

Petrobras Santos Basin

Pre-Salt Oil Field CCUS

CSLF: 2023 Technical Group Mid-Year Meeting

June 2023, Warsaw, Poland



CCUS

PRE-SALT - STRATEGIC ASSET IN THE ENERGY TRANSITION

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

- ✓ 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_2 venting to the atmosphere in production operations.



- 300 km from the coast
- 136 wells
- 3,3 million boe/day (Feb/23)
- Oil: 2,6 MMbbl/day
- Total Gas: 111, 5 MMm³/day
- High CO₂ content (> 20%)
- High GOR (250 sm³/m³)



PETROBRAS EMISSIONS RESULTS, TARGETS AMD AMBITION

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RESULTS

39% less operational emissions and **55%** less methane intensity since 2015

E&P: Emissions per barrel (intensity) have halved since 2009

Refining: **12%** reduction in GHG emissions intensity since 2015

- IUGA 97.3%
- Closed Flare
- CCUS-EOR
- Energy Efficiency

2022 results

*Our ambition is to neutralize emissions in activities under our control by 2050 and influence partners to achieve the same ambition in non-operated assets.

2025-2030

- 6 Commitments
- 100% operational coverage
- Targets on absolute emissions, intensity in all segments and methane

- All eletrics
- Ecotype vessels
- OGMP 2.0
- *Refining excelence*



Ambition for NET ZERO 2050*



Pre-Salt: Challenges and Opportunities for the Brazilian Industry

The implemented solution involves separating CO_2 from natural gas, compressing the CO_2 -rich stream, and reinjecting it back into the reservoir associated with the EOR.

WE HAVE CHALLENGED ALL TECHNOLOGICAL LIMITS



CO2 CAPTURE, UTILIZATION AND

STORAGE (CCUS)

 CO_2 capture (polimeric membrane), CO_2 compression/reinjection, and optimizations of deck space/cargo.

Drilling and Completion: improving the penetration rate, applying intelligent completion; New materials to reduce costs of wells; quality of cements and resistance to CO₂

S. P. C. S. Maria

Reservoir: WAG \rightarrow water alternate CO₂; Rock – fluids interaction

Reservoir Monitoring: 4D seismic. pressure and temperature sensors (PDGs) enabeling real-time monitoring

Subsea: flexible risers for water depth of 2,200 (7,218 ft), considering CO₂ and high pressure;

PIONEER AND LARGEST CCUS PROJECT IN THE WORLD

Reducing emission intensity and increasing the reservoir's recovery

- ✓ Currently the largest CO₂ 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.



PUBLIC

CARBO

AND STORAGE

PETROBRAS

SANTOS BASIN CONCENTRATES PRE-SALT ASSETS AND BOOSTS PRODUCTION GROWTH



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- Operated production in the Santos Basin in 2027: 3.5 Mmboed
- CD 2022_2027



We have gained valuable knowledge thus far, but our study and learning journey continues....



The prospective Life Cycle Analysis (LCA) used operational data as parameters in different operation configurations. In all cases, there was an advantage in carbon accounting for reinjection. Further studies are being carried We follow the results of CO2 recirculation using different techniques and modeling. In semiquantitative estimates, recirculation increases while fields mature. Data are continuously being analyzed and modeled. The thick layer of salt is a highly efficient geological seal, and we use 4D seismic and real-time monitoring to ensure no migration nor leakage of CO2. Studies are routinely updated to indicate the maximum injection pressures.

CO2 CAPTURE, UTILIZATION AND STORAGE (CCUS)

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PIONEER AND LARGEST CCUS PROJECT IN THE WORLD

Reducing emissions and increasing the reservoir's recovery

✓ Target 2025: Reinjection of 80 million tCO₂ in CCUS-EOR projects (cumulative)









"Distinguished Achievement Award for Companies, Organizations, and Institutions" OTC, 2015

- First separation of CO₂ associated with natural gas, with injection of CO₂ into production reservoirs;
- Deepest underwater CO₂ gas injection well;
- First use of the method of alternating water and gas injection.

Firjan Sustainability Award, Climate Change and Energy Efficiency category, 2020.

DRIVING CCUS BEYOND TO NET ZERO EMISSIONS

New opportunities and business models





CCS: ADVANCING BRAZIL'S CLEAN ENERGY MATRIX TOWARDS NET-ZERO 2050

Renewables Share in the Energy Mix: 92.1% (2022) Energy mix is the second least carbon-intensive of the G20 (35.28 kgCO2e/GJ)





*Brazilian NDC (Nationally Determined Contribution), pledged in the Agreement on Climate Change under the UNFCCC (United Nations Framework Convention on Climate Change) commits to neutrality until 2050 (BRASIL MMA, 2022). Brazil has also committed to eliminating illegal deforestation by 2028 and is a signatory to the Global Methane Pledge. **PUBLIC**

PETROBRAS AMBITION TO CCS NEW FRONTIERS CARBON PETROBRAS BR CAPTURE, UTILIZATION AND STORAGE Learned skills and future goals **Experience** in Expertise on ultra-Comprehension Explore complex deepwater of Brazilian's opportunities on infrastructure CCUS - EOR **CCUS HUB's** geology projects 2025 2050 **CCUS-EOR** Pre Salt First of kind 80Mt CO₂ stored in the preproject of CO₂ Multiple Hubs 2050 salt CCUS-EOR storage in saline **Commercial Hub Net Zero Ambition** 60Mtpa aquifer (100.000 project tons CO2/day)



Raquel Coutinho <u>rcoutinho@petrobras.com.br</u>

Petrobras - Climate Change