Upstream decarbonization

Where do we stand?

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The big challenge

Energy is a large and complex system, and the world is trying to make the most rapid change in history in order to achieve the needs of decarbonization. Meanwhile, the population and the economy are growing, demanding more affordable, reliable and clean energy. Meeting the decarbonization goals of the net zero scenario requires a surge in global energy investment to USD 5 trillion by 2030 (IEA).

01 Energy makes up nearly **75% of global emissions**

02 Fossil fuels account for more than **80% of the world primary energy**

03 Still **hundreds of millions of people are deprived** of energy access

04 Global population will achieve more than **9 billion** in 2050 and the economy will be twice as big as today

How to provide energy to a growing global population while decarbonizing our sources within the deadlines and with acceptable costs for society?

The world is committed to decarbonization

Society

Society and mainly the millennials are demanding concrete actions to tackle climate issues

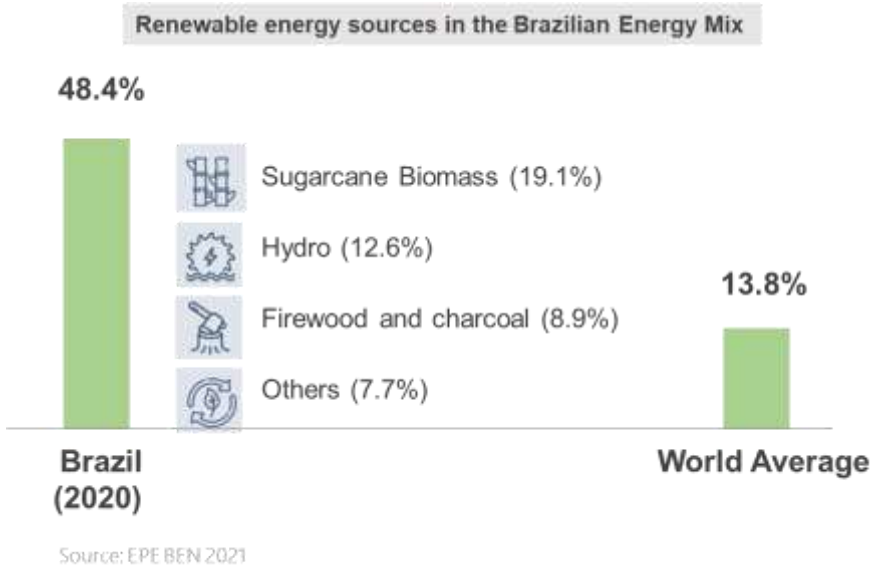
Investors

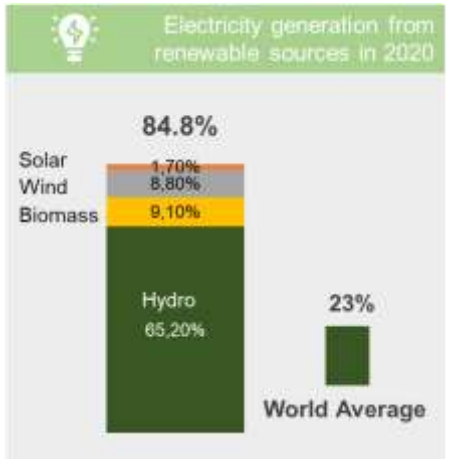
Shareholders and investment funds are joining the battle against climate change. Cases like what happened in Exxon and Chevron boardrooms demonstrate that decarbonization is a must. A growing number of institutional investors and funds now incorporate various ESG investing approaches

Government

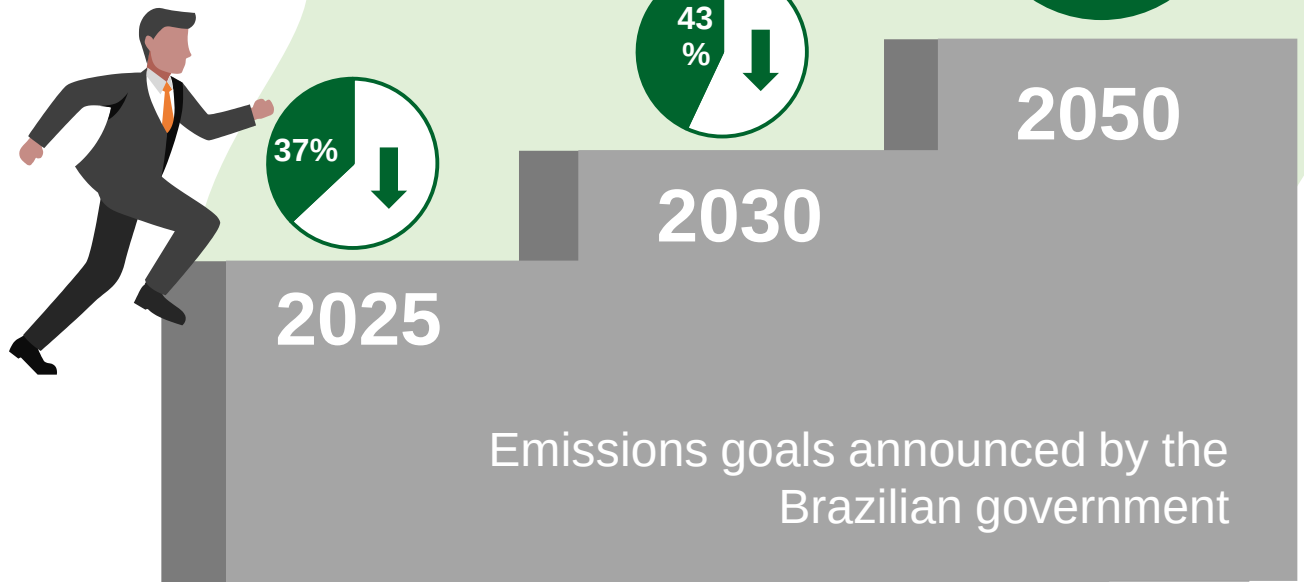
As of September 2021, 53 countries and the European Union have pledged to meet net zero; **in total they account for 60-70% of today's global GDP and energy-related CO2 emissions**, and for around one-third of energy-related methane emissions, the other main greenhouse gas - World Energy Outlook 2021 (IEA)

Brazil has one of the cleanest energy mix in the word, but is also committed to decarbonization





Brazil´s National Determined Contribution in the context of Paris Agreement: targets for 2025 and 2030, compared to 2005 GHG emissions



Emissions in the energy sector represent less than half of world average

01 Brazil is not ranked in the top emitters in the energy sector

Top Emitters in Energy Sector (All GHG)

2018	CO_2e
Others	12.57Gt
China	10.32Gt
United States	5.27Gt
India	2.42Gt
Russia	2.28Gt
Japan	1.09Gt
Iran	716.76Mt
Germany	713.82Mt
Canada	626.07Mt
South Korea	617.23Mt
Indonesia	598.17Mt

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Brazil (437,33 Mt)

Source: Climate Watch (CAIT)

02 Energy makes up nearly three-quarters of global emissions, but in Brazil it represents around 30% of the total emissions

Emissions by Sector – Word (All GHG)

2018	
Energy	76%
Agriculture	12%
Industrial Processes	5.9%
Waste	3.3%
Land-Use Change and Forestry	2.8%

Emissions by Sector – Brazil (All GHG)

2018	
Agriculture	35%
Energy	31%
Land-Use Change and Forestry	27%
Waste	4.9%
Industrial Processes	2.0%

03 Brazil accounts for 1.3% of global fossil fuel and cement emissions

Top Fossil Fuel and Cement Emitters (CO2)

2019	
Others	34%
China	28%
United States	15%
India	7.2%
Russia	4.6%
Japan	3.0%
Iran	2.1%
Germany	1.9%
Indonesia	1.7%
South Korea	1.7%
Saudi Arabia	1.6%

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Brazil (1,3%)

Source: Climate Watch (GCP)

CO2 emissions per capita: on average, each Brazilian emits 1/7 of what an American emits and 1/3 of what a citizen of the European Union or a Chinese emits in the production and consumption of energy

The role of the O&G Industry in the pathway to net zero

O&G will continue to play an important role

O&G play a critical role in today's energy and economic systems (more than 50% of primary energy), being affordable, reliable and providing supplies that are necessary in the pathway to net zero. Also, the O&G industry has the skills, infrastructure and capital to help unlock net zero solutions such as CCS, low-carbon hydrogen and offshore wind.

Carbon reduction is imperative in the O&G sector

Regardless of the speed and the pathways of the transition, climate impacts will become more visible and severe over the coming years. Emissions reduction are not an option if the sector wants to retain its social license to operate. The competitive landscape will also be about the lower carbon footprint.

O&G demand should decrease before supply

Hydrocarbon demand is not falling fast enough to match the potential underinvestment in fossil fuels nowadays. Therefore, the gas, coal, and electricity crisis shows that investments in traditional sources are still needed if there is demand, like the one motivated by the rapid economic rebound from the covid recession and weather factors, and to create redundancy.

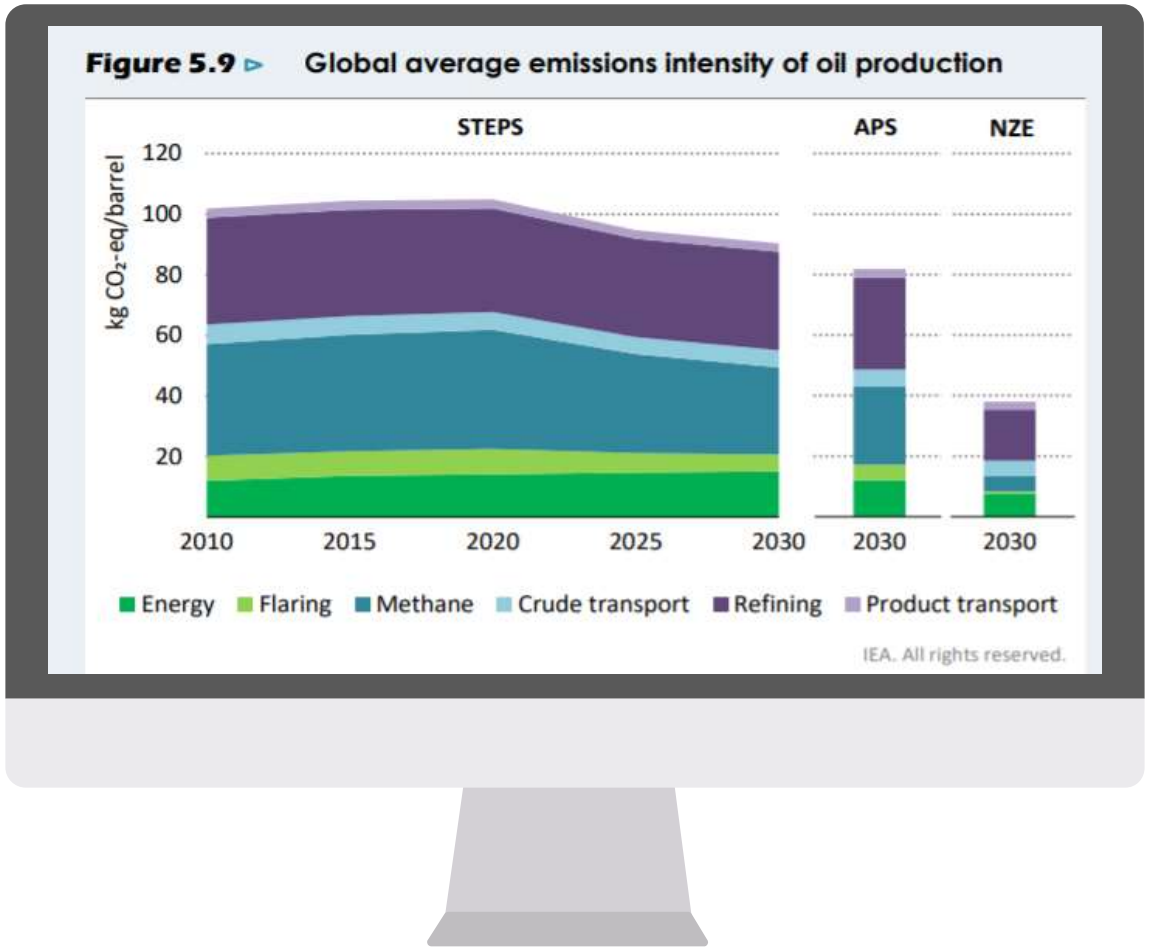
Decarbonizing the O&G operations

Oil and gas operations are responsible for around **15% of global energy sector GHG emissions** today (IEA, 2020).

Options to reduce these emissions include **tackling methane leaks, minimizing flaring, switching to low-carbon options to power generation, incorporating energy efficiency improvements and using CCUS** for large centralized sources of emissions.

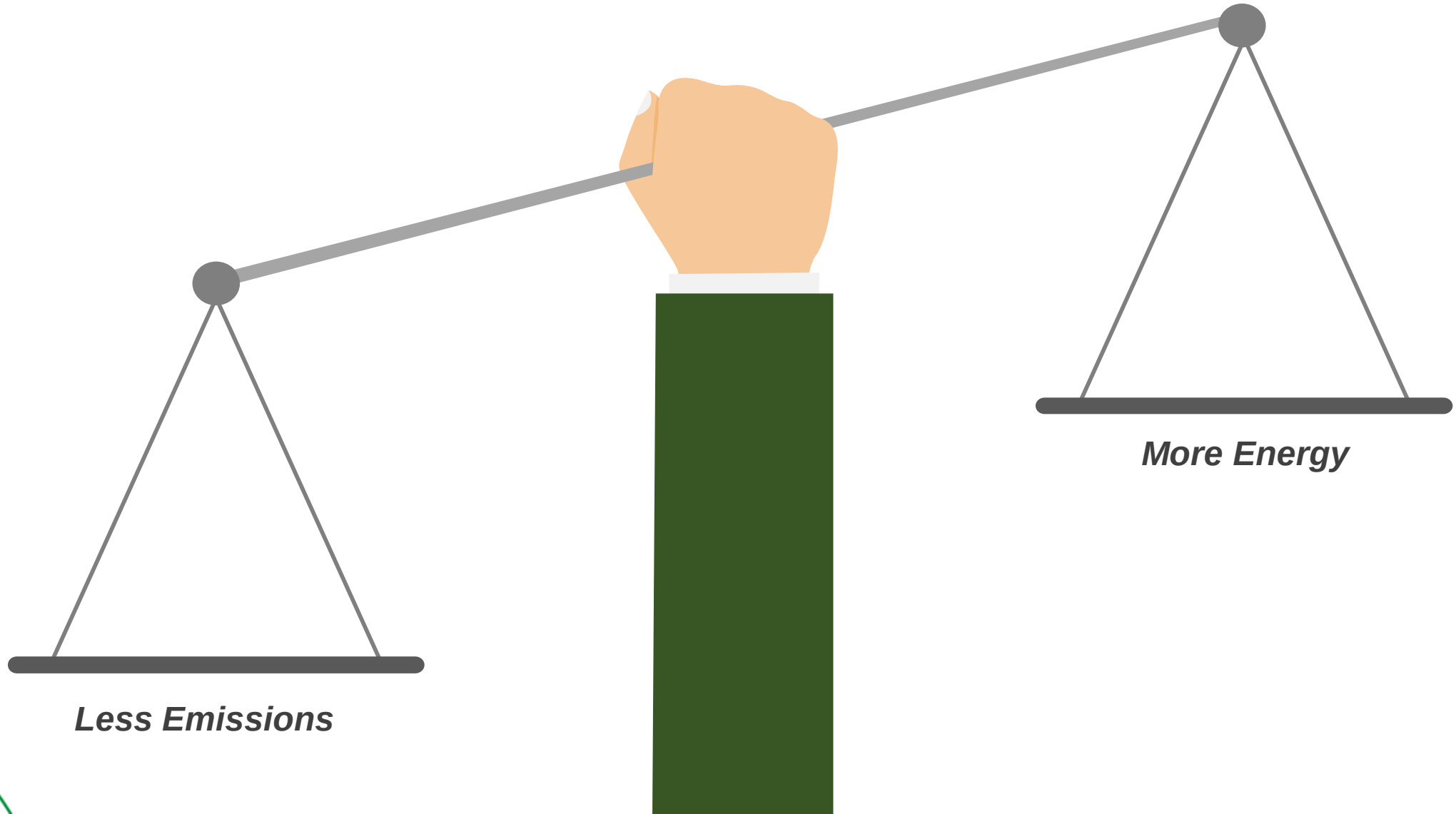
Majors O&G companies are decarbonizing and committing to net zero scenarios. **In 2020, the 7 largest IOCs invested 5.9 billion dollars (8,5% of their total CAPEX) in decarbonization.** (IHS)

Source: World Energy Outlook 2021 (EIA)



The imperative pathway in the Brazilian energy sector

As a developing country, Brazil needs more energy, including more O&G production to meet the needs of society (O&G represents 46% of primary energy in Brazil). But our mission is to be able to produce this energy in the best standards in terms of sustainability/low emissions.

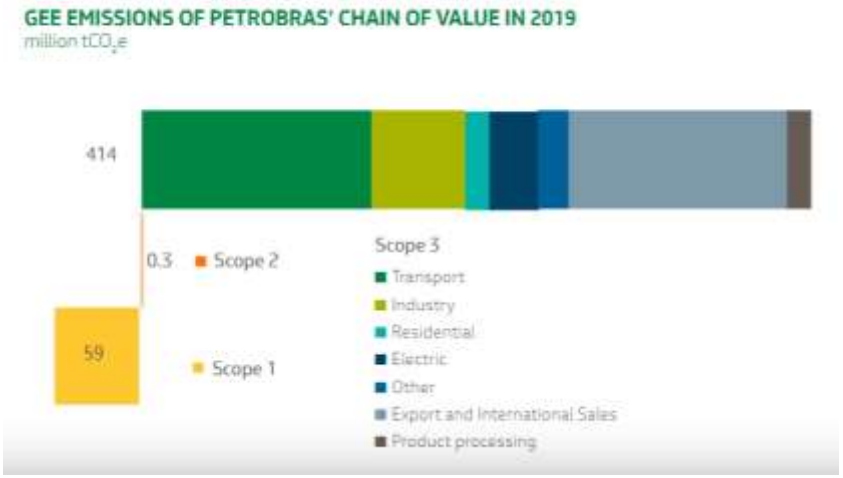


We are already seeing upstream decarbonization commitments by the majors, like Petrobras

Petrobras operates more than 90% of the O&G production in Brazil

Source: Petrobras Climate Change Supplement

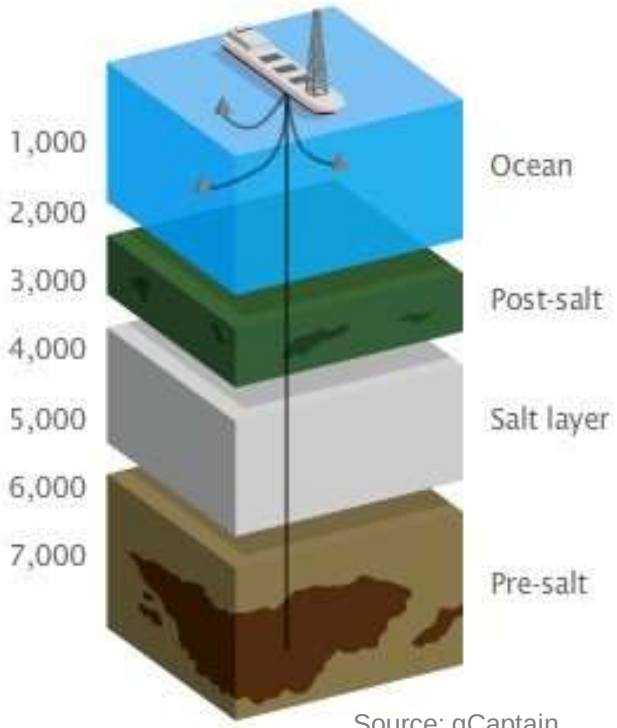
Reduction of more than 40% in the upstream carbon intensity during 2009 and 2019. Such improvements allowed an **increase of 40% of the O&G production, without disrupting the absolute emissions.**



Petrobras established several ESG commitments in the E&P such as **zero routine flaring by 2030 and 30-50% reduction in methane emissions by 2025.**

Recently, Petrobras **committed to net zero carbon emissions** (scope 1 and 2, which represented 59,3 million tCO2e in 2019).

Due to the quality of our assets, we believe we can maintain our position as a competitive O&G producer, with low carbon emissions



Source: gCaptain

Pre-Salt (72% of total production): globally competitive assets in the energy transition scenario, with low breakeven and low GHG emissions

- ✔ Low sulfur content
- ✔ High productivity

Bacalhau oil discovery, to be operated by Equinor, is expected to produce about **9 kg of carbon dioxide (CO2) per barrel**, against a global average of 17 kg per barrel.

Source: Reuters

Post-salt: more challenging due to the already in place old infrastructure, recently acquired by independents

RD&I: Government and operators are seeking to support the development of green/clean technologies

CNPE Resolution No. 2/2021

It guides the allocation of RD&I resources to the themes of hydrogen, nuclear energy, biofuels, energy storage, digital transformation and strategic minerals for the energy sector etc.

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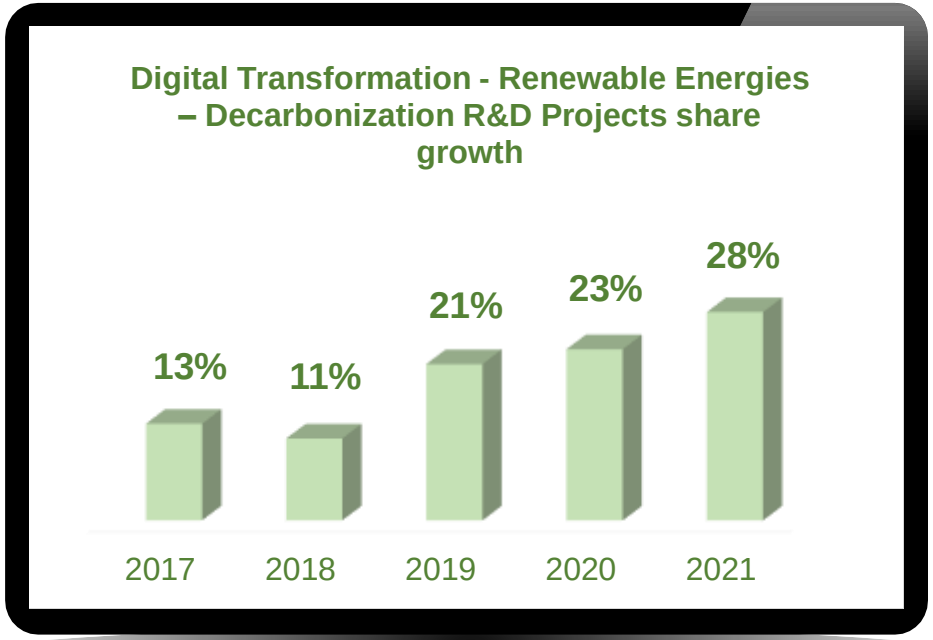
RD&I ANP Resolution

Update under public consultation. The new version proposes greater clarity in the eligibility of RD&I projects related to the energy transition, including decarbonization, CO2 capture and environmental characterization and protection studies. Priority process will also be established for projects covered by CNPE 2/2021



Over the past five years, oil companies have been increasing the proportion of R&D projects related to **Digital Transformation, Renewable Energy and Decarbonization** compared to all contracted projects per year. Emerging digital technologies could help improve efficiency, reduce costs and reduce the emissions intensity of oil and gas production.

Regulation already in place related to upstream decarbonization

Monitoring

Avoiding Emissions

Supporting Clean Energy

Law No. 12,351/2010

Presentation of GHG inventory in areas under Production Sharing regime (art. 29)

Integrated Operational Safety System (SISO)

Supervision of serious incidents related to loss of gas containment and recurrence of emergency shutdowns of facilities, which have direct impacts on emissions

Resolution ANP 806/2020 (Gas Flaring)

Gas Flaring regulation aligned to the best practices. **Brazil has already a high produced gas utilization rate** (97,7%), which means that 2,3% of gas production is flared (August 2021)

Resolution ANP 17/2015 (Development Plan)

The description of the Production Units and their facilities should include the main characteristics of the chosen development project, aimed at **maximizing energy efficiency and reducing emissions** (13.1.3). An update of this regulation is under development

Resolution ANP 817/2020 (Decommissioning)

Seeks to ensure the evaluation of the reuse of facilities for integration purposes with renewables and opens the possibility of evaluating fields for carbon capture and sequestration as soon as the activity is effectively regulated

Updates in the Resolution CONAMA 382/2006

It allows the use of All Electric technology in production units, by eliminating the emission limits of each turbogenerator with up to 100 MW of power. The objective is to reduce the carbon intensity of operations

ANP is committed to contribute more to upstream emissions reduction

RESULTS FOR THE SOCIETY

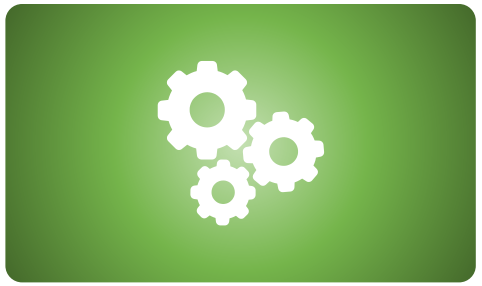
Stimulate safer and more sustainable regulated activities and contribute to the reduction of greenhouse gas emissions

Implement regulatory actions aimed at the safety and sustainable development of regulated markets

Regulatory gaps regarding decarbonization in Brazil

There is a lack of integration of emissions reduction targets or net-zero into O&G policies.

ANP does not receive full GHG emissions reports for the whole upstream sector. Hence, there is no benchmarking analysis.



There are no energy integration studies to build closer links between O&G and renewables, reducing carbon emissions from oil and gas production.

There is no CCS regulation and we still did not consolidate our potential storage capacity.

A potential new regulatory approach for upstream decarbonization

New regulatory measures are being studied by ANP

Monitoring

GHG inventories reported to ANP

Data Assessment to tackle the most relevant sources of emissions

Transparent sustainability indicators made public to society in ANP dynamic panels

Regulate

Reduce methane leakage

Minimize flaring and venting even more

A robust approach in the new development approvals: emissions indicators to be analyzed and discussed

Collaborate

Propose of ESG indicators to be used by the operators in the sustainability reports

Partnerships with other government institutions (like EPE), industry, supply chain, to develop energy integration studies, CCS potential storage capacity and carbon economics analysis

Brazil has also huge and diverse potential for renewables

Brazil is currently among the five most attractive emerging markets for investments in renewable energy. (https://global-climatescope.org/)
Oil majors are also betting on the Brazilian renewables market. We believe they will integrate their portfolio with cleaner energy projects, while capitalizing on synergies and tapping the huge potential in Brazil for renewable energy projects.

Biofuels

Brazil has large experience in producing biofuels and benefits from a longstanding well-established industry. Shell (Raízen) and BP (BP Bunge Bioenergia) are betting high in this market.

Biogas/ Biomethane

Biogas has every condition to achieve greater participation in the Brazilian energy matrix. The sugarcane industry represents a large opportunity for biogas generation. One example is the Raízen Geo Biogas plant.

Hydrogen

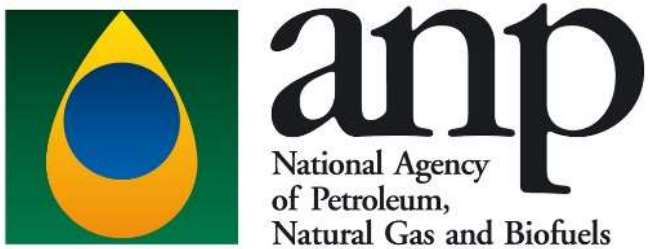
National Hydrogen Program has been established recently. Possible investments in green hydrogen announced so far in Ceará, Pernambuco and RJ States are only from companies in the renewable energy sectors.

Solar

Wind

Solar and Wind energies represent a good proportion of our energy matrix. Total operates three solar plants and is developing new wind projects through its affiliate Total Eren. Also, the first solar plant in Equinor's global portfolio is located at Ceará State (Apodi solar power plant).

Brazil enjoys great potential for offshore wind plants. Brazil's shallow waters alone hold potential for 700GW of offshore wind generation. Equinor plans to install 4GW of offshore wind energy in Rio and Espírito Santo States.



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