

# CCS: The Brazilian Perspective

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## Objectives of this presentation

- **To discuss Brazil's possibilities for implementing CCS projects, in the medium term**
- **To analyze technical, political, legal, geographical, geological and economical aspects that may influence CCS implementation in Brazil**
- **Issues that were considered in this analysis: technology, legislation, industrial sources and storage sites as well as the proximity between them, and funding possibilities**



# Summary

1. **Technology Availability and Current Projects**
2. **Legislation**
3. **Emission sources and storage reservoirs**
4. **Project Financing**
5. **Conclusion: SWOT chart and table with main opportunities**



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# Petrobras Oil Production in the Pre-Salt offshore province

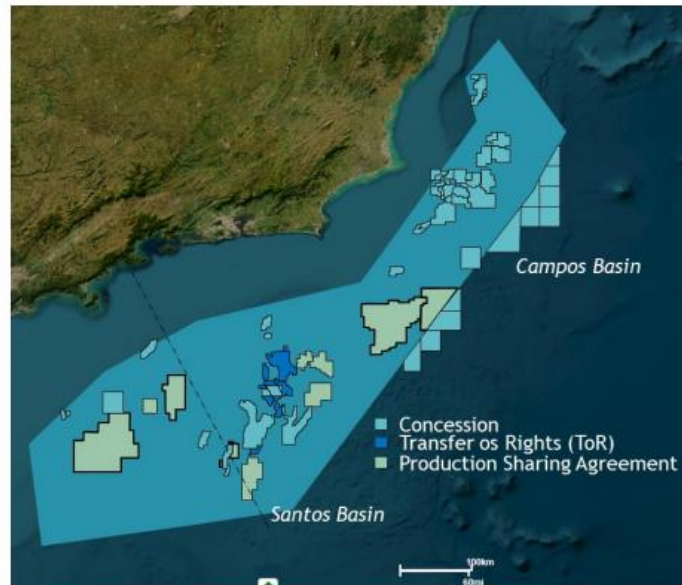
## PRE-SALT - STRATEGIC ASSET IN THE ENERGY TRANSITION

A long technological journey since the first discoveries in ultra-deep waters

CARBON  
 CAPTURE,  
 UTILIZATION  
 AND STORAGE



- ✓ Among the most important discoveries over the last decade
- ✓ The fast growth in production proves the high productivity of the wells in operation in the pre-salt
- ✓ Brazil still does not have a regulated carbon market.
- ✓ Petrobras and partners have committed to avoiding CO<sub>2</sub> venting to the atmosphere in production operations.



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- 300 km from the coast
- 136 wells
- 3,3 million boe/day (Feb/23)
- Oil: 2,6 MMbbl/day
- Total Gas: 111, 5 MMm<sup>3</sup>/day
- High CO<sub>2</sub> content (> 20%)
- High GOR (250 sm<sup>3</sup>/m<sup>3</sup>)

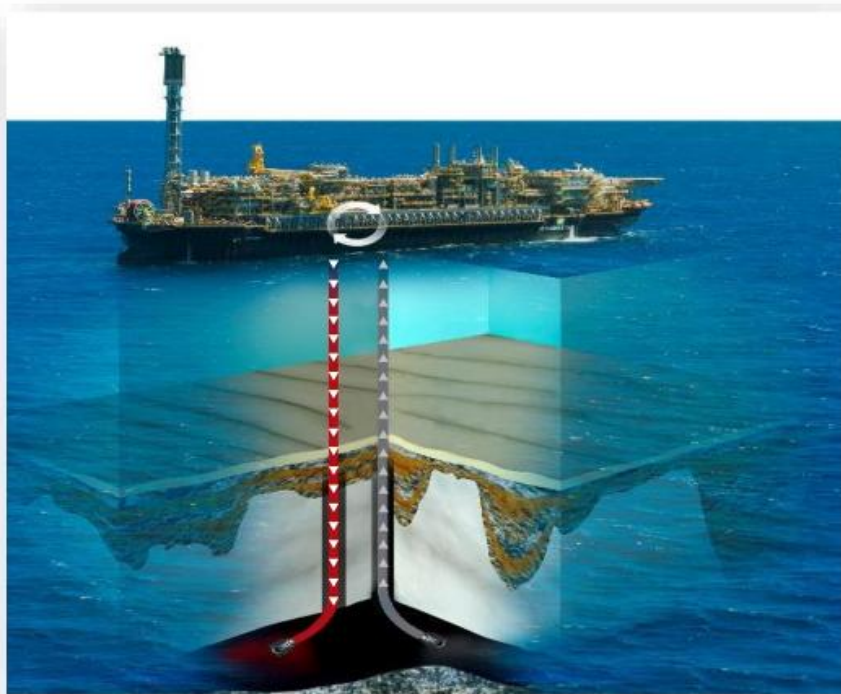
## PIONEER AND LARGEST CCUS PROJECT IN THE WORLD

Reducing emission intensity and increasing the reservoir's recovery

- ✓ Currently the **largest CO<sub>2</sub> injection project in the world** (annual reinjection)
- ✓ **First CCUS project in ultra-deep waters** (started in 2010)
- ✓ **Success of the CCUS Project** increases the recovery factor
- ✓ GHG production intensity in the main pre-salt fields is in **the industry's first quartile**, and CCUS plays a critical role in these results.

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 AND STORAGE

BR PETROBRAS



2022

40.8  
 million tons of  
 CO<sub>2</sub>  
 reinjected\*

- >10 million tons CO<sub>2</sub>/y injection
- 25% of the world's CO<sub>2</sub> injection capacity
- 21 FPSOs with CCUS technology
- Low GHG Intensity in Production (below 11 Kg CO<sub>2</sub>e/boe)

\*Cumulative results

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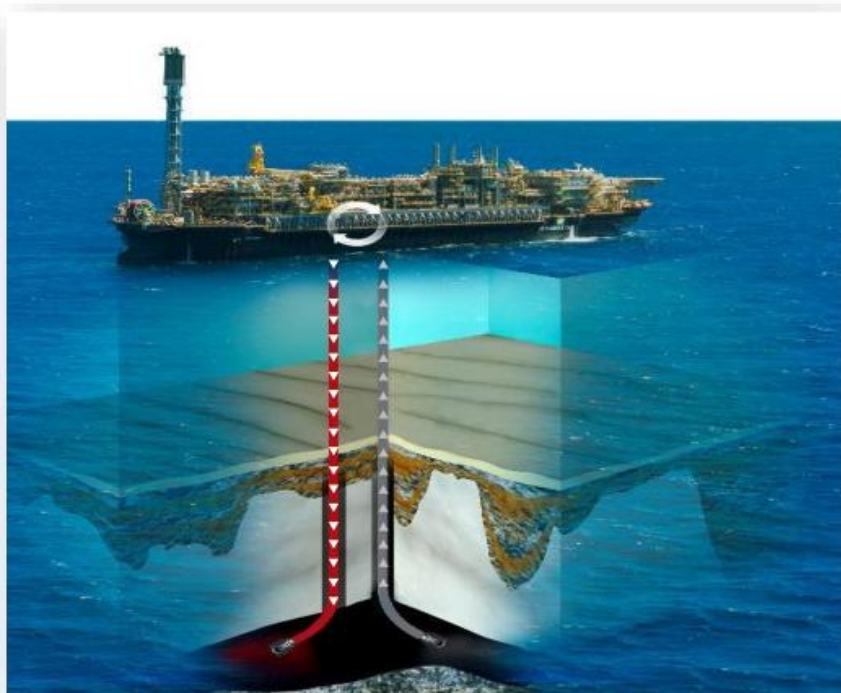
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**13 MM tons of CO<sub>2</sub> were injected into these fields in 2023. Expected cumulative value in 2025 is 80 MM tons of CO<sub>2</sub>**

\*Cumulative results

PUBLIC

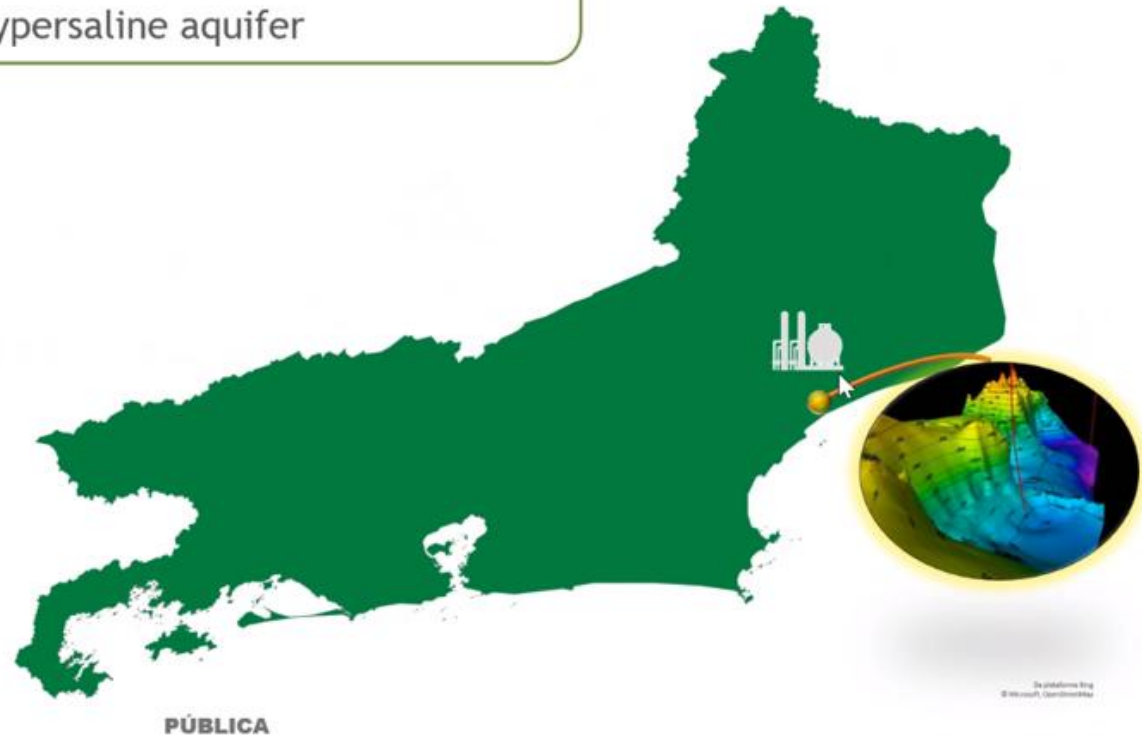
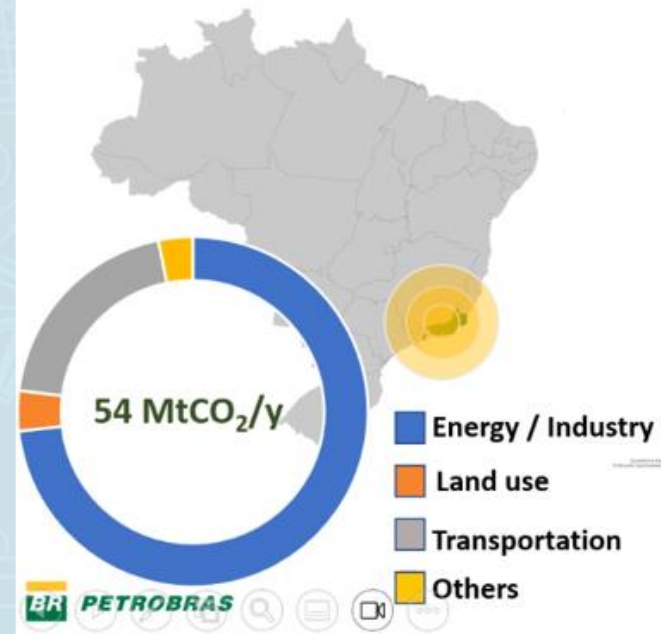
## Petrobras CCS Pilot and Future hub

### Rio de Janeiro CCS Hub - First of a kind

An opportunity to kick start Brazil decarbonization

#### Rio de Janeiro state

- Demonstration project under evaluation
- CO<sub>2</sub> stream from a gas processing plant
- Storage in a hypersaline aquifer





## Rio de Janeiro CCS Hub - First of a kind

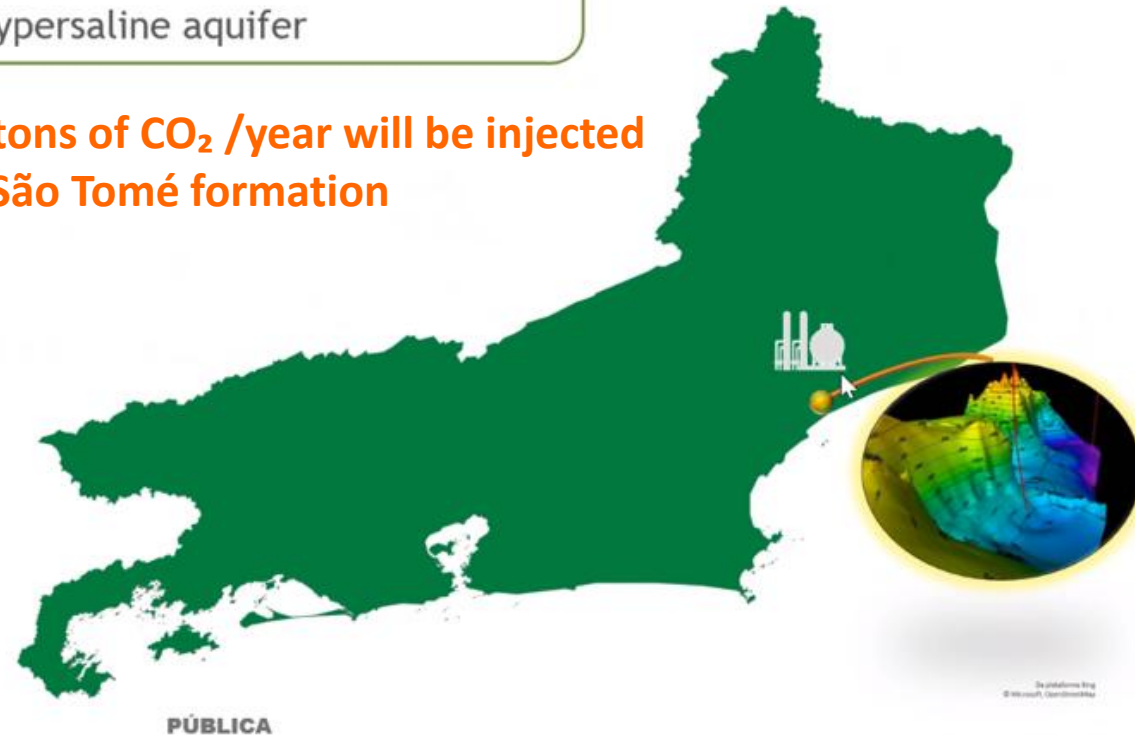
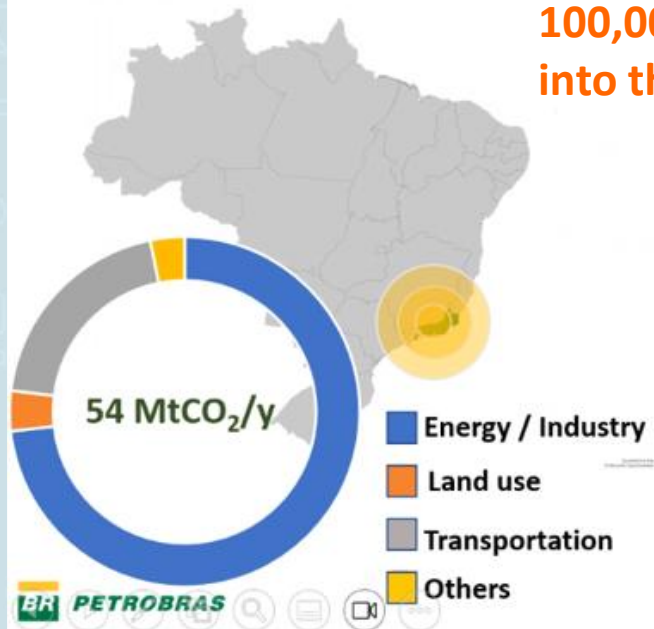
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CARBON  
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100,000 tons of CO<sub>2</sub> /year will be injected  
 into the São Tomé formation

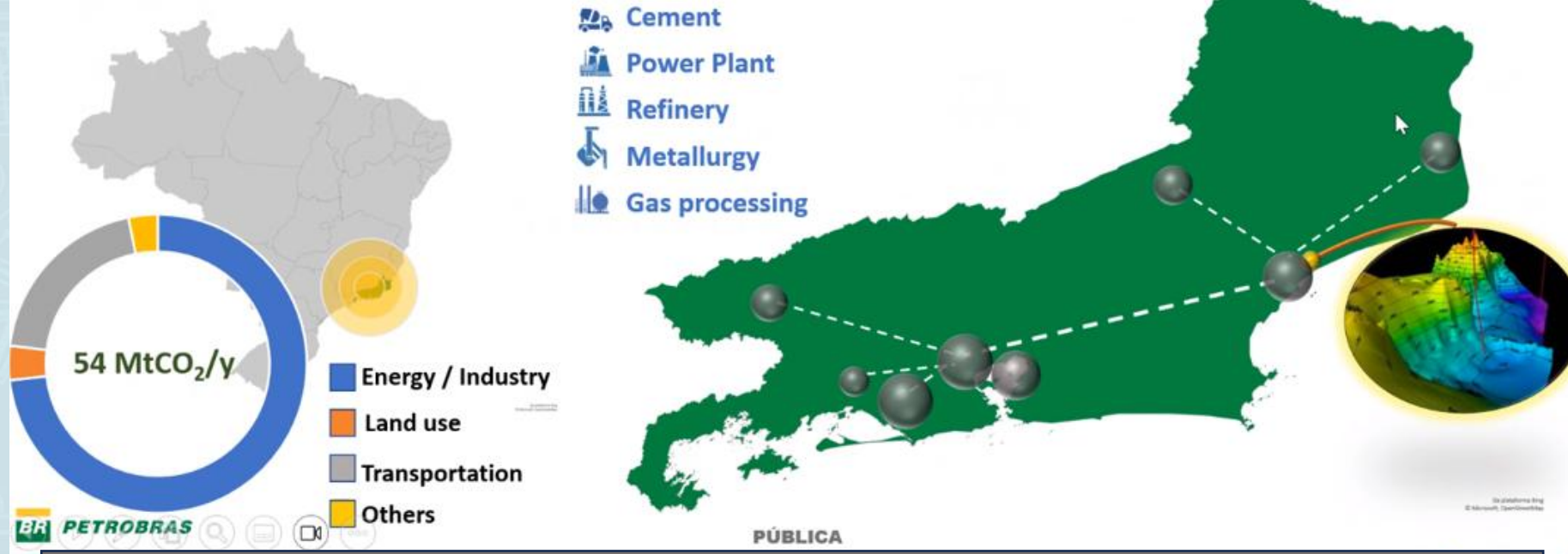


## Rio de Janeiro CCS Hub - First of a kind

An opportunity to kick start Brazil decarbonization

### Rio de Janeiro state

- CCS Hub with capacity for 25 MtCO<sub>2</sub>/y
- Selected hard-to-abate clusters
- Ambition to be the first decarbonized region in Brazil





## What the Global CCS Institute Says



# DEVELOPMENTS IN BRAZIL

Brazil hosts an operating CCS facility in the Santos Basin where Petrobras continues progressing toward its goal of injecting 80 million tonnes of CO<sub>2</sub> by 2025.

Source: <https://www.globalccsinstitute.com/>

## What the OGCI Says



Rio de Janeiro CCS Hub

# Rio de Janeiro CCS Hub

Petrobras is working on a pilot project for the development of the first commercial CCUS hub in Brazil.

Source: [https://ccushub.ogci.com/focus\\_hubs/rio-de-janeiro-ccs-hub/](https://ccushub.ogci.com/focus_hubs/rio-de-janeiro-ccs-hub/)

# A new entrant in the Brazilian CCS

**FS** Fueling Sustainability  
 ENERGIA QUE ABASTECE O BEM

YOU ARE IN INSTITUTIONAL

ACCESS **INVESTOR RELATIONS** A+ A- CONTRAST PT | EN Q

ABOUT FS OUR BUSINESS SUSTAINABILITY PEOPLE PRESS ROOM CONTACT

## BECCS

Carbon Capture and Storage (CCS) is a way to remove CO<sub>2</sub> from the atmosphere and store it in geological reserves. This contributes to reducing carbon in the atmosphere.

FS has been developing feasibility studies and basic engineering to prove the feasibility of a project of this nature for its implementation. When a CCS is coupled to a bioenergy plant, BECCS (Bioenergy Carbon Capture and Storage) is achieved. In the BECCS system, carbon emitted derives from the fermentation of renewable raw materials, in other words, it comes from a biogenic cycle and therefore does not add additional carbon emissions from fossil inventory. This way, CCS coupled to a bioenergy plant can achieve negative carbon intensities.

The CO<sub>2</sub> captured in the BECCS system may have its carbon credits used to offset the reduction in emissions required by other companies.



## Details about the FS Bioenergy project

- Municipality of Lucas de Rio Verde, in Mato Grosso (central state)
- Capture CO<sub>2</sub> from a corn ethanol extraction plant. Injection 8 km from the plant, in a saline aquifer
- Studies carried out by an international service company
- According to information provided at the CCS LATAM Congress 2024, the injection well was drilled, but some problems arose. Were there any injection difficulties?

Source: da Silva et al. Enabling the First BECCS Project for Zero-Carbon Ethanol Production in Latin America. Presented at the SPE-AAPG-SEG CCUS Symposium, Rio de Janeiro, Brazil, 22–23 May.

## A word about technology

- This technological capacity, as is usually the case in the oil industry, is not concentrated solely in the hands of Petrobras, but is an achievement of the technological ecosystem comprised not only by the operator, but also by service companies, equipment suppliers, and R&D institutions
- Funding for R&D is widely available to Brazilian universities under levy of 1% of gross revenue, managed by the National Petroleum Agency (ANP levy )
- The existence of this capable technological community will facilitate the expansion of CCS projects in Brazil.



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## Brazil's stage regarding legislation

- Brazil's federal government is aligned with the sustainability agenda and will host COP30 in Belém City, Brazil
- For that reason, the Brazilian government passed important pieces of legislation to make viable the development of the carbon market and of CCS activities



## Carbon Storage: Act 14.993, approved in October, 2024

- The law defines in a very generic way obligations of CCS operators regarding safety, monitoring, contingency plan, inventory maintenance, and obtaining carbon credits. Everything will be detailed and regulated by the National Petroleum Agency (ANP)
- Capture, transportation and storage will be carried out with authorization given by ANP which will issue rules on the qualification of interested parties
- Term of 30 years, extendable for the same period
- Drawback: There may be some waiting for the complete regulation of the activity

## Brazilian Regulation of the Carbon Market: Act 15.042, approved in December, 2024

- The Act creates the Brazilian Greenhouse Gas Emissions Trading System (SBCE), which establishes maximum GHG emission quotas, mainly for industries
- The Act defines the Brazilian Emissions Quota (CBE) and the Verified Emissions Reduction or Removal Certificate (CRVE), each one equivalent equivalent to 1 ton of carbon dioxide)
- The purchase and sale of carbon credits may be carried out on stock exchanges, with regulation and supervision by the Brazilian Securities and Exchange Commission (CVM). There will be certification bodies accredited by the SBCE.



## Brazilian Regulation of the Carbon Market: Act 15.042, approved on December 11, 2024

- Companies that emit between 10,000 and 25,000 tCO<sub>2</sub> per year must submit an emissions monitoring plan to the SBCE management body, send an annual report on emissions and removals of gases and comply with other obligations to be issued by SBCE
- 25,000 tCO<sub>2</sub> per year works as a cap. Emissions should not exceed that cap. In the initial phase, companies that are in this category will only report the balances.
- These emission levels may be modified considering the cost-effectiveness of regulation and compliance with the commitments undertaken by Brazil (NDCs)

## Brazilian Regulation of the Carbon Market: Act 15.042, approved on December 11, 2024

- The regulated market will be implemented in five phases. In the first phase, lasting 12 months, extendable for another 12 months, regulations will be issued
- In the next phase, operators of regulated activities will have one year to implement measuring instruments to report emissions
- In phase 3, lasting two years, these operators will only have to submit to the system's management body a monitoring plan and a report on greenhouse gas emissions and capture
- In phase 4, the first National Allocation Plan will come into effect. The last phase will result in the full implementation of the SBCE
- Drawback: The SBCE rules will be implemented gradually over up to six years.



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## Sedimentary Basins in Brazil



### Sedimentary Basins near to sources

- 1 Santos Basin (Pre-Salt, green offshore fields)
- 2 Campos Basin (mature offshore fields)
- 3 Reconcavo Basin (mature onshore fields) in Bahia State
- 4 Paraná basin (sedimentary sandstone e basalt layers)
- 5 Paraná basin, saline aquifers on sedimentary rocks

Source: Brazilian Atlas of CO2 Capture and Geological Storage, 2014

Figure 38: Sedimentary basins.



## Main Emission Sources

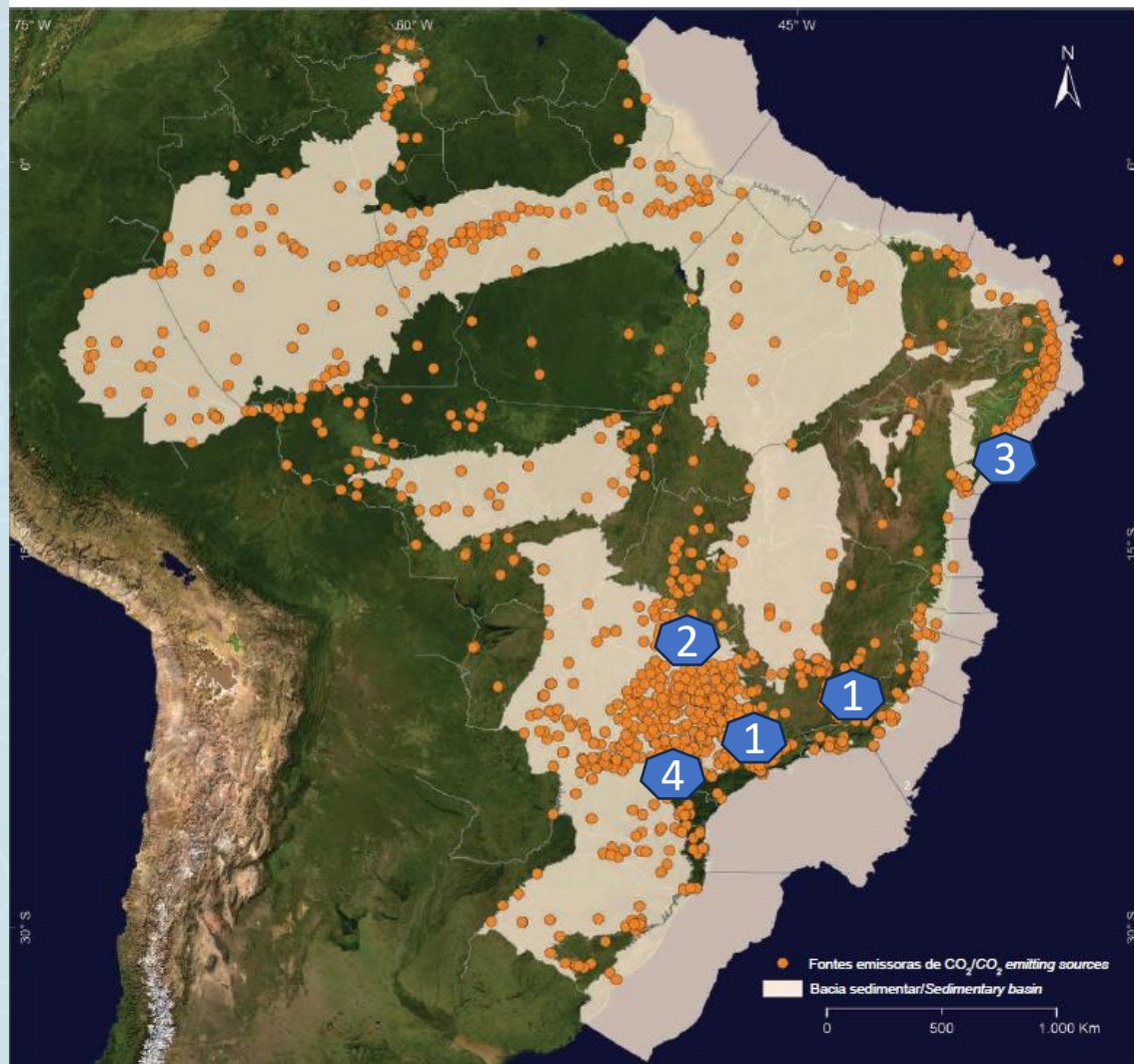


Figure 21: Sedimentary basins and CO<sub>2</sub> emitting sources in Brazil.

### Main Sources

- 1 Heavy Industrial area in the SouthEastern states, near the coast
- 2 Many sugar-cane plants in the SouthEast and Center South
- 3 Industrial complex in Bahia State
- 4 Industrial area in the Southern states

Source: Brazilian Atlas of CO<sub>2</sub> Capture and Geological Storage, 2014

## CO<sub>2</sub> Emission (Ktons/years)

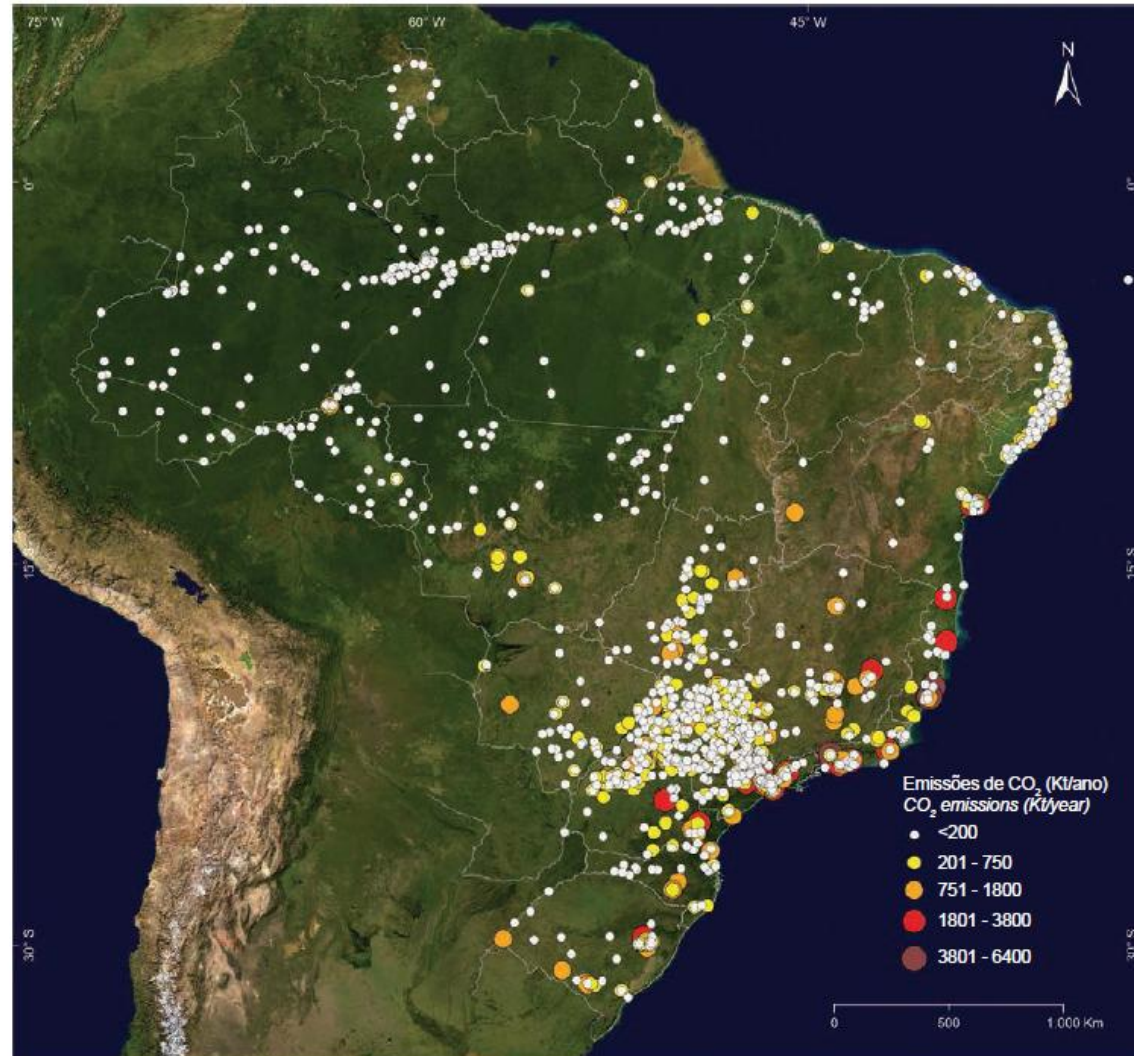
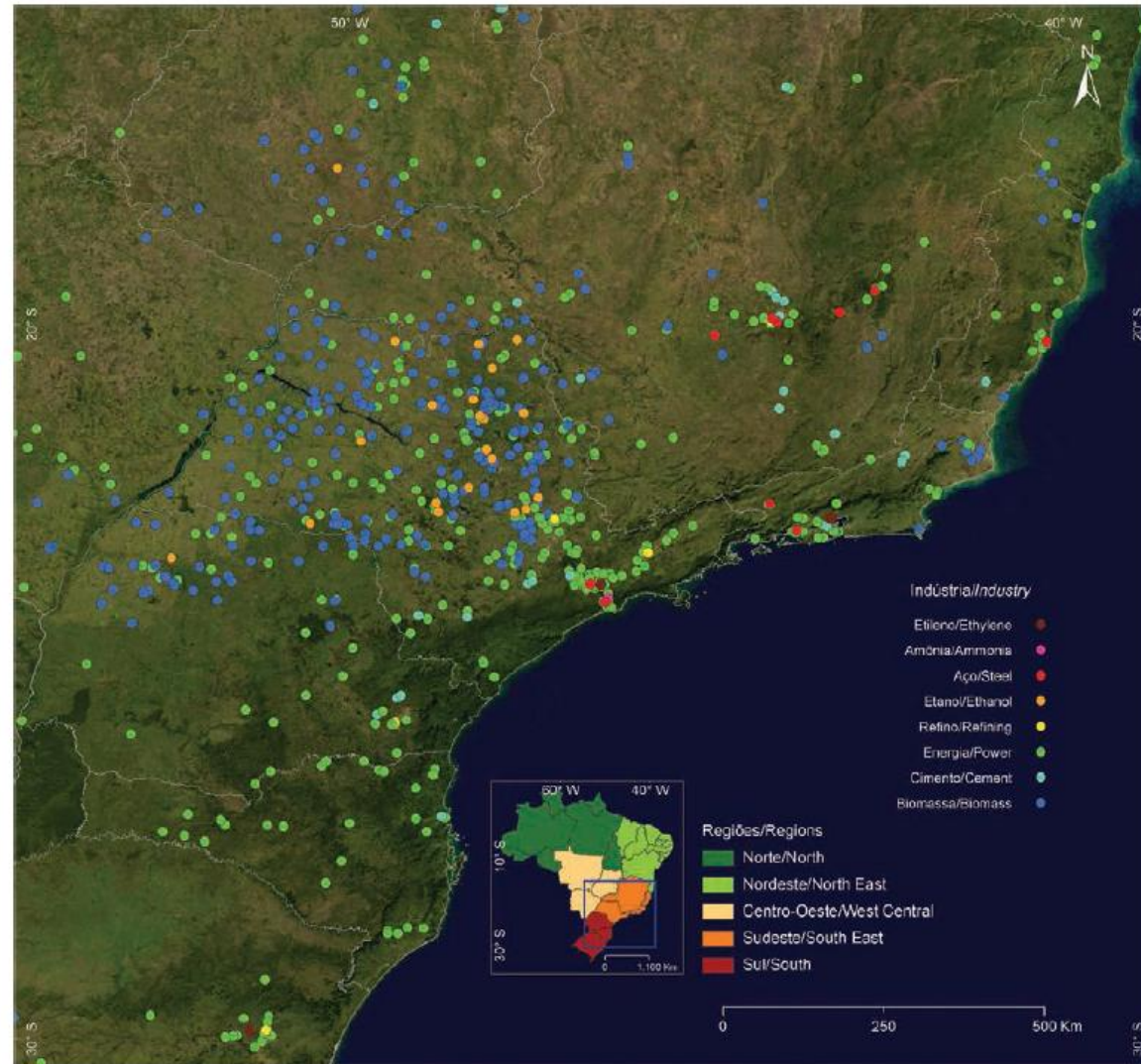


Figure 26: CO<sub>2</sub> emissions from stationary sources per mass emitted annually.







Source: Brazilian Atlas of CO<sub>2</sub>  
 Capture and Geological Storage,  
 2014



## Stationary Sources in the Southeast



### Type of Source

-  Biomass
-  Power Generation
-  Ethanol Plants
-  Steel
-  Refineries
-  Cement

Source: Brazilian Atlas of CO<sub>2</sub> Capture and Geological Storage, 2014

Figure 23: CO<sub>2</sub> stationary sources per type: Southeast region.



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## Budget situation of the Brazilian Government

- The Brazilian federal government's commitment to the sustainability agenda is unequivocal. However, the funding capacity of the Brazilian Government is limited
- According to several financial analysts, the gross government debt is projected to reach 82.0% of GDP in 2025, and the primary balance is expected to be negative, with a deficit of approximately R\$ 87.265 billion in 2025. This puts the government under pressure

## A Word on funding

- The funding and subsidies to sustainability projects announced by the government are not related to CCS
- In this scenario, the provision of tax incentives or government funding is unlikely to occur, at least at the levels of billion dollars needed to construct a big offshore hub
- Potential funding sources will have to rely on private sector investment from oil and gas companies, international climate finance mechanisms, green bonds, carbon credits, and partnerships with international organizations and development banks



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## Strengths

- Technology maturity
- Technology ecosystem represented by Petrobras, International companies, service companies and Universities
- Proximity between industrial sources and storage reservoirs
- Legislation being implemented by the Federal Government

## Opportunities

- CCS Hubs on the coast capturing from industry complexes and injecting in offshore aquifers
- Hubs or single source projects on Center – Southeast capturing from ethanol plants (BECCs) to inject in saline aquifers
- Hubs on Bahia State (capture from industrial area. CCS in mature fields may be preceded by EOR-CCUS)
- CCS at the Paraná basin (Capture from industries or ethanol plants, injection on basalt aiming re-crystallization)

## Weaknesses

- Slow implementation of legislation
- Low probability of government funding
- Poor geological characterization of saline aquifers in Brazil's Center-SouthEast

## Threats

- Setback in CCS international activities
- Choice of aquifers for BECCs projects without a sound knowledge of storage aquifers may increase risks



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## Opportunities for CCS in Brazil

ASPECT	CO2 INJECTION IN THE PRE-SALT (EOR)	CCS IN DEEP SALINE AQUIFERS	CCS IN BASALTIC FORMATIONS (PARANÁ BASIN)	CCS IN DEPLETED OILFIELDS ONSHORE (BAHIA) AND OFFSHORE (CAMPOS BASIN)
<b>Objectives and trapping mechanisms</b>	EOR	<ul style="list-style-type: none"> <li>Permanent storage of CO2</li> <li>Mitigation of greenhouse gases</li> </ul>	<ul style="list-style-type: none"> <li>Permanent storage through mineralization</li> </ul>	<ul style="list-style-type: none"> <li>Permanent storage of CO2</li> <li>Mitigation of greenhouse gases</li> </ul>
<b>Geological Risks</b>	<ul style="list-style-type: none"> <li>Wellbore integrity risks</li> </ul>	<ul style="list-style-type: none"> <li>Induced seismicity</li> <li>Communication with fresh water aquifers</li> </ul>	<ul style="list-style-type: none"> <li>Drilling challenges due to basalt's hardness.</li> </ul>	<ul style="list-style-type: none"> <li>Wellbore integrity risks in old wells</li> </ul>
<b>Technological Challenges</b>	<ul style="list-style-type: none"> <li>Remaining hydrocarbons which can complicate CO2 storage</li> <li>Reevaluation of existing infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Characterization and monitoring</li> <li>Managing injection rates to avoid fracturing.</li> </ul>	<ul style="list-style-type: none"> <li>Drilling challenges due to hardness of basalt</li> <li>Variable mineralization rates</li> </ul>	<ul style="list-style-type: none"> <li>Requires monitoring</li> <li>managing injection rates to avoid fracturing.</li> </ul>
<b>Economic Considerations</b>	<ul style="list-style-type: none"> <li>EOR additional Oil can offset some costs of CO2 storage</li> </ul>	<ul style="list-style-type: none"> <li>Federal budget for financing is tight</li> </ul>	<ul style="list-style-type: none"> <li>Costs higher due to specialized drilling equipment and the</li> <li>Unpredictability of mineralization rates.</li> </ul>	<ul style="list-style-type: none"> <li>Higher costs due to monitoring</li> <li>Federal budget for financing is tight</li> </ul>
<b>Regulatory Framework</b>	<ul style="list-style-type: none"> <li>Extensive experience and existing regulations</li> </ul>	<ul style="list-style-type: none"> <li>Requires regulations and operational expertise</li> <li>Less data data available</li> </ul>	<ul style="list-style-type: none"> <li>Requires regulations and operational expertise</li> <li>Less data data available</li> </ul>	<ul style="list-style-type: none"> <li>Requires the development of regulations and operational expertise.</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>Does not offset emissions from HC consumption</li> <li>Risk of methane release</li> </ul>	<ul style="list-style-type: none"> <li>High if leakage occurs;</li> <li>Requires monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Permanent and secure storage of CO2 as carbonate minerals.</li> </ul>	<ul style="list-style-type: none"> <li>Requires monitoring</li> </ul>

## Thank You Very Much

Feel free to write me if you have any further questions

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