed by light vehicles in the country, though the cost to consumers remains high. The demand for biofuels, driven by the automotive and aviation sectors, is expected to grow exponentially, with the International Energy Agency (IEA) projecting a 22% increase by 2027. Brazil will invest R$ 200 billion in biofuels by 2037, focusing on areas such as sustainable aviation fuel (SAF), green diesel, second-generation ethanol (E2G), and carbon capture and storage. These investments are also linked to integration with the National Green Mobility and Innovation Program (MOVER).

Currently, 1.2% of Brazil's territory is used for sugarcane cultivation, with 0.9% dedicated to ethanol production. Ethanol plants generate their own energy by burning sugarcane bagasse and, in some cases, sell excess electricity to the grid.

The adoption of public policies for biofuels that minimize impacts related to water use, biodiversity, and deforestation while generating decarbonization certificates is essential to prevent environmental impacts. The CBIO decarbonization credit (an environmental asset equivalent to one ton of carbon), under the Renovabio program and traded by biofuel producers, can incentivize farmers and producers to adopt better management practices to reduce greenhouse gas emissions across the entire biofuel production chain.





Carbon Capture, Storage and Utilization in Brazil

Picture of 2035

Carbon Capture, Utilization, and Storage (CCUS) alternatives, which have proven to be low-risk, are highly relevant for Brazil's decarbonization pathway in the energy transition. These low-carbon technologies help reduce carbon emissions, especially in the energy and industrial sectors. The concept involves removing excess CO_2 from the atmosphere through Carbon Capture, Utilization, and Storage (CCUS), using direct air capture technology and storage, particularly from hard-to-decarbonize sectors. Technological innovations for improving transportation networks and ensuring safer storage monitoring are constantly evolving.

Today

Some studies highlight the enormous potential for associating Bioenergy with Carbon Capture, Utilization, and Storage (BECCUS), considering Brazil's large biofuel production, especially sugarcane bioethanol, and the advantages of capturing CO_2 from fermentation processes. Enhanced oil recovery, beverage production, urea and methanol industries, and low-carbon hydrogen production are listed as some of the main possibilities for utilizing the captured CO_2. Moreover, the Paraná and Santos Sedimentary Basins have been identified as the most promising for carbon storage, as they are located near major CO_2 emission sources and have favorable geological conditions. To enable CCUS projects in Brazil, the following are required: the development of a regulatory framework with public policies and financial incentives to make CCUS projects commercially viable; assessment of water availability without compromising its multiple uses; an integrated pipeline network for CO_2 transport; and more mature characterization of the sedimentary basins for CO_2 storage. Furthermore, long-term monitoring will be essential to ensure safe carbon sequestration.

Robust Transportation and Logistics Infrastructure Networks

Picture of 2035

The growing demand for transportation is driving the expansion of infrastructure and railway modernization, but more notably, there is an increase in the fleet of heavy trucks. With technological advancements, these trucks, powered by B100 biodiesel, emit 95% fewer greenhouse gases. The rise in energy efficiency from electrifying truck fleets for predefined short- to medium-distance delivery routes has led to investments in charging infrastructure and decentralized energy systems. The modernization of transportation and logistics optimization in Brazil reduce costs, improve supply management, ensure safety, and increase competitiveness, opening new business opportunities. The Internet of Things (IoT) is transforming all transportation modes by connecting equipment and vehicles to enhance logistical efficiency. Big Data and AI organize the transportation chain, while virtual platforms and apps bring all supply chain links closer. Vehicles are becoming less polluting, and drones simplify deliveries. Smart infrastructure and 5G networks are driving Industry 4.0 in logistics, transforming productivity, safety, and costs.







Today

Transportation activity is expected to grow by 3.2% per year until 2032, which will require the expansion of the railway network and an increase in the fleet of heavy trucks. This growth will drive energy demand up by 1.6% per year, which, in turn, may raise the risk of greenhouse gas emissions. However, the Decennial Energy Expansion Plan (PDE) forecasts a 7% improvement in energy and electrical efficiency in the transport sector by 2032, driven by technological advances in vehicles and a greater share of collective road transport, contributing to a reduction in energy intensity.

After fifteen years of railway concessions, freight transportation in Brazil has evolved, now representing over 26% of the total volume. This improvement has boosted productivity and modernized the sector, but tariff prices have remained high due to a lack of regulatory control. The first tariff review occurred in 2012. Analyses suggest that this policy spurred GDP growth, exports, and investments but reduced supply and returns in the railway sector.

Investments in transportation infrastructure are crucial to reducing logistical costs and the “Brazil Cost.” The integration between transportation infrastructures and logistical intermodality enhances the country’s connectivity, facilitating the flow of industrial production and access to global markets.

Integrated Energy Management and Port Operations

Picture of 2035

The upward innovation of the maritime sector relates to the modernization of ports. Brazil is following the trend of major global ports, undergoing a series of informatization and digitalization processes, culminating in the development of smart ports.

Ports with better energy performance and a focus on integrated energy management serve as models for new investments, emphasizing self-generation from renewable sources, including green hydrogen and carbon capture and storage Cloud-based energy monitoring solutions are being used to optimize energy consumption and reduce emissions. The modernization of some ports has led to significant improvements in operational efficiency through the implementation of solutions like digital twins and process automation, while customs digitalization reduces waiting times. Operational safety is also a priority to protect both operations and people. IoT and digital twins help minimize critical failures, enhancing overall port operation efficiency, enabling quicker startups, agile commissioning, better cargo flow management, reduced waiting times, and increased productivity.



Today

Brazil, as a major economy and commodity exporter, conducts over 90% of its foreign trade via maritime routes, with ports handling R$ 293 billion annually. There is significant potential to increase port productivity by improving operational efficiency and enabling new logistical solutions for the development of cabotage and inland waterway navigation. The new PAC (Growth Acceleration Program) plans 137 projects with R$ 54.8 billion allocated to modernizing the port sector, which faces challenges such as adapting to larger vessels, operational efficiency, intermodal infrastructure, and environmental issues. Port decarbonization, as emphasized by the International Maritime Organization (IMO), plays a crucial role in the energy transition process. A study by DNV GL highlights the need to electrify port activities and replace fossil fuels with renewable sources. Brazil has already secured over $22 billion in investments for the construction of green hydrogen production plants, all concentrated in ports such as Pecém in Ceará, Suape in Pernambuco, and Açu in Rio de Janeiro.

R$ 293 billion
transacted annually

137
modernization projects

R$ 54,8 billion
to modernize the port sector

CO_2



Airport and Aviation Safety and Efficiency



Picture of 2035

Brazil is one of the leading producers of small aerial vehicles that do not require large infrastructures for takeoffs and landings (Vertical Takeoff and Landing – VTOL), used for transporting small cargo or people.

Aligned with global best practices to increase the use of air transport, several airports in Brazil have enhanced user experiences, leading to significant investments in airport expansion and modernization, as well as the development of more modern, comfortable, and, above all, safer aerial equipment. These improvements have contributed to higher growth rates in flights. Global practices include initiatives such as the use of body scanners and electronic gates to automate border controls, as well as baggage inspection technologies and Artificial Intelligence to streamline security and boarding procedures.

In addition to technological advancements in aircraft, air operations, and emission offset systems using carbon credits, aviation is advancing its energy transition through the use of sustainable aviation fuels (SAF). Brazil plays a crucial global role as a significant producer with expertise in ethanol and diesel.

Today

Airports still require modernization in infrastructure, technologies, and security across multiple areas, such as personal safety, fire prevention, cybersecurity, baggage, cargo, and operational security. To address these challenges, it is crucial to modernize and expand terminals and runways and establish public-private partnerships to attract investment and innovation.

The adoption of automation technologies and improvements in operational and energy efficiency are also critical. Additionally, the "Aeroportos+Seguros" (Safer Airports) program includes high-standard measures to enhance the safety and protection of passengers and baggage.

The International Civil Aviation Organization (ICAO), a United Nations body of which Brazil is a member, has adopted the Long-Term Aspirational Goal of achieving net-zero carbon emissions in international aviation by 2050. Bill 528/2020, which proposes the creation of the National Sustainable Aviation Fuel Program, aims to require minimum percentages of sustainable aviation fuel (SAF) usage starting in 2027.

Brazil, with its abundance of raw materials, technologies, and extensive experience in biofuel production, particularly ethanol and biodiesel, has great potential to become a global leader in this emerging market.

The development of drones and unmanned aerial vehicles (UAVs) has propelled the global market for aerial transport solutions. There has been an increase in research, prototypes, and experimental operations of autonomous or piloted aircraft designed for cargo and passenger transport over short and medium distances, typically featuring electric propulsion and Vertical TakeOff and Landing (VTOL) capabilities. These innovations open new possibilities for cargo deliveries and urban and regional mobility. Brazil should not be left out of the aerial vehicle market. Although this market has not fully taken off in the country, research indicates that 780 units have been reserved, placing Brazil in a prominent position – behind only the United States and China in the sector.

Low Carbon Urban Mobility

Picture of 2035

The integration of transportation modes, low-carbon and collective mobility have improved quality of life, made the system more efficient, and consequently increased the country's competitiveness. Integrated digital solutions have enhanced mobility, monitoring, sustainability, and connectivity in Brazilian cities. The expansion of metro systems, trains, buses, and bike lanes has been essential to increasing coverage. Digital railway infrastructures, with the automation and electrification of rail networks, have optimized costs and improved energy efficiency. Maintenance operations have enhanced performance, while digital solutions and software have increased the capacity of existing infrastructure and improved passenger experiences.

Combustion vehicles are undergoing the energy transition, with buses, distribution trucks, and light vehicles running on biodiesel, alongside a significant increase in electric vehicles. This transition demands the implementation of ultra-fast charging stations and the rapid advancement of wireless charging technologies, promising quicker and more convenient recharges. Electric vehicles connect to the smart grid, with the added benefit of returning energy to the grid through smart charging and energy commercialization.



Today

Today, traffic congestion and insufficient public transportation increase commute times, while reliance on road vehicles raises pollutant and greenhouse gas emissions. The National Green Mobility and Innovation Program (Mover) aims to stimulate investments in new technological routes and heighten decarbonization requirements for Brazil's automotive fleet, including passenger cars, buses, and trucks. This initiative is spurring investments in electric vehicles. By 2030, Brazil's vehicle fleet is expected to reach 56 million, with 11.8% being electric. A robust charging infrastructure will be crucial to alleviate range anxiety and encourage consumer transition to electric vehicles.

Enhanced integrated management, along with collaboration between the government, the private sector, and civil society, will boost the country's competitiveness, make mobility more accessible, and reduce urban congestion and pollution.

The electrification of public and private transportation is a growing trend that can significantly reduce greenhouse gas emissions. Expanding the electric vehicle charging infrastructure is essential to support this transition. The adoption of electric cars, both for individual and collective transport, not only reduces the carbon footprint but also improves air quality in urban areas, promoting a healthier environment for the population.

Addressing urban mobility challenges will require prioritizing improvements in public transportation quality, as outlined in the Urban Mobility Act, and investing in the maintenance and expansion of rail networks, subways, buses, and bike lanes. Strengthening integrated management through collaboration between the government, the private sector, and civil society will be crucial to achieving a more efficient, accessible, and sustainable mobility system.



Energy Efficiency, Loss Minimization and Water Quality Assurance

Picture of 2035

Digitalization enables the optimization of water and sewage systems both energetically and operationally, as well as integrated asset management, enhancing maintenance processes throughout the equipment lifecycle. The combination of AI with detailed digital hydraulic models, IoT, digital twins, and real-time monitoring allows for simulating different scenarios, identifying the best solutions, detecting leaks with near-instant accuracy, and fully automated, energy-efficient operation of pumping stations. This ensures effective system operation during rainfall events, thereby preventing and reducing flooding. Sensors distributed throughout the network continuously monitor various parameters, and real-time data analysis enables quick identification and response to any changes in water quality.

The journey toward a more sustainable and resilient future for water and sewage systems is marked by technological innovation, collaboration across different sectors of society, and the integration of these systems with other urban infrastructures, such as renewable energy sources and the circular economy as a response to the unsustainable linear model. This approach values water as a service, a source of energy, and a carrier of nutrients. Digitalizing these systems will not only ensure the availability of quality water for all but also contribute to building a more just and equitable world.



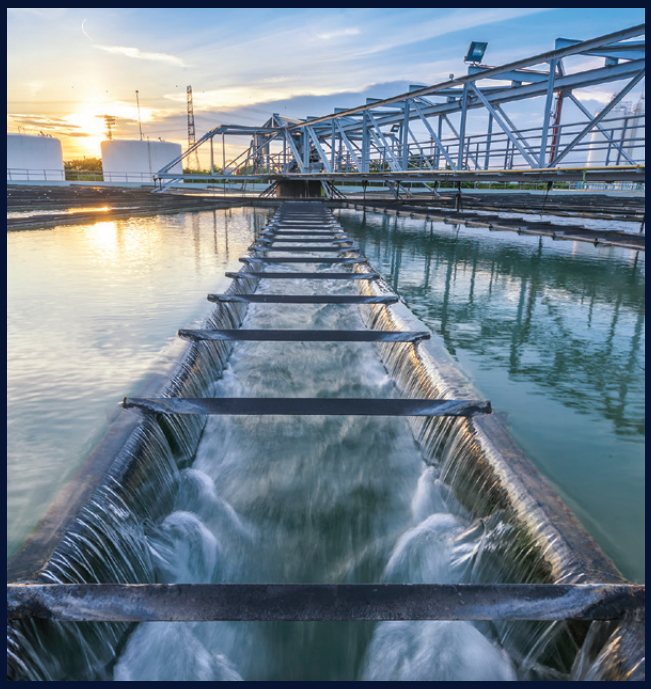
Target by 2033



coverage in sewage collection and treatment



of the population with access to drinking water



Current Scenario

37,8%
of the treated water is wasted

33 million
Brazilians have no access to treated water

93 million
people have no sewage collection

Today

The Sanitation Legal Framework aims to provide 99% of the population with access to potable water and 90% with sewage collection and treatment by 2033. Although progress has been made in attracting private investments and improving service efficiency, many municipalities still need to demonstrate economic and financial capacity to make the necessary investments to meet this goal.

In our distribution system, 37.8% of treated water is lost, while 33 million Brazilians lack access to treated water, and 93 million do not have sewage collection. In 2021, around 130,000 hospitalizations were recorded due to waterborne diseases, resulting in 1,483 deaths.

The deficiencies in the sanitation sector can be overcome through the effective implementation of the New Sanitation Legal Framework, which should include public policies to reduce water loss, ensure sewage treatment, simplify procedures for allocating funds to municipalities, and encourage greater private sector participation. However, as urban populations grow, water consumption increases, leading to more wastewater, water pollution, public health risks, and supply chain impacts. Climate change exacerbates these stresses, affecting the quantity, distribution, timing, and quality of available water.

Strategic planning is necessary to expand access to underserved areas, improve efficiency, and integrate the circular economy into water and waste management operations.



Applied Technologies for Sustainable Food Systems

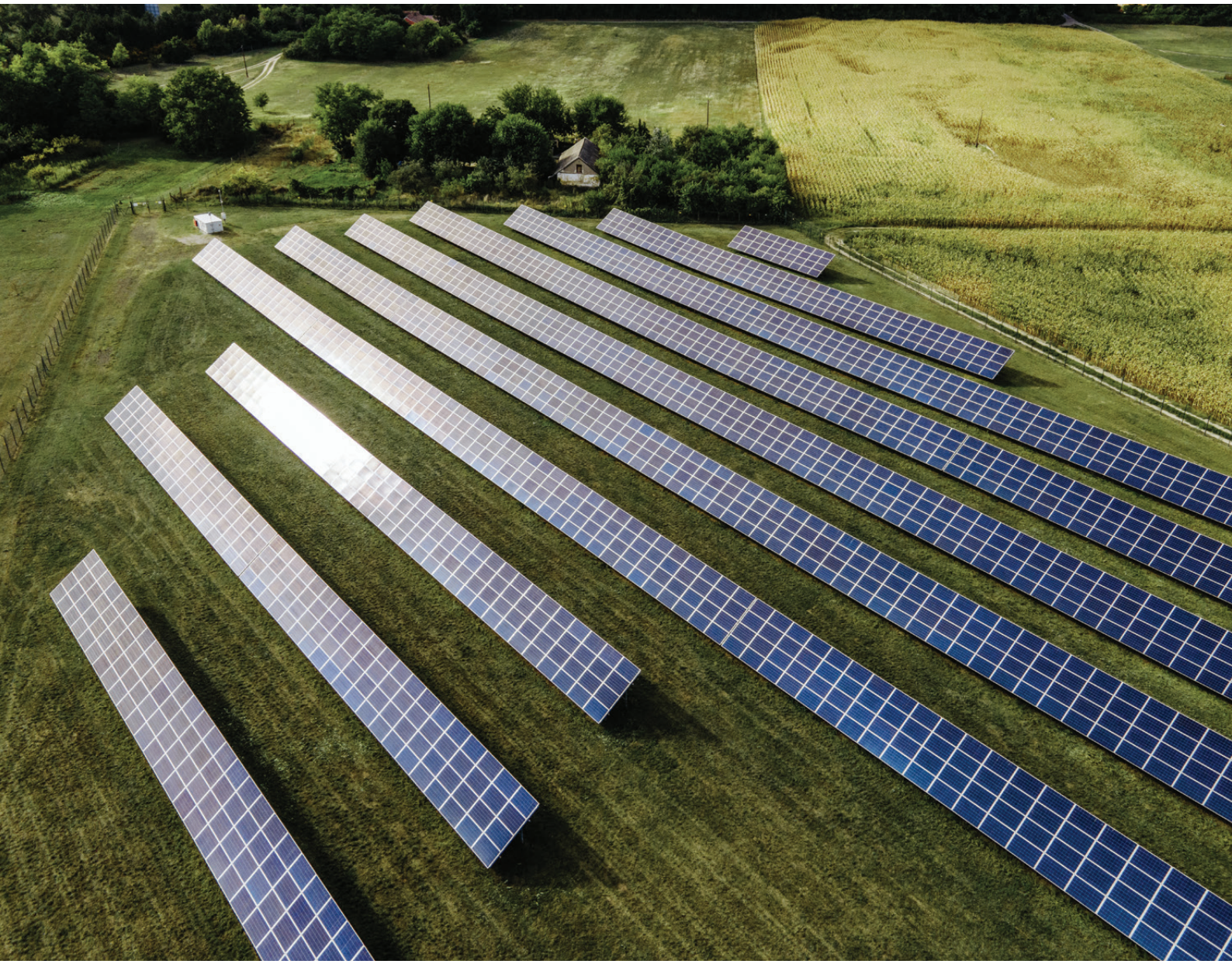


Picture of 2035

Brazil, as a major food producer and guardian of the world's largest tropical forest, leads the sustainable transformation of agri-food systems, combining food security and biome conservation, and including the development of small and medium producers in this process.

Leading companies in the Food and Beverage sector use digital and automation solutions to ensure better management with transparency and traceability throughout processes. This results in product quality and safety control, reduced waste (energy, water, raw materials), and increased operational efficiency. Data collection identifies critical points to assist in prioritization and compliance. The adoption of metrics helps reduce Scope 1, 2, and even 3 emissions. These companies use 100% green electricity, operate carbon-neutral factories, and engage their entire supply chain in this effort. Key partners, such as manufacturing, transportation, technology companies, and startups, are essential to solving shared challenges. Excess heat generated during production can be captured and reused in other processes, while byproducts can be recycled into packaging, supporting circularity.





Today

Brazil aims to take a leading role as one of the world's largest producers of sustainable food by 2050, increasing productivity and the regenerative power of the food sector without expanding land use. This will be achieved through low-carbon technology and innovation, while tapping into the potential of biodiversity, preserving it, and ensuring the survival of small and medium producers. Companies also cannot achieve their sustainability goals without undertaking a digital transformation of all aspects of the production process, from sourcing and manufacturing to distribution.

Small and medium producers are also part of the food and beverage industry's value chain. They are suppliers who impact the carbon footprint through indirect emissions (Scope 3). Collecting data throughout the value chain is complex but essential for accurate carbon calculations, reporting, and reduction. There are already examples of companies in the sector using data to report ESG metrics ahead of the new EU taxonomy, which will require more than 100 mandatory disclosures. Data has primarily been used for reporting and decarbonization efforts, with AI and partnerships being key to sustainability. True change comes from action, with investments in concrete data, partnerships, and innovation.

Impact Reducing Technologies in the Mining Sector

Picture of 2035

Driven by Mining 4.0 in the country, digital technologies continue to transform the industry, making it more efficient, safer, and sustainable. These advancements enable the mining sector to become cleaner and safer for workers. Artificial Intelligence is gaining prominence as a tool for controlling autonomous vehicles, removing operators from high-risk areas, reducing fuel consumption, and extending the equipment's lifespan. AI in georeferencing improves precision and quality in exploration, operational safety, and logistical optimization, making mining operations more efficient and secure. Additionally, AI enhances land mapping and management, ensuring efficient land use and minimizing conflicts with local communities. Digital twins assist mining companies with real-time monitoring, process optimization, risk simulation, decision support, and virtual training, thereby increasing efficiency, safety, and sustainability. Smart mining integrates the entire production chain, enhances asset capacity, and improves planning and execution. Meanwhile, robotics and automation elevate dam monitoring and resource management to new levels, ensuring better oversight and safety.





Today

Brazil is one of the world's key players in the mining industry. Although the sector relies on extractive activities, it plays a significant role in society by supplying raw materials to other industries and supporting technological progress. The mining industry in Brazil is expected to invest $50 billion by 2027 and expand its potential for exploring rare earth elements used in high-tech applications, such as lasers, supermagnets, and components for electric vehicles. Facing pressure from society, governments, and investors for more responsible and sustainable practices, the sector must work to reduce socio-environmental impacts, such as CO_2 emissions. The mining sector, which includes the steel industry, accounts for 5% of Brazil's total emissions.

Adopting the best available techniques and innovations in Brazil's mining sector is crucial for sustainability. However, closer cooperation between the government, public mining agencies, and companies is needed to increase knowledge and awareness among small businesses and implement sustainable practices.

Brazil's mining sector has already made significant strides in digitalization. Companies are incorporating technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), big data, and automation to optimize operations, enhance safety, and reduce costs.

Efficiency and Circular Economy in the Metal Industry

Picture of 2035

Emission reduction technologies, such as carbon capture, enable up to 90% of blast furnace exhaust gases to be recycled. These gases are reused in combustion, while the remaining highly concentrated CO_2 is captured and stored.

Industry 4.0 in Brazilian steelmaking is driven by digitalization, which enhances productivity, optimizes energy consumption, minimizes waste, and controls emissions. Blockchain technology verifies the sustainability quotient of steel value chains, providing reliable data to assess the net carbon impact. It also helps create more agile supply chains, while cloud computing allows command and control centers to oversee geographically dispersed mine-to-metal value chains.



Today

Metal production remains a CO_2 and energy-intensive activity. As noted earlier, the mining sector, including steelmaking, accounts for 5% of Brazil's total CO_2 emissions. However, the steel industry is committed to continuing to reduce the carbon footprint of its operations and product use. Technological advancements have helped the sector lower emissions, but many technologies needed for a faster, more sustainable transition are still under development, such as green hydrogen with Direct Reduced Iron (DRI) and Electric Arc Furnaces (EAF), which are expected to be the cleanest alternatives for steelmaking in the future. However, it may take time for hydrogen to become economically viable and efficient.

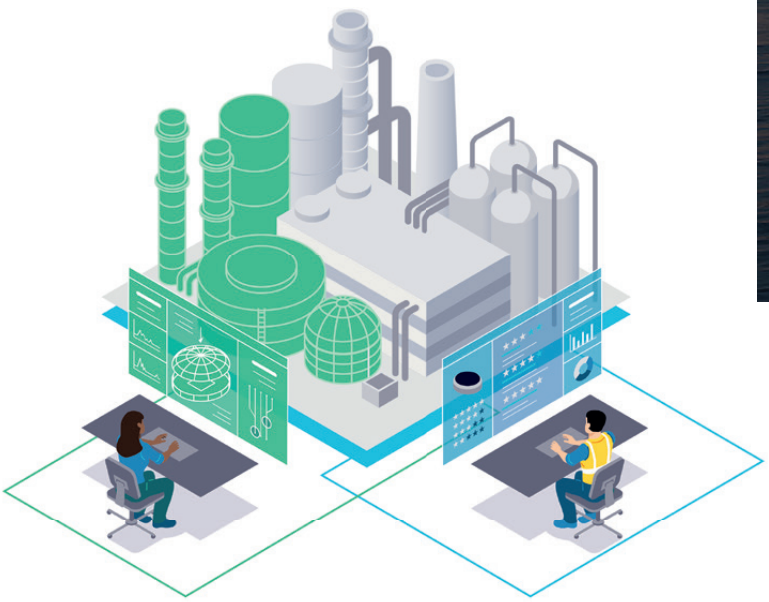
Investors are seeking more sustainable portfolios, requiring greater ESG compliance and performance. Improving these metrics benefits the sector and meets regulatory and stakeholder expectations. Digitalization can enhance processes and sustainability reporting. Steel producers must balance decisions across industry, consumers, and environmental concerns, aligning stakeholders to accelerate change and develop solutions.

Currently, there is no single solution for drastically reducing CO_2 emissions in steelmaking, but the industry's main focus areas are: Impact Education - The industry takes responsibility for emissions, striving for efficiency, maximizing scrap use, and developing low-carbon technologies; Efficiency and Circular Economy - the industry promotes reuse and recycling; Advanced Products - the industry develops innovative steels to support social transformation and carbon neutrality.



Digital Technologies for the Petrochemical Sector







Picture of 2035

Technologies like digital twins, open IoT-based cloud platforms, and big data analytics, integrated into powerful software, bring both incremental improvements and transformative advancements to operations. In an oil and gas context, a digital twin enables a more efficient design phase, essential for the effective use of capital-intensive equipment. During construction, it allows for virtual testing, training, and commissioning, meaning revenue generation can begin earlier. During operations, the digital twin facilitates remote performance monitoring and predictive diagnostics. This not only allows for real-time adjustments to optimize operations but also provides the ability to forecast maintenance needs, thereby increasing uptime. In more tech-intensive terms, the sector is investing in new methods of Carbon capture (CCUS) to control emissions, as previously discussed.



Today

The petrochemical sector alone accounted for about 9% of total global emissions in 2020 (McKinsey, 2020). In Brazil, the main sources of emissions in the sector come from the high volume of energy required to operate internal refining and oil and gas extraction processes. Numerically, the primary sources of CO2 emissions can be ranked as follows: Electricity generation (68%), Flaring (26%), Venting (6%), and Fugitive emissions (0.02%).

The chemical sector is considered one of the critical agents for any industrial and agricultural complex in the country. Brazil ranks as the sixth-largest chemical complex in the world and is the largest global producer of green polymers. Nevertheless, significant investments still go into the petrochemical route, responsible for over 95% of the sector's carbon emissions. Energy transition is crucial for transforming the industry, as it is highly energy-intensive and depends on updating the energy mix to reduce emissions. The chemical industry also provides essential materials for renewable energy technologies, playing a vital role in transforming other sectors and ecosystems.

With the growing consumption of plastics, tires, batteries, and other materials, along with stringent global government regulations, there are extensive growth opportunities in recycling.

To reduce pesticide use, the National Program of Inputs for Organic Agriculture (Bioinputs) was launched in 2020. It encourages the adoption of less toxic, natural technologies that comply with organic production legislation.

Visionary investors and industry leaders are recognizing the need for transformation. Chemical startups are emerging, seizing the opportunity to introduce new chemistries to the market. This innovation is crucial to face current and future challenges.

Innovation in chemical processes and AI-assisted discovery is increasingly central to partnerships within its ecosystem (supply chain, startups, and academia). This broad range of applications enables predictive maintenance, supply chain management, and process optimization. Digital twins model the entire supply chain, from sourcing raw materials to product distribution. They optimize logistics, inventory levels, and demand forecasting, ensuring efficient operations.

Recycling saves energy and reduces CO2 emissions, which is crucial given the scarcity of raw materials and pollution. Recycling processes and automation and digitalization technologies are essential for transforming plastic waste into valuable resources, promoting a circular economy.

Digitalization in Operational Optimization of the Automotive Sector

Picture of 2035

Digital technologies enable automotive industries to generate transparent carbon emission reports and integrate monitoring throughout their supply chain. For sector competitiveness, simulation tools predict the impacts of operational changes, aiding in decision-making regarding technological investments and more efficient processes. These technologies are also being adopted across the production chain. Manufacturers benefit from increased efficiency and productivity achieved through the adoption of Industry 4.0.

Today

The National Green Mobility and Innovation Program (MOVER), aiming to expand sustainability requirements across all vehicle types, is driving investments in the automotive sector and the development of new technologies, including electric vehicle production. MOVER seeks to promote increased investments in energy efficiency, including minimum recycling thresholds in vehicle manufacturing and expanded requirements for vehicle efficiency and safety. This will involve measuring the carbon footprint across the entire lifecycle, which will demand the use of recycled materials. The program addresses the challenges of national market competitiveness and emphasizes the need for a stable and more predictable environment.



Digitalization to Improve Processes in the Pulp and Paper Sector

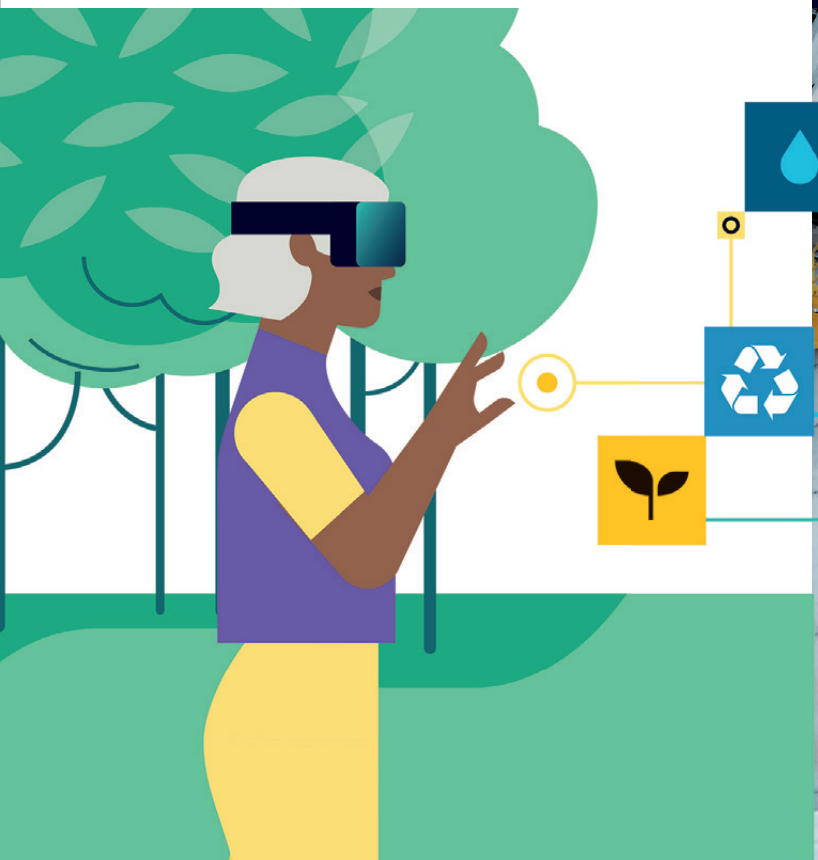
Picture of 2035

The sector is betting on technology as a key to its sustainable development. AI, IoT, and digital twins enable the industry to enhance operations through process optimization and resource control. In the forestry and logistics segment, digitalization provides an efficient way to manage material flow and supply chain planning. In pulp manufacturing, more efficient control of digital processes not only saves resources but also increases pulp production.

Today

The country is highly competitive in pulp production, especially in the forestry stage, thanks to its climate, soil, and Research & Development (R&D) efforts. As a result, Brazil exports around 70% of its production and is the second-largest pulp producer in the world. To ensure that commodity expansion does not compromise but rather contributes significantly to conservation gains, robust and coherent land use policies are necessary to avoid major conflicts between restoration and production.

The sector covers 15 million hectars, approximately 6 million of which are privately protected areas. The focus should remain on improving water resource management, energy efficiency, and the use of renewable sources, aiming to perform at the level of the best available technologies and increase recycling while supporting the development of future processes and technologies. The electrification of key processes – particularly heating and drying – offers significant potential for the reduction of CO_2 emissions and should be pursued. In paper production, the emphasis is on energy efficiency gains. Overall, digitalization is a way to control energy consumption and boost sector productivity.





Contribution to the Advancement of Brazilian Society and Economy



At Siemens, we work with all types of relevant partners to create a better future.

Our activities in countries like Brazil revolve around the goal of achieving a Net Zero economy by 2030, as well as supporting the country in advancing the United Nations' 2030 Agenda for Sustainable Development Goals. The challenges include rebuilding and upgrading factories to ensure a clean industry, digitalizing existing infrastructure, and establishing reliable ecosystems that help companies improve their productive efficiency. We also contribute with technology to promote more sustainable ways of working.

1 Helping Customers Achieve their Goals

Our customers in Brazil are embracing this transformation. They are pioneers who need technology to solve real problems, create value, and gain a competitive edge. That's why Siemens' ambition is to create technology with purpose: to help them transform their businesses. To translate the drivers of change into sustainable progress, companies need simulation technology to support process analysis. They need resilient systems that can scale as quickly as their businesses, enabling sustainable value growth. They need a partner like Siemens, who thinks outside the box.

2 Creating Technology With Purpose

With our deep know-how, a strong ecosystem of partners, and our leadership in technologies, Siemens is well-positioned to drive Brazil's sustainable transformation. Our ambition is to promote sustainability in all areas and strategically invest in our portfolio. We have always maintained a strong commitment to our role in society, within our communities, and as an employer.

By investing in our employees, we create an environment where they can thrive, with a focus on lifelong learning, equity, and well-being. Through our DEGREE framework, based on our Environmental, Social, and Governance (ESG) commitments, we are dedicated to creating a better tomorrow, achieving more with less.



3 Multiply the impact: Transformation needs cooperation

Now is the time to act to master humanity's biggest threats and improve people's lives. We believe that the upcoming transformation will work best if different stakeholders come together. Within an ecosystem of partners, businesses and communities, people need to jointly develop solutions for a more flexible, cleaner, and healthier Brazilian economy, using planetary resources more efficiently. We want to enable our Brazilian partners to achieve their goals, multiplying our collective impact across whole industries and the backbone of our economy.

Looking back through history, we know one thing for sure: real progress always needs collaboration. By working with each other, we are stronger and can multiply our impact. We stand ready to work together with anyone who wants to make an impact for a more sustainable future.

With our portfolio, and along with our partners, we develop sustainable innovations for a more livable world.

The key opportunity areas we identified throughout this project include:

- Digital Decarbonization
- Circularity
- Electrification and New Business Models
- Ecosystems & Partnerships
- Emerging sectors focusing on new green technologies
- Shaping new industry standards
- Digital Twins & Simulation
- Connectivity and Data Management
- Autonomous Decision Making & Prediction



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IBGE, BNDES, MDIC, Ministério da Fazenda MDIC, Plano de Transformação Ecológica

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