PETROBRAS

CLIMATE CHANGE SUPPLEMENT

2022-2023 cycle
Issued in March 2023.
Updated in July 2023.

Message from Senior Management

Letter from the Chairman and Lead Director of the HSE Committee

On the update of the Climate Change Supplement, we reinforce our support and our position in favor of initiatives that decarbonize Petrobras' operations, innovate, make our production processes and our products more sustainable, and that promote solutions based on nature that mitigate climate change, in particular, the preservation and expansion of forests.

We recognize the climate urgency, and for more than a decade, Petrobras has been working on decarbonizing its operations, ensuring a robust trajectory of reducing oil and gas operational emissions. In addition to the improvements achieved over the years, we have already announced the ambition to achieve operational emissions neutrality by 2050.

The ongoing climate change imposes the need for actions aligned with the energy transition that will contribute to the sustainability of our planet and our company. In this sense, we support and guide our executives so that the challenges and opportunities associated with the transition are analyzed and correctly addressed.

In the 2023-2027 Strategic Plan, we decided to focus and move forward on new business analyses. We prioritize the hydrogen, wind, and carbon capture segments. In addition, considering the significant potential of Brazil for highly competitive nature-based solutions carbon credits, we have strengthened our initiatives on forest conservation and incorporated the possible use of offsets as a complementary strategy for decarbonization, focusing on high-quality and high-integrity credits, aligned with international best practices and socioeconomic and environmental co-benefits.

The Climate Change Supplement is part of the dialogue with our stakeholders and demonstrates the resilience of our business and planning, aligned with the objectives of the Paris Agreement and our position in the search for a just and responsible energy transition.

Gileno Gurjão Barreto
Chairman

Marcelo Gasparino da Silva
Lead Director of the HSE Committee

Letter from our CEO and Chief Institutional Relations and Sustainability Officer

Mitigating climate change is one of the significant challenges that humanity urgently needs to face. To achieve that, coordinated and practical efforts by all actors are essential, as the scale and complexity of the energy transition will require time and significant investment.

Scale because secular energy systems must be transformed at their core structure. Current global energy consumption is equivalent to about 100 billion barrels of oil per year, most of which comes from: oil (29%), natural gas (23%), and coal (26%) (IEA, 2022).

Complexity because there are multiple choices for decarbonization routes that reduce emissions equivalently; however, with different economic and social implications. In all scenarios, an increase in society's interest in less carbon-intensity products is expected – and oil and its products are no exception.

Thus, we understand that promoting economic, social, and environmental development is a complex task. Still, Petrobras believes it is possible and is ready to contribute to a safe and just energy transition.

Petrobras' contribution includes (i) investing resources and technologies in the production of **carbon-efficient oil in Brazil**, generating energy and relevant revenues to finance a responsible energy transition; (ii) investing in the capacity to offer **gas and dispatchable energy** to enable a high share of renewables in the Brazilian electricity matrix; (iii) investing and exploring new opportunities in **lower carbon intensity products and businesses**; (iv) promoting research and development of new technologies and low-carbon solutions and (v) investing in **socio-environmental projects for the recovery and conservation of forests**.

Petrobras also advanced in 2022 in commitments related to climate change: we improved the commitment to reduce absolute emissions by 2030, we increased the commitment to reinject CO_2 in CCUS projects, and we improved the methane intensity reduction goal – an action that is reinforced through our support and agreement with the Oil and Gas Methane Partnership (OGMP 2.0) initiative.

With dialogue and planning, permanently seeking actions that contribute to a just transition from an economic, social, and environmental perspective, the goals set in the Paris Agreement can be reached.

Ethics and transparency are some of Petrobras' core values, which are reinforced through the annual release of our Climate Change Supplement, a document that presents the position of Petrobras as a sustainable company committed to a world under decarbonization.

Jean Paul Prates
Chief Executive Officer

Rafael Chaves
Chief Institutional Relations and Sustainability Officer

Executive summary

Our Climate Change Supplement describes how we incorporate the challenges of climate change into our choices and processes following the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), whose compliance can be identified in the Map for TCFD Requirements.

Our actions and results related to carbon management and climate change are based on three fundamental pillars: Carbon quantification and transparency; Resilience of our position in fossil facing the low-carbon transition; Strengthening our skills to create value in a low-carbon economy.

Targets, metrics and performance

Reduction of Operational Emissions: Ambition and Commitments[1]

Our six sustainability commitments focused on mitigating climate change cover 100% of the emissions under our operational control (scope 1 and 2), offering targets for the 2025 and 2030 horizon. In addition, we set our ambition to neutralize emissions in activities under our control by 2050 and influence partners to achieve the same ambition in non-operated assets. In the 2023-2027 Strategic Plan (SP 2023-2027), we revised three of our commitments aiming at more challenging targets.

For more than a decade, we have been working on decarbonization activities and we have a gradual and consistent GHG emission reduction. These are significant gains in carbon efficiency that their cumulative contribution over time must be considered.

Decreasing absolute emissions

Total 2015
78.2
million tCO_2e

2022
47.6
million tCO_2e

39% reduction in total operational emissions since 2015.

Without thermal power plants emissions

2015
57.5
million tCO_2e

2022
44.2
million tCO_2e

Without thermal power plants emissions, about a 23% reduction.

The main factors were the low thermal power dispatch in 2022, divestments, and the implemented initiatives focused on emission efficiency in the operating segments.

Ambitions and Targets
(Baseline -2015)

Reduction of total operational absolute emissions by 30% by 2030
(revised from 25% to 30%)

Ambition:
net zero by 2050

[1] The 2022 emissions performance results presented in this supplement were verified by a third party. All performance results for emissions presented in this supplement are intrinsic, without using offsets.

More efficiency and fewer emissions in Exploration and Production

Emissions per barrel (intensity) have halved since 2009

2022
15.0 $kgCO_2e/boe$

Tupi and Búzios
(pre-salt oil):
51% of our production in 2022 with a performance of 9.4 $kgCO_2e/boe$ and 9.1 $kgCO_2e/boe$, respectively: 1st quartile of industry

Low flaring and high gas utilization: average of 97.3% in 2022

All new projects adopt zero-flare concepts in their routine.

CCUS-EOR
10.6 million tCO_2 reinjected in the year 2022, with an accumulated of 40.8 million tCO_2

> Previous target surpassed in advance

> Largest CCUS project in the world
(in annual injection, as per the Global Status of CCUS 2022 report)

Fewer emissions and more methane efficiency

> Methane emissions intensity in the upstream segment

2015
0.65 tCH_4/thousand tHC

2022
0.25 tCH_4/thousand tHC

Absolute methane emissions

> Reduction of about 67%

2015
150 thousand tCH_4

2022
50 thousand tCH_4

Ambitions and Targets

Achieve GHG emissions intensity in the E&P segment of 15 $kgCO_2e/boe$ until 2025, maintaining 15 $kgCO_2e/boe$ by 2030

Zero routine flaring by 2030*

*As per the World Bank initiative for the E&P segment.

Reinjection of 80 million tCO_2 by 2025 in CCUS projects *(Carbon Capture, Utilization and Storage)*

Revised from 40 to 80 million tCO_2

Consolidation of the 55% reduction in the methane emissions intensity in the segment upstream by 2025, reaching 0.29 t CH_4/thousand tHC

Revised from 40% to 55% (Compared to the 2015 baseline)

More efficiency and fewer emissions in Refining

Absolute GHG emissions from refining have reduced by about 22%, while carbon intensity has reduced by about 12% since 2015

2015
43 $kgCO_2e/CWT$

2022
37.9 $kgCO_2e/CWT$

Ambitions and Targets

Achieve GHG emissions intensity in the Refining segment of 36 $kgCO_2e/CWT$ by 2025 and 30 $kgCO_2e/CWT$ by 2030

Energy: energy security in the low-carbon matrix

Absolute reduced emissions in 2022
4.2 million tCO_2e

> Average intensity of electricity supply 0.329 tCO_2e/MWh

Result affected by low dispatch in thermal power plants during 2022, the lowest in the last 11 years.

Ambitions and Targets

Net Zero ambition by 2050

Lower emission in support logistics

Emissions in offshore operations
vessels and aircraft
reduced by 40% compared to 2015.

Ambitions and Targets

Net Zero ambition by 2050

Net zero Ambition

In addition to our short- and medium-term commitments, our long-term ambition is to neutralize emissions in activities under our control (Scopes 1 and 2) by 2050 and influence partners to achieve the same ambition in non-operated assets.

Transparency in value chain emissions (Scope 3)

We maintain transparency of our indirect emissions – referred to as Scope 3. In addition to the disclosure of emissions in the main category related to the use of our products (category 11), as of 2020, we also disclose category 10, referring to emissions from product processing. The two categories together correspond to almost all of our estimated Scope 3 emissions, and in 2022 they summed 438 million tCO_2e. From 2015 to 2022, Scope 3 emissions accounted for approximately 88% of the total emissions reported for the value chain (Scopes 1, 2 and 3).

We advanced in Life Cycle Assessment studies for oils and refining products to contribute to internal processes, define sustainability strategies, and contribute to the energy transition and a low-carbon economy.

We voluntarily obtained the ISCC Plus and ISCC EU RED certifications for the Diesel R produced at REPAR to certify its sustainable production. We believe that the certification of sustainable products, following international standards related to sustainability, transparency, good management, and environmental and social responsibility, is a consolidated trend for operating in these new markets.

Gold Seal

Our inventory has been published voluntarily since 2002 and verified annually by a third party, representing our pioneering spirit regarding GHG management. We are also founding members of the Brazilian GHG Protocol Program, and we publish our inventory in its Public Emissions Registry. In 2022, our 2021 base year inventory was awarded a Gold Seal for the fifth consecutive year, a standard of excellence in data quality and availability.

Scenarios and resilience

Our Scenarios

The impacts on the global energy supply caused by the conflict in Ukraine brought issues related to security and access to energy to the center of the discussion. The effects of the crisis have multiple repercussions: in the urgency of transforming energy systems to be more secure, reliable, and resilient, according to the mix of natural gas, oil, coal, and electricity, and on food and climate security.

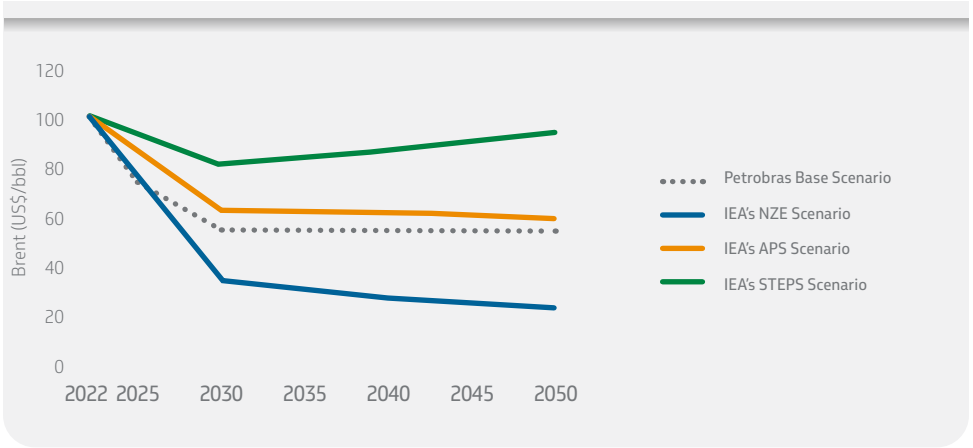
The last Conference of the Parties (COP), held in Egypt, ratified the need to reduce global greenhouse gas (GHG) emissions in all sectors, in line with the specificities of each country and recognizing the need to support a just transition.

The oil and gas industry has an important challenge in minimizing its operational emissions and delivering less carbon-intensive products since energy transition scenarios point to a relevant role for petroleum products in the coming decades. The high energy density maintains the competitiveness of fossil fuels, the possibility of transport and storage, and the already developed infrastructure. An essential aspect of the resilience of products under a low-carbon transition is the viable scale of substitutes.

In our three scenarios, the pace of transition varies, and we estimate persistent, albeit decreasing oil demand. They are based on consolidated trends and critical uncertainties related to economic growth models, environmental policies, technological innovation and behavioral changes.

- The Resilience Scenario considers the accelerated pace of energy transition. It projects the oil price in the long term at US$ 35/bbl, similar to the price forecast in the Net Zero Emissions by 2050 Scenario of the International Energy Agency (IEA) (which presents a 50% probability of limiting the temperature increase to 1.5°C, in line with the ambition of the Paris Agreement).

- The Base Scenario considers an oil price range between US$ 85/bbl in 2023 and US$ 55/bbl from 2030, that is, price expectations similar to the APS scenario of the International Energy Agency (which is aligned to a 50% probability of keeping it under 1.7 °C).
- The Growth Scenario presents a gradual pace of transition, reflecting the technological and policy coordination challenges. Higher prices can be sustained, converging to US$75/bbl in the long term.



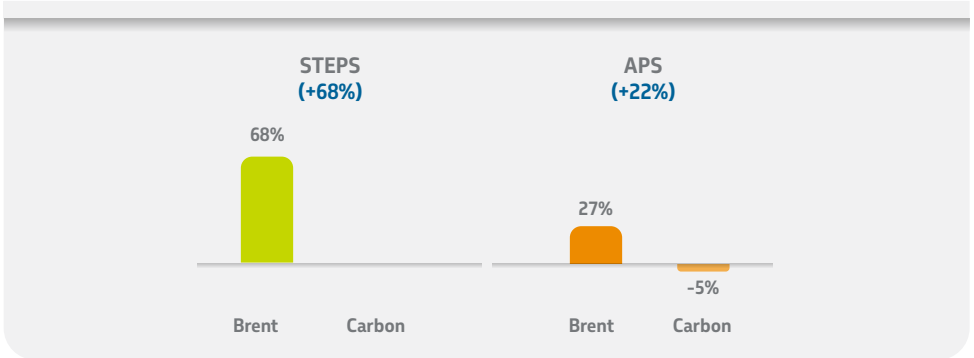
Our governance requires that all investments generate value in all three scenarios, and the portfolio optimization is based on the Base Scenario. Using conservative price assumptions focuses investments on resilient assets to a low-carbon energy transition.

Resilience

The 2022 edition of the International Energy Agency's World Energy Outlook (WEO) brought updates on the current outlook and long-term scenarios for global energy markets, indicating how the energy system can respond to and evolve to the current global crisis.

To test the resiliency of our premises, we performed simulations using the scenarios from International Energy Agency to assess the impact on our portfolio value, following TCFD recommendations.

We carried out simulations of the net present value of our portfolio in the Base scenario, evaluating its sensitivity to the Brent price and the carbon price of the IEA's external scenarios, used as a reference (STEPS – Stated Policies Scenario, APS – Announced Pledges Scenario and NZE – Net Zero Emissions by 2050 Scenario):



Note: Considers the impact of the price of Brent only in the E&P segment. Carbon price effect before taxes.
The STEPS scenario considers carbon prices only for already regulated markets, without defining this price for Brazil and, consequently, without impacting the portfolio value for this variable.

Using the assumptions of the STEPS external scenario, which reflects existing policies and has higher oil prices, there would be an increase in portfolio value relative to the value calculated with the assumptions of our Base scenario (68%).

Compared with the APS external scenario, which already considers carbon taxation for countries not yet regulated, such as Brazil, and the balance with higher oil prices, there would be a positive impact (22%) on the portfolio value calculated with the internal assumptions.

Comparison with the NZE scenario, which models significant changes in the energy demand profile, showed an 68% negative impact on the net present value of the portfolio compared to our Base scenario, but a smaller negative impact (39%) compared to the Resilience scenario, due to the combined effect of the difference between the Brent price curves and the premises regarding a carbon price.

We emphasize that, despite the long-term oil price in our Resilience scenario having a similar trajectory to that of the NZE scenario, our forecast for oil demand is higher (57 million barrels of oil/day against 23 million barrels of oil/day, in 2050).

There are many uncertainties about the shape and dynamics of a future carbon market in Brazil, and there is not enough reliable information about the future intentions of regulators to allow us to consider the impact of the carbon price on the valuation of our portfolio for the purposes of accounting estimates. However, we use carbon price curves associated with internal scenarios in portfolio risk analysis, in sensitivity analysis of investment projects and to assess the possibility of using the Decarbonization Fund.

We monitor external O&G supply and demand analysis and develop studies to minimize our portfolio risks. Recent results published in WEO 2022 indicate that new projects in ultra-deepwater in Brazil play an important role in meeting energy demand. They project a 45% increase in the country's production by 2030 compared to 2021, in the APS scenario (aligned with the Paris Agreement), indicating the area's competitiveness is reflected in low costs and high production efficiency.

As a complementary analysis to assess the alignment of projects with the goals of the Paris Agreement, data from the IEA and S&P Global were used. Using the least cost methodology (LCM), potential oil and gas supply was compared to projected demand, and projects were ranked according to their costs. The analysis showed that according to the IEA's APS scenario, our sanctioned but not-yet-completed and unsanctioned projects align with a projected demand retraction in 2030. According to S&P Global data, our projects have a breakeven average below US$ 40 per barrel and are considered resilient. The methodology for calculating the breakeven of S&P Global includes the costs of exploration, development, and operation of the field, in a prospective view (*point forward*), but does not include decommissioning costs or residual values. The breakeven value calculated internally by Petrobras is lower than the value estimated by the S&P methodology.

Strategies and portfolio

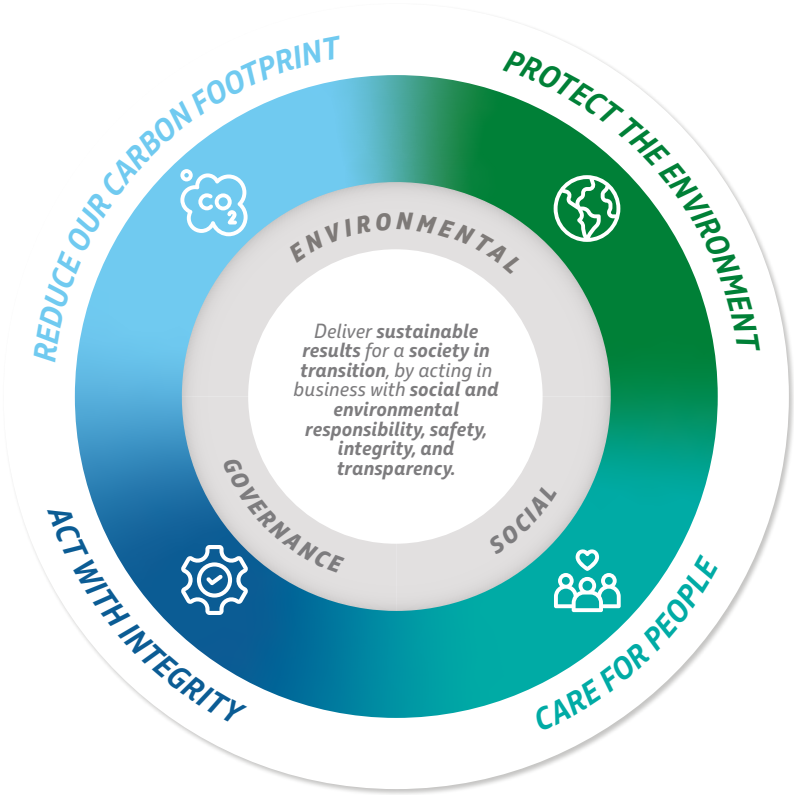
Our Strategies

Our vision is to be the best energy company in generating value, focusing on oil and gas, sustainability, safety, respect for people and the environment. We contribute to reliable and efficient energy generation for an environmentally sustainable world. Our strategic model seeks double resilience: economic, resilient to low price scenarios, and environmental, with high emission efficiency. Also, we maintain our purpose of "Providing Energy that ensures prosperity in an ethical, safe and competitive way". Along these lines, our strategies aim to contribute to a prosperous and sustainable future effectively:

ESG Strategy

"Deliver sustainable results for a society in transition, by acting in business with social and environmental responsibility, safety, integrity and transparency."

SP 2023-2027 integrated the ESG (Environmental, Social and Governance) elements into a single vision, highlighting four main ideas:



E&P Strategy

- **Maximize portfolio value, focusing on deep and ultra-deepwater assets.**

RTM Strategy

- **Withdraw completely from fertilizers and biodiesel businesses participation.**
- **Operate with assets focused on proximity of the oil supply and the consumer market, adding value to the refining park with more efficient processes and new products, moving towards a low-carbon market.**
- **Act competitively in the oil and oil product trade, maximizing value captured through integration and the safe and efficient operation of the upstream and downstream logistics chain.**

G&P Strategy

- **Operate competitively in trading own natural gas, completely withdrawing from gas distribution and transportation.**
- **Optimize the thermoelectric portfolio focusing on self-consumption and trading of own natural gas.**

Innovation Strategy

- **Innovate to generate value in business, today and in the future, and achieve the goals in decarbonization.**

Portfolio

E&P investments seek double resilience for project sustainability. The cost of production is an important element of resilience in all scenarios, particularly in an accelerated transition to a low-carbon economy. Then, our perspective is to operate with average E&P extraction costs of US$ 5.5/boe, being as low as US$ 4.2/boe in the case of pre-salt production, which will represent around 80% of the company's total at the end of the five-year period. Our projects show positive economic results with a Brent of US$ 35/bbl in the long term.

In the refining, transportation, and commercialization segment, we seek portfolio management and regional synergy with exploration and production assets and with the main Brazilian markets. We strive for resilience through operational excellence in energy efficiency, emissions, and reliability, anchored by the RefTOP Program and AVANÇA LOG, aiming to be among the best refiners in the world regarding efficiency and operational performance.

In the G&P segment, we seek to adapt to the high share of renewables in the Brazilian energy matrix. Considering the intermittency of modern (wind and solar) sources and the seasonality of hydropower, dispatchable Thermal Power Plants are necessary to provide energy security to the growing incorporation of renewable sources. In this sense, we continue focusing on selling gas from our portfolio and optimizing our thermal power plants portfolio, seeking efficiency gains in the thermal power.

Brazilian context and voluntary contributions to Brazil's decarbonization journey

Brazil is committed to reducing greenhouse gas emissions by 37% in 2025 and 50% in 2030, compared to the 2005 baseline, and achieving emissions neutrality by 2050. The country also committed to eliminating illegal deforestation by 2028 and has signed the *Global Methane Pledge*.

Brazil has a unique emissions profile globally, with most of its emissions arising from land use change (38%) and the second least carbon-intensive energy matrix of the G20. Reducing deforestation and encouraging reforestation and restoration are essential to the country's decarbonization trajectory. Additionally, the energy sector must continue to contribute to minimizing climate change, maintaining or increasing the contribution of renewable sources, and improving the efficiency of fossil fuels through investments and actions that reduce and offset their emissions, taking social and economic aspects into account.

The transport sector is responsible for 33% of final energy consumption in Brazil, which is influenced by several factors, such as *per capita GDP*, availability and efficiency of logistics infrastructure, environmental policies, and people's behavior. Our road infrastructure results in one of the most fuel-intensive economies net, around 0.31 boe/thousand US$GDP, equivalent to twice the world average. Therefore, the economy is susceptible to its cost. In this sense, opportunities to increase the efficiency of the logistics and transport infrastructure play a relevant role in decarbonization since they may lead to lower primary demand for energy and lower cost for the same energy service.

However, a significant change in the transport matrix requires high investments and takes time. Using existing technologies and infrastructure, biofuels play a relevant role in the carbon intensity of the Brazilian transport sector. Brazil is the only country in which the use of biofuels exceeds 10% of the energy demand in the transport sector, reaching approximately a 23% share in this sector, higher levels than those presented in the IEA's NZE scenario for 2030 in the world transport sector. This high share is linked to incentive policies, such as the RenovaBio, Combustível do Futuro (Fuel of the Future), and Rota 2030 Programs.

In 2022, renewable energy sources were responsible for around 92% of the electricity supply to the SIN (National Interconnected System). According to International Renewable Energy Agency (IRENA), a reduction in GHG emissions consistent with the 1.5°C target requires the participation of around 90% of renewable energy in the world's electricity matrix in 2050 (IRENA, 2022).

We believe compliance with Brazilian commitments must consider a just and inclusive energy transition process. Success in controlling emissions from land use change, identifying, and developing decarbonization options at the lowest cost to society, and ensuring access to energy (fundamental for competitiveness and social well-being) will be competitive edges for companies and nations, involving risks and opportunities.

Voluntary Social and Environmental Investment with Impacts on Climate Change

We support projects focused on the restoration or conservation of forests and natural areas of the Atlantic Forest, Amazon, *Caatinga* and *Cerrado*, contributing to the mitigation of greenhouse gas emissions due to deforestation in Brazil and collaborating for Sustainable Development Goals 13 (Climate Action) and 15 (Life on Land).

Our current portfolio, in 2022, had an area of influence in more than 27.8 million hectares of native ecosystems. The net incremental benefit (net removal and avoided emissions) estimated from the efforts conducted from 2013 to date by these projects is around 2.3 million tCO_2e, with gains also for biodiversity, water, and social and economic development. Our initiatives involve net removal through vegetation recovery activity and productive reconversion and also avoided emissions through measures that prevent deforestation and forest degradation.

Just Transition

Just transition discussions have been historically marked by the mention in the Paris Agreement (2015) that the countries' commitments should consider the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities. During COP 27, the need for a just energy transition was reinforced based on development priorities defined at the national level and aligned with the increase in renewable energy generation or with lower GHG emissions.

In this sense, we recognize the relevance of the search for a just transition, and we are attentive and active to evolve in this theme to incorporate its elements in our business management increasingly. SP 2023-2027 highlights areas of action that contribute to the security of the energy supply and include short-term strategies for reducing emissions and producing fuels with lower carbon intensity. Social participation is carried out continuously and systematically, per Petrobras' Health, Safety and Environment (HSE) policy, through two guidelines for community relations and communication. The assessment of social-environmental and climate risks is required during the gate approval process of investment projects and involves the characterization of the social context, and assessment of social and climate risks.

Governance, incentives and risk management

Governance at all levels

Our governance on climate change and energy transition risk management is structured to address these issues at all company levels. We count on the active oversight of the Board of Directors' Health, Safety and Environment (HSE) committee, on an executive committee that advises the Executive Board, and on committees at the tactical level in all segments. The integration of the theme between the different levels is carried out by the Executive Management of Climate Change, which is dedicated to emissions, climate and energy performance, and reports to the Institutional Relations and Sustainability Department.

Robust incentives

The top metrics provide more explicit guidance on the company's key short-term targets. In SP 2023-2027, three metrics linked to variable remuneration were maintained, two environmental and one financial:

> Compliance with greenhouse gas targets index (IAGEE),
> Volume of oil and oil products spilled (VAZO) and
> Economic Value Added (Delta EVA®).

The variable compensation of each employee and executive is calculated based on individual goals and on the percentage of achievement of these top three metrics. We reinforced the incentives and, in 2023, the percentage of compliance with the GHG targets index affects between 7% and 20% of the variable compensation amount (decreasing percentage from the CEO to employees without a managing role). Executive officers related to the E&P and Refining segments have an additional impact relative to the emissions in their respective segments.

Integrated and quantified risk management

Petrobras has a history of managing and quantifying climate-change related risks. Our risk management process is integrated, which allows for the standardization of the analysis and the effective management of all identified risks. The set of climate change and energy transition related risks was assessed with a very high degree of severity, being monitored by senior management. Regarding the theme, Transition Risks and Physical Risks of Climate Change were identified, and are monitored and reviewed annually: Market Risk, Technological Risk, Regulatory Risk, Legal and Reputational Risk, and Physical Risks, such as water scarcity for onshore assets and meteoceanographic changes for offshore assets.

We highlight our quantification of the risk of carbon pricing on the portfolio value, considering the possibility of implementing a carbon market in Brazil. The simulations considered the gradual implementation of the instrument and ranges of values that vary over time from US$ 0/tCO_2 up to US$ 130/tCO_2 depending on the scenario. Currently, more than 97% of our operational emissions occur in Brazil, so our analysis consider country-specific perspectives. We also highlight the advances in our studies to improve the predictability of physical climate changes.

We also see opportunities in new businesses, such as biorefining, which uses our skills in refining technologies and operations. Additionally, we identify the development of an opportunity to place pre-salt oil streams, produced with lower GHG intensity, in markets that value products with this characteristic.

In 2022, we contracted a new line of credit associated with corporate sustainability goals (*Sustainability-Linked Loan*) in the amount of US$ 1.25 billion and maturity in July 2027. This operation was signed with three banks, expands our liability management strategy by diversifying financing models and reinforces our commitment to decarbonizing operations.

Investments and initiatives

Ensuring proper quantification of carbon-related risks and opportunities is one of our top priorities, and transparency is critical to enabling our stakeholders to understand the motivations behind our decisions. SP 2023-2027 reinforced our commitment to advance the decarbonization of our operations while seeking to capture new business opportunities and deepen studies to diversify our portfolio.

Our low-carbon investment forecast has increased in this strategic plan, providing US$ 4.4 billion for the decarbonization of operations, production and supply of bioproducts (renewable diesel and sustainable aviation kerosene), and low-carbon research and development.

It's a big challenge for Petrobras to achieve its ambition of operational emissions neutrality and meet society's ambition. To overcome this challenge, innovation remains a crucial pillar to accelerate the development of technological solutions and create opportunities for the future.

GHG mitigation strategy and integrated management

We are constantly identifying GHG mitigation opportunities to support our sustainability commitments and the ambition of neutrality of operational emissions. Since 2021, we have used the Marginal Abatement Cost Curve (MACC) methodology to assess and compare different mitigation opportunities across all segments we operate. The MACC allows us to classify options based on the relationship between the cost of implementation and the potential for greenhouse gas abatement. Our integrated MACC includes over 500 mitigation opportunities, classified into five categories: efficiency, energy, losses, process, and CO_2 removal.

We structured the Carbon Neutral Program to strengthen our current low-carbon position with an integrated corporate vision of all our initiatives. The Program has a fund dedicated to decarbonization projects, the Decarbonization Fund, with a budget of US$ 600 million for the five-year period (2023-2027). In 2022, through specific governance, the first portfolio of projects under the Decarbonization Fund was approved, covering initiatives in the E&P, Refining, G&P and Logistics operations.

Seeking operational excellence to reduce greenhouse gas emissions, we continually improve and update project development requirements. Specific programs focus on increasing operational efficiencies, such as EF100, FPSOzero, RefTOP, *Avança Log*, projects in G&P and for maritime transport and offshore logistical support, aiming to contribute to reducing GHG emissions in different segments.

Low-Carbon Products and Businesses

We are attentive to opportunities that contribute to long-term sustainability, diversifying our portfolio of products and businesses. We have developed a new generation of products in line with our focus on acting as a protagonist in the supply of low-carbon products, focusing on the *BioRefining* Program.

Throughout 2022, we analyzed diversification opportunities that also reduce the carbon footprints of our products and businesses. We developed studies and metrics that allow comparing different types of projects and opportunities in the energy and non-energy markets. We plan to deepen these studies in new initiatives analysis. In 2022, three segments were selected for potential portfolio diversification, for which we will advance in internal studies: Offshore Wind Energy, Hydrogen and Carbon Capture.

Emissions compensation strategy and support for the regulated carbon market

We believe in carbon markets as an important instrument for fighting climate change. We are engaged in conversations regarding implementing a regulated carbon market in Brazil and supporting the country's carbon market development.

We have included offsets in our strategy as a possibility for achieving even more ambitious results than those possible with the intrinsic decarbonization of our operations while at the same time contributing to the preservation of Brazilian ecosystems. Potential compensations will be complementary, and not substitutive, of intrinsic mitigation efforts. We seek to invest in high-quality carbon credits to bring climate, socioeconomic and environmental benefits. We are committed to transparency and traceability in disclosing the origin and use of credits.

Transparency and engagement

Transparency as a Value

We value transparency in our stakeholder engagement, guided by our social responsibility and HSE policies, our Code of Ethical Conduct, and our Ethical Conduct Guide for Suppliers. We systematically monitor and adhere to world-class climate reporting codes such as the Global Reporting Initiative (GRI Standards), the DJSI requirements (Dow Jones Sustainability Index), CDP and TCFD (Task Force on Climate-related Financial Disclosures), as well as our industry guidelines and the reporting and transparency parameters agreed upon in the OGCI (Oil and Gas Climate Initiative).

Global Recognition

We are part of the list of global companies that stand out in climate change mitigation actions, as announced by the international organization CDP, formerly known as the *Carbon Disclosure Project*. We have voluntarily responded to the questionnaire since 2004, and in 2022 we received an **A⁻** rating by CDP in recognition of good practices demonstrated in 2021. For the second consecutive year, we qualified to be part of the Dow Jones Sustainability Index World (DJSI World) from the S&P Global's Corporate Sustainability *Assessment*, one of the most important sustainability indexes in the world, which assesses the best social, environmental, and economic management practices. For the sixth consecutive year, we were part of the B3 Carbon Efficient Index (ICO2 B3), an indicator that anticipates the vision of how Brazilian companies prepare for a low-carbon economy.

Cooperation and Dissemination of Knowledge and Best Practices

We actively participate in several initiatives and forums that seek coordinated and collaborative actions on climate change, involving the oil and gas sector internationally and locally, and other segments of the industry and the business sector. In this sense, we are active members of the IBP, IPIECA, IOGP, and ARPEL. Since 2018, we have integrated the Oil and Gas Climate Initiative (OGCI), which brings together twelve of the world's largest oil and gas companies, responsible for more than 30% of the world's O&G production. We also seek to cooperate internationally, with the exchange of information and the search for solutions, working together with reference institutions for the promotion of sustainable development.

Workforce Engagement

We develop actions to extend knowledge and opportunities for personal and professional development to employees on Climate Change. In 2022, we launched two Distance Education modules on Climate Change Mitigation, which address the concept of climate change, its consequences, the actions of the energy industry and the industry's commitments to reduce and neutralize GHG emissions. By the end of 2022, around 70,000 people had completed the two modules, with the participation of 95% of our employees.

Supplier Engagement

We have developed several initiatives to deploy our sustainability commitments to the goods and services supplier market. We improved our communication channels with the market and offered a direct channel for suppliers to present sustainable technological ideas and solutions. We hold monthly live meetings with suppliers to share information and discuss related topics. We annually award the "Best Suppliers" that stand out in performance and sustainable practices. The "ESG Journey for Suppliers" was launched to promote supplier engagement on sustainability issues. The "Carbon Neutral Program" includes the supply chain and encourages the reduction of greenhouse gas emissions. Also, Petrobras is mapping supply chain emissions through an initiative with the CDP Supply Chain to identify areas of opportunity for reducing emissions. In 2022 we were recognized as a leading company in supplier engagement by the international organization CDP. The **A⁻** rating, related to the 2022 cycle, was achieved in the Supplier Engagement Rating – SER.

Targets, metrics and performance

Pillars of carbon management and climate change

Given our scenarios and strategy, our actions related to carbon management and climate change are based on three pillars:

1.
Carbon quantification and transparency

2.
Resilience of our position in fossil facing the low-carbon transition

3.
Strengthening our skills to create value in a low-carbon economy

Carbon quantification and transparency

Our decisions today affect carbon performance and value generation in the short, medium, and long term. We strive to ensure that the risks and opportunities of climate change are adequately captured in our scenarios, quantified, and considered in our choices. Our goal is to promote sustainability and resilience in our business, which entails ongoing efforts to improve continuously our decision-making processes. We embrace carbon transparency and highlight our support for the TCFD (Task Force on Climate-related Financial Disclosures) and the adoption of external references of disclosure and performance like the Sustainability Accounting Standards Board (SASB), IPIECA, Global Reporting Initiative (GRI) and International Association of Oil & Gas Producers (IOGP).

Resilience of our position in fossil facing the low-carbon transition

The Oil and Gas industry supplies more than half of the primary energy consumed worldwide, meeting the needs of mobility, industrial production, residential cooking and heating, and electricity generation. Our scenarios indicate that oil and gas will remain in the world's energy matrix over the next few decades, albeit in decreasing volumes. In 2021, the sector's share exceeded 55% of the total supply of primary energy (bp Statistical Review of World Energy, 2022), and products meet this demand with widely varying carbon performance.

Our priority is to operate at low costs and with superior emissions performance, safeguarding the competitiveness of our oil in world markets in a scenario of slowdown and subsequent contraction in demand. In our understanding, companies will become more competitive in the long-term market the more they can produce at low costs and with lower greenhouse gas (GHG) emissions, thriving in scenarios of low oil prices, carbon pricing, and possible oil differentiation practices based on the GHG emissions intensity in production.

Strengthening our skills to create value in a low-carbon economy

We recognize that the goals of the Paris Agreement require profound reductions in greenhouse gas emissions and the transformation of the energy supply. Our scenarios point to an unequivocal energy transition, albeit at an uncertain pace. The risks and opportunities are different and depend on the markets, each company's characteristics, innovation evolution, and public policies.

To strengthen our low-carbon position, we prioritize investment in decarbonizing our operations, developing products with lower carbon intensity and skills for the future. We are advancing in the analysis of possible new businesses that can diversify revenues and reduce exposure to carbon, ensuring the company's sustainability in the long term.

Emissions Management[1]

As an integrated energy company operating in the O&G and electricity markets, we monitor the absolute emissions and carbon intensity of our activities and the value chain of our products:

O&G
Supply of crude oil, oil products, and gas.

Power
Power supply, mainly by gas thermoelectricity.

We hold relevant oil and gas reserves, and our scenarios indicate that there will be a persistent world demand for oil in the coming decades, albeit decreasing. Accordingly, our priority is to continue supplying oil and gas in a competitive, environmentally responsible, and highly emission-efficient manner. Operational performance in terms of greenhouse gas (GHG) emissions is one of the strategic requirements for the company's long-term resilience.

Among our actions, we have developed a set of metrics to manage emissions and monitor targets related to gas flaring and energy efficiency. We have maintained teams dedicated to emissions and climate change for over 20 years and inventory all assets under operational control. We have proprietary software for managing the emissions inventory with about 10,000 sources fed monthly – SIGEA® (Sistema de Gestão de Emissões Atmosféricas da Petrobras - Petrobras Atmospheric Emissions Management System). Our inventory has been published voluntarily since 2002 and verified annually by a third party, representing our pioneering spirit regarding GHG management. We are also founding members of the Brazilian GHG Protocol Program and we publish our inventory in its Public Emissions Registry. In 2022, our 2021 base year inventory was awarded a Gold Seal for the fifth consecutive year, a standard of excellence in data quality and availability.

In an inventory, in addition to quantifying the emissions from the emission sources of our own operations, it is also necessary to consider the indirect emissions, that is, those that occur throughout the entire chain, from the production of supplies to the use of the product. This way, we can estimate the total impact of a particular activity.

Therefore, the GHG Protocol created a globally harmonized methodology based on carbon scopes:

SCOPE 1

Direct GHG emissions that occur as a result of the company's own operations at sources that are owned or controlled by the company.

SCOPE 2

Referring to emissions from the acquisition of electrical and thermal energy consumed by the company. These are indirect emissions, as they occur at third-party sources.

SCOPE 3

Referring to other indirect emissions, that is, those that occur in sources not owned or controlled by the company, but those exist as a result of its activities.

[1] The 2022 emissions performance results presented in this supplement were verified by a third party. All performance results for emissions presented in this supplement are intrinsic, without using offsets.

Our climate commitments

Since 2011, we have committed to voluntary targets for reducing the greenhouse gas emissions intensity and improving the energy use of our processes. In 2019, our targets aimed at decarbonization began to have the base year of 2015, the year of the creation of the Paris Agreement. At each Strategic Plan cycle, our commitments are reassessed. Of our six public commitments related to the carbon theme, three were updated in the 2023-2027 Strategic Plan:

Reduction of total operational absolute emissions by

30%

by 2030, em compared to 2015

Zero

routine flaring by 2030

Reinjection of

80

million tCO_2 by 2025 in CCUS projects (Carbon Capture, Utilization and Storage)

Greenhouse Gas (GHG) emissions intensity in the E&P segment: Achieve portfolio intensity of

15

$kgCO_2e$/boe until 2025, maintaining 15 $kgCO_2e$/boe by 2030

GHG emissions intensity in the Refining segment: Achieve an intensity of

36

$kgCO_2e$/CWT by 2025 and 30 $kgCO_2e$/CWT by 2030

Consolidation of the

55%

reduction in the methane emissions intensity in the upstream segment by 2025, reaching 0.29 t CH_4/thousand tHC, compared to 2015

For all targets, direct operational greenhouse gas emissions (Scope 1) and indirect emissions from the acquisition of electrical and/or thermal energy produced by third parties (Scope 2) are considered.

Regarding absolute emissions, Petrobras' commitment aims at a condition of maintaining the level of emissions in 2030 in relation to 2022 when considering in this year's projection the emissions related to the average thermoelectric dispatch of the last five years. Petrobras' commitment is not to exceed 54.8 million tons of CO_2 in 2030, unless there is a great demand for electricity generation from thermal plants due to national water stress events. Achieving the commitment considers the possibility of using carbon credits, as a complementary strategy and depends on the initiatives to improve the efficiency of our operations and divestments planned in SP 2023-2027.

The "Zero Routine Flaring by 2030" initiative of the World Bank aims to eliminate routine flaring, that is, result from the impossibility of disposing, using or reinjecting the gas produced in the E&P segment. Its scope does not include non-routine flaring, such as during startups, malfunction, maintenance of assets or flaring for emergency reasons. The $kgCO_2e$/boe indicator considers in its denominator the gross production of oil and gas ("*wellhead*").

The $kgCO_2e$/CWT indicator uses the CWT (Complexity Weighted Tone) methodology, developed by Solomon Associates and CONCAWE (Conservation of Clean Air and Water in Europe – the association of European oil and gas refining and distribution companies) specifically for the European oil refining industry and adopted by the European Union Emissions Trading System (EU ETS) in setting the sector's GHG reduction targets. The CWT of a refinery considers a load equivalent to distillation with respect to the GHG emission potential, given the different process units and their respective loads processed in a refinery. Thus, it is possible to compare emissions from refineries of different sizes and complexities.

The value indicated for the re-injection commitment is the cumulative total since 2008.

The commitments linked to carbon intensity in our E&P and Refining operations are top metrics and, therefore, influence the variable compensation of all the company's employees.

>> See chapter **Governance, Incentives and Risk Management**

In addition to our short- and medium-term commitments, our long-term ambition is to neutralize emissions in activities under our control (Scopes 1 and 2) by 2050 and influence partners to achieve the same ambition in non-operated assets. Our commitments involve both working on existing assets and designing new projects.

Note: Our ambition refers to emissions in Brazilian territory, where more than 97% of our operational emissions occur. For other issues, we aim to achieve neutrality within a period compatible with the Paris Agreement, in line with local commitments and international organizations.

Advances in Our Climate Commitments

Reduction of absolute emissions by 30% by 2030

The review of the absolute operational emissions commitment (from 25% to 30%, in the 2015 base year) demonstrates our efforts to move forward with the decarbonization of our operations. This movement is supported by the Carbon Neutral Program and by the budget expansion foreseen for the Decarbonization Fund.

>> See chapter **Investments and Initiatives**

Reinjection of 80 million tCO_2 by 2025 in CCUS projects

Our previous commitment pointed to the reinjection of 40 million tCO_2 by 2025 in CCUS-EOR projects (Carbon Capture, Utilization and Storage, associated with EOR – Enhanced Oil Recovery). We have the largest offshore CO_2 reinjection program in the world, in the pre-salt fields (Global Status of CCUS 2022), concerning the annual reinjection capacity – we managed to reach this level of reinjection still in 2022. Thus, we have increased our commitment, doubling the accumulated value of reinjections until 2025: 80 million tCO_2.

Consolidation of the 55% reduction in the upstream methane emissions intensity by 2050

The revision of the methane emissions intensity target (40% to 55%, in the 2015 base year) demonstrates our commitment to reducing GHGs and increasing methane efficiency. This movement aligns with several initiatives we participate in the industry, such as the near-zero methane ambition, the OGCI global flaring monitoring panel and the Zero Routine Flaring initiative of the World Bank.

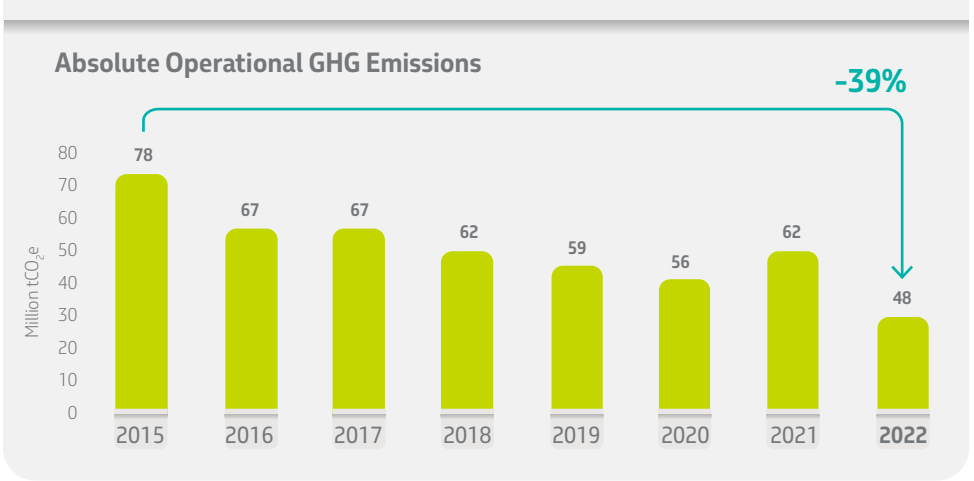
We also joined the Oil and Gas Methane Partnership (OGMP 2.0) to reinforce methane management.

Absolute Operational GHG Emissions

Our emission reduction target encompasses 100% of the assets operated in all our businesses, including power generation, for all greenhouse gases, making it a material, relevant, short, and medium-term contribution to tackling climate change. Our GHG emissions intensity targets (E&P and Refining) represented a coverage of 82% of the emissions from the activities we operated in 2022.

Between 2015 and 2022, our absolute operational emissions dropped by 39%. In 2022, emissions summed 47.6 million tCO_2e. It is important to highlight that the GHG emitted in 2021 was strongly affected by the high demand for energy dispatch in our thermoelectric plants, requested by the National Electrical System Operator (ONS) to guarantee the electricity supply in a year of water crisis. In 2022, due to the increase in the hydroelectric reservoirs' water level, the ONS reduced the demand for thermoelectric generation. The low thermoelectric dispatch in 2022, the lowest in the last 11 years, significantly affected our result. The actions implemented for efficiency gains and reducing losses in the operating segments and the divestments completed at the end of 2021 and throughout 2022, were also vectors for lower GHG emissions.

We opted to neutralize our Scope 2 emissions in Brazil in 2022 (156.3 thousand tCO_2) through the purchase of Renewable Energy Certificates (I-REC). Our Scope 2 emissions abroad totaled 157 tCO_2, representing only 0.0003% of our absolute operational emissions in 2022. If not offset, our Scope 2 emissions would represent 0.3% of our operational emissions in 2022.



We seek the neutrality of Scope 2 emissions via the Decarbonization Fund.

To carry out our industrial and administrative activities, we use electricity purchased from third parties in the free contracting environment or directly from local electricity distributors.

According to the Brazilian GHG Protocol Program guidelines, we must report our Scope 2 emissions obligatorily following the location-based approach, in which the average emissions for electricity generation for the National Interconnected System (SIN) are used as an emission factor.

In 2022, we decided to pursue neutrality of these emissions in order also to report using the market-based approach, which allows us to report our Scope 2 emissions according to our purchased electricity portfolio, not varying based on the carbon intensity of the national grid.

In this regard, we acquired Renewable Energy Certificates (I-REC) which guarantee that 100% of the electricity purchased for use in our industrial and administrative operations in Brazil is generated from renewable sources. Thus, we neutralized our Scope 2 emissions in Brazil in 2022 (156.3 thousand tCO_2, equivalent to 3.66 million MWh of purchased renewable electricity).

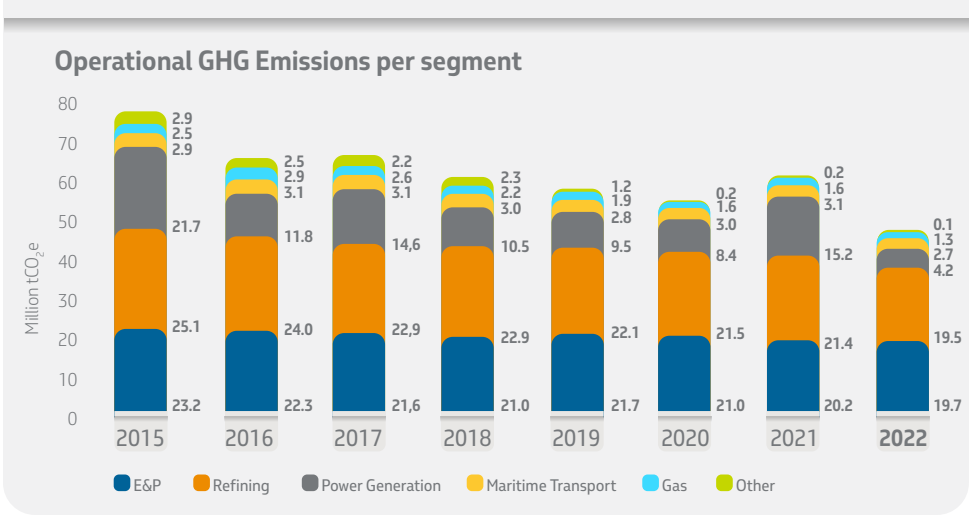
This initiative reinforces our carbon sustainability commitments, stimulating and contributing to Brazil's mostly renewable electricity matrix.

Our target for a 30% reduction in absolute operational emissions by 2030, compared to 2015, considers a stable trajectory for our operational emissions, already contemplating the expected increase in production for the period. It is supported by a set of systemic actions to be implemented in the coming years and depends on the execution of the divestment portfolio. It considers the possibility of compensation with carbon credits as a complementary strategy.

>> See chapter **Investments and Initiatives**

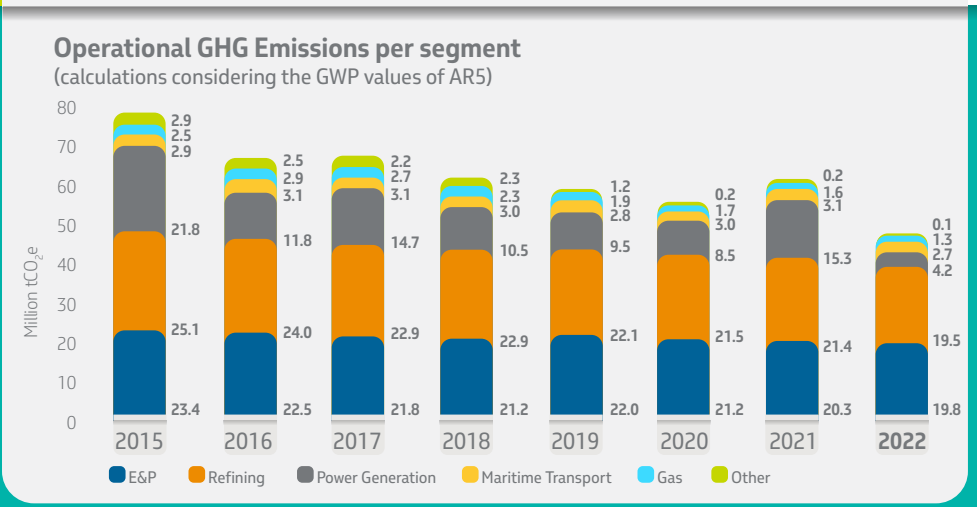
Emissions per business segment

The quantification of our absolute operational emissions considers not only the activities of exploration, production and refining of oil and power generation. We include in our inventory emissions from all our operating activities, such as maritime transport and logistical support activities, gas processing and transport, biofuel production, and administrative activities, among others. In our governance, we monitor absolute operational emissions per business segment.



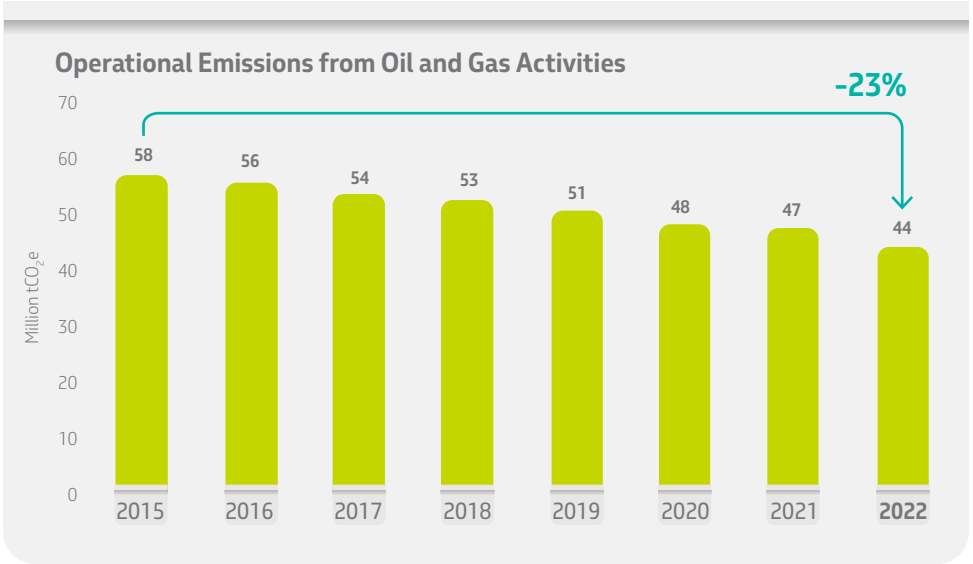
Note:
Maritime Transport: own cabotage and long-haul vessels or time-chartered vessels
Gas: includes natural gas processing and treatment units, LNG terminals and natural gas transportation activities
Others: include administrative and operational activities not previously described, including *Petrobras Biocombustíveis*; the fertilizers sector (until 2020); *Liquigás* (until 2019); *BR Distribuidora* (until 2018).

Our climate commitments set since 2019 were based on tons of CO_2 equivalent data considering the Global Warming Potential (GWP) values contained in the Fourth Assessment Report of the IPCC – Intergovernmental Panel on Climate Change (known as AR4). Thus, all performance data on GHG emissions presented in this Supplement must follow the same premise. For information and comparison purposes, we also present our operational emissions per segment in tons of CO_2 equivalent calculated considering the GWP values in the Fifth Assessment Report of the IPCC (AR5).



Operational Emissions from Oil and Gas Activities

We also monitor operational emissions from only our oil and gas activities, whose calculation of operational emissions does not include emissions arising from our activities in the thermoelectricity market. Thus, we can verify the results of our efforts to reduce absolute emissions without the influence of the thermoelectric dispatch requested by the ONS.



Note: The historical figures of absolute emissions attributed to O&G activities were revised to incorporate Scope 2 emissions from the production of steam that our thermal power plants exported to our other operating units. In our global inventory of emissions, which includes all our activities, emissions from these thermoelectric plants are already accounted for in our Scope 1 and are not reported as Scope 2, ensuring that there is no double counting.
Total operational emissions (Scopes 1 and 2) from our O&G activities have shown a continuous downward trend over recent years, reaching a 23% reduction between 2015 and 2022.

E&P GHG Emissions Intensity

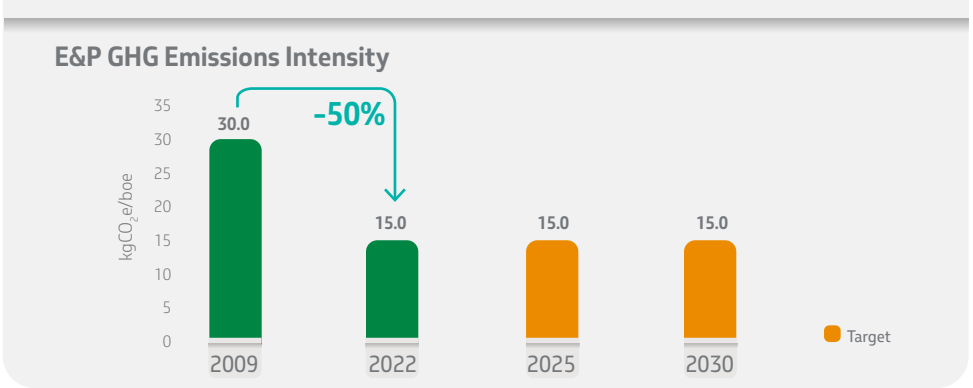
We monitor our GHG emissions intensity performance in the oil and gas production segment, with outstanding results in the pre-salt fields.

Our commitment is to continue improving the carbon efficiency of our E&P activities, with the target of reaching 15 $kgCO_2e$/boe in 2025, maintained until 2030.

In oil and gas projects, it is natural for the fields to mature over time, with a progressive increase in water production and energy demand, as well as a drop in the oil production rate. Therefore, in order to increase its production levels, it becomes necessary to employ energy-intensive techniques, such as water and/or gas injection, and this affects GHG emissions intensity.

This natural trend towards increased portfolio intensity poses an additional challenge to the upstream segment's carbon performance. The greater the intention to reduce emissions intensity across the entire E&P portfolio, the more challenging it will be to offset the GHG emissions intensity of mature fields.

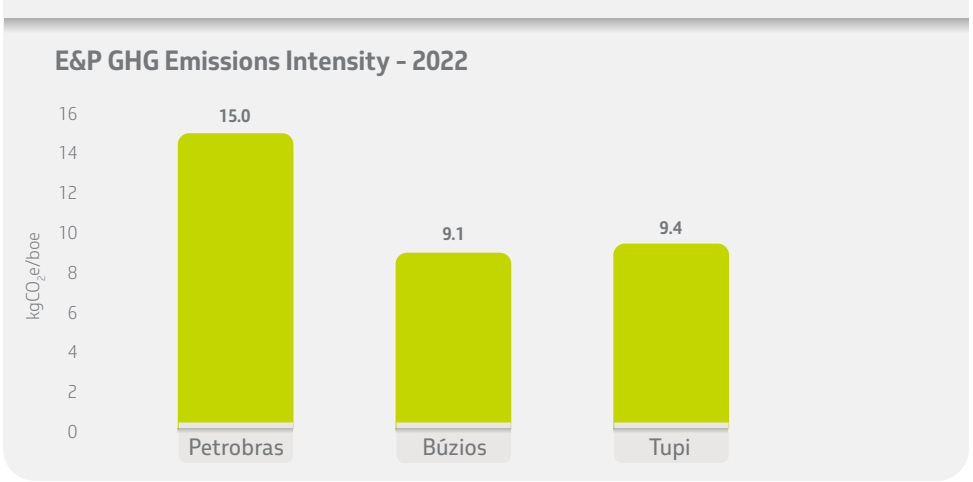
In this sense, the 18 new FPSOs that we plan to deploy in this five-year period become a challenge and an opportunity to reduce emissions intensity.



Some of the main vectors for reducing GHG emissions intensity in E&P:

- **High operational efficiency profile of the new assets;**
- **Reduction of flaring, fugitive emissions, and venting;**
- **Energy-efficiency;**
- **Portfolio management;**
- **CCUS-EOR (Carbon Capture, Utilization and Storage, associated with Enhanced Oil Recovery).**

Also, it is important to highlight the relevant result in the pre-salt fields, with increasing representation in our production curve. Tupi and Búzios fields alone, for example, accounted for around 51% of our total production in 2022.



To seek greater reduction of this index, we can act on two aspects:

1) Implement mitigation actions in operational assets to avoid the natural upward trend; and

2) Ensure that new units are included in the portfolio with low GHG emissions intensity.

During the commissioning of new production units, in the first 3 to 4 months of operation, GHG emission levels are necessarily higher since their natural gas utilization systems are not yet in full operation. These emissions, therefore, are considered temporary emissions and do not represent the intrinsic performance of these units.

In order to have greater transparency on the performance of new units and units implemented, from 2023 onwards, we will monitor the performance of the E&P segment through 3 metrics: E&P GHG Emissions Intensity - Implemented Units (top metric), E&P GHG Emission Intensity - New Units, in addition to the E&P GHG Emissions Intensity of the entire portfolio, related to our history and sustainability commitment (weighting of the two previous indicators).

We have developed a new tool to support the management of greenhouse gas emissions. A real-time dashboard deployed on more than 30 platforms to identify operational opportunities that may reduce emissions and increase the energy efficiency of the units. The Energy and Carbon Dashboard is a valuable tool for diagnostics and recommendations, which connects experts and operators. The use of artificial intelligence to build more complex diagnoses and prognoses is under development. This new solution allows us to understand our operations more accurately, support decisions, and better predict our future emissions trajectory, including the impact of technological innovations, to fulfill commitments made in our low-carbon agenda.

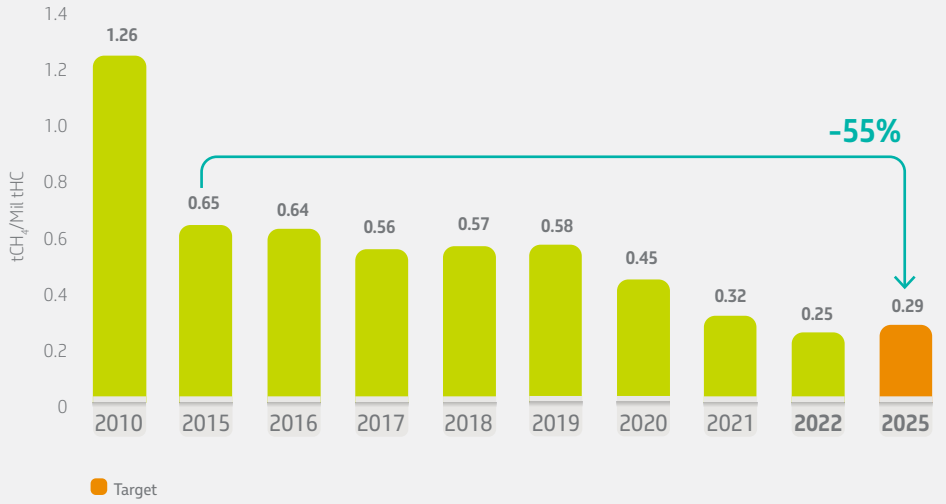
Methane Emissions

Our segments' carbon intensity targets incorporate all greenhouse gases. However, given the characteristics of methane, whose warming potential is very high in the short term, we monitor methane emissions with specific metrics.

In this context, one of the targets in our set of commitments is to consolidate the 55% reduction in methane emissions intensity in the upstream segment, compared to 2015, reaching in 2025 the value of 0.29 tCH_4/thousand tHC (tons of methane emission per thousand tons of hydrocarbons produced).

Over the past five years, we have reached a decrease in the intensity of methane emissions in E&P of about 60%. This result is mainly due to the reduction in the amount of gas sent to the flare and a consequent increase in the Associated Gas Utilization Index, optimization of venting emission estimation and adjustment of the flaring emission protocol (combustion efficiency).

Methane Emissions Intensity in the upstream segment



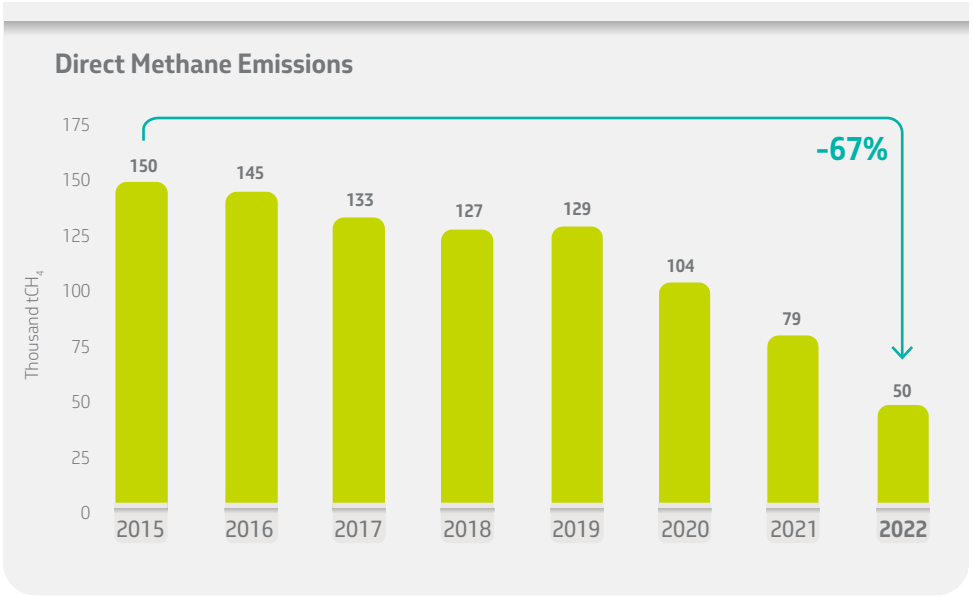
Main vectors for reducing the intensity of methane emissions in E&P:

- Implementation of the mitigation portfolio for flaring, venting and fugitive emissions by 2025 (units already built), including monitoring of fugitive emissions with Optical Gas Imaging (OGI);
- New design guidelines: closed flare, low emission valves and gas recovery systems from cargo tanks, gas recovery from closed drainage and TEG regeneration systems.

Our target to reduce E&P methane emissions intensity supports the target to reduce E&P GHG emissions intensity and the target to reduce Petrobras' absolute emissions. It also contributes to the Global Methane Pledge, a commitment established by Brazil at COP26 to reduce methane emissions by 30% by 2030 (based on 2020).

In addition to the 2025 commitment, in early 2022, we announced adherence to the "Aim for zero methane emissions" promoted by Oil and Gas Climate Initiative (OGCI). This oil and gas industry initiative recognizes that eliminating methane emissions from the upstream segment is one of the best short-term opportunities to contribute to climate change mitigation and proposes a joint effort to achieve "near-zero methane emissions" in 2030.

Between 2015 and 2022, we reduced our direct methane emissions by 67%:



Adherence to OGMP 2.0

In early 2023, we announced our adherence to the Oil and Gas Methane Partnership 2.0 (OGMP). The OGMP 2.0 is a multi-stakeholder initiative whose main attribution is the definition of a methane emission reporting framework for the oil and gas industry, with a strong focus on data transparency and credibility. More than 80 companies in the sector are already part of OGMP 2.0, coordinated by the United Nations Environment Program (UNEP) and the Climate and Clean Air Coalition (CCAC) – a worldwide volunteer organization for reducing GHG emissions.

By joining this initiative, we reinforce our commitment to transparency in this matter and seek best practices for monitoring and quantifying our methane emissions, in all segments, within three years for operated assets and five years for non-operated ones.

In the RTM segment (Refining, Transportation and Marketing), a fugitive emissions control program is already applied in Refining. It is also used in part of the Gas & Power units.

LDAR – Leak Detection and Repair – is a methodology comprised of stages that allow the definition of a monitoring plan, direct measurement of mapped emission sources, management, maintenance, and more precise control of fugitive emissions.

We are making progress in expanding the program to all our units.

Commitment to reduce methane emissions in upstream activities

Committed to reducing methane emissions in our operations, we have action plans on three main paths:

Flaring reduction

ACTIONS ON EXISTING ASSETS

- Monitoring of gas leakage through valves
- Control loop optimization
- Optimization of system starts and stops procedures
- Gas recovery through the Flare Gas Recovery Units (FGRUs)
- Equipment reliability optimization

ACTIONS ON NEW ASSETS (PROJECTS)

- Increase in FGRU capacity
- Incorporation of zero routine flaring concept

Fugitive emissions reduction

ACTIONS ON EXISTING ASSETS

- Optimization of control and counting of process components
- Monitoring of fugitive emissions with infrared cameras (*Optical Gas Imaging – OGI*)

ACTIONS ON NEW ASSETS (PROJECTS)

- Valves with fugitive emission requirements

Venting reduction

ACTIONS ON EXISTING ASSETS

- Process optimization for better stabilization of produced and stored oil

ACTIONS ON NEW ASSETS (PROJECTS)

- Gas recovery from systems such as the glycol regenerator
- Gas recovery from cargo tanks (gas blanketing)

Satellite monitoring of gas flaring

We are one of the pioneering companies supporting satellite monitoring of gas flaring in oil and gas production sites, led by the Global Gas Flaring Reduction Partnership (GGFR). The GGFR, a coalition of governments, companies and, organizations committed to mitigating routine gas flaring, is closely affiliated with the World Bank.

In order to increase the transparency of global emissions data, this project aims to enable public visualization and reporting of gas flaring volumes in oil and gas production assets, including offshore platforms. The monitoring is carried out by satellites that capture nighttime images of the glow emitted by flares, and through mathematical models, calculate the amount of gas burned. The data obtained is fed into a global flaring monitoring dashboard and made available on a web platform by the GGFR. The online platform was developed in collaboration with OGCI (Oil & Gas Climate Initiative) and research institutes such as the Payne Institute. We actively participated in the calibration stage of the mathematical models, contributing to more reliable estimated volumes.

>> The platform with global emissions data can be found here

Zero Routine Flaring

In 2018, we announced our support for the Zero Routine Flaring by 2030 initiative of the World Bank, and meeting its criteria is one of our public commitments.

To meet this commitment, we work to map and reduce routine flaring volumes in our E&P assets in operation and the projects for new units.

In 2022, routine flaring represented 5% of the total flaring volume in the E&P segment, resulting in 59.2 million Sm^3.

We emphasize that we already have a high Associated Gas Utilization Index performance, reaching 97.3% in 2022.

We improved the identification of flaring reasons throughout 2022, and we started 2023 already reaching 100% classification among the routine flaring, non-routine flaring, and safety flaring categories, as provided for in the World Bank initiative.

Additionally, we reviewed our engineering guidelines and incorporated the concept of zero routine flaring into the design bases of oil and gas production units. In this way, all new projects will start operating in compliance with the commitment. For example, the Flare Gas Recovery Units (FGRUs) will be implemented in our new units, in addition to the gas recovery from cargo tanks, the closed drainage systems and the glycol regeneration, which also affect methane emissions.

Emissions control at our Amazon Unit (UN-AM)

In 2022, we intensified emission control at our Amazon Unit (UN-AM) by identifying gas leaks in the relief system, maintaining the tightness of control valves and PSVs (Pressure Safety Valves), reducing purge gas and undue leaks to flare.

In addition to corrective actions, we implemented operational control measures and a culture change. Alert limits and daily monitoring with justifications for deviation were implemented to identify and promptly reduce leaks to flare. By combining corrective and management actions, it was possible to reduce the average daily flaring by about 55% in the three flares of the Unit.

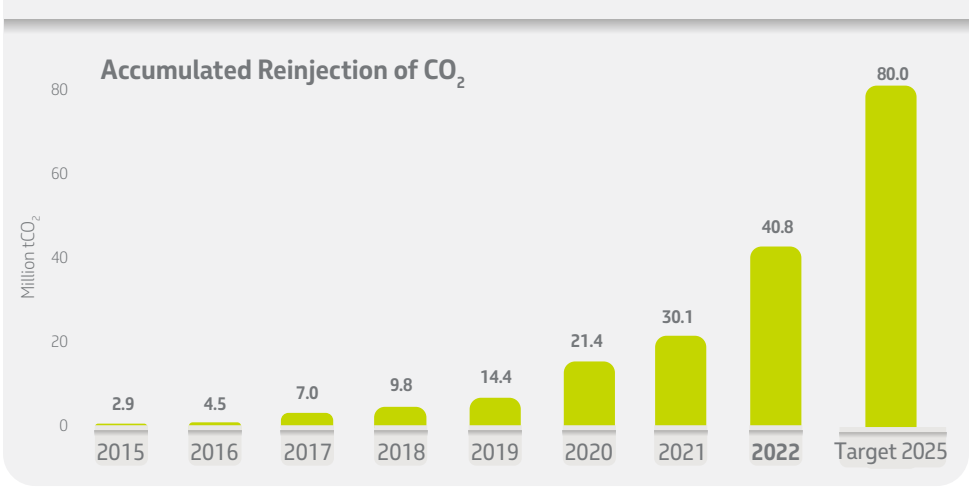
CO_2 Reinjection

In 2022, we injected 10.6 million tCO_2, the highest amount in a year. Since the beginning of our CCUS program, which began as a pilot project in the Tupi field in 2008, we have already reached an accumulated volume of 40.8 million tCO_2.

Due to the performance of recent years, our commitment was revised, now reaching an accumulated total of 80 million tCO_2 by 2025, which will contribute to technological evolution, cost reduction, and demonstration of the security of CCUS technology for application in the oil and gas industry and other sectors.

The reinjection of CO_2 in production fields, associated with Enhanced Oil Recovery (EOR), will continue to play an important role in the pathway for reducing the GHG emissions intensity in oil and gas production.

>> See chapter **Investments and Initiatives**



Main vectors:

> Start-up of new FPSOs using CCUS-EOR technology

> Confirmation of the E&P reinjection volume in the main assets: Tupi, Mero, and Búzios.

GHG Emissions Intensity in Maritime Transport

In the maritime transport segment, we monitor the greenhouse gas emissions of the contracted fleet and improve metrics to monitor the performance in terms of emissions intensity in maritime transport in long-haul and cabotage operations, following the new guidelines of the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO).

Beginning in 2023, we will also start monitoring our GHG Emissions Intensity in Maritime Transport per ton transported x mile and our GHG Emissions Intensity in Maritime Transport per cargo capacity x mile.

Among the actions implemented in 2022 to improve logistical and operational performance with a carbon efficiency bias, we highlight the following:

> Speed management: We achieved around 70% of trips operating at optimal speed, with lower emissions, and meeting the logistical deadlines agreed upon with our customers.

> Route optimization based on meteoceanographic conditions: choosing the best navigation route for long distances considering the weather conditions brought gains of around 1% in consumption and, consequently, a reduction in emissions compared to the forecast contractual consumption.

> Choice of ships for coastal navigation or long-haul navigation based on consumption: more efficient ships with lower consumption are prioritized for long-distance schedules (long haul).

In addition to operational actions, we implemented changes in the vessel hiring process to hire vessels with better consumption performance and, consequently, lower greenhouse gas emissions.

We ended 2022 with 37 Eco Type ships. Eco Type is a term used by the market to identify vessels built from 2015 onwards, with improved construction designs to comply with the energy efficiency improvement measures established by the International Maritime Organization (IMO), aimed at reducing fuel consumption and greenhouse gas emissions. The main difference lies in the technologies applied in the construction of these ships, with additional equipment to the hull and engines developed to assist in energy efficiency, as well as improved design that reduces vessels' weight and water resistance. Due to the modern technologies used and lower fuel consumption, the rental value of Eco Type ships is generally higher than that of a conventional vessel. Therefore, we have reserved part of our Decarbonization Fund budget to support this initiative.

In 2022, we carried out improvements on our Transpetro fleet ships dedicated to long-haul routes, such as painting with high-performance paint during ship docking and modifying vessels with the addition of hull appendages and propellers that improve the hydrodynamic profile. We estimate that those improvements can provide a reduction of approximately 4% in fuel consumption and, consequently, in GHG emissions.

GHG Emissions Intensity in Logistic Support Activities

The performance of our logistics support segment for exploration and production activities, which includes vessel operations, offshore air transport, port operations, road transport and storage, is monitored internally by indicators of emissions intensity per ton of transported cargo, in the case of Platform Supply Vessels, or per passenger transported, in the case of air transport by helicopters used in our offshore activities.

In 2022, the main initiatives that made it possible to reduce emissions in logistical support activities were:

- Management and speed control of support vessels, in which, based on procedures and monitoring, a 13% reduction in the emissions intensity by PSV-type vessels was verified, without affecting the level of service provided to client maritime units;
- Testing of a new support vessel route optimization system, in which optimal routes for delivering cargo to platforms are mapped, so as to reduce distances and navigation times;
- Engagement with the market of maritime support vessels, aviation, and land logistics to reduce greenhouse gas emissions. By meetings with senior management and including the low-carbon issue in PEOTRAM (Programa de Excelência Operacional no Transporte Aéreo e Marítimo – Program for Operational Excellence in Air and Maritime Transport) audits used in our procurement processes.

Since 2015, several actions have contributed to a 40% reduction in emissions in the fleet of support vessels and aircraft, including:

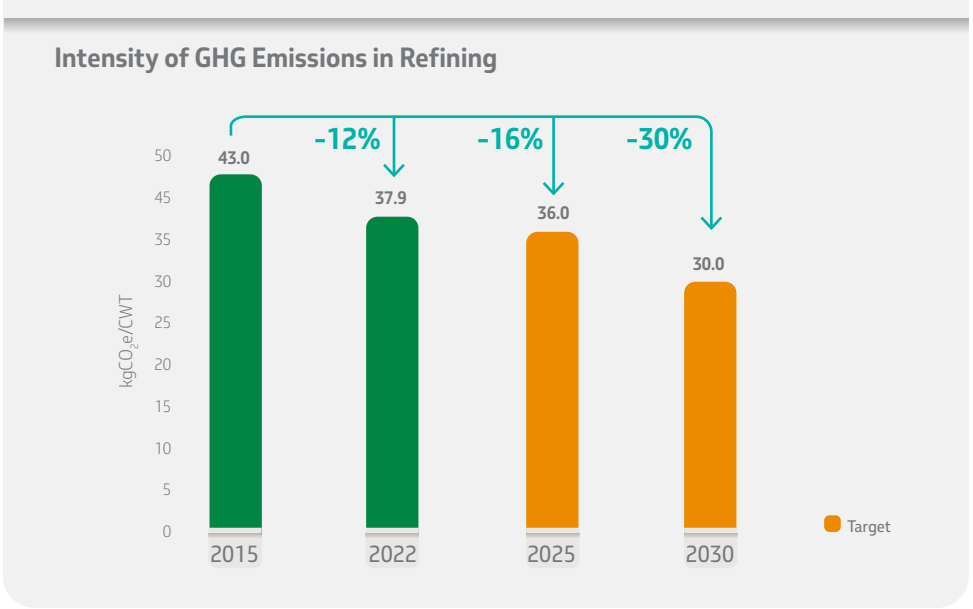
- Optimization of the fleet of vessels and aircraft
- Optimization of flights in the Campos Basin
- Optimization of vessel routes
- Strategic initiative to reduce diesel consumption
- Implementation of service clusters (for rigs and production units)
- Fleet of multipurpose vessels

Beginning in 2023, new emission efficiency metrics in E&P Logistics will be monitored internally, such as GHG Emissions Intensity per ton of cargo transported by maritime support vessels and GHG Emissions Intensity per passenger transported in helicopters.

GHG Emissions Intensity in Refining

In refining activities, we established the target of reducing the GHG emissions intensity in refining by 16% by 2025 (36 $kgCO_2e$/CWT), expanding to 30% by 2030 (30 $kgCO_2e$/CWT), based on the 2015 performance. We also point out that actions to reduce the intensity of GHG emissions bring gains in reducing other gas emissions (particulate matter, sulfur oxides and nitrogen oxides).

In 2022, the refining GHG emissions intensity, with additional efforts, followed the reduction trend of recent years, reaching the result of 37.9 $kgCO_2e$/CWT.



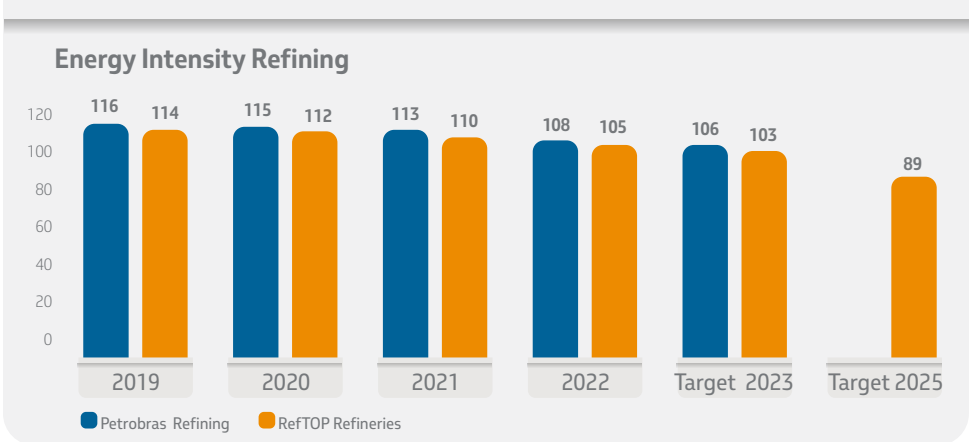
The main vectors for reducing the emissions intensity in refining are:

> Improvements in energy performance;
> Cargo optimization;
> Reduction of flaring;
> Management of hydrogen production and use.

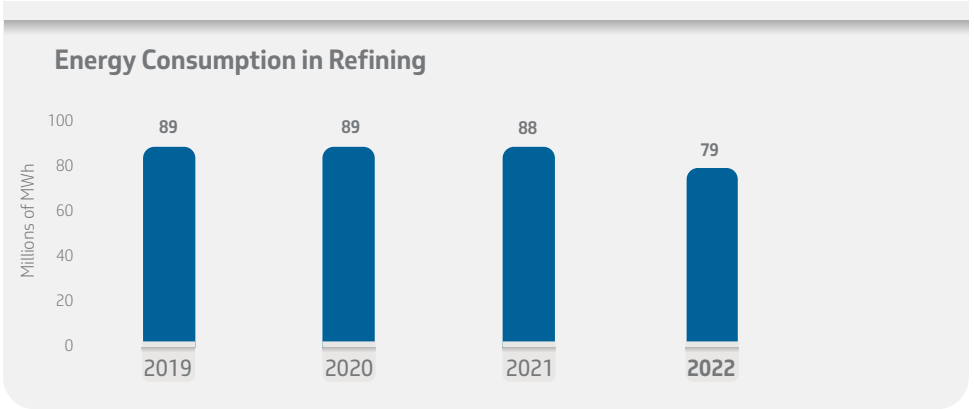
The main vector for reducing the GHG emissions intensity in refining is the improvement in energy performance. We monitor our energy intensity in refining through the relationship between the total primary energy consumption of a refinery and a standard energy consumption, which considers the volume of processed feed, feed quality, complexity and severity of the process units.

In addition to monitoring the energy intensity of our refining park, we specifically monitor the energy intensity of the refineries covered by our RefTOP Program. It consists of a set of initiatives to increase the efficiency and operational performance of our five refineries located on the RJ-SP axis: Presidente Bernardes Refinery (RPBC), Duque de Caxias Refinery (REDUC), Capuava Refinery (RECAP), Paulínia Refinery (REPLAN) and Henrique Lage Refinery (REVAP). In this context, our target is a 15% reduction in energy intensity.

>> See chapter **Investments and Initiatives**



Similarly, we monitor total energy consumption in our refining park and have an internal target for the refineries covered by the RefTOP. The 2022 result confirms our downward trend and reflects portfolio management's effect.



2022 Achievements

At the Paulínia Refinery (REPLAN), the revision and optimization of the feed preheating battery of the Delayed Coking Unit (U-980) enabled savings in fuel gas consumption in the unit's furnaces of 3,600 tons per year. With the implementation of this project, around 9,000 tCO_2 ceased to be emitted annually.

In 2020, we started adapting the process gas heat recovery boiler at the Henrique Lage Refinery (REVAP), in two stages. First, we have already proceeded with the partial alignment of the furnace gases for heat recovery, using results from computational simulations. In the second stage, the total alignment of process gases was made possible in December 2022 through modifications to the boiler steam circulation system. We estimate that the avoided emission is around 30,000 tCO_2 per year.

We also highlight great operational efforts and focus on the maintenance of our process furnaces. These measures provided an increase in the combustion efficiency of this equipment throughout 2022, leading to a reduction in fuel consumption that enabled an estimated annual prevention of 25,000 tCO_2.

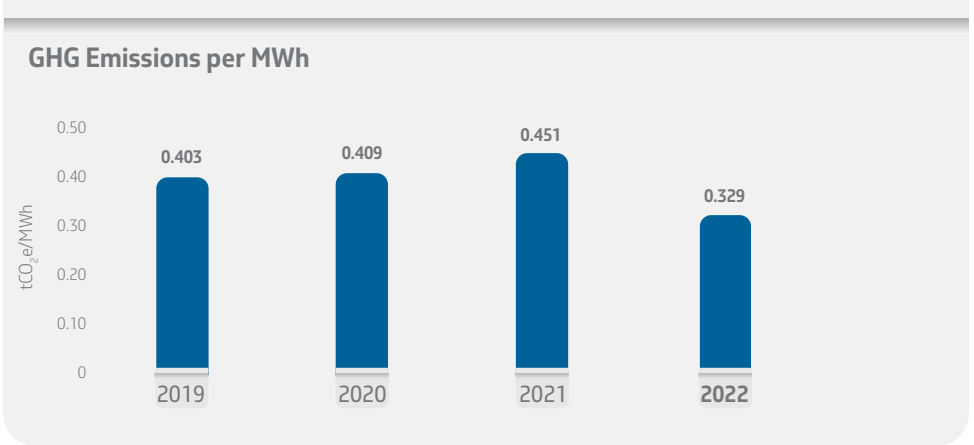
Another relevant highlight is the reduction in systemic gas flaring compared to the 2021 performance. Thanks to maintenance efforts and operational continuity of top compressors, monitoring and repair of gas valves connected to the flare system, and the optimization of refining processes, we reduced hydrocarbon flaring, resulting in an estimated annual prevention of 63,000 tCO_2 in 2022.

GHG Emissions Intensity in Power Generation

The electricity generation in our thermal power plants reflects the decisions of the Brazilian National Electric System Operator (ONS – Operador Nacional do Sistema Elétrico), which determines the moment a specific energy generation unit is dispatched. Therefore, our emissions in the segment depend on a series of factors, including the availability of other generating units in the country, climatic conditions, and the inherent seasonality of the Brazilian electrical system.

Although we do not have targets referring exclusively to our power generation activities, we monitor our emissions intensity in these operations. Our thermal power plants are mostly gas-powered, and we have highly energy-efficient units that operate in a combined cycle and are integrated with our other steam export assets. Also, in recent years, we have concluded investments in improving the efficiency of the turbo generators at the Baixada Fluminense (RJ), Cubatão (SP), Ibirité (MG), Termobahia (BA), and Termorio (RJ) plants, allowing for a reduction in fuel consumption and in carbon emissions per energy generated. According to the 2nd Inventory of atmospheric emissions in thermoelectric plants by the Instituto de Energia e Meio Ambiente (IEMA), published in December 2022, our GHG emissions intensity per MWh is approximately 20% lower than the average of thermal power plants using fossil fuels in the Brazilian National Interconnected System. In calculating the intensities, the study did not consider the plants with cogeneration (IEMA, 2022).

In 2022, we reviewed the methodology for calculating the emissions intensity indicator at our thermal power plants, in line with the Energy Statistics Manual of the International Energy Agency (IEA). In the new methodology, we appropriated only the emissions related to electricity generation without considering the share of emissions associated with steam generation in our plants that operate with cogeneration.



Considering this methodology, our thermal power plants operated, in 2022, with average GHG emissions per electricity generated of 0.329 tCO_2e/MWh.

In addition to the metric mentioned, starting in 2023, we will internally use a performance indicator on emissions from our thermal power plants weighted by their respective pre-determined reference performances according to the project conditions and operational situations for supplying the power system and exporting steam. This indicator, measured in percentage terms, is related to the power plants' actual and reference energy efficiency. The total relative performance of the park is calculated as the weighted average of the energy generated by each power plant during the period.

Efficiency improvements in our turbo generators

Between 2018 and 2022, we invested in upgrading the turbo generators at the Baixada Fluminense (RJ), Cubatão (SP), Ibirité (MG), Termobahia (BA), and Termorio (RJ) thermal power plants, which represent approximately 30% of our installed capacity. These investments consist of modifying internal components and updating turbo generator control systems, resulting in increased efficiency in natural gas use for power generation.

The modernization implemented, in 2022, in Block 1 of Termorio, allows a power gain of up to an additional 27.5 MW depending on the mode of operation (7.2% of the capacity of this generation block).

Also, by 2026, efficiency improvements will be made in the other 2 generation blocks (Blocks 2 and 3) of Termorio, with a total increase of 63 MW expected (10% of the installed capacity of blocks 2 and 3).

In the five projects already implemented, the total estimated reduction is around 21,600 tCO_2e/year.

With the implementation of additional efficiency improvements in the other Termorio blocks, depending on their mode of operation, the estimated further reduction in emissions is around 37,800 tCO_2 in the SP 2023-2027 horizon.

Fugitive Emissions Monitoring Program

Until 2021, the fugitive emissions in our thermal power plants were accounted for and estimated based on international calculation protocols[1]. In 2022, the fugitive emissions from part of our thermal power plants started to be measured using the LDAR methodology – Leak Detection and Repair established by the Environmental Protection Agency (EPA, Method 21). We carried out measurements at the Termorio, Seropédica, Baixada Fluminense, and Termomacaé power plants and found annual values lower by about 98% than previously estimated fugitive emissions for these assets.

Beginning in 2023, the implementation of the fugitive emissions measurement and management program will be completed in 100% of our thermal power plants using the LDAR methodology.

NOTE 1: Emissions Inventory Guidelines, TCEQ, publication RG-360, December 2005 and Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

Active Portfolio Management

Aligned with the strategic decarbonization goals, Active Portfolio Management foresees divestment in less efficient thermal power plants, focusing on our participation in segments with greater competitive advantage and profitability. In December 2021, we completed the divestment of the Arembepe, Bahia 1, and Muricy plants, which together have a total installed capacity of 304 MW and operate on fuel oil. With the completion of this project, we estimate that we avoided around 255,000 tCO_2e* in our portfolio in 2022.

*Note: Avoided emissions considering the average emissions of the three plants in the period from 2019 to 2021.

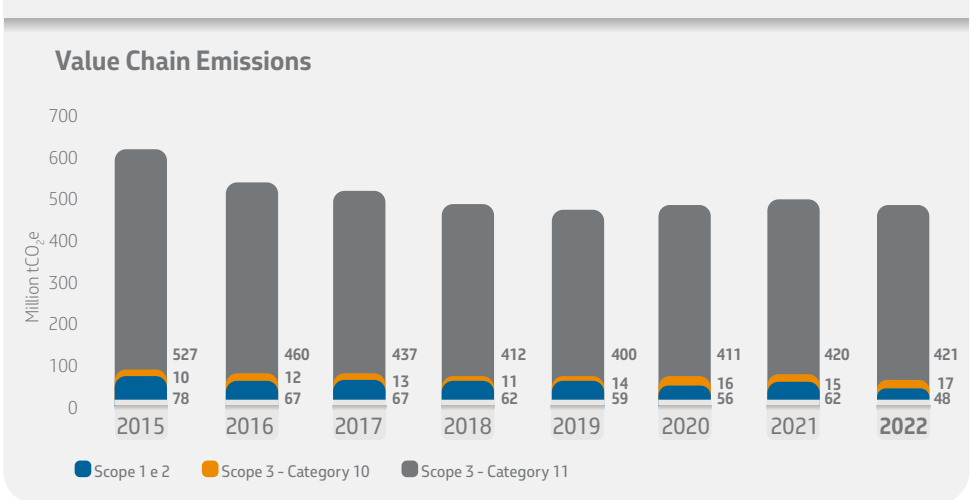
Value Chain Emissions

As an integrated energy company, we monitor the absolute emissions and carbon intensity of the value chain of our global energy mix. We also consider the carbon performance of each individual product to be relevant, as there are significant differences in the carbon intensity of different oils, natural gas streams and electricity itself from fossil fuels.

In the oil and gas value chain, most emissions occur in the use stage by final consumers. Therefore, to know the real impact of our products, it is necessary to calculate our Scope 3 emissions.

To compute Scope 3, we use two categories according to the GHG *Protocol*: indirect emissions from sold product processing (Category 10) and indirect emissions related to the use of products delivered to the market (Category 11).

In the period from 2015 to 2022, our Scope 1 emissions (direct operational emissions) and Scope 2 (indirect emissions from the acquisition of electrical and/or thermal energy produced by third parties) amounted to approximately 12% of the total emissions reported for the value supply chain (Scopes 1, 2 and 3).



Value Chain GHG Emissions Intensity

Since 2019 (2018 fiscal year), we have used the value chain GHG emissions intensity metric as an element of analysis of our carbon risks and opportunities, aiming at monitoring our operations and business.

$$\text{INTENSITY} = \frac{\text{Total Emissions } (gCO_2e)^*}{\text{Total energy delivered through our products (MJ)}}$$

* Total Emissions = Scope 1 + Scope 2 + Scope 3 (Category 10 + Category 11)

The metric allows analysis regarding the amount of GHG emissions associated with each unit of energy delivered to our consumers. As it is an indicator of total emissions, it is calculated by summing our operational emissions (Scopes 1 and 2) with those related to processing (Scope 3 – Category 10) and the use of our products (Scope 3 – Category 11). Monitoring this indicator adds robustness to our analyses, allowing us to assess the impact of the decarbonization of our assets in operation, the intensity of our mix of liquid fuels and gas, and the effects of the insertion of renewable energies or the removal of CO_2. In 2022, according to this metric, the intensity of our value chain was 81.8 gCO_2e/MJ.

Life Cycle Assessment

Life Cycle Assessment (LCA) is a technique that identifies and quantifies the resources used and the emissions into air, land, and water, enabling the assessment of the potential environmental impacts throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal, and has its principles and calculation procedure described in ISO 14040 and ISO 14044. The life cycle of fossil fuels involves the stages of oil exploration and production, transportation, processing in refineries, distribution, and use of products.

Intending to further assess the carbon intensity of our products, we carry out preliminary Life Cycle Assessment studies of the produced oils and refined products. These assessments are used internally to improve our processes and define our sustainability strategies and product portfolio, as a way to contribute to the energy transition and a low-carbon economy.

So far, we have already carried out the Life Cycle Assessment of part of our oil production basins and our refineries. We continue to work on the evolution of our models to develop more agile systems that enable us to assess a more significant number of oil production and refining units.

Digital LCA

We are developing a digital model to carry out LCAs in our refineries with agility and focus on calculating the carbon intensity of products. The pilot implementation is being carried out at the Henrique Lage Refinery (REVAP), expected to be completed in 2023. The Digital LCA model uses real-time information from refinery management systems, such as the digital twin of refinery processes (used to optimize production), the energy panel (energy performance data), information from SIGEA® (Sistema de Gestão de Emissões Atmosféricas da Petrobras - Petrobras Atmospheric Emissions Management System), the product movement database and other complementary systems. With this data set, it is possible to calculate, in a more flexible and traceable manner, the carbon intensity of the products from a refinery, contributing to the knowledge and management of emissions associated with production and also contributing to meet customer demands, develop products with lower carbon intensity and certify low carbon products. Preliminary results are already being assessed, making it possible to improve the model under development.

Sustainable Product Certification

The certification of sustainable products is a worldwide trend, in line with ESG practices. These practices ensure that a product follows international standards related to transparency, good management, quantification of carbon emissions in its life cycle, and environmentally responsible production, with safe working conditions, and compliance with human, labor, and land rights, among others.

Certification is a process that involves a detailed analysis of the generation of a product and the tracking of information along the production chain, with the evaluation and validation by a third party of sustainability indicators proposed by a specific certification scheme. It is a rigorous process, with control and traceability requirements for many documents and internal records, which range from the purchase of raw materials to the receipt, storage, processing, and sale of the sustainable product produced.

In February 2023, we voluntarily obtained ISCC Plus and ISCC EU RED certification for the production of Diesel R produced at the Presidente Getúlio Vargas Refinery (REPAR), as a way of attesting that the renewable portion of this product follows strict environmental, social and governance practices in its production. We are also evaluating the certification of other less carbon-intensive products, like what was done for Diesel R, in line with our biorefining projects and commercial strategy and with the demands of the consumer market.

ISCC certification

ISCC is an independent organization with global operations in certification systems that endorse the sustainability of raw materials and renewable products by evaluating sustainability criteria throughout the production chain. The ISCC certification system is a multi-step process applied to all types of agricultural, forestry, and fossil raw materials that contribute to the circular economy and bioeconomy. Different products can be certified by ISCC, for example food, feed, chemical compounds, fuel, and energy.

Metrics

In the table, we present our metrics used in the assessment of carbon risks and opportunities.

METRIC	UNIT	SCOPE	DESCRIPTION	USE OF THE METRIC
Absolute Operational GHG Emissions	tons of CO_2e	100% of activities with operational control	Total GHG emissions, including Scope 1 and Scope 2, in terms of CO_2 equivalent (CO_2e) from us and shareholdings under our operational control.	Public Commitment: Reduction by 30% by 2030 (base year 2015)
Operational Emissions from Oil and Gas Activities	tons of CO_2e	Oil and Gas Exploration and Production, Natural Gas Processing and Treatment and Oil Refining activities with operational control	Total GHG emissions, including Scope 1 and Scope 2, in terms of CO_2 equivalent (CO_2e), excluding GHG emissions from the operations of Thermal Power Plants.	Internal Monitoring
E&P GHG Emissions Intensity	$kgCO_2e$/boe	Oil and Gas Exploration and Production activities under operational control	GHG emissions, in terms of CO_2e, from E&P activities in relation to the total oil and gas operated production (wellhead) registered in the same period. Scope 1 and 2 GHG emissions are considered. This indicator represents the rate of GHG emissions per barrel of oil equivalent produced, being used to analyze the carbon performance of the assets in our current and future portfolio. It is comprised of the weighting of E&P GHG Emissions Intensity - Implemented Units and E&P GHG Emissions Intensity - New Units	Public Commitment: 15 $kgCO_2e$/boe until 2025, maintained until 2030.
E&P GHG Emissions Intensity - Implemented Units	$kgCO_2e$/boe	Oil and gas Exploration and Production activities under operational control that were already in full operation in December of the previous year to which the indicator refers and that remain in our portfolio	GHG emissions, in terms of CO_2e, from E&P activities, which were already in full operation at the end of the year prior to the reference year, in relation to the total operated oil and gas production (wellhead) registered in the same period. This indicator makes up the E&P GHG Emissions Intensity.	Used for the composition of the Compliance with GHG targets index
E&P GHG Emissions Intensity - New Units	$kgCO_2e$/boe	Oil and gas Exploration and Production activities under operational control in the commissioning process during the year to which the indicator refers	GHG emissions, in terms of CO_2e, from E&P activities, in the commissioning process during the reference year, in relation to the total operated oil and gas production (wellhead) registered in the same period. This indicator makes up the E&P GHG Emissions Intensity.	Internal Monitoring
Upstream Methane Emissions Intensity (IOGP)	tCH_4/thousand t hydrocarbons	Oil and gas exploration and production activities and natural gas processing and treatment activities under operational control	The indicator uses the IOGP metric that represents the ratio between methane emissions and the total operated production of hydrocarbons.	Public Commitment: Consolidation of the 55% reduction by 2025, reaching 0.29 tCH4/thousand t of hydrocarbons (base year 2015).
Upstream Methane Emissions Intensity (OGCI)	%	Oil and gas production activities and natural gas processing and treatment activities under operational control	The indicator uses the OGCI metric that represents the ratio between the volume of methane emission by the volume of gas delivered to the market.	Internal Monitoring
GHG Emissions Intensity in Maritime Transport per ton transported x mile	gCO_2e/(ton x mile)	Maritime Transport Activities of ships chartered in the Time Charter Party (TCP) modality	Ratio between the total mass of CO_2e emitted on ships and the product of cargo actually transported on ships by the distance sailed in nautical miles (tons x miles).	Internal Monitoring

GHG Emissions Intensity in Maritime Transport per cargo capacity x mile	gCO_2e/(DWT x mile)	Maritime Transport Activities of ships chartered in the Time Charter Party (TCP) modality	Ratio between the total mass of CO_2e emitted on ships and the product of ship capacity (deadweight tonnage - DWT) by the distance sailed in nautical miles.	Internal Monitoring
GHG Emissions Intensity per ton of cargo transported by maritime support vessels	tons of CO_2e / tons of cargo transported	Support vessels that transport cargo to the Maritime Units	Ratio between the total mass of CO_2e emitted in support vessels carrying out cargo transport (PSV - *Platform Supply Vessel*) by the total mass of cargo that these vessels carry to the platforms.	Internal Monitoring
GHG Emissions Intensity per passenger transported in helicopters	kg of CO_2e/ number of passengers carried by helicopters	Air Transport Operations	Ratio between the total mass of CO_2e emitted by helicopters working for Petrobras by the number of passengers transported	Internal Monitoring
Refining GHG Emissions Intensity	$kgCO_2e$/CWT	Refining activities with operational control	GHG emissions, in terms of CO_2e, from Refining activities in relation to the activity unit called CWT (Complexity Weighted Tone). CWT represents a measure of activity, similar to UEDC (Utilized Equivalent Distillation Capacity), which considers the potential for GHG emissions, equivalent to distillation, per process unit, allowing better comparability between refineries of different complexities. This indicator composes the analysis of the carbon performance of the assets in our current and future portfolio.	Public Commitment: 36 $kgCO_2e$/CWT by 2025 and 30 $kgCO_2e$/CWT by 2030.
Energy Intensity	-	Refining activities with operational control	It considers the relationship between the total primary energy consumption of a refinery and a standard energy consumption that takes into account the volume of processed feed, the quality of the feed, the complexity and severity of the process units.	Internal Monitoring
Value Chain GHG Emissions Intensity	gCO_2e/MJ	100% of activities with operational control and use of energy products	Total GHG emissions from our operations (Scope 1 and Scope 2) and Scope 3 emissions (Category 10 and Category 11) in relation to the total energy delivered to our customers in energy products. This metric represents an analysis regarding the amount of GHG emissions associated with each unit of energy delivered to our consumers.	Internal Monitoring
GHG Emissions Intensity in Thermal Power Plants	tCO_2e/MWh	Commercial generation of power from thermal power plants under operational control	GHG emissions, in terms of CO_2e, from the processes of Thermal Power Plants in relation to the electricity generated. Scope 1 and 2 GHG emissions are considered. This indicator comprises the analysis of the carbon performance of the assets in our current and future portfolio.	Internal Monitoring
Compliance with Performance in terms of GHG emissions from Thermal Power Plants	%	Commercial generation of power from thermal power plants under operational control	Performance in terms of GHG emissions from our thermal power plants, relative to its reference performance, determined in accordance with the project conditions and operational situations of service to the electrical system and steam export. The total relative performance is calculated as the weighted average of the energy generated by each thermal power plants in the period.	Internal Monitoring
Breakeven Carbon Price	US$/$tCO_2e$	Projects under assessment	The indicator represents the value of a carbon tax that would bring the NPV of the project under analysis to zero using a simplified internal methodology.	Analysis of the result in the decision-making process of each investment project.
NPV Carbon Price Sensitivity	% or currency unit	Projects under assessment	The indicator represents the impact on the NPV of the project under analysis derived from a possible carbon pricing, using a simplified internal methodology.	Analysis of the result in the decision-making process of each investment project.
Portfolio NPV Loss	%	Company Portfolio	The indicator represents the impact on the NPV of the Portfolio when compared to the international scenarios indicated in this Supplement, due to the effect of oil and carbon price assumptions in the evaluated periods.	Internal Monitoring

Scenarios and resilience

According to the Sixth Report of the Intergovernmental Panel on Climate Change (IPCC), climate change will affect all systems, natural and human, and its economic impacts are expected to grow with global warming. However, specific implications present high levels of uncertainty, depending on factors such as advances in carbon-neutral technologies, market structures, behavioral changes, and planning for a just transition.

The impacts on the global energy supply caused by the conflict in Ukraine brought issues related to security and access to energy to the center of the discussion. The effects of the crisis have multiple repercussions: in the urgency of transforming energy systems to be more secure, reliable, and resilient, according to the mix of natural gas, oil, coal and electricity; and on food and climate security.

The last Conference of the Parties (COP), held in Egypt, in Sharm El-Sheik, ratified the need to reduce global greenhouse gas (GHG) emissions in all sectors, in line with the specificities of each country and recognizing the need for a just transition support. The discussion on reducing the use of fossil fuels, including oil and gas, also gained momentum, although no agreement was reached.

The oil and gas industry has an important challenge in minimizing its operational emissions and delivering less carbon-intensive products since energy transition scenarios point to a relevant role for petroleum products in the coming decades.

Our Scenarios

The use of corporate scenarios in strategic planning is an instrument that qualifies the strategic analysis and the consequent long-term positioning decisions. We have been preparing our own scenarios for more than three decades, which guide our vision of the future and are used to quantify assumptions and assess risks.

Our scenarios indicate that there will be persistent world demand for oil in the coming decades. We hold relevant reserves, and it is our priority to continue supplying oil and gas in a competitive and environmentally responsible manner.

In these scenarios, consolidated trends and critical uncertainties combine to shape energy transition trajectories. Economic growth models, environmental and climate policies, technological innovation, and changes in society's behavior play a decisive role in the transition and substantially change projections for our industry (demand and oil price). The intrinsic competitiveness of liquid fossil fuels remains based on the high energy density, the possibility of transport and storage, and the existence of already developed infrastructure, factors of greater or lesser importance in different energy services. The determining aspect of the resilience of each product in the low-carbon transition is the viable scale of substitutes, so innovation is a particularly relevant factor in the transition. Even in the most accelerated transition scenario (Resilience), we estimate persistent demand, albeit decreasing, for oil products in the coming decades, which should be progressively supplied in models with less carbon intensity.

The price of oil is a variable that decisively influences the definition of the portfolio and the identification of the profitability of assets in the context of accelerated transition. In the current context, in addition to the uncertainties inherent in the functioning of the oil market, there are structural issues brought about by the COVID-19 pandemic, such as changes in the population's mobility habits and the impacts of the war between Russia and Ukraine. Russia is one of the world's main oil producers and exporters and its involvement in the conflict, as well as the sanctions imposed by the USA and the European Union on the country, resulted in sharp increases and volatility in oil and gas prices throughout 2022. In line with this context, the scenarios consider the short-term effects of this situation and try to envision the possibilities that these events will cause medium and long-term changes, especially regarding the pace of energy transition.

We also note the consolidation of the mobility electrification trend, and the cost reduction and scale expansion of modern renewable energy production and energy storage.

In addition to the demand for fossil products, the transition to a low-carbon economy affects two important variables in our value creation: Brent price and carbon price. We monitor progress in carbon market regulation in Brazil, the main market where we operate, through a specific risk analysis methodology, identifying threats and opportunities for our businesses. Currently, we carry out value quantification and portfolio decisions under the assumptions of our Base scenario.

Growth Scenario

In the short term, the scenario is characterized by the economy's rapid recovery after the pandemic's effects. The war between Russia and Ukraine results in high energy prices and short-term inflation. The decrease in oil and gas exports from Russia to Europe forces a diversification and an increase, in the short term, in the use of coal.

In the medium and long term, economic growth is accelerated, with an expansion of trade flows. The transition of the Chinese economy to a more consumption-oriented dynamic is successfully carried out, and the Indian economy gains relevance. From the environmental point of view, despite the advances, there are still coordination and financing difficulties in deepening the transition to a low-carbon economy.

The result of this scenario is accelerated economic growth, an energy matrix still focused on fossil sources and high commodity prices.

Base Scenario

In the short term, the scenario is characterized by a more gradual recovery trajectory after the effects of COVID-19. The war between Russia and Ukraine impacts energy prices and global inflation, requiring long-term action by Central Banks.

In the medium and long term, economic growth is average, in line with that observed in the recent past. The climate and environmental policies align with the goals already announced, without deepening them. There is a greater concern with mobility and air quality in large urban centers.
More direct solutions for the energy transition, driven by large cities and popular pressure, characterize this scenario. The global energy matrix has undergone substantial changes, especially regarding the participation of coal and renewable sources.

The result of this scenario is a more diversified energy matrix, with growth in the share of renewables and commodity prices in line with what has been observed historically.

Resilience Scenario

In the short term, the scenario is characterized by a delay in solving the pandemic and a significantly slower recovery trajectory. The disintegration of global production chains and the war between Russia and Ukraine slow down the expansion of world trade amid nationalization strategies in several countries and industries.

The consequences of these events have caused more lasting impacts on private debt and the labor market.

In the medium and long term, the environmental issue becomes central, and countries are driven to cooperate and coordinate efforts for a quick transition to a low-carbon economy. The demand for fossil products is discouraged, so that the prices of these energy sources are lower.

The result of this scenario is lower global growth, a greater share of renewables in the global energy matrix and lower commodity prices.

International Energy Agency Scenarios

The World Energy Outlook (WEO) of the International Energy Agency (IEA) also uses scenarios to examine future energy trends from a global energy and climate model. The scenarios highlight the importance of public policies in the future of the energy system but also bring other elements and influences, such as economic aspects and demographic context, technology and learning costs, energy prices and accessibility, corporate sustainability, and social and behavioral factors.

The 2022 edition of WEO brought updates on the current and long-term scenarios for global energy markets, indicating how the energy system can respond to and evolve to the current global crisis (IEA, 2022).

STEPS
Stated Policies Scenario

It reflects existing policies and measures under development in each sector and indicates where the energy system can go without further intervention by public policymakers.

The current WEO 2022 scenario indicates a rupture in the historically observed relationship between GDP growth and emissions growth.

APS
Announced Pledges Scenario

It considers all climate pledges made by governments worldwide, including Nationally Determined Contributions (NDCs), as well as long-term net zero targets. It assumes that they will be met in full and on time, maintaining, with a probability of 50%, the temperature increase in 2100 around 1.7°C.

It is the closest scenario in certain aspects to the Sustainable Development Scenario (SDS), a scenario used in previous editions of the WEO to model a trajectory below 2°C and discontinued in the 2022 edition. Its results also show adherence to those modeled in the SDS scenario, especially concerning the global temperature increase.

In the APS scenario, countries committed to *net zero* goals make efforts to minimize emissions from oil and gas operations, increasing production costs. Projects with lower costs and lower emissions are the least affected.

NZE
Net Zero Emissions by 2050 Scenario

Normative scenario describing an ambitious trajectory for the global energy sector to achieve net zero CO_2 emissions by 2050, indicating a roadmap to achieve that goal. This vision also addresses the key United Nations Sustainable Development Goals (SDGs) related to energy, in particular, universal access to energy by 2030.

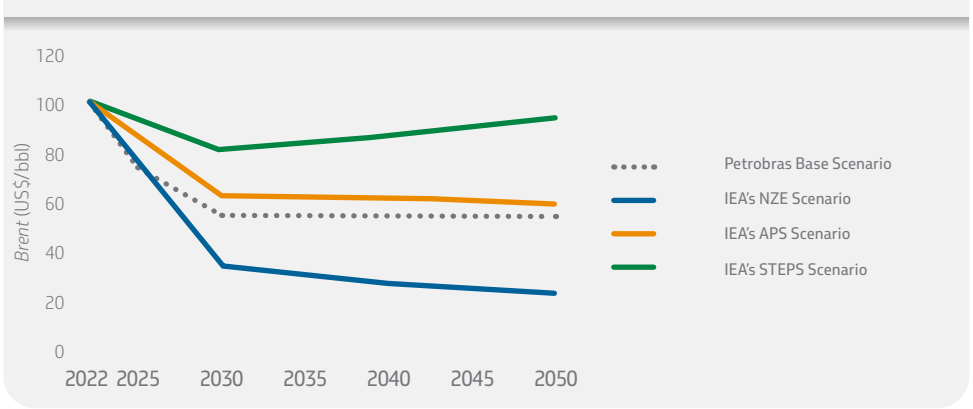
On the proposed trajectory, global temperature peaks below 1.6°C around 2040, before dropping to around 1.4°C by 2100.

Oil price projection for the International Energy Agency scenarios and our scenarios

Our Base scenario considers an oil price range from an average of US$85/bbl in 2023 and reaching US$55/bbl from 2030 onwards. That price range is similar to the International Energy Agency's APS scenario, which is aligned with a 50% probability of keeping the temperature increase below 1.7°C by 2100.

Our Resilience scenario, where we project an oil price of US$ 35/bbl in the long term, is similar to the price predicted in the International Energy Agency's NZE scenario, which presents a 50% probability of limiting the temperature increase to 1.5°C in accordance with the ambition of the Paris Agreement.

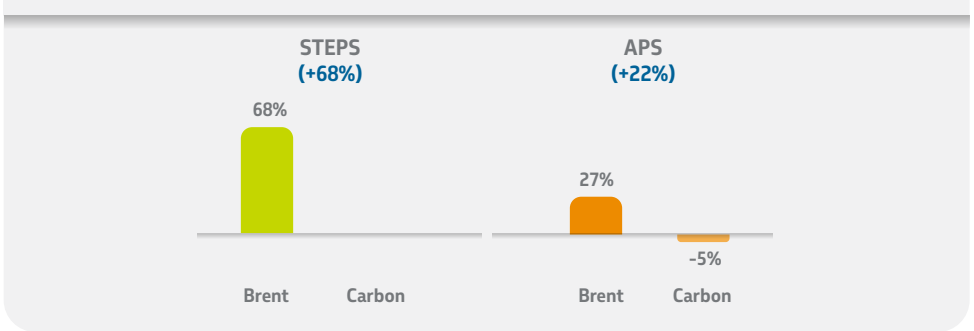
Our Growth scenario considers the support of higher prices, converging to US$75/bbl in the long term.



To test the resilience of our assumptions, we performed simulations of the impact of the International Energy Agency's scenarios on the value of our portfolio, in compliance with TCFD recommendations.

Integrated Resilience Quantification: Assumptions Aligned with the Paris Agreement

We carried out simulations of the net present value of our portfolio in the Base scenario, using sensitivity to the Brent price and the carbon price of the external reference scenarios (STEPS, APS and NZE). As further discussed, the total impact on each scenario is the sum of the two outcomes.



Considers the impact of the price of Brent only in the E&P segment. Pre-tax carbon price effect.

Note: The STEPS scenario considers carbon prices only for already regulated markets, without defining this price for Brazil and, consequently, without impacts of this variable on the portfolio value.

The oil price sensitivity calculation considers the impact of the Brent price only on the E&P segment and similar margins in the other segments. To calculate the effect of the carbon price, we considered a future regulated market for carbon credits based on international references of markets already in operation (Europe, USA, and China), since there are still many uncertainties regarding the operation of a future carbon market in Brazil.

Using the assumptions of the STEPS external scenario, given higher oil prices, there would be an increase in the portfolio value in relation to that calculated with our Base scenario assumptions (68%). Compared with the APS external scenario, which already considers

carbon taxation for countries not yet regulated, such as Brazil, and the balance with higher oil prices, there would be a positive impact (22%) on the portfolio value calculated with the internal assumptions.
The results reflect the conservative price assumptions of our internal scenarios adopted in the 2023-2027 Strategic Plan and our strategic choice of the portfolio with high resilience to price volatility in the face of the energy transition.

Adopting more conservative price assumptions aims to direct investments toward assets that are resilient to the economy aligned with the goals of the Paris Agreement. As an external reference for our resilience assessment, we use the NZE scenario. This normative scenario models significant changes in the energy demand profile to reach neutrality in 2050 (50% probability limiting the temperature increase to 1.5ºC). If we compare the quantification of our Base scenario with the assumptions of the NZE scenario, there would be a negative impact of 68% on the net present value (NPV) of our portfolio due to the incidence of carbon prices and the price of oil. However, when compared to our Resilience scenario, the negative impact is about 39%, due to the combined effect of the difference between the Brent price curves and the premises regarding a carbon price.

We emphasize that, despite the long-term price of oil in our Resilience scenario having a similar trajectory to that of the NZE scenario, our forecast for oil demand is higher (57 million bpd against 23 million bpd, in 2050).

There are many uncertainties regarding the functioning of a future carbon market in Brazil, and there is not sufficient and reliable information about the future intentions of regulators to allow us to consider the impact of the carbon price on the valuation of our portfolio for accounting estimates purposes. However, we use carbon price curves associated with internal scenarios in portfolio risk analyses, sensitivity analyses of investment projects, and assessing eligibility for using the Decarbonization Fund.

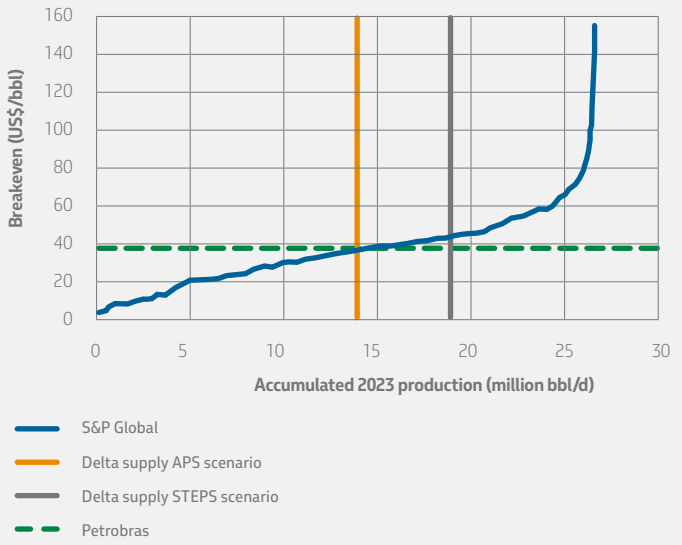
The International Energy Agency uses a bottom-up optimization model of energy supply and demand, considering in the analysis a mix of fuels and technologies from a cost-minimization perspective, while taking into account technical, economic, and regulatory constraints.

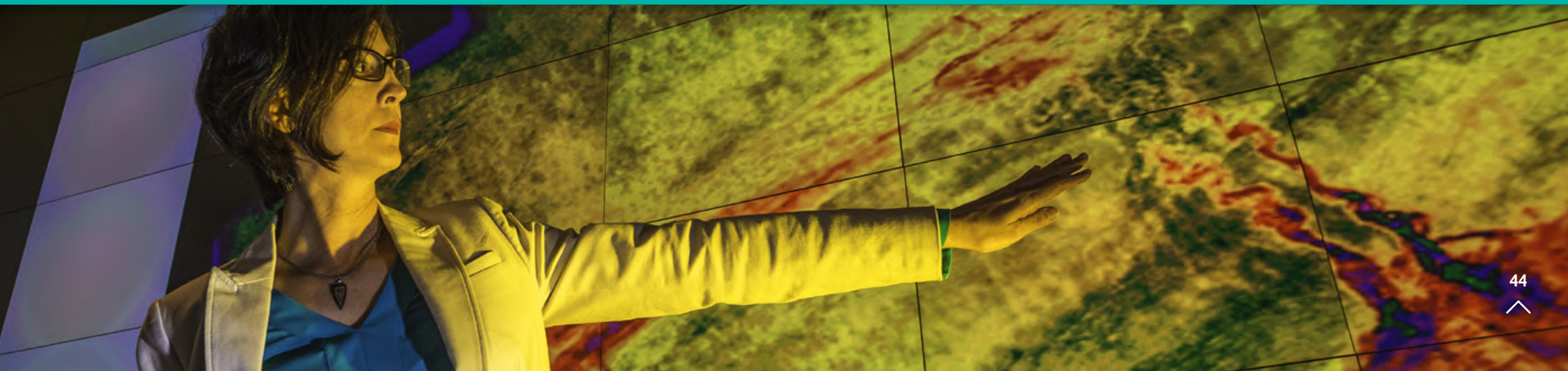
To model the oil supply, production for each country or group of countries is projected according to the type of asset in which investments are made: mature fields, new fields, and unconventional projects. The profitability of each type of project is based on assumptions about the cost of capital and operating cost of the different projects. Projects are prioritized based on the present value of their respective cash flows, and the most profitable ones are developed to meet the projected production supply gap in different scenarios.

The results published in WEO 2022 indicate that new projects in ultra-deep waters in Brazil play an important role in meeting energy demand (IEA, 2022). They project a 45% increase in the country's production by 2030 compared to 2021, in the APS scenario (aligned with the Paris Agreement), indicating the region's competitiveness reflected by low costs and high production efficiency.

Despite the lower predicted consumption of oil and gas in all scenarios, due to the natural decline of existing oil fields, new investments are needed to meet expected demand in order to avoid supply shortages and consequently, price shocks. We use data from the International Energy Agency and S&P Global to test our projects' alignment with the Paris Agreement's goals. According to the Least Cost Methodology (LCM), the potential supply of oil and gas is compared to the projected demand for a given scenario, where new projects are ranked according to their breakeven cost, and then grouped to meet demand at the lowest supply cost.

The analysis indicated that our sanctioned projects, but not yet in operation, and unsanctioned projects, are aligned with a projection of declining demand compatible with the IEA's APS scenario in 2030. According to global data from S&P Global, our projects are resilient and show a breakeven average below US$ 40 per barrel. S&P's breakeven calculation includes exploration, development, and field operation costs, in a point-forward view. Decommissioning costs are not considered, nor are residual values. The breakeven value calculated internally by Petrobras is lower than the value estimated by the S&P methodology.





Strategies and portfolio

Our Strategies

We contribute to reliable and efficient energy generation for an environmentally sustainable world. Our strategic model seeks double resilience: economic, resilient to low price scenarios, and environmental, with high emission efficiency.

With the vision of "Being the best energy company in value generation, focusing on oil and gas, sustainability, safety, respect for people and the environment", we preserve our values in the 2023-2027 Strategic Plan.

Also, we maintain our purpose of "Providing energy that ensures prosperity in an ethical, safe and competitive manner". Along these lines, our strategies aim at effectively contribute to a prosperous and sustainable future:

Our values

Respect for life, people, and the environment

Ethics and transparency

Overcoming challenges and trust

Market and results orientation

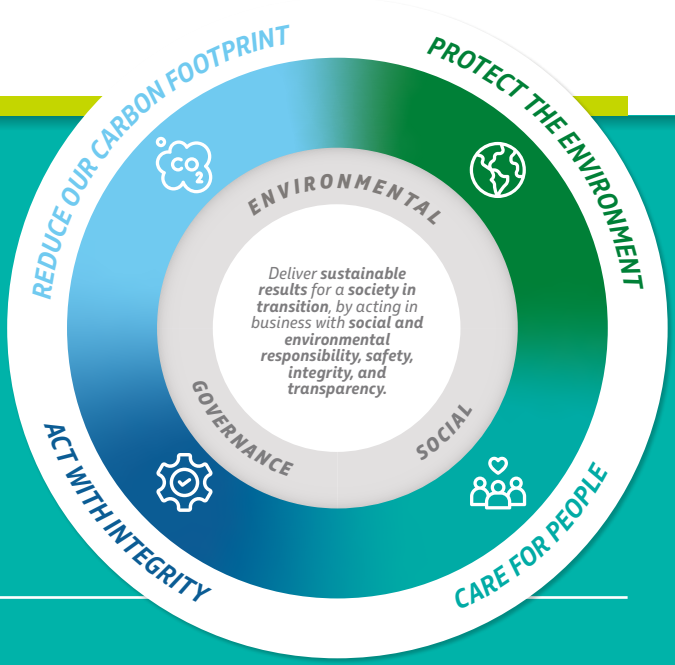
ESG Strategy

SP 2023-2027 integrated the ESG (Environmental, Social and Governance) elements into a single vision, summarizing the Company's position and strategy on the subject:

Deliver sustainable results for a society in transition, by acting in business with social and environmental responsibility, safety, integrity and transparency.

We improved our transparency on corporate social responsibility, highlighting four key ideas:

- **Reduce our carbon footprint**
- **Protect the environment**
- **Care for people**
- **Act with integrity**



E&P Strategy

Maximize portfolio value, focusing on deep and ultra-deepwater assets.

RTC Strategy

Refining, Transport and Marketing

Withdraw completely from fertilizers and biodiesel businesses participation.

Operate with assets focused on the proximity of the oil supply and the consumer market, adding value to the refining park with more efficient processes and new products, moving towards a low-carbon market.

Act competitively in the oil and oil product trade, maximizing value captured through integration and the safe and efficient operation of the upstream and downstream logistics chain.

G&P Strategy

Operate competitively in trading own natural gas, completely withdrawing from gas distribution and transportation.

Optimize the thermoelectric portfolio focusing on self-consumption and trading of own natural gas.

Innovation Strategy

Innovate to generate value in business, today and in the future, and achieve the goals in decarbonization.

Our Portfolio

E&P

Due to the quality of our reserves, technology, and assets, we can remain a competitive producer, supplying oil and gas with reliability and superior quality in terms of carbon intensity and resilience to low oil prices. The value of our E&P portfolio comes from our strengths in deepwater and ultra-deepwater oil exploration and production. Our portfolio resilience assessment ensures that every investment project is viable at an oil price of $35/bbl over the long term.

The cost of production is an important element of resilience in all scenarios, particularly in scenarios of accelerated transition to a low-carbon economy. Then, our perspective is to operate with average E&P extraction costs of US$ 5.5/boe, being as low as US$ 4.2/boe in the pre-salt production, which will represent around 80% of the company's total at the end of the five-year period.

Our total cost of oil produced[1] (CTPP), which includes extraction costs, government royalties, and depreciation and amortization, remains competitive, with a value of US$ 33/bbl.

[1] Does not include, mainly, exploratory investments and cost of capital.

Decision-making Process for Investments, Acquisitions, and Divestments

Capital investments are approved only if they maintain their viability (net present value greater than zero) in all our scenarios, including Resilience. This premise applies to all projects[2] and ensures that our investments remain economically viable even in lower price scenarios.

Assessments of aspects related to emissions and climate change are an integral part of the investment project phase gate process. In addition to emission estimates, absolute and/or intensity indicators are calculated, and potential mitigation measures or reduction opportunities are evaluated. Sensitivity analysis to carbon pricing is also part of the evaluation process for new ventures, in which economic indicator changes are evaluated when considering the carbon prince curve of the Base scenario.

[2] It is worth noting that projects eligible for the decarbonization fund use criteria such as avoided emissions, internal carbon price, and the marginal cost of emission abatement, under a specific approval governance.

RTM

Our refining, transportation, and marketing strategy is based on portfolio management and regional synergy with exploration and production assets and with the main Brazilian markets. We seek resilience through operational excellence in energy efficiency, emissions, and reliability, anchored by the RefTOP Program and AVANÇA LOG, aiming to be among the best refiners in the world regarding efficiency and operational performance.

In an environment of the energy transition, the second source of transformation is adapting our production to market evolution. The refining park continues to be modernized, expanding the production capacity for low-sulfur fuels. Among the highlights of these investments, we have the projects to implement a new HDT (Hydrotreating) at REPLAN and the revamp of HDTs at REVAP and REDUC, which will increase our capacity to produce S-10 diesel (ultra-low sulfur diesel fuel that has a maximum sulfur content of 10 parts per million). With the start-up of the GASLUB cluster and the 2nd production train of RNEST in 2028, our S-10 diesel production capacity grows by 318 thousand bpd.

Also, we see the opportunity to capture value by applying our technical skills to market development and the production of less carbon-intensive fuels through advanced industrial routes. For example, our BioRefining Program focus on producing Sustainable Aviation Kerosene and renewable diesel in plants integrated with oil refineries. These actions represent approximately 8% of total Refining investments.

We also seek to offer non-energy products with greater added value, as in the case of the production of Group II lubricating base oils at the GASLUB cluster, adding around 12,000 barrels per day of advanced lubricants.

In terms of logistics, investments are planned for the maintenance of 36 ships, also considering the demands of environmental legislation, as well as the installation and replacement of 178 km of pipelines to improve the flow of our products and reach even higher levels of safety and protection to the environment.

In maritime transport, we seek to optimize routes, control the speed of vessels, and advance in contracting vessels with better consumption performance and, consequently, lower greenhouse gas emissions.

>> See chapter **Investments and Initiatives**

G&P

Our G&P strategy adapts to the high share of renewables in the Brazilian energy matrix. Considering the intermittency of modern (wind and solar) sources and the seasonality of hydropower, dispatchable thermal power plants are necessary to provide energy security to the growing incorporation of renewable sources. In this sense, we continue focusing on selling gas from our portfolio and optimizing our thermal power plants portfolio, seeking efficiency gains in thermal power plants.

In collaboration with our partners, we will expand our infrastructure and portfolio and continue to operate competitively in the natural gas market, seeking a significant increase in the supply of about 50 million m³/d of natural gas. We highlight the startup of the integrated ROTA 3 project, in 2024 (gas pipeline and Natural Gas Process Unit capacity at the GASLUB cluster of 21 million m³/d), SEAP - Sergipe Águas Profundas (Sergipe deep-water), in 2027 (gas pipeline capacity of 18 million m³/d), and BM-C–33– pre-salt in the Campos Basin, in 2027 (gas pipeline capacity of 16 million m³/d). The optimization of our thermal power portfolio profile focuses on natural gas-fired power plants with high efficiency, seeking to offer a capacity of 3.6 Gigawatt average in 2027, reaching 5.1 Gigawatt average in 2030.

Profitable Diversification

Moving forward with initiatives aimed at portfolio diversification, throughout 2022, specific governance mechanisms were implemented. The most promising businesses in the energy transition were mapped and characterized from our perspective. A relevant range of knowledge about these businesses already developed in the company was gathered.

In addition to the efforts to offer products with lower carbon intensity, with emphasis on biorefining, the SP 2023-2027 brings as an evolution the businesses that were identified by a multicriteria analysis, among several studied, as the most suitable for further studies by the Company: offshore wind power, hydrogen, and carbon capture. We do not have investment provided in this strategic plan for these possible new businesses.

Brazilian context and voluntary contributions to Brazil's decarbonization journey

Brazilian Context

More than 97% of our operational emissions occur in Brazilian territory. Thus, our actions to mitigate climate change must be aligned with the country's decarbonization path.

Brazil is committed to reducing greenhouse gas emissions by 37% in 2025 and 50% in 2030, compared to 2005. 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.

Commitments to reduce emissions signed by Brazil:

UPDATE OF THE BRAZILIAN NDC

> Reduction of 37% of Brazilian emissions in 2025 and 50% in 2030, with 2005 as the base year.

GLOBAL COMMITMENT TO METHANE REDUCTIONS

> 30% reduction in methane emissions in Brazil by 2030, with 2020 as the baseline.

GUIDELINES FOR A NATIONAL STRATEGY FOR CLIMATE NEUTRALITY

ACTIONS FOR THE ENERGY SECTOR INCLUDE:

> Achieve a 45% to 50% share of renewable energies in the composition of the energy mix in 2030
> Expand the participation and consumption of biofuels through RenovaBio Program
> Encourage the manufacture and use of electric and hybrid electric vehicles
> Promote efficiency gains in the energy and electricity sector
> Encourage the energy use of residues
> Reduce the carbon footprint of the oil and gas, and biofuels sector

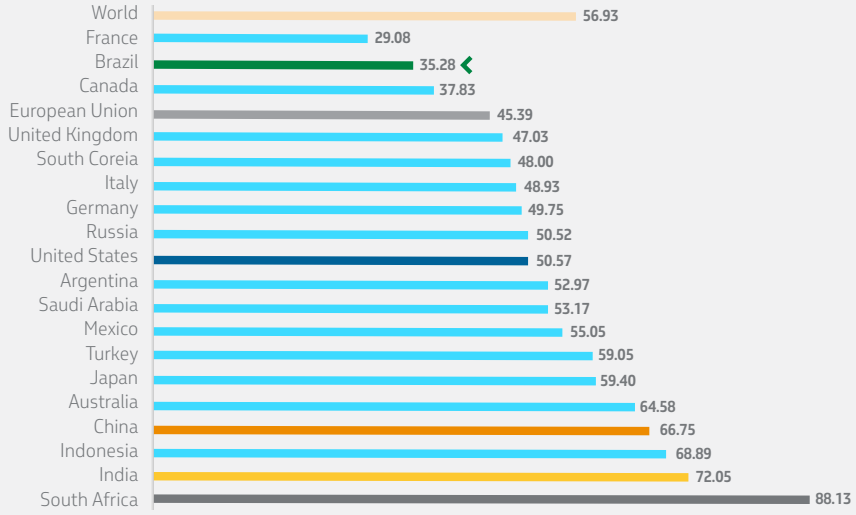
Profile of GHG Emissions in Brazil

Brazil has a different profile in the decarbonization scenario. While emissions from energy production and use predominate in the world (76%), in Brazil, greenhouse gas emissions related to land use and land use change correspond to 38% of total emissions, followed by emissions from the agricultural industry (28.5%) and energy (23.2%) (WORLD RESOURCES INSTITUTE, 2020; BRASIL MCTI, 2022).

The significant representativeness of emissions related to the land use and land use change highlights the importance of successfully controlling these emissions, which presents a favorable marginal abatement cost among other decarbonization options. Studies such as that of the World Economic Forum (WORLD ECONOMIC FORUM, 2021) estimate a potential of 1 billion tons of CO_2e per year in forestry projects with a cost below US$ 35/tCO_2e in Brazil, which represents around 15% of the world's potential for mitigating emissions through low-cost restoration and preservation of biomes.

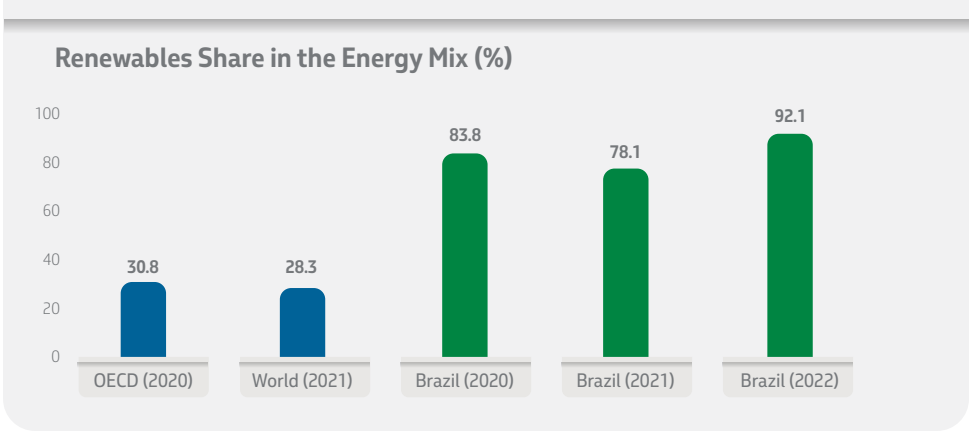
The Brazilian energy mix is the second least carbon-intensive of the G20 (35.28 $kgCO_2e/GJ$). The low-carbon intensity of the Brazilian energy sector directly results from the high share of renewables in its energy mix.

G20: Energy Sector GHG Intensity per Primary Energy Consumption ($kgCO_2/GJ$), 2021



Source: Based on the "bp Statistical Review of World Energy 2022" and "BEN 2022 | Relatório Síntese | Ano base 2021"

Electric power generation in Brazil is based on renewable sources and has low emissions when compared to most other countries.



Note: Data referring to the OECD and Brazilian data on domestic electricity supply in 2020 and 2021 obtained from EPE (2022b); Worldwide data obtained from REN21 (2022); Brazilian data on electricity generation connected to the SIN in 2022 obtained from ONS (2023).

Due to the water stress registered in 2021, there was an increase in fossil thermoelectric generation and a decrease in the share of hydropower generation compared to 2020. In 2022, hydroelectric generation recovered due to the improvement in rainfall and the implementation of a water crisis management strategy. In total, renewable energy sources were responsible for around 92% of the electricity supply to the SIN in 2022, with 72.5% coming from hydroelectric plants, 13.4% coming from wind farms, 4.0% generated in biomass/industrial waste thermal power plants and another 2.1% from solar plants (ONS, 2023). According to International Renewable Energy Agency, a reduction in GHG emissions consistent with the target of 1.5°C requires the participation of 90% of renewable energy in the global electricity mix in 2050 (IRENA, 2022). Thus, in a typical year, the Brazilian electricity mix is already comprised of renewable energy at the recommended level. In the case of Brazil, the challenge is maintaining the high share of renewable sources in the Brazilian electricity mix.

The transport sector is responsible for 33% of the final energy consumption in Brazil. Its consumption is influenced by several factors, such as *per capita GDP*, availability and efficiency of logistics infrastructure, environmental policies, and people's behavior. Cargo transport represents 40% of this energy demand and is mainly based on road transportation. Our road infrastructure results in one of the most fuel-intensive economies net, around 0.31 boe/thousand US$GDP, equivalent to twice the world average. Therefore, the economy is susceptible to its cost (EPE, 2022b). In this sense, opportunities to increase the efficiency of the logistics and transport infrastructure play a relevant role in decarbonization since they may lead to lower primary demand for energy and lower cost for the same energy service.

In recent years, there has been an incentive to increase concessions and investments in railroads, waterways, and ports. Rail investments are expected to be key in raising its share in the Brazilian transport matrix (IEA; EPE, 2021). However, despite the growing participation of other modes, road freight transport should maintain its high representation in the energy demand of the transport sector (EPE, 2022c).

Transforming infrastructure requires high investment and an extended time frame. On the other hand, renewable liquid fuels still impact the prices of goods and services, and demand public incentive policies impacting government revenue.

Worldwide, the demand for biofuels is correlated with the adoption of public policies such as mandatory mixtures, different taxation systems and subsidies. For biofuels to be widely used, they need to be competitive with fossil fuels. Thus, government policies promote the production of biofuels through legal, political, and regulatory frameworks that establish specific commercialization rules, with the mandate being the most used rule today.

Using existing technologies and infrastructure, biofuels play a relevant role in the carbon intensity of the Brazilian transport sector. According to the OECD, Brazil is the only country in which the use of biofuels exceeds 10% of transport energy demand (OECD-FAO, 2022), reaching approximately 23% share in the transport segment (EPE, 2022b). As a reference, the IEA's NZE scenario for 2030 expects a global contribution of 15% of biofuels in the transport sector.

The country is among the three largest producers and consumers of biodiesel in the international ranking[3], driven by public incentives, such as the RenovaBio Program. In 2021, the use of renewable fuels in Brazil amounted to 66.9 million tCO_2e in avoided emissions compared to fossil equivalents (EPE, 2022a).

Prioritizing the use of the existing supply infrastructure in the territory, the RenovaBio Program fosters an increase in biofuel production in the country under sustainable standards and contributes to fulfilling emission reduction targets.

Other Brazilian policies and programs related to the transport sector seek to improve energy efficiency, such as the Rota 2030 Program, or encourage less carbon-intensive fuels, such as biodiesel and sustainable aviation kerosene, an initiative launched in the Combustível do Futuro (Fuel for the Future) Program.

[3] In 2021, Indonesia, Brazil and the United States accounted for 18%, 15% and 14% of world production, respectively (REN21, 2022)

In the Brazilian decarbonization journey, the new renewable energy technologies, such as offshore wind and hydrogen should also be mentioned. Offshore wind generation has more than 55 GW of installed capacity worldwide (GWEC, 2022) and awakens the interest of different agents in Brazil. There are currently 70 requests for environmental licensing of offshore wind farms at IBAMA (Brazilian Institute for the Environment and Renewable Natural Resources, a federal agency linked to the Ministry of the Environment and Climate Change), totaling more than 170 GW (IBAMA, 2022). However, the regulatory environment and cost competitiveness still must be addressed to allow the development of this energy source at the expected pace and scale.

Increasing the share of hydrogen in the Brazilian energy mix is one of the aspects of the National Hydrogen Program (PNH2), established by CNPE nº 6/2021 Resolution. The PNH2 proposes to define a set of actions that facilitate the joint development of three fundamental pillars for the successful development of a hydrogen economy: public policies, technology, and the market.

We believe the new O&G exploratory frontiers are part of the future energy solution, ensuring a secure energy supply. We consider that new exploratory projects will use the technical knowledge accumulated by our teams in decades of activity, combined with the latest artificial intelligence tools, using all possible data in our projects, thereby reducing costs and environmental impacts. We recognize the importance of developing these new frontiers in a context that meets the comprehensive characteristics of ESG and can bring more sustainable and resilient energy solutions in energy transition scenarios toward a low-carbon economy.

Aligned with the Brazilian movement, in 2022, we deepened the analysis of new opportunities for diversification, and we will further deepen technical and economic studies to evaluate investment opportunities and business models in offshore wind, hydrogen, and CCUS, aiming at diversifying revenues and with a potential to contribute even more to the decarbonization trajectory in the country.

We believe compliance with Brazilian commitments must consider the just and inclusive energy transition process. Continuing decarbonization requires identifying lower-cost options for society, making energy more accessible, a fundamental element of competitiveness and social well-being.

The energy sector must continue to contribute to minimizing climate change, maintaining or increasing the contribution of renewable sources, and improving the efficiency of fossil fuels through investments and measures that reduce and offset their emissions. Reducing deforestation and encouraging reforestation and restoration are essential factors in the country's decarbonization path.

We support projects that act throughout their implementation in the direct recovery or conservation of forests and natural areas of the Atlantic Forest, Amazon, Caatinga and Cerrado, contributing to the mitigation of greenhouse gas emissions due to deforestation in Brazil.

Voluntary Social and Environmental Investment with an Impact on Climate Change

One of our Social Responsibility Policy guidelines is investing in socio-environmental programs and projects, contributing to the communities where we operate and, consequently, to society. Our voluntary socio-environmental investment complies with the 2023-2027 Strategic Plan as a tool to support the sustainability of our business.

The socio-environmental projects in the Forest line of action contribute to reducing greenhouse gases and generate several social and environmental benefits in their regions, supporting natural climate solutions.

Our portfolio of Forest-oriented projects in the Petrobras Socio-environmental Program is dynamic and, in 2022, had 22 projects under execution. Around R$ 73 million will be invested throughout these initiatives, considering contracts that started in 2018 and others that will unfold until 2025.

In 2022, we supported projects in the direct recovery or conservation of around 254,000 hectares of forests and natural areas of the Atlantic Forest, Amazon, Caatinga and Cerrado, and approximately 11 million hectares, including sustainable management actions and monitoring by the communities, contributing to the mitigation of greenhouse gas emissions and, in particular, to Sustainable Development Goals 13 (Climate Action) and 15 (Life on Land).

The actions of vegetation recovery and productive reconversion lead to the net removal of carbon from the atmosphere (CO_2 removal from the atmosphere through biomass production). On the other hand, direct conservation actions prevent deforestation and forest degradation in their areas, preventing the carbon stored in the existing vegetation from being emitted into the atmosphere. The set of results that represents the gains obtained through the carbon flows between vegetation and the atmosphere is called the net incremental benefit, which includes net removal and avoided emissions. This benefit estimated for our efforts since 2013 until now is approximately 2.3 million tCO_2e. We only consider the results accumulated in ongoing projects in 2022, acknowledging that the results reported by projects used a shared methodological guide prepared in 2019 to guide the carbon quantification. This guide brings together the methods of the Intergovernmental Panel on Climate Change (IPCC), the World Resources Institute (WRI)/Brazilian GHG Protocol, the United Nations Framework Convention on Climate Change (UNFCCC)/Clean Development Mechanism (CDM), the Verified Carbon Standard VCS/Verra, and the Brazilian National Inventory of Anthropogenic GHG Emissions from Land Use, Land Use Change and Forestry (UTMUTF).

Carbon stock benefit

In addition to the net incremental carbon benefit, some supported projects show expressive results regarding carbon stock, which represents the amount of carbon stored in the existing vegetation in the project area. The presence of the project contributes through direct or indirect conservation actions so that the vegetation remains preserved over time. Here are some significant projects and their results:

Tradição e Futuro da Amazônia (Tradition and Future of the Amazon): operates in 5 indigenous lands (Kayapó, Menkragnoti, Capoto/Jarina, Las Casas and Baú), located in the states of Pará and Mato Grosso, strengthening the ways of life of the Kayapó-Mebêngokrê, through actions supporting territorial and environmental management in their communities. Carbon Stock: approximately 3.2 billion tCO_2e.

Florestas de Valor (Valuable Forests): operates in the northern region of Pará (municipalities of Oriximiná and Alenquer) and in the southeast of Pará (municipality of São Félix do Xingu), strengthening the livelihoods of quilombolas, family farmers and indigenous peoples of the Waiwai, Hixkaryana, Kaxuyana, and Tunayana peoples, through the structuring of socio-biodiversity product chains, strengthening of community enterprises, implementation of sustainable production systems and access to public policies and institutional markets. Carbon Stock: approximately 15.6 million tCO_2e.

No Clima da Caatinga (In the Caatinga Climate): operates in the states of Ceará and Piauí, in the Serra das Almas Natural Reserve, a 6,285 ha Private Natural Heritage Reserve (PNHR), strengthening the livelihoods of 40 rural communities located around this area through forest conservation and restoration actions, environmental education, dissemination of social technologies for adapting to semi-arid conditions and climate change. Carbon Stock: approximately 1.5 million tCO_2e.

Environmental compensation

In addition to voluntary investments, since 2009, we have offset more than 1.6 million tCO_2 in compliance with licensing conditions.

We highlight that the ongoing projects, in 2022, contributed to strengthening more than 27.8 million hectares of protected areas, such as conservation units and indigenous lands, through actions such as fire monitoring, biodiversity monitoring, and sustainable management for income generation through the development of socio-biodiversity chains[4]. The projects have been involved in several forums or councils with participation from civil society and public authorities, such as Conservation Units Management Councils, Municipal and State Environmental Councils, and River Basin Committees. As a result, these initiatives support the management of these areas and enhance their conservation capacity, also contributing to income generation through the valorization and commercialization of socio-biodiversity products.

See below some of our forest-focused volunteer projects. More information is available on the Society and Environment page of the Petrobras website:

>>Click here and access

Vale Sustentável

The Vale Sustentável (Sustainable Valley) project partnered with 19 rural communities in the municipalities of Alto do Rodrigues, Assú, Carnaubais, Guamaré, and Itajá in the state of Rio Grande do Norte to recover 150 hectares in the Caatinga biome. The path found by the Rio Grande do Norte Association of Agricultural Engineers (ANEA), which runs the project sponsored by the Petrobras Socio-environmental Program, was to strengthen family farming, and food and nutritional security for hundreds of families. In two years of operation, 15,000 early fruit seedlings were distributed and are cultivated in productive backyards with guidance from project technicians, without pesticides. In addition to the agroecological gardens, the community learned how to raise bees, promoting the production of high-quality honey. The surplus of fruits, vegetables, greens, and honey, is sold at free markets in the region, contributing to income generation, eradication of poverty and hunger, and quality health (SDG 1, 2 and 3). Another activity, between 2020 and 2022, was the training of 56 seed collectors, an important activity for the production of seedlings of native species, some endangered, as is the case of Aroeira (*Myracrodruon urundeuva*), Barauna (*Schinopsis brasiliensis*) and Umburana (*Amburana cearenses*), and recovery of protected areas in the region.

Semeando Água

The Semeando Água (Sowing Water) project operates in the region of the Cantareira System, which covers approximately 230,000 hectares within the limits of 8 municipalities in São Paulo and Minas Gerais. Research carried out by IPÊ (Environmental Research Institute) shows that the soil is the critical element to water security in this system, which supplies water for more than 7 million people. Water needs to infiltrate and remain stored in the soil, being gradually released to the reservoirs to maintain the water level. Therefore, the project seeks to engage landowners, producers, and rural successors by inviting them to rethink land use. The addition of new project partners, the "Water Sowers", begins with the rural properties planning, carried out by the landowners in partnership with the project team. It includes the legal adaptation of the properties following the guidelines of the Brazilian Forestry Code. The plan is that land use connects the need for conservation with the economic potential. Among the alternatives are Ecological Pasture Management, Agroforestry Systems, Fruit Growing, and Silviculture of species native to the Atlantic Forest. Since 2013, the Semeando Água project has attracted the partnership of more than 40 producers who grow coffee, flowers, honey, juçara palm trees, and native fruits of the Atlantic Forest, adding production and ecological services to approximately 100 hectares. The project also develops environmental education activities to prepare school communities to face the challenges of climate change, called "Escolas Climáticas" (Climate Schools). There will be 6 schools and over 1,000 children and adolescents benefit through technical support and necessary inputs to diagnose the needs, plan and implement impactful actions for climate change mitigation and adaptation.

[4] The profile of the projects and type of action affect this value and reflect the composition of the portfolio, whose dynamics may lead to annual variations.

Fogão do Mar

If, on the one hand, mangroves are considered vital to curb climate change, on the other, they are threatened by urbanization, logging, and other risks associated with humankind. The Fogão do Mar (Sea Stove) project sees the kitchen as an opportunity to conserve mangroves in 90 communities in the municipalities of Maragojipe and Cachoeiras, in Bahia. With our sponsorship, the project carried out by Instituto Perene delivered 2,800 eco-efficient stoves, improving the quality of life of families (many in quilombola communities), protecting the environment by reducing deforestation to obtain firewood, and strengthening communities. The "rocket stove" type requires less firewood and has better combustion, emitting fewer polluting particles than a rudimentary stove. The process of building and installing the stoves generated income in the two municipalities in the Recôncavo region of Bahia, not only by using local content, but also by training 92 young residents who underwent professional training. That training allows the knowledge about stove construction to be kept at these places, where there are few job opportunities, even after the completion of the project.

Raízes do Purus

The Raízes do Purus (Purus Roots) project has developed a collective management for the Pirarucu fishery with indigenous peoples, contributing to the conservation of thousands of hectares of the Amazon rainforest, while ensuring food security, strengthening income generation, community organization, and territorial surveillance. The Paumari were one of the pioneers in implementing sustainable management of the Amazon "giant" in indigenous lands. Pirarucu's recovery, the world's largest freshwater fish, which can reach up to 3 meters and 200 kilograms, went from scarcity to abundance thanks to the sustainable management carried out in three indigenous lands. Since 2009, they have intensified surveillance of lakes and started monitoring stocks. It took five years of complete fishing restriction, and today they celebrate the 600% increase in the number of fish. Only 30% of adult fish can be fished annually. In 2013, 448 individuals were counted, and in 2021, the number of adult Pirarucus increased to 2,995, resulting in a quota of 650 individuals. Over 36 tons of high-quality animal protein were marketed through Associação Indígena do Povo da Água – AIPA (Indigenous Association of the Water People). With the support of Raízes do Purus, and other projects carried out by the Native Amazon Operation (OPAN), the Paumari are progressively and continuously being trained for the management of their association and processes related to management and fishing and have achieved significant advances in the structure they have for these activities, in particular for the acquisition of floats destined for the surveillance and pre-processing of the Pirarucu. Also, the project has a substantial estimated contribution of 1.6 million tCO_2e in terms of avoided greenhouse gas emissions through actions that prevent deforestation and forest degradation.

No Clima da Caatinga

The No Clima da Caatinga (In the Caatinga Climate) project is committed to reducing the potentiating effects of global warming through the conservation of the semiarid region by developing an integrated model for the conservation of the Caatinga. In addition to the forest restoration actions in the semiarid region, the project stands out for the distribution of social technologies for coexistence with the hot and dry climate on the border of the states of Ceará and Piauí, where the average annual rainfall is only 650 mm. In 11 years, the project conducted by Associação Caatinga has already carried out the distribution of 88 cisterns – 20 more are under construction – and five Biowater Systems, promoting adaptation to the semiarid conditions of the region and improving the quality of life of the people who live in the Serra das Almas Natural Reserve, located between the cities of Crateús (CE) and Buriti dos Montes (PI). The distributed cisterns have the capacity to store up to 16,000 liters of rainwater, suitable for drinking, which is enough to meet the needs of a family of five for 8 months. The Biowater System has the capacity to filter up to 500 liters of water. The process takes place through mechanisms that remove solid waste from the water used at home. The excess water is used to irrigate vegetable gardens, farms and gardens. More than 6,440 hectares of preserved caatinga over more than 13 years have the potential to contribute with about 7,000 tCO_2e.

Floresta Viva Initiative

To expand our investments in a more diverse portfolio of projects in this area, in line with our objectives and strategic commitments, we established a partnership with the Brazilian Development Bank (BNDES) through the match-funding Floresta Viva (Living Forest). Aimed at gathering joint financial support for reforestation projects of native species in Brazilian biomes, we intend to follow the path of generating carbon credits. Petrobras will invest R$ 50 million from 2022 to 2026 and the initiative will have the Brazilian Biodiversi-

ty Fund (FUNBIO) as a managing partner, with the role of making selections, contracting, and monitoring projects.

In partnership with the BNDES and with the execution of FUNBIO, we launched "Manguezais do Brasil" (Brazilian Mangroves) in November 2022, which is the first request for proposal under Floresta Viva. A total of R$ 44.4 million from Petrobras and the BNDES resources will be made available for up to nine ecological restoration projects for mangroves, salt marshes/apicuns, restingas, and their draining basins. We believe in the importance of this call as an advance in this knowledge frontier, particularly in Brazil, which has one of the world's largest extensions of mangroves. This initiative will reinforce our socio-environmental investments in blue carbon. Petrobras Socio-environmental Program's project portfolio in effect in 2022 includes six supported projects focused on mangroves.

An example is Projeto Mangues da Amazônia (Mangroves of the Amazon Project), supported by us since 2021. It aims to restore degraded mangrove areas in the planet's largest continuous area of mangroves, located on the Amazon coast. The project has already reforested 14 hectares with 204,000 seeds and seedlings, while developing socio-educational activities with 514 children and young people and training 178 people. Also, it has participatively developed management plans for the sustainable use of the Uçá crab (*Ucides cordatus*) and the white mangrove (*Laguncularia racemosa*) in order to contribute to economic sustainability and ensure community participation in biodiversity conservation and management of the three Marine Extractive Reserves served.

Our actions for blue carbon

Mangroves are coastal ecosystems of great ecological, social, and economic importance, relevant to marine and terrestrial biodiversity, which serve as protection for coastal areas and on which many traditional communities depend. They are sensitive ecosystems with great carbon storage potential and are subject to high anthropogenic pressure due to urban expansion and related activities.

Knowledge gaps about these ecosystems and factors such as complexity and high transaction costs make them a global challenge. This ecosystem was chosen as the focus for one of the first voluntary initiatives being developed by the World Economic Forum at the "Ocean 100 Dialogues" forum, where we joined the most prominent companies operating in the oceans to discuss transformative corporate initiatives for more equitable and sustainable use of the oceans.

Just Transition

Just Transition is characterized by an inclusive path towards a low-carbon economy, with changes in energy use patterns, which seeks to assess and minimize the social impacts for its stakeholders.
Strategies for this transition seek to ensure that employees, communities, and the supply chain have fair opportunities to access and develop new sustainable livelihoods, especially in the following aspects:

Community: guarantee accessibility, availability, and reliability of the energy necessary for living, considering the cost, distribution infrastructure, and essential equipment for using energy sources.

Employees: plan the development of new technical skills, retention, and reallocation of employees in new businesses, especially in the event of discontinuity in some areas of activity.

Supply Chain: incorporate sustainability requirements in contracting that consider a minimum adaptation time for the companies participating in the business value chain.

Just Transition discussions have been historically marked by the mention in the Paris Agreement (2015) that the countries' commitments should consider the imperatives of a Just Transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities. Additionally, in this context, the International Labor Organization reinforced in its "Guide to a Just Transition" that a just transition for all towards an environmentally sustainable economy needs to be well managed and contribute to the goals of decent work for all, social inclusion, and the eradication of poverty (ILO, 2015).

During COP 27, in Sharm El-Sheik, it was reinforced the need for a just energy transition based on development priorities defined at a national level and aligned with the increase in the generation of renewable energy or energy with lower GHG emissions.

Our Position for a Just Transition

We recognize the relevance of the movement towards a just transition, and we are attentive and active to evolve in this theme, so that we can incorporate more and more of its elements in our business management. Our corporate social responsibility practices and compliance with legislation practices that are applied in portfolio management (new ventures and divestments) and in mitigating the socio-environmental impacts of our operating assets are already aligned with many aspects necessary for a just transition.

Aiming to deliver sustainable results for a society in transition, our investment plans and targets for reducing greenhouse gas emissions are assessed annually so that the pace and scale of actions follow the progressive technological advances, risk assessment, and regulatory changes in the subject of the energy transition. In our 2023-2027 Strategic Plan, we highlight our areas of activity that contribute to the security of energy supply, such as the production of highly efficient oil in terms of emissions and the supply of gas and dispatchable energy that enables the high share of renewables in the Brazilian electricity mix.

Within the context of the just transition, our short-term strategies include reducing operational emissions from existing assets and producing less carbon-intensive fuels, such as Diesel R (diesel with renewable content, produced via co-processing). Our Strategic Plan also contemplates the project of a new biorefining unit dedicated to sustainable aviation kerosene and renewable diesel production.

For the medium-long term horizon, in the search for diversification alternatives in which we have competitive advantages to act in the future, the SP 2023-2027 signaled three segments for deepening the studies and business models: hydrogen, offshore wind energy, and carbon capture. The investment decision will depend on sustainability assessments in economic and environmental aspects.

In the environmental licensing process for new undertakings, the environmental agency can define social participation in the decision-making process for the license by holding public hearings, which are held by Petrobras, and have the participation of different agencies and communities inserted in the influence areas of the enterprise or activity.

Calls for public hearings, as well as their minutes, are made available by Petrobras on the Transparency Portal:

>>Click here and access

Environmental Impact Studies, Environmental Impact Reports, and Simplified Environmental Reports are available on the Society and Environment page of the Petrobras website:

>> Click here and access

We highlight that social participation throughout the lifecycle of Petrobras' businesses is carried out in a continuous and systematic manner, in accordance with our HSE policy, through the application of two of its guidelines:

Community relationship guideline that aims at mitigating safety, environmental and health risks, and impacts for communities potentially exposed to risks in the territories where it operates, keeping them informed about company activities;

Communication guideline that aims to clearly, accurately, and diligently communicate information related to safety, environment, and health, to serve different stakeholders.

We share our commitments and decarbonization targets in the communication channels with our supply chain. We also have procedures for assessing the risks of including sustainability requirements in contracting processes, including market consultation. Currently, the priority areas for incorporating sustainable procurement requirements are those where efficiency provides the benefits of cost reduction and emissions reduction.

Considering the company's voluntary socio-environmental investment through the Petrobras Socio-environmental Program, especially in the Forest line of action, in addition to the carbon contribution, several social and environmental benefits are produced, such as:

- **Associated biodiversity conservation**
- **Income generation by supporting local productive chains**
- **Promotion of gender equity**
- **Food security**
- **Maintenance of ecosystem services**
- **Development of forest inventories**
- **Communities training**
- **Generation of knowledge and georeferenced database**

Management of Socio-environmental and Climate Risks in Projects

In addition to the legal obligations of the environmental licensing process, we have defined an internal system for assessing socio-environmental and climate risks, besides other aspects, during the investment project phase gate approval process. The system requires presenting a set of project information compatible with each development phase, which must be included in the set of decision support documents, among them the phase's Technical and Economic Feasibility Study Report. Among the documents that constitute this report for investment projects, we highlight the Social Responsibility Report and the Health, Safety, and Environment (HSE) Report. The Social Responsibility Report includes information about the project, the characterization of the social context, and the identified social risks matrix. The HSE Report presents the description of compliance with the applicable HSE requirements, including, in addition to other information, assessments on socioeconomic aspects, climate and atmospheric emissions, including greenhouse gases, carbon risk of projects, and climate risk assessments.

During the phase change assessment, other documents may be mandatory, depending on the investment amount, such as an evaluation from external reviewers of the project, with an assessment of the project's adherence to our sustainability commitments and legislation, including compliance with the Social Responsibility and HSE requirements, as well as indicating to decision-makers the most relevant points and risks of the project, whether positive or negative.

The social responsibility analysis of investment projects gives rise to recommendations that include the review of emergency response plans, the monitoring of occurrences and community complaints, actions to publicize projects and operational activities, and the inclusion of social responsibility clauses in service contracts.

We have processes for developing asset decommissioning projects, in addition to HSE policies, guidelines, and standards, which establish the guidelines, procedures, and activities to plan and execute offshore and onshore asset decommissioning. Compliance with the decommissioning obligation involves different activities carried out in accordance with the decommissioning plan approved by regulatory bodies and in accordance with applicable legal requirements. In compliance with ANP Resolution 817/2020, we now include a chapter in the Facility Decommissioning Programs with information on the social responsibility and sustainability system.

The main social risks identified in the E&P segment project review groups are damage to fishing and tourism in the event of a major accident, circulation restrictions due to vessel movement, and the risk of human rights violations in the supply chain.

In the case of the project review groups in the Refining and G&P areas, the social risks that stood out were the exaggerated expectation of generating labor, inconvenience to communities and the risk of human rights violations in the supply chain.

In E&P, Refining and G&P projects, the risk of a resurgence of Covid-19 was identified and addressed. All social risks are recorded and dealt with by the actions of the local Social Responsibility Plans.

In 2022, we obtained approval from the Brazilian regulatory bodies for decommissioning the FPSO Capixaba in the Jubarte field in Espírito Santo and completing the unmooring of the P-07 platform in February. Also, we advanced with approval stages for the decommissioning of other production systems, such as the P-33 and P-26, and we continue to carry out disconnection operations and removals of subsea equipment already approved for decommissioning projects underway in the Campos Basin, highlighting those related to the project to revitalize the Marlim field. We also abandoned 13 wells.

In 2022, we created an Executive Decommissioning Committee with the purpose of monitoring the evolution of the best global practices and deliberating the strategic guidelines for the implementation of decommissioning projects. It should also be noted that in 2022 we modified our strategy for the disposal of decommissioned units, and we are implementing a green recycling policy for platforms undergoing decommissioning, in line with the best practices.

In the case of divestment, strict criteria are applied in the selection of potential buyers to guarantee the technical, financial, and operational capacity to continue the business. The divestment process requires a risk assessment and the participation of different company areas to ensure compliance with our sustainability commitments, compliance with legal and regulatory requirements, and the adoption of the best HSE and Social Responsibility practices.

Given the active portfolio management planned in SP 2023-2027, the HSE and Social Responsibility areas assess social risks and impacts on divestment projects. These assessments consist of: an analysis of socio-environmental impacts; recognition of the social context of the territory; identification, analysis, and qualification of the severity of social risks (bowtie and risk matrix) conducted in workshops with a multidisciplinary group; a proposal of an action plan for dealing with risks and monitoring the entire process. Over the past year, we have valued several assets at different stages of our divestment portfolio. We can highlight the social risk assessments made in refineries and onshore and offshore E&P assets in divestment processes. These assessments will support a treatment management plan with remediation, transfer, and mitigation activities, if necessary, of the most severe social risks. With this management plan, the company can mitigate the risks or involve the purchaser of the asset in the process to correctly deal with the main social impacts to be addressed.

Employee Relocation

In times of transformation, our focus is always on the professionals involved. Along with safety and operational continuity, attention and respect for people are fundamental principles we apply in all our actions.

We adopt an integrated change management journey for employees affected by collective transfers in order to manage the different aspects involved in the transition, with attention to people and a focus on transparency. In this process, we consider the diversity of individual situations and provide specific actions for allocating, moving, and acclimating employees, promoting the necessary training. Additionally, we implement communication and engagement activities for stakeholders, health actions, organizational climate surveys, and labor impact studies.

Health Journey Project in Portfolio Management

We reiterate our full attention and comprehensive care for employees, emphasizing those in assets that are currently undergoing divestment process. With this purpose in mind, the Health Journey Project in Portfolio Management has been developed over the last four years. In this project, actions are taken to welcome and care for employees, healthcare professionals, and managers who will be transferred to other units.

Our employees are involved in educational actions, with topics covering the importance of care and attention to health in situations of change, stress management, the role of support networks, and financial education, among others. In addition, all employees of such public undergo a listening and welcoming process when they are individually attended to, and their biopsychosocial issues are carefully evaluated by a multidisciplinary healthcare team, seeking recommendations regarding the timing and movements of the transfer.

We also rely on local occupational health services, which systematically monitor the health conditions of these employees throughout the process through regular occupational assessments, availability for spontaneous demand, and readiness for emergency care.

Governance, incentives and risk management

The topic of climate change is part of our Health, Safety and Environment (HSE), and Social Responsibility (SR) Policies.

Health, Safety and Environment Policy

Principle 1 **HSE IS VALUE**	Our zero-fatality and zero-leak ambitions, sustainability goals and commitments, including climate change requirements, are integrated into the company's strategy and decision-making processes.
Principle 4 **SUSTAINABILITY IN BUSINESS**	We conduct our business and activities with environmental responsibility, contributing to sustainable development, committing ourselves to the ambition of carbon neutrality of our operations and to the prevention and mitigation of environmental impacts of activities and products and with the improvement of the environmental quality where we operate.

Social Responsibility Policy

GUIDELINE 2.8	Contribute to sustainable development and to climate change mitigation in alignment with national and international commitments to which we are signatories.
PRINCIPLE	We provide the energy that moves society to accomplish its full potential, respecting human rights and the environment, interacting responsibly with nearby the communities, and overcoming sustainability challenges of our business, including the transition to a low-carbon energy matrix.

Governance of climate change-related risks and opportunities

Our governance focused on risk management (threats and opportunities) of climate change and energy transition is structured in such a way that these issues are addressed at all levels of the company.

The integration of the theme across different levels is carried out by **Climate Change Executive Management,** whose function is to conceive and coordinate the positioning, strategies, and corporate actions related to carbon management, atmospheric emissions, energy efficiency, and climate change, both for us and for our holdings, aiming at maximizing the company's value creation facing risks and opportunities linked to the transition to a low-carbon economy.

Roles and responsibilities of the different governance bodies in climate change-related decisions in the company:

- **Board of Directors (BoD)**: is responsible for defining the general direction of the company's business, establishing its mission and strategic goals, including those related to sustainability; approving the Strategic Plan and the company's global policies, including those on the environment and social responsibility; in addition to monitoring goals, results, and more severe business risks, including those of a socio-environmental nature.
- **HSE Committee**: composed of appointed directors and external members, it is responsible for advising the Board of Directors in establishing policies and guidelines related to the strategic management of HSE, climate change, transition to a low-carbon economy, and social responsibility, among other matters. The committee also monitors relevant sustainability indicators and topics, as well as the management and mitigation of the main risks related to the topic.
- **Executive Board**: comprised of the CEO and executive officers, it is responsible for managing the company's business in accordance with the mission, goals, strategies, and guidelines established by the Board of Directors. The Executive Institutional Relations and Sustainability Officer is responsible for managing and overseeing sustainability-related matters, including climate and the transition to a low-carbon economy.

The advisory committees of the Executive Board are made up of executive managers from the corporate and operational areas who report directly to the members of the Executive Board:

- **HSE Executive Committee**: meets monthly and is responsible for analyzing and issuing recommendations to the Board of Directors on topics related to HSE, such as: strategies, policies, guidelines and their implementation and deployment; goals and investment plans for the development of strategies; performance monitoring and recommendation of improvement actions for the company units and its shareholdings; audit recommendations; proposals for projects and improvement actions and demands of the HSE Committee of the BoD.
- **Risks Executive Committee**: monitors risk treatment actions, analyzing and issuing recommendations on risk management policies and processes, as well as mitigation actions for the main risks, monitoring metrics and risk exposure limits, referring relevant issues to senior management.
- **Management forums of the business segments** (E&P, Refining & Natural Gas, and Trading & Logistics Segment): comprised of the director of the respective business segment and its executive managers, with the participation of a representative of the Climate Change Executive Management, for discussion and deliberation of specific matters of each area.
- **Strategic commissions of the business segments** (E&P, Refining & Natural Gas, and Trading & Logistics Segment): comprised of the executive managers of each business segment, with the participation of a representative of the Climate Change Executive Management, to discuss specific matters of each operational area and recommend topics for deliberation in the Management Forums.
- **Segment-specific Climate Committees**: bring together general managers or managers just below the executive managers of the business segments for joint deliberations on a subject.
- **Climate Commission**: brings together representatives from all areas for joint deliberations under the coordination of the Climate Change Executive Management.

In addition to the described governance, the theme also integrates the discussions of forums aimed at building the Strategic Plan, such as:

- **ESG Corporate Forum:** a forum that brings together professionals from areas related to sustainability and governance issues to assess cross-sectional issues of strategic planning to ensure greater consistency with the positioning and quantification of businesses.
- **Profitable Diversification Committee**: constituted in 2022, the body is responsible for evaluating the company's entry into new business segments, considering multiple aspects, including climate. The Committee is coordinated by the Strategy and Planning area with the participation of Executive Managers who represent each of the company's Boards.

Incentive

The top metrics provide more explicit guidance on our key short-term goals. These are metrics that are rolled out throughout our organizational structure, from top to bottom, to ensure that individual employee actions are aligned with the Plan's main commitments.

In Strategic Plan 2023-2027 (SP 2023-2027), the top metrics focused on value generation, safety, and sustainability in operations were maintained:

> **IAGEE:** Compliance with greenhouse gas targets index

> **VAZO:** Volume of oil and oil products spilled

> **TRI:** Total recordable injuries

> **Delta EVA®:** Economic Value Added

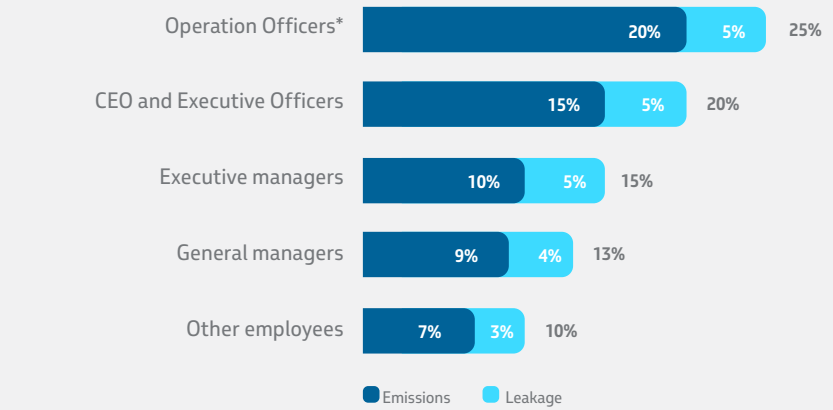
The IAGEE and the VAZO reflect the SP 2023-2027 alignment with low-carbon and environmental sustainability commitments, while the TRI is a fundamental tool for achieving our ambition in terms of safety: zero fatalities. The IAGEE represents the consolidation of attendance of the greenhouse gas intensity targets for E&P and Refining.

For 2023, the IAGEE indicator underwent a change in the factor that represents the E&P segment, which now considers only the GHG intensity of the units in full operation in the year the indicator is monitored.

>> See the metrics table in chapter **Targets, Metrics and Performance**

The IAGEE, VAZO, and ΔEVA® indicators impact the variable compensation of all employees, including senior management. Our variable compensation program aims to align individual performance with our global goals and increase engagement so everyone feels responsible for our results. Thus, the variable remuneration of each employee or executive is calculated based on individual goals and the percentage of achievement of these top three metrics.

Minimum percentage of variable compensation linked to emissions and leakage targets in 2022



*** Note:**
Exploration and Production, Production Development, Marketing and Logistics, Refining and Natural Gas, and Digital Transformation and Innovation

Climate Change Management in Shareholdings

In addition to our operating units, we participate in companies and partnerships involving other projects. Our governance accompanies these participations, seeking excellence in management and strategic alignment.

The controlled companies whose assets are operated or whose operational activities are coordinated by us are directly subject to our goals, initiatives, and governance.

Subsidiaries holding assets with their own operation have specific metrics and initiatives to reduce GHG emissions in line with our net zero ambition.

For other holdings in which Petrobras is not the controlling shareholder, we are developing a plan to engage and disseminate good practices in governance and climate change management, in line with our ambition to neutralize operational emissions.

Risk Management Process

We have a risk management policy that establishes guidelines and responsibilities based on the following principles:

> **Respect for Life and Diversity**

> **Alignment with the Strategic Plan**

> **Ethical Behavior and Compliance with Legal and Regulatory Requirements**

> **Integrated Risk Management**

> **Risk response actions consider possible long-term cumulative consequences, impacts on stakeholders, and are oriented towards preserving and adding value and business continuity**

Risks (threats and opportunities) are identified by each organizational unit, considering the specificities of its processes, operations and objectives. Risks are classified into three groups according to their possible origin: Operational, Financial, and Compliance. Risks are assessed, considering the probability of occurrence and impacts on the financial, image and reputation, legal and compliance, environmental, and life dimensions.

Risk Classification

> **Operational Risk:** Includes risks arising from our core activities, in addition to risks arising from failures, deficiencies or inadequacies in internal processes, provision of goods and services, systems, as well as natural disasters and/or actions by third parties.

> **Financial Risk:** Includes risks arising from market fluctuations, counterparty defaults and mismatches between assets and liabilities.

> **Compliance Risk:** Includes risks arising from laws and regulations applicable to our business, our Code of Ethical Conduct and other internal rules and procedures.

Identified risks must have one or more associated actions corresponding to the risk response. Actions can be of the following types: avoid, reduce, transfer, accept, or exploit (applicable to opportunities). Risks with a very high and high severity or medium degree of severity with a high impact should not be accepted. Response plans with deadlines and responsible persons are established for these risks.

Annually, the Risks Executive Committee (CE-Riscos) and the Executive Board define the strategic risks, according to their importance for the implementation of the company's Strategic Plan, their scope, degree of severity, and resources required for their treatment. These risks must be monitored quarterly by the Executive Board and presented to the advisory committees related to corporate risk management: Statutory Audit Committee (CAE) and the CE-Riscos, being subsequently presented to the Board of Directors.

In addition to strategic risks, other relevant risks, such as those of very high and high severity, are also monitored by senior management.

The set of risks related to climate change and energy transition is evaluated with a very high degree of severity and is currently considered a strategic risk, being monitored according to the described governance.

Risks Related to Climate Change and Energy Transition

Risk category	Risk factor	Description and impact	Time frame	Actions
Transition Risks	Market	> Global: increased demand for energy and products with lower carbon intensity, leading to a reduction in the oil demand and a consequent drop in the prices of fossil products. Preference for fossil products with lower GHG intensity in production processes. > In Brazil: the demand for our products may be affected especially by the increase in demand for alternative fuels, also stimulated by public policies such as the RenovaBio program.	Medium to long term	> Monitoring and assessing the risk of reduced demand for our products due to the energy transition, estimating its possible impacts. > Portfolio value and resilience analysis compared to accelerated transition scenarios. > Least Cost Methodology analysis > Six carbon sustainability commitments, with a short- and medium-term vision and neutrality ambition for 2050. > Development and offer of products with lower emissions in the life cycle and/or renewable content under the BioRefining Program. > Deepening of studies in offshore wind, hydrogen, and CCUS within the Profitable Diversification strategy.
	Technological	>Loss of competitiveness due to non-implementation or implementation of ineffective or non-cost-effective technologies to reduce emissions from our operations and products.	Medium to long term	> Investment in low-carbon R&D. > Monitoring of technological advances in external forums. > Provision of financial resources through the Decarbonization Fund to accelerate the incorporation of technological options for mitigating emissions. > Carbon Neutral Program, especially the Disruption approach.
	Regulatory	> Increased requirements for controlling GHG emissions in licensing processes, which may cause operational restrictions and financial penalties for our activities. > Complementation of regulation for the adoption of a carbon pricing instrument in Brazil, considering its various aspects and possible formats.	Medium-term	> Monitoring of regulatory risk with an assessment of potential impacts and opportunities. > Six carbon sustainability commitments, with a short- and medium-term vision and neutrality ambition for 2050.

Risk category	Risk factor	Description and impact	Time frame	Actions
Transition Risks	Legal and Reputation	> Litigation and/or loss of reputation for non-compliance with climate commitments.	Medium term	> Periodic monitoring and evaluation of results at the different levels of the company's governance, including senior management. > Investment in transparency: adoption of the TCFD recommendations as a reference in the disclosure of information related to the topic; response and monitoring of our results in the various external evaluation rates, such as the CDP and DJSI, performing gap analysis for improvements; a direct dialogue with investors and society about our strategies and positioning on climate change and energy transition, through the Climate Supplement, Sustainability Report, website, bilateral events, among others. > Promotion of social and environmental responsibility associated with the business, generating a positive impact on society, and the environment, strengthening our reputation.
Physical risks	Water scarcity	> Reduction of water availability affecting onshore facilities.	Medium to Long term	> Assessment of the risk of water scarcity in onshore facilities. > Sustainability commitment to reduce our freshwater intake by 40% by 2030, monitored by the company's governance, including Senior Management.
	Meteoceanographic change	> Extreme weather events can impact facilities and operations. > Changes in wind patterns, waves, and ocean currents can alter the operating conditions of our assets.	Long term	> Studies to improve the predictability of physical climate change. > Updating standards and technical specifications for meteoceanography incorporating future climate projections. > Adaptation of existing facilities and incorporation of climate variability in new development projects.

Carbon pricing risk study

The quantification of the carbon pricing risk was based on portfolio value simulations that considered the possibility of implementing a carbon market in Brazil. The impact of the cost resulting from a potential national cap and trade system was studied as an instrument to contain operational emissions. Currently, more than 97% of our operational emissions occur in Brazil, so our analyses consider Brazil's specific characteristics and perspectives in our carbon prices used in each scenario.

Despite the publication of Decree No. 11075/2022, the definition of the instrument to be adopted in Brazil is still pending in the federal legislature, and the regulated sectors and segments will be defined by the government.

In this study, we consider the gradual implementation of the instrument and ranges of values that vary over time from US$ 0/tCO_2 to US$ 130/tCO_2, depending on the scenario.

Our investment strategy incorporates the assessment of transition risks. The impacts of carbon taxation on the Net Present Value (NPV) are part of the sensitivity analysis of the evaluation process of new investments, requiring that all have a positive NPV in all corporate scenarios. In addition to the deterministic analysis of NPV in the various strategic scenarios and the sensitivity analyses of carbon taxation, stochastic risk analyzes are carried out considering other uncertainties that may impact the profitability of investment projects, such as oil prices, gas prices, derivatives prices, exchange rates, investment cost, operating costs, implementation schedule, production curve and demand for products.

>> See chapter **Scenarios, Strategies, Portfolio and Resilience**

Physical impacts of Climate Change

We assess the physical risk associated with climate change in our operations through research and development of climate regionalization with renowned institutions in Brazil and abroad (University of São Paulo – USP, National Institute for Space Research – INPE and National Oceanic and Atmospheric Administration – NOAA), parameters considered potentially more susceptible to these changes, such as water availability for our refineries and thermoelectric plants, and wave, wind and ocean current patterns for our platforms, generating qualified information for the process of adapting our Southeast basin operations (Campos, Santos and Espírito Santo).

For environmental variables in the oceanic region, we currently have a technological partnership with IAG/USP (Institute of Astronomy, Geophysics and Atmospheric Sciences, IAG) to simulate atmospheric conditions, ocean circulation, and future waves under the effect of RCP climate projections 4.5 and RCP 8.5 of the Earth System Models MPI and HadGEM, using dynamic downscaling for suitable representation of the physical phenomena of interest in the Santos, Campos and Espírito Santo Basins (92% of the expected production for 2022 is concentrated in these basins), based on the regional atmospheric models RegCM4 and WRF and the WW3 wave model. The time frame for these simulations is 2060, with a time lag of 10 years. Climate projection rounds of 4 high-resolution CMIP6 models (HighResMIP) were also analyzed in this study: HadGEM3-GC31-HM, MRI-AGCM3-2-S, MPI-ESM1.2-XR, and ECMWF-IFS-HR.

Regarding the future trends of annual average winds over the southeast basins, both in the selected CMIP6 HighResMIP simulations (SSP5-8.5) and in the regional simulations developed for the RCP8.5 scenario, it was observed that only HadGEM3 projects an increase of up to 0.3 m/s. In contrast, most of the project's projections show a downward trend in wind intensity between 25°S-35°S over the Atlantic close to the continent in the RegCM4 simulations and between 15°S-25°S in the WRF ones. Both simulations project a decrease in winds above the 80% percentile for the entire period (2005-2060).

Regarding the seasonal trends of winds and waves, the results indicate that there is no expressive trend of change in the average behavior until 2060, showing slight trends of reduction and increase with magnitudes and significant heights below 0.5 m/s and 0.75 m, respectively. However, when evaluating the behavior of the trend of wind extremes, there is a tendency for a slight increase in the frequency of events with speeds above the 95th percentile for all basins. In the Santos basin, speeds close to 15 m/s occur more frequently in the near future (2006-2030).

As a step forward in incorporating these results into our projects and offshore operations, an analysis was carried out of the influence of these climate projections on the estimates of extremes represented in the Technical Specifications of meteoceanography in force for the regions of Tupi (Santos Basin), Marlim (Campos Basin) and Jubarte – Parque das Baleias (Espírito Santo Basin). In general terms, it appears that the methodology applied to estimate extremes with the historical reference data of these regions already features a conservative approach that contemplates the variability identified in the future climate projections developed in the climate regionalization. This result allows estimating that the offshore structures of the southeast basins, which account for the highest percentage of the company's production, were dimensioned appropriately for the useful life for which they were designed, being resilient to the predicted climate changes.

Another ongoing initiative is the development of a system of physical climate risk indicators for coastal and offshore installations, following the example of the indicator developed for water risk at onshore units. Its purpose is to integrate the assessment of climate effects through reliability indicators of project parameters, and definition of operational indicators with improvement in the estimation of risk of interrupting offloading operations.

Also, we carried out physical risk assessments of our operations due to changes in hydrodynamic circulation (currents and vortices) and found that, over the useful life of our assets, the magnitude of impacts is within the safety parameters already considered in our projects.

Water scarcity risk management

The availability of fresh water is essential for our operations, considering the production and processing of oil and gas, including the cooling systems and steam generation. In addition to population growth and consumption, climate change – and the consequent increase in extreme events such as droughts and floods – puts pressure on existing and future water availability in different regions of the world.

Therefore, it is necessary to have mechanisms to manage the water scarcity risks in our facilities. To achieve that, we conducted an inventory of the use of water resources, which covers all our water-using facilities – such as refineries, thermal plants, and production assets – and we use tools for mapping and assessing water risk, such as:

- WRI's (World Resources Institute) Aqueduct Water Risk Atlas, is applied annually to all our onshore facilities.
- Water Scarcity Risk Index (IREH) is revisited every two years, for a set of around 45 facilities identified as priorities for mapping. This set includes all refineries and thermal plants, in addition to the production assets and terminals considered most relevant for the assessment. The IREH is an internal risk tool developed in partnership with the Federal University of Rio de Janeiro (UFRJ), which considers aspects of water availability, watershed vulnerabilities and resilience of our facilities.

Also, a Decision Support System was recently developed in partnership with the University of São Paulo (USP), which allows the creation of water availability scenarios using projected precipitation[5] and soil cover data to analyze risk and vulnerability in meeting water demands at our units. Three refineries with different hydrological characteristics and coverage areas were defined as pilot units for the development of the system: REPLAN, REPAR, and RNEST. With the conclusion of the pilots in 2022, we will advance implementing the system, which will be another important resource for the continuous improvement of our water risk management.

From the mapping of scarcity risks, we assess the possible actions for their mitigation or adaptation. Among the activities developed or planned, we highlight the following:

- In-depth studies at a local level (facility and watershed levels) to assess current and future water availability. They also involve identifying locational and technological alternative sources, such as reuse.
  In 2022, we completed these studies for 26 priority facilities, including refineries, thermal plants, and onshore production assets;
- Studies for the optimization of water use, such as, optimization of cooling systems in priority thermal plants.
- A portfolio of actions and projects that support the achievement of our Water Sustainability Commitment. These actions are focused on reuse and complemented by measures to reduce water waste or adopt alternative water sources. The evolution of such activities and projects is periodically monitored by our HSE Governance and the Executive Board.

As a result, our water scarcity risk management has been receiving significant external recognition. In 2022, we achieved the highest score in management of "Water-Related Risks" (for the 4th consecutive year) in the Dow Jones Sustainability Index (DJSI World) and were graded A- (Leadership) in the CDP Water Security (2nd consecutive year), that assesses the management of such risks in conjunction with other aspects related to the company's water security.

[5] This system performs hydrological modeling, based on precipitation data available from regionalized projections generated by INPE's atmospheric model Eta, and forced by global models (CMIP5 HadGEM2-ES, BESM, MIROC5 and CanESM2)

Climate Change Opportunities

The interest in low-carbon products and services brings new opportunities to the business. New profitable businesses arising from new markets and/or leveraged by public policy can lead to revenue diversification and reduced exposure to carbon. It is our priority to innovate and seek models to maximize value creation and our competitiveness in low-carbon businesses. The assessment of diversification opportunities, especially those that are synergic with our competencies, is the focus of the Profitable Diversification Committee, which, in addition to continuing the emphasis in biorefining, indicated further studies in offshore wind, hydrogen, and carbon capture and storage. Development opportunities are supported by our Research and Development (R&D) investment in low-carbon solutions, with a minimum allocation of 10% of R&D investment.

We have been working on developing and offering low-carbon products to the market. In addition to fuels with renewable content, such as Diesel R (already on sale), sustainable aviation kerosene, and bunker with renewable content, we also develop sustainable asphalts.

>> See chapter **Investments and Initiatives**

Product differentiation to the Foreign Market

The main pre-salt oil streams that we produce have a low level of GHG emissions associated with their production, a performance that gives us the possibility of exploring potential markets that already value sustainability as a quality requirement. We have the perspective of a growing pre-salt oil production curve for the coming years, and we are preparing to develop opportunities to offer products for markets and customers that recognize value in high-efficiency emissions associated with production.

Contracting Sustainability-Linked Loan

In 2022, we contracted a credit line with sustainability commitments (Sustainability-Linked Loan – SLL), in the amount of US$ 1.25 billion and maturity in five years. The contract was concluded with the Bank of China, the MUFG, and The Bank of Nova Scotia, with the aid of incentive mechanisms for achieving sustainability commitments, based on the Greenhouse Gas (GHG) Intensity indicators for E&P and Refining and the upstream segment's methane intensity indicator.

This is the first time we have contracted a financing associated with its corporate sustainability targets, which reinforces the company's focus on decarbonizing its operations and expands the liability management strategy by diversifying financing models, in line with the sustainability requirements that are increasingly present in debt markets.

The operation had competitive costs compared to market benchmarks.

Investments and initiatives

We continue to strengthen our initiatives related to environmental, social, and governance (ESG) aspects, with the commitment to advance decarbonization and to always act ethically and transparently, with safety in our operations and respect for people and the environment.

Our strategic model remains anchored in the premise of producing oil and gas compatible with scenarios of accelerated decarbonization.

Over the past few years, as a result of systemic actions, we have reduced our operational GHG emissions and achieved efficiency gains in our operations. In oil and gas production, we highlight the performance in the pre-salt fields, our leadership in CCUS-EOR, improvements in energy efficiency, and control of losses in operations. In refining, our emissions performance is accompanied by process and refinery load optimization and process energy efficiency.

Seeking to reinforce the decarbonization initiative, the Strategic Plan 2023-2027 brings important elements that reinforce our sustainability agenda and low-carbon positioning, allocating a US$ 4.4 billion CAPEX.

Investments to strengthen our low carbon position

DECARBONIZATION OF OPERATIONS	BIOREFINING	SKILLS FOR THE FUTURE
US$ 3.7 billion	**US$ 0.6** billion	**US$ 0.1** billion
RefTop Portfolio **US$ 0.8 billion**	Renewable Diesel	R&D ** for activities not related to the operation
Decabonization Fund **US$ 0.6 billion***	Sustainable aviation kerosene	Profitable diversitication
Low Carbon Solutions in New E&P projects **US$ 2.1 billion**		
R&D** in decarbonization scopes 1 and 2 **US$ 0.2 billion**		

US$ 4.4 BILLION (5.6% OF TOTAL CAPEX)

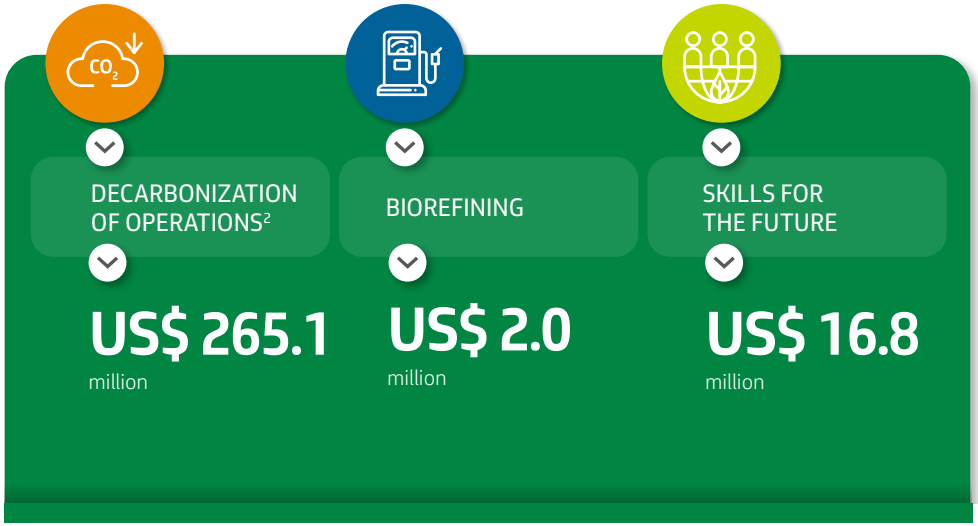
* Expenditures classified as CAPEX can be allocated as OPEX for amounts related to the decarbonization fund and R&D expenditures.

** The forecast expenditures for the low carbon portfolio correspond to 10% of the total R&D budget, which depend on the legal obligation.

Our forecast for low-carbon investments increased considerably between SP 2022-2026 (forecast of US$ 2.8 billion) and SP 2023-2027. The main motivators were:

- **E&P:** increase in the budget to US$ 2.1 billion due to the incorporation of low-carbon solutions in 7 new projects of production units. The solutions adopted in the new projects include CO_2 separation, high-capacity flare gas recovery system, cargo tank gas recovery system, and valves with fugitive emission requirements.
- **Reftop:** budget increase to US$ 813 million, considering 148 projects, 100 related to energy efficiency, ensuring greater operational availability, lower energy intensity, and lower emissions. The initiatives were mapped and matured throughout 2022, increasing the demand for resources focusing on the GHG emissions intensity by 2030 target.
- **Decarbonization Fund:** increase in the maturity of candidate projects for the Fund, review of the carbon price curve, with a potential increase in the number of projects that will use Fund resources, and inclusion of the possibility of buying carbon credits in the budget.

We spent about US$ 284 million[1] in low-carbon initiatives in 2022, including amounts classified as CAPEX and OPEX, as per the table below:



Decarbonization initiatives prioritized through the marginal abatement cost curve

Considering our six sustainability commitments focused on carbon and our ambition to neutralize emissions, we systematically map opportunities for mitigating greenhouse gases. Since 2021, we have organized a set of options to mitigate operational GHG emissions in all segments we operate, using the Marginal Abatement Cost Curve (MACC) methodology.

The MACC methodology allows evaluating and comparing different emission mitigation opportunities through their Marginal Abatement Costs (MAC). The MAC is represented by the ratio between the financial cost (referring to the implementation of the opportunity) and its GHG abatement potential, in the unit of US$/$tCO_2e$:

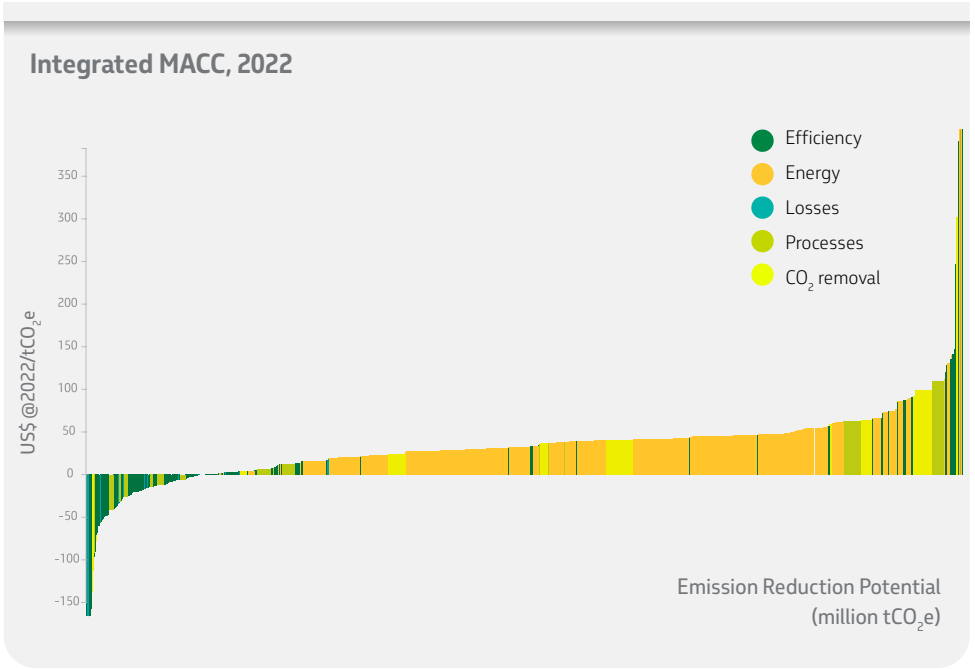
$$\text{MAC (US\$/tCO}_2\text{e)} = \frac{\text{– Net Present Value of the project (US\$)}}{\text{Total GHG abatement through the project (tCO}_2\text{e)}}$$

[1] The estimates consider systems and equipment for investments in new production development projects, with calculations estimated by each project's total physical progress. Low-carbon investments on chartered platforms are not considered.
[2] Includes investment in Oil and Gas Climate Initiative – Climate Investments (OGCI CI) of US$ 12.3 million, in Decarbonization of Operations.

Based on this ratio, it is possible to rank the opportunities, assisting in identifying solutions with better cost-effectiveness. Our Integrated MACC has more than 500 mitigation opportunities with different technological maturities. Opportunities are divided into five categories:

- **Efficiency:** mitigation opportunities focusing on energy efficiency and optimizing systems and equipment. E.g.: combined cycle, All Electric, use of cold deep water, Eco Type vessel chartering, energy efficiency.
- **Energy:** mitigation opportunities focusing on adopting less carbon-intensive energy sources. E.g.: external energy from the coast, energy production plants with CCUS, supply of biomethane for operations, hybrid vessel, and fuel replacement.
- **Losses:** mitigation opportunities focused on reducing energy and product losses. E.g.: reduction of venting, optical gas imaging (OGI), flare gas recovery unit (FGRU).
- **Process:** mitigation opportunities focusing on intrinsic emissions from refining processes. E.g.: co-processing of bio-oil, reduction of emissions in the production of hydrogen.
- **CO_2 Removal:** CO_2 removal opportunities. E.g., CCUS, oxyfuel.

In the integrated MACC, the estimated MAC of each opportunity can be viewed, as well as its potential for abatement of operational emissions in case of implementation.



Note: Estimates of costs and emission reductions are based on internal work, literature data, and benchmarking, including uncertainties inherent to the studies. The initiatives are not ordered in terms of deadline or readiness level.

The results of the analysis of the opportunities of the integrated MACC supported our 2021 decision to aim for neutrality in the long term. Throughout 2022, the integrated MACC subsidized the development of the first portfolio of decarbonization opportunities under the Decarbonization Fund.

Carbon Neutral Program

The challenge of achieving operational emissions neutrality is great, and we recognize that we have many, but not yet all, answers on how to get there. To overcome this challenge, the Carbon Neutral Program was structured to strengthen our current low-carbon position, accelerating and reducing the costs of decarbonization solutions, bringing greater competitiveness to the company. It seeks an integrated corporate vision of all our initiatives developed by different business areas.
The program includes the following approaches:

Carbon neutral program

OPERATIONAL EXCELLENCE

Reduction of emissions in operations

DISRUPTION

Carry out projects in a different way, aiming at lower emissions without increasing costs

SUPPLY CHAIN

Engage suppliers and expand the impact of decarbonization

LOWER EMISSIONS FROM PRODUCTS

Mitigate scope 3 emissions

REMOVAL

Seek CO_2 removal opportunities through technological or nature-based solutions

COMMUNICATION AND RELATIONSHIP

Transparency and external relationship plan

Opportunities portfolio for the Decarbonization Fund

The program has a fund dedicated to decarbonization projects, with a budget of US$ 600 million for the five-year period (2023-2027). Governance for access to the Decarbonization Fund involves analyzing and prioritizing decarbonization alternatives, using criteria such as MAC, the total amount of GHG abated, technological maturity, and project phase (window of opportunity), among others. We also consider the evaluation of the Net Present Value of the alternatives considering the internal carbon price in a specific governance.

In 2022, we approved the first portfolio of projects under the Decarbonization Fund, covering 13 opportunities with a total expected investment of US$ 76 million. The impacts of emission reduction will occur from 2023 (the year of first implementation), reaching about 1 million tCO_2e avoided per year when the 13 opportunities are fully implemented.

Projects approved under the Decarbonization Fund

EXPLORATION & PRODUCTION	> Use of infrared cameras to detect and repair fugitive emissions on offshore oil and gas production platforms (optical gas imaging) in four areas;
GAS & POWER	> Use of certified renewable energy in our operations; > Measurement of fugitive emissions in Gas Treatment Units; > Installation of flare gas recovery system in the Cabiúnas Gas Treatment Unit;
LOGISTICS	> Chartering of more efficient vessels;
REFINING	> Installation of a preheating system in the REVAP coke unit; > Replacement of REPLAN electric motors with more efficient ones; > Installation of a turbo expander at REDUC; > Installation of a load filter and deaerator tower to reduce incrustation at REVAP; > Electric motorization at RPBC.

Operational Excellence

Initiatives seeking operational excellence involve assets and new projects to reduce greenhouse gas emissions.

We continuously improve and update the energy performance requirements for developing investment projects in the Conceptual and Basic Project phases.

In the Refining, Gas, and Power segments, an internal standardization of the best energy efficiency practices was recently carried out, considering the available technologies integrated with the market's consolidated engineering practices. The established criteria aim to reduce atmospheric emissions and align our projects with decarbonization goals.

EF100

We invest in increasing operational efficiency in oil production to generate more value in our operations. In this sense, the Company gathered 21 initiatives in the EF100 Program, distributed in three pillars: Safety/Environment, Integrity/Compliance, and Efficiency.

Some initiatives have a direct effect on reducing emissions, such as CONFIA-E&P, which seeks to increase the reliability of assets, and initiatives to recover Topside Integrity and Naval compliance. Reviewing procedures, including good practices, and intensifying the use of technology, are the main actions for increasing production availability.

The plan for the association to OGMP 2.0 was incorporated into the program and represents another example of synergistic action with the Carbon Neutral Program and other company initiatives.

>> See chapter **Targets, Metrics and Performance**

All Electric

At E&P, we developed a high production capacity project with greater energy efficiency, reducing the emission of GHG and other gases, such as nitrogen oxides. The configuration, called All Electric, is more efficient and allows the reduction of fuel demand to generate energy on the platforms. In this configuration, all rotating equipment is driven by electric motors, including compressors that were previously driven by turbines. The project takes advantage of CONAMA Resolution 501/2021 of November 2021, which now allows this configuration for units with more than 100 MW of power generation, typical of pre-salt.

With All Electric, Petrobras will be able to reduce the intensity of greenhouse gas emissions from these new units by up to 30%.

The All Electric will be deployed on platforms P-84 and P-85, which will be installed in Atapu and Sépia fields, respectively, in the ultra-deepwater of the Santos Basin.

HISEP

HISEP, an acronym for High-Pressure Separation, is a technology developed and patented by Petrobras that allows subsea separation and reinjection of gas produced with a high CO_2 content found in large quantities in the pre-salt oil and gas production fields.

This separation and reinjection of the CO_2-rich gas still occur on the seabed preventing this volume of gas from being processed on the platform. This allows the unit to have a smaller and simpler gas processing plant since part of the gas will be previously removed in a subsea environment, enabling an increase in the unit's oil processing.

In addition to the positive effects resulting from the simplification of the plant, the separation and injection of CO_2-rich gas can be used to maintain the pressure in pre-salt reservoirs, operating as a secondary oil recovery mechanism. HISEP technology can also have positive effects in reducing the GHG emissions intensity of the unit, depending on the field of application.

HISEP is under contracting, and a pilot unit will be installed in the Mero field.

RefTOP

In 2021 we launched the RefTOP Program, intending to be among the best oil refining companies in the world. The program consists of a set of initiatives to increase reliability, efficiency, and operational performance to achieve operational availability greater than or equal to 97% by 2025 in refineries that are not in the divestment portfolio (Presidente Bernardes Refinery – RPBC, Duque de Caxias Refinery – REDUC, Capuava Refinery – RECAP, Paulínia Refinery – REPLAN and Henrique Lage Refinery - REVAP). Thus, we position ourselves competitively in the opening of the oil refining market in the country. The investment foreseen in SP 2023-2027 is US$ 0.8 billion, including actions to improve energy performance and reduce emissions, and is part of the US$ 9.2 billion of investments foreseen for Refining, Gas, and Power in the Strategic plan.

Since its launch, RefTOP has promoted a detailed analysis of Refining assets to identify opportunities for value creation in the Energy Performance and Climate dimension, a partnership among the operation, innovation, and engineering teams. The analysis is based on the results of studies by Solomon, an institution specialized in benchmarking for the oil refining industry worldwide, with Petrobras participating in its studies since 1992.

It is RefTOP's priority to increase the energy performance of refineries through actions such as increasing the combustion efficiency of furnaces and boilers, reducing losses, recovering energy flows, and optimizing the thermoelectric system, resulting in better use of sources such as natural gas, electricity and steam in operations. The program also promotes the intensive use of digital technologies, automation, and robotization in our refineries. Optimization and real-time monitoring through Digital Twins (digital representations of operational facilities) were implemented in all five refineries of the Program, and we also made progress in the quality of our models. The adherence of our refining operations to these models increased from 82% in 2020 to 91% in 2022.

In 2022, 5 new projects were implemented, including new heat recovery exchangers at REPLAN's Coke-I Unit (which generated reductions of around 13,000 m^3/d of natural gas consumption and 9,000 tCO_2e/year), in addition to a set of operational initiatives, which together led to a reduction of around 4% in Energy Intensity of Program's refineries

compared to the previous year. Considering all projects and initiatives for operational and maintenance improvements implemented in 2022 under the RefTOP program, around 550,000 tCO_2e and 1 million m^3/day of Natural Gas consumption (6%) were avoided (compared to the 2021 performance), maintaining production levels.

As a result, the GHG Emissions Intensity of the Program's refineries reached 36.6 $kgCO_2e$/CWT in 2022.

The new Energy Performance and Climate projects focus on reducing the consumption of primary energy sources in Refining (natural gas, electricity, and steam) and optimizing the generation and distribution of these energies. We are planning energy integration across processes, modernization of thermoelectric plants installed in refineries, and installation of more efficient equipment, among others. Examples include:

- Increased heat recovery from the Catalytic Cracking Unit at RECAP;
- New thermoelectric power plant at REDUC;
- Replacement of large machines at the Catalytic Cracking Unit at REDUC;
- Replacement of compressors at the Catalytic Cracking Unit with more efficient machines at RPBC;
- Replacement of the blower at the Catalytic Cracking Unit with equipment driven by an electric motor at REPLAN;
- Increase of condensate recovery at RPBC;
- Energy integration between Petroleum Distillation and Propene Separation units at REVAP;
- Increased efficiency of heat exchanger systems in process units at REPLAN, RECAP, and RPBC.

GHG emissions intensity of RefTOP's refineries ($kgCO_2e$/CWT)

2020	2021	2022
40.2	38.2	36.6

Operational availability gains

In 2022, 8 of our 11 refineries (including REMAN) achieved Solomon's top quartile for North American Operating Availability. We have focused on analytical solutions, consistently promoting the integration of maintenance, inspection, engineering, and operation systems, allowing for more accurate diagnoses, quicker decision-making, and reduced equipment failures by predicting anomalous behavior.

Gas & Power Strategic Projects

In 2021, we started a set of initiatives covering natural gas processing assets and thermoelectric plants aimed at implementing projects to modernize process facilities. We seek greater value generation through increased operational availability, reliability, and energy efficiency, with decarbonization and reduced use of water resources.

As an example of these initiatives, we can mention the projects to improve the gas turbines in blocks 2 and 3 of the Termorio thermoelectric plant (RJ), which resulted in an estimated increase in power of around 63 MW and 1.6% in efficiency gains, in addition to the rise in the time between maintenances to up to 48,000 hours, depending on the mode of operation. Such results will promote a reduction of emissions in the order of 37,800 tCO_2 at Termorio under SP 2023-2027.

At the Monteiro Lobato Gas Treatment Unit, in Caraguatatuba, São Paulo (UTGCA), an initiative will be implemented to redirect and recover part of the gas that would be flared, allowing its recovery in LPG, C5+ or commercial gas. The reduction in emissions resulting from this use totals approximately 5,800 tCO_2e annually.

At the Cacimbas Gas Treatment Unit, in Espírito Santo (UTGC), another initiative to partially recover gases that would be routed to flaring is under development to enable the reuse of approximately 10,000 Nm^3/d of gas, reducing 6,600 tCO_2e annually after its implementation.

Other projects are under study to increase the efficiency of the thermoelectric plant's operation, such as improving the combustion process (by changing the air filtration system, cooling the combustion chamber, automatically adjusting the burning parameters, and the possibility of turbine models conversion), as well as new opportunities for gas processing assets.

One of the alternatives to achieve our operations' decarbonization targets is replacing part of the fossil natural gas consumed in refineries and thermoelectric plants with biomethane. Biomethane has the potential to reduce emissions by up to 95% compared to fossil natural gas, with the great advantage, compared to other decarbonization alternatives, of using the existing infrastructure of fossil natural gas, such as distribution and transport networks.

AVANÇA LOG

The AVANÇA LOG Program will invest US$ 810 million from 2023 to 2027 and aims at integrating Petrobras' productive chain with efficiency, reduction of emissions, and focus on value generation through the implementation of around 40 projects, aiming at:

- Maximizing operational availability for oil and products transportation.
- Accessing strategic markets with our own infrastructure, contracted or in partnerships.
- Exploring opportunities on the path of energy transition and sustainability of the segment.
- Generating value with greater efficiency in internal processes and digital solutions.

Maritime Transport

In the case of maritime transport, our main initiatives under development aimed at reducing operational emissions are:

- Actions to optimize fuel consumption and increase energy efficiency on ships. Main highlights: installation of hydrodynamic appendages and ultrasonic antifouling systems, in addition to optimizing the ship's trim (difference between the aft and forward drafts of the vessel) through numerical simulation software. This optimization can reduce the vessel's resistance and result in lower fuel consumption.
- Actions for operational improvement and energy efficiency in pumping systems in terminals aimed at reducing power consumption.

We assessed decarbonization scenarios to meet regulatory targets for reducing greenhouse gas emissions from maritime transport. We have developed a tool to indicate fleet strategies, more profitable logistics operating ranges, alternative fuel options, and supply availability.

Additionally, we seek to develop projects aimed at generating renewable energy, such as installing photovoltaic cells to generate solar energy in terminals for our own consumption - actions carried out by Transpetro.

Logistic Support Activities

We raised a series of opportunities through the MACC methodology in logistic support activities. Under the method, we prioritize initiatives that, in addition to improving logistical and operational performance, also bring efficiency gains in GHG emissions, gaining scale and scope of implementation. Among them, we can highlight the following:

- Hybrid support vessel (in bidding process);
- Use of antifouling paint on hulls (inclusion in technical specifications). In addition to preventing the proliferation of the orange cup coral, this measure increases navigation efficiency, reducing emissions.

Disruption

New concepts and technologies are needed to follow the trajectory toward emission neutrality. They must be available and accessible to be incorporated into the development of oil and gas production projects since the early stages of the project development.

The Disruption approach collaborates with initiatives such as the FPSOZero Program and projects in the research and development phase that could significantly reduce the company's emissions.

In 2021, we structured the FPSOZero Program to build a vision of the future for FPSO-type platforms in line with Petrobras' strategy. The Program aims to develop actions to reduce GHG emissions, reduce hours of exposure to risk in the implementation and operation phases, and increase the added value of new FPSO projects.

In the path of decarbonization of operations for new projects, short-term actions consider the achievement of zero routine flaring with the recovery of gases from the flare, zero routine venting with the recovery of gases vented from the cargo tanks and processing plant, in addition to actions to increase energy efficiency with the use of variable speed drives in pumps and compressors, and valves with requirements for low fugitive emissions.

In the medium and long term, the program seeks to develop more disruptive solutions such as capturing exhaust gases from power generation turbines (PCCC – Post Combustion Carbon Capture), use of cold deep water, cogeneration (Waste Heat Recovery Unit), and new designs of equipment and systems for oil, gas and water treatment.

Supply Chain

In 2022, we reviewed the policies, guidelines, and procedures that guide the application of sustainability requirements in contracts that include:

> Revision of internal rules;

> New relationship channels with the supplier market;

> Team training;

> Implementation of ESG-aligned contractual levers;

> Review and update of technical and contractual requirements;

> Improvement of the supplier performance evaluation system;

> Development of structuring projects with other O&G companies through reference entities in the oil industry.

We have developed an agenda of initiatives associated with the reduction of carbon emissions with our suppliers, partners, and other members of our supply chain, aligned with SP 2023-2027, and directly reflected in ongoing actions in the process of supplying goods and services, such as:

> New technology solutions for decarbonization;

> Prior engagement actions and communication with the supplier market; and

> Alignment of incentives associated with implementing operational actions to reduce GHG emissions.

The Carbon Neutral Program and the business areas point out technological solutions to reduce priority emissions to overcome our challenges. Thus, the Supply area unfolds the strategic plan along with the supply chain, assessing opportunities, engaging the market, and providing contractual solutions that enable the development of new technologies aligned with our net zero ambition, such as HISEP, All Electric, equipment with low fugitive emissions, among other innovations to enable increased efficiency and energy transition.

Lower Emission Products

We seek opportunities that contribute to long-term sustainability, diversifying our portfolio of products and businesses.

Value chain MACC

Unlike our operational emissions, scope 3 emissions reported in our corporate inventory refer to the processing and use of our products, activities we have no direct control of. However, given the relevance of scope 3 emissions in our inventory, it is important to develop studies to support future business assessments involving the entire value chain.

In 2022, we developed studies and metrics that allow the comparison of different projects and initiatives through simplified economic analysis and the value chain emissions expected for each project, in a view parameterized by the investment. The methodology allows the comparison between different types of projects and different opportunities in energy and non-energy markets. Ongoing assessments consider the impact of new product development on the emissions intensity of our value chain, making it possible to

compare different strategies that can support the reduction of emissions associated with all our activities.

We intend to deepen studies and support analysis of portfolio diversification, incorporating emissions from the value chain in the analysis of new diversification initiatives.

Portfolio Decarbonization

We believe in innovation and synergies with our assets to seek business models with competitive advantages in the long term, enabling diversification with value creation.

We plan to be a leading company in the supply of low-carbon products, focusing on the BioRefining Program and applying our competencies in refining technologies and operations.

Throughout 2022, we analyzed several opportunities for diversification that also reduce the carbon intensity of our products and businesses. Three segments were selected for potential portfolio diversification, for which we will advance in internal studies: Offshore Wind Energy, Hydrogen and Carbon Capture.

New Generation of Products

In 2020, we launched the BioRefining 2030 Program, which includes projects to produce a new generation of more modern and sustainable fuels, such as Diesel R, with renewable content.

Co-processing renewable raw materials in existing refineries is the fastest and most cost-efficient way to offer fuels with renewable content to the market and start the journey of decarbonizing our products.

The vegetable oil co-processing technology was patented by Petrobras in 2006 using the process called HBIO.

Renewable diesel is a modern biofuel, chemically the same as mineral diesel (derived from petroleum) but produced from renewable or residual raw materials. This new fuel can be added to mineral diesel oil (derived from petroleum) and commercialized in any mixture percentage. With the use of renewable raw materials, the reduction of CO_2 emissions referring to the renewable share is around 60% compared to fossil diesel.

We concluded the adaptation at the Presidente Getúlio Vargas Refinery (REPAR) to carry out the co-processing of refined soybean oil and diesel in our HDT (hydrotreatment) unit, enabling the production of Diesel with 5%v of renewable content (Diesel R5). The current capacity is 32 thousand bpd of Diesel R5. In 2022 we also carried out the Diesel R5 test in a bus fleet in Curitiba. The test results corroborated the "drop-in" characteristic of the fuel: it is a product that can be used in systems designed for diesel without the need for any change in the engines and in the logistics infrastructure. Thus, the first sale of Diesel R5 was possible.

We carried out the Life Cycle Assessment of the product, which supported the international certification of the renewable content of Diesel R. This process was successfully concluded, resulting in ISCC Plus and ISCC EU RED certifications.

We also plan to carry out co-processing at REPLAN, RPBC, and REDUC and expand Diesel R production at REPAR.

Technologies to produce renewable diesel and sustainable aviation kerosene have also been developed to implement dedicated biofuel units. The construction of a dedicated industrial unit in the RPBC is under evaluation, with a processing capacity of 790 kta of load and flexibility for different raw materials from 2028, and we are evaluating the opportunity of a second unit. The implementation of dedicated units will allow the company to contribute to decarbonizing the road and air transport segments while diversifying its portfolio with products with lower carbon intensity.

In addition to these initiatives, we made progress in offering more sustainable products, such as bunker with renewable content and new, more sustainable asphalt.

Bunker with Renewable Content:

In a pioneering effort in the country, we started testing the supply of a new fuel with lower carbon intensity for the maritime sector. It began in September 2022 and is planned to last until the first half of 2023. We use a mixture of 90%v mineral bunker and 10%v biodiesel in the test in a Transpetro vessel. In the first stage of the project, during the tests carried out in the laboratory of the Petrobras Research Center (Cenpes), no impacts were found in meeting the main properties of the bunker specification.

New and more sustainable asphalts

We developed CAP Pro, an asphalt that can be applied at lower temperatures than usual, generating energy savings and lower GHG and vapor emissions, resulting in gains for the workers and the environment in using the product. The operational advantages associated with machining and application also benefit road users due to the shorter road closure time during paving works and faster lane clearance. Another benefit of CAP Pro is to allow for greater use of reclaimed asphalt pavement (RAP) in asphalt concrete, making it even more sustainable. CAP Pro is being tested on roads by partner companies and will be available for sale in the second half of 2023.

We are also developing CAP AP, a high penetration asphalt with rejuvenating capacity, ideal for hot recycling services for damaged asphalt coatings. CAP AP is more sustainable than traditional products as it allows greater use of recycled content (RAP) without the need for rejuvenating agents. This product was tested on a highway with heavy traffic in the state of São Paulo in a paving process that included recycling 20% of RAP, resulting in a performance similar to typical solutions with virgin materials. In addition to its use in recycling services, this new product brings advantages when used as an input in industrialization processes to produce polymer-modified asphalts, emulsions, and waterproofing agents. The launch of CAP AP is scheduled for the first half of 2023.

Carbon Removal and Credits

We believe that emissions offsets can be used as a complementary tool in our decarbonization path. These offsets can be natural, taking advantage of the removal potential involved in the recovery and preservation of forests, soils, oceans, and seaweed, or through technological solutions such as CCUS and CO_2 direct air capture (DAC). While we expect to use offset, these initiatives should be thought of as additional contributions to intrinsic mitigation efforts and do not replace society's need to use less carbon-intensive energy.

Our operating assets are mostly installed in Brazil, and we supply a large part of the energy consumed in the country. We prioritize the acquisition of REDD+ credits (reduction of emissions from deforestation and forest degradation) as a voluntary contribution to the mitigation of national GHG emissions, of which 38% result from land use and land use changes (BRASIL MCTI, 2022). We have included offsets in our strategy as a possibility for achieving even more ambitious results than those possible with the intrinsic decarbonization of our operations while, at the same time, contributing to the preservation of Brazilian ecosystems.

We seek high-quality credits to ensure that they are actually bringing climate, socioeconomic and environmental benefits, taking advantage of the Brazilian potential to generate highly competitive natural-based credits. We are committed to disclosing the origin and use of our carbon credits in a transparent and traceable way. Believing in carbon markets as an important instrument in fighting climate change, we are engaged in discussions regarding the implementation of a regulated carbon market in Brazil. We support the development of an economy-wide carbon market in Brazil.

Our actions in the carbon market provide for the following:

- acquiring carbon credits to offset our operational emissions up to the limit of 20% of operational emissions for the year;
- initiating our own origination of carbon credits associated with socio-environmental responsibility programs.

Additionally, we identified a growing trend in several markets to value products by their emissions in the value chain, either through actions linked to regulated markets or voluntary markets. Thus, we see demand from our customers and society for products with lower carbon intensity, whether obtained through gains in production efficiency, new production processes, the inclusion of renewable raw materials in their composition, and partial or complete compensation of their emissions through carbon credits.

Within the scope of the Floresta Viva initiative, we will invest R$50 million in exclusive RFPs (request for proposal) with the BNDES, which will contribute the same amount, totaling R$100 million over the next 5 years. In 2022, we launched the first Floresta Viva RFP, called Manguezais do Brasil, which provides for the investment of R$ 44.4 million for the restoration of areas of Mangroves, Restingas, and Contributing Basins. These environments have a high potential for carbon sequestration, contributing to gains in climate resilience, biodiversity, and socioeconomic benefits. This RFP provides for the generation of carbon credits as one of the attributes of the projects.

>> See chapter **Brazilian context and voluntary contributions to Brazil's decarbonization journey**

In addition to the approach in carbon markets described, we have devoted special attention to developing business models, technologies, and activities for CCUS, given the natural synergy of this activity with the oil and gas industry and our experience with CCUS-EOR in the pre-salt layer.

We are studying opportunities and business models with CCUS projects for CO_2 capture and storage from industrial processes, seeking to decarbonize our operations and those of third parties. These new projects will allow Petrobras and its partners to achieve the decarbonization commitments, for instance, a net zero ambition.

Through the OGCI (Oil and Gas Climate Initiative), of which we are members, we participated in the composition of a study (White Paper) to develop propositions and guidelines necessary for the implementation of a CCUS hub in Brazil, considering the local challenges for its implementation and the opportunities for the country.

Carbon capture, utilization, and storage in oil production units (CCUS-EOR)

In addition to being a pioneer in ultra-deepwater, our CCUS program in the pre-salt fields is the world's largest in operation, considering the amount of CO_2 reinjected annually. According to the 2022 Global CCS Institute report, the storage capacity of all CCUS projects in operation worldwide is 42.5 million tCO_2 per annum. In 2022, we injected about 10.6 million tCO_2 into the pre-salt reservoirs, that is, approximately 25% of the reported global capacity.

Since the beginning of the project, which began as a pilot in the Tupi field, we have already reinjected 40.8 million tCO_2 in pre-salt reservoirs. Our goal is to expand the annual reinjection capacity and reach the mark of 80 million tCO_2 reinjected by 2025.

This landmark will be possible by developing a set of innovations to optimize the CO_2 capture, transport, and storage process. We are developing new materials for application in CO_2 removal membranes, seeking greater capacity, selectivity, and durability. As a result, we will have a reduction in the energy demand for compressing the gas to be injected into the reservoir, reducing the intensity of GHG emissions throughout the process. We are also implementing the HISEP project, an unprecedented and Petrobras-patented technology, in which the CO_2-rich gas from the reservoir will be separated and reinjected in a system located at the seabed. Thus, it will be possible to increase field production with efficiency gains.

Innovation and skills to create value in a low-carbon economy

Our strategy is to

Innovate to generate value in business, today and in the future, and achieve the goals in decarbonization.

We consider innovation a fundamental element to build a decarbonization path that considers sustainability and the impact of energy costs on society.

We are committed to investing in research, development, and innovation (RD&I) in low-carbon technologies, exploring and prospecting opportunities in the oil and gas, biorefining, and modern renewables chains. As an important pillar of our strategic direction, these areas receive a minimum allocation of 10% of our investment in RD&I, having priorities such as technological innovation, building models that maximize value creation, and increasing the competitiveness of our current businesses and of emerging businesses considering energy transition scenarios.

Our researchers, laboratories, and pilot plant hubs are increasingly qualified and prepared to create and test technologies that will help us meet our decarbonization commitments and ambition and diversify our businesses in the short, medium, and long term.

Main initiatives of low-carbon R&D

Decarbonization of operations

Our projects to reduce GHG emissions from operations prioritize gains in energy efficiency and reduction of losses, boosting the operational performance of our assets so that they reach their greatest potential, being less intensive in energy use. We develop and evaluate technologies that make it possible to replace conventional fossil fuels with those obtained from renewable sources, such as biofuels and renewable energy. We invest in developing carbon removal technologies, such as CCUS, which are fundamental for removing residual emissions. In parallel to these actions, we seek to provide advanced technologies for monitoring and mitigating methane emissions.

New challenges and solutions for Exploration and Production

In the Oil and Natural Gas Exploration and Production segment, we operate from the conceptual design of more efficient and less emission-intensive drilling rig and production unit projects, to seeking solutions for existing operations. In this segment, the electrification of operations, energy efficiency, and CCUS-EOR activities have been the focus of a large part of our RD&I activities, with emphasis on the following:

(1) Advanced methane monitoring technologies (e.g., drone, OGI, IOT Sensors, etc.) and intelligent mitigation systems for production units;

(2) Assessment of bottlenecks to enable the electrical connection of deep-water platforms to the onshore electrical grid;

(3) Offshore natural gas thermoelectric generation, with CO_2 capture and storage and its interconnection with O&G assets (Power Hub);

(4) Renewable offshore electricity generation and its interconnection with O&G assets;

(5) Subsea processing systems, which reduce the energy consumption of the production units (potential reduction of energy consumption and emissions, including the development of membranes for separating CO_2 from natural gas in subsea environments);

(6) Cold deep-water intake in offshore units with more efficient design.

We are developing a tool for monitoring and evaluating the existing CO_2 removal system in production units that have CCUS-EOR technology installed. With it, we will monitor the selectivity of the membranes and losses of hydrocarbons by the permeate stream in real-time, with direct gains in reducing the intensity of emissions. In 2021, a pilot project was carried out in one of our production units. Membrane monitoring (CO_2 membrane digital twin) is currently implemented in 3 production units, 2 at UN-BS and 1 at BUZIOS.

Additionally, we are developing new materials for application in these CO_2 removal membranes. We seek greater capacity, selectivity, and durability and, consequently, a reduction in energy demand in the compression of the current to the reservoir, reducing CO_2 emissions throughout the process and reducing costs. For example, the ceramic membranes for capturing CO_2 from natural gas that we are developing have already been qualified on a laboratory scale, and we plan, in 2023, to conclude tests on a field demonstration scale.

More Sustainable Refining: Reduction of Emissions and Use of Renewable Sources

In the Refining segment, our aim is to reduce operational emissions through actions to improve energy and operational efficiency, in addition to capturing CO_2 from stationary sources. Some highlighted activities in refining are:

(1) Studies of CO_2 removal opportunities via CCUS Hubs;

(2) Intelligent monitoring and control of flare systems: Smart Torch;

(3) Use of biomethane and other renewable raw materials in co-processing with natural gas in the Hydrogen Generating Unit (HGU);

(4) Solutions to improve energy performance and reduce losses;

(5) New process concepts and catalytic systems to maximize the production of light olefins in catalytic cracking units – FCC;

(6) Processing of renewable raw materials, such as vegetable oil and bio-oil, in FCC.

Advances in the Gas and Power Segment

For the Gas and Power segment, in addition to supporting the improvement of energy and operational performance, we develop technologies and strategies to reduce fugitive emissions, capture CO_2 in exhaust gases, and interconnect units in CCUS Hubs.

(1) Advanced methane monitoring technologies (e.g., drone, OGI, IOT Sensors, etc.) and smart mitigation systems for thermal power plants (TPPs) and natural gas production and treatment plants;

(2) Integration studies of gas treatment units and TPPs to CCUS Hub;

(3) CO_2 conversion in products with higher added value;

(4) Exhaust gas capture.

Low-Carbon Diversification

Society's interest in the energy transition is increasing, and there is a forecast for growth in low-carbon energy markets, such as biofuels, renewable energy, and hydrogen.

Civil aviation, maritime transport, and road freight transport are difficult to electrify sectors and, therefore, are expected to use low-carbon fuels as a decarbonization vector. The growing demand for sustainable chemicals and petrochemical products has motivated the development of solutions to produce renewable petrochemical intermediates, which can be implemented by adapting existing units or new processes. For these opportunities, we develop technologies that enable the production of biofuels and sustainable products in synergy with our refineries and integrate more easily into existing value chains for mobility. These include:

(1) Co-processing of oils and fats in HDT (Hydrotreating) and HCC (Hydrocracking) units for the production of diesel and aviation kerosene with renewable content;

(2) Bunker fuel with lower GHG emissions through the incorporation of renewable currents in fossil fuel;

(3) Petroleum derivatives with lower GHG emissions, such as CAP Pro and CAP AP and low-carbon fuels for aviation;

(4) New technologies and process concepts for the production of biofuels;

(5) Production of sustainable chemicals and petrochemicals.

Offshore wind energy

Our RD&I projects in offshore wind energy support the assessment of the technology's potential as an alternative for diversifying our portfolio and as a source of energy supply for our platforms. Projects developed include:

(1) Conceptual studies for floating wind turbines capable of operating in ultra-deep water;

(2) Assessment of the geotechnical behavior of marine soils to allow better foundation designs;

(3) Development of a tool to increase the competitiveness of projects by optimizing logistical operations and construction methods for wind farms;

(4) Development of national technology for measuring offshore wind resources.

Lower carbon intensity hydrogen

Lower carbon intensity hydrogen is an important vector for decarbonizing different industrial sectors and has also been prioritized in our innovation actions. The O&G industry has always been a significant producer and consumer of H_2, which places it in a privileged position to operate in this sector. Some of our studies include the following:

(1) Production of hydrogen from the co-processing of renewable raw materials in the hydrogen generation unit (HGU);
(2) Project conceptions for producing blue hydrogen from capturing and storing CO_2 generated in the HGU;
(3) Evaluation of technologies for producing green hydrogen from electrolysis;
(4) New H_2 production routes with lower carbon intensity;
(5) Optimized technological solutions for the transfer, transport, and storage of hydrogen
(6) Technologies for producing hydrogen carriers, such as ammonia and LOHC (liquid organic hydrogen carriers).

CCUS

The CCUS, cited as an important element in the decarbonization of the E&P, Refining, and G&P segments, in addition to providing longevity to our operations, also opens up new business opportunities for Petrobras. Due to its relevance, we explored the technological possibilities for reducing the costs of CO_2 capture, storage, and conversion, exemplified by the RD&I actions described below.

(1) Enzymatic technology for CO_2 capture;
(2) CO_2 conversion through microalgae;
(3) BECCS (Biomass Energy with Carbon Capture Storage) in Brazil;
(4) Conception studies of CCUS Hubs in Brazil;
(5) Use of advanced membranes for CO_2 capture from natural gas;
(6) CO_2 conversion technologies in higher value-added products.

Petrobras – Conexões para Inovação

Conexões para Inovação (Connections for Innovation) is Petrobras' open innovation program. Through this program, which has eight modules for promoting technology development opportunities with Petrobras, we encourage initiatives to intensify our integration with the innovation ecosystem, especially science and technology institutions, universities, startups, companies from different sectors, and entrepreneurial researchers.

Within the program, low-carbon projects and solutions have gained priority. Currently, Petrobras has more than 70 partnerships with universities, science and technology institutes, and companies to jointly develop solutions that contribute to the reduction of emissions and renewable energies, totaling a contracted investment of more than R$ 300 million.

Of this total, more than 60 partnerships were signed through the Technological Partnerships module, more oriented towards associations with universities and science and technology institutes aimed at developing technologies typically found at low or intermediate maturity levels.

Since the first RFP for the Startups module launched in 2019, we have partnered with small technology-based companies to develop solutions in the areas of energy efficiency and carbon reduction (which includes improving the carbon performance of operations, as well as carbon capture and storage). Eight startups already have ongoing or completed projects with Petrobras in this area.

The list of challenges and the respective startups selected to jointly develop the technologies is presented below.

RFP	Challenge	Startup
2019	Compact technologies for CO_2 separation and capture to operate at offshore structures. Reduce costs and increase the efficiency of CO_2 capture and reinjection processes in offshore structures.	Pam Membranas
2020	Identification and quantification of steam losses in heated systems.	Immer Messen
2020	Reduction of Greenhouse Gases emissions (CO_2 and methane) of Petrobras' processes and operations with greater efficiency and lower costs.	Alfa Sense
2021	Reduction of CAPEX, footprint (occupied area by the processing unit) and Greenhouse Gas Inventory through the prediction of potential optimizations in a process plant with All Electric configuration conceived by concepts of combined cycle, deep-water capture, among others.	MOTTA, SOUTO E DAMASCENO SISTEMAS LTDA
2022	Develop a system with a responsive and user-friendly platform, for the purchase of biomethane from different certified producers, using Blockchain technology, as a reliable, auditable, marketing support tool, with product quality tracking integrated with a billing process, with emission reduction certifying agencies integrated in this Ecosystem to obtain the carbon credit through the system so that the process of capturing value by the agents can become more agile and efficient.	DR WARS Laboratories
2022		Goledger
2022	Catalyze supply chain development of residual grease raw materials.	CONDEPORTS INVEST Selletiva - Soluções em Logística Reversa

Innovation Ecosystem

We participate in the Regional Entrepreneurship Acceleration Program of the Massachusetts Institute of Technology (MIT Reap). In 2020, MIT selected Rio de Janeiro to participate in this Program that involves universities, companies, government, entrepreneurs, and venture capital investors. The purpose of the initiative is to develop a methodology for structuring and governance of the first energy and sustainability innovation ecosystem (iEcossistema) in the world.

The program started in June 2021, involving all regions that are part of the Program's Cohort 8: Rio de Janeiro (Brazil), Egypt, Northern Ireland (UK), Los Angeles (USA), Manizales (Colombia), and Wallonia (Belgium).

Expected to last until May 2023, the program provides for the proposition and implementation of initiatives to accelerate entrepreneurship in the region, such as: mapping the energy and sustainability innovation ecosystem of Rio de Janeiro; creation of the EnergINN training program (focused on training and pre-incubation of researchers, university students and/or corporate professionals with the aim of generating innovations and large-scale enterprises for the energy and sustainability sectors); In January 2023, we signed a protocol for the creation of the Rio Energy Bay Institute and the beginning of discussions on its integration with the Centro de Energia e Finanças do Amanhã (Center for Energy and Finance of Tomorrow), of the Rio de Janeiro Municipal Government. The Institute brings together different segments of society to transform the Rio de Janeiro region into Brazil's first world-class innovation ecosystem in the energy and sustainability segment.

Transparency and engagement

Transparency as a value

We value transparency in our work with our stakeholders, guided by our social responsibility and HSE policies, Code of Ethical Conduct, and Guide to Ethical Conduct for Suppliers. We systematically monitor and adhere to world-class climate reporting codes such as the Global Reporting Initiative (GRI Standards), the DJSI requirements (Dow Jones Sustainability Index), CDP and TCFD (Task Force on Climate-related Financial Disclosures), our industry guidelines such as the complementary reporting methodology of IPIECA (Guide for Voluntary Reports of the Oil and Gas Industry) and the reporting and transparency parameters agreed in the OGCI (Oil and Gas Climate Initiative).

We declare support for the TCFD, an initiative of the Financial Stability Board (FSB), requested by the G20 and announced in 2015, with the mission to develop recommendations for disclosure of financial risks related to climate change for use by companies in providing information to investors.

This Climate Supplement follows the recommendations of the TCFD, covering the four thematic areas of the initiative: Governance, Strategy, Risk Management, Metrics and Targets. Since 2018, we have used the TCFD as a benchmark for our carbon management process and are continually moving towards incorporating its guidelines deeply into our decision-making processes.

Recognition

In 2022, for the second consecutive year, we qualified to join the Dow Jones Sustainability Index World (DJSI World) from S&P Global's Corporate Sustainability Assessment. DJSI World is one of the most important sustainability indexes in the world, which evaluates the best social, environmental, and economic management practices. Qualifying for the DJSI World recognizes our efforts and initiatives in the environmental, social, and governance aspects.

We are part of the B3 Carbon Efficient Index (ICO2 B3) for the sixth consecutive year. This indicator assesses companies' commitment to the transparency of their emissions and anticipates the vision of how they are preparing for a low-carbon economy. Also, to be part of the ICO2 B3 assessment, the company must be part of the IBrx 100 (comprised of the 100 Brazilian companies with the most traded shares on the stock exchange) and report the annual inventory of greenhouse gas emissions.

Petrobras is double A⁻ at CDP 2022

We are part of the list of global companies that stand out in climate change mitigation actions, as announced by the international organization CDP, formerly known as the Carbon Disclosure Project. In 2022, we received the **A⁻** rating in recognition of our good practices carried out in this area and demonstrated in 2021. Under the Supply Engagement Rating (CDP Supplier Engagement Rating), we also obtained an **A⁻** this year.

CDP is a global reference for investors in providing quality information on risks and opportunities associated with reducing greenhouse gas emissions, climate, water security, and forest management. Currently, CDP is used by more than 680 investors, whose assets total more than US$ 130 trillion.

CDP's assessment is carried out annually through a questionnaire sent to companies listed on the main stock exchanges in the world, analyzing aspects related to carbon and climate management, water security, and forest management. We have voluntarily responded to the questionnaire since 2004.

Also, the company maintained its **A⁻** rating in water security. These classifications mean that we are recognized as industry leaders, a category that is reserved only for companies that demonstrate best practices in addressing environmental issues.

Cooperation and Dissemination of Knowledge and Best Practices

Our strategy for engaging in climate change includes assessing the external scenario, seeking to incorporate the positions of our stakeholders in decision-making processes that are material to climate change, analyzing gaps, evaluating synergies in positioning, and incorporating new insights into our internal and external communication strategy.

We believe that the transition to a low-carbon economy is an area where collaboration is essential. This way, we partner with other companies and the science, technology, and innovation community. We actively participate in several initiatives and forums that seek coordinated and collaborative actions on climate change, involving the oil and gas sector internationally and locally, as well as other industry segments and business sectors.

We promote our position on energy transition and sustainability by disclosing the main ongoing initiatives in major international events for the energy sector. Throughout 2022, we highlight some opportunities that reinforce our positioning:

- At CERAweek in Houston, we participated in the "Latin America Oil & Gas: Striving to Compete" panel, which discussed, among other aspects, the view of governments and companies on the impact of the Energy Transition on the E&P industry in the challenging scenario.
- At Offshore Technology Conference (OTC), we participated in the panels "Accelerating the Energy Transition: Highlighting Developments in Brazil and Argentina" e "Shifting to a low-carbon offshore industry".
- At Offshore Northern Sea (ONS), we shared our contributions to the energy transition and our expertise in carbon capture and storage.
- In the main industry event in Brazil, Rio Oil & Gas, we participated in several round tables and in the forum dedicated to dealing with investments by the main oil companies in the Energy Transition, with the participation of the Oil and Gas Climate Initiative – Climate Investments (OGCI – CI).
- At the ADIPEC Conference, in Abu Dhabi, we were present on three panels, all related to the climate issue: "The Global Methane Challenge", "The Road to decarbonizing logistics and supply chain" e "Accelerating progress in carbon capture, utilization, and storage".
- At the Arpel Conference, in Lima, Peru, we participated in the panel debate entitled "The challenges of mainstreaming sustainability into business strategies", where we showed how we have used reporting processes and market indicators to improve our sustainability management system.

Brazilian Institute of Oil and Gas (IBP)

In Brazil, the Brazilian Institute of Oil and Gas (IBP), the industry's institutional representative, develops, together with its associates and specialists, policies and lines of action for all segments and demands of the oil, gas, and biofuels industry. Through IBP, we operate directly in four Working Groups (WG) related to sustainability: WG on Energy Efficiency, WG on Nature Based Solutions (NBS), WG on Carbon Pricing, and WG on Methane Reductions.

Since 2021, IBP has reinforced its commitment to contribute to the decarbonization journey of the O&G industry by 2050 through investments in technology that increase the carbon efficiency of operations and reduce emissions. As an associated company, we endorse this commitment, seeking to generate wealth from our oil and gas reserves while supporting the decarbonization of the national economy, in line with the commitment assumed by Brazil in the Paris Agreement, which aims at the neutrality of emissions by 2050.

In 2022, the IBP launched the Industry Agenda for the period from 2022 to 2024, whose pillars are: market structure, business environment, ESG agenda, and energy transition. (SOURCE: IBP lança Agenda da Indústria 2022 com as prioridades para o avanço do setor de óleo e gás - IBP – Only in portuguese)

Oil and Gas Climate Initiative (OGCI)

Since 2018, we have integrated the Oil and Gas Climate Initiative (OGCI), which brings together twelve of the largest oil and gas companies in the world, responsible for more than 30% of the world's O&G production.

We act through the Executive Committee (ExCom) and the Climate Investments (CI). We also contribute to the technical aspect, participating in different work groups (workstreams*):* Carbon capture, utilization, and storage (CCUS); Low emission opportunities; Role of natural gas; Energy efficiency; Natural climate solutions; Transport. Additionally, we participate in task forces that seek to promote progress on the topic: Legal; Data Reporting; Carbon Intensity; Communication; Materiality.

OGCI supports initiatives such as the Methane Guiding Principles, Global Methane Alliance, and the Zero Routine Flaring by 2030, of the World Bank, in which Petrobras is a direct signatory, with the commitment to eliminate routine flaring in fields in operation by 2030.

The twelve member companies that comprise the OGCI have jointly reduced absolute methane emissions by around 40% and absolute greenhouse gas (GHG) emissions by 18% since 2017. To achieve these results, companies have invested a total of US$40 billion in low-carbon solutions over the last five years. (OGCI | Annual Progress Report 2022 | Leadership With Impact).

IPIECA

IPIECA is the global oil and gas association that seeks to promote environmental and social performance during the energy transition. The institution has been operating for 45 years in promoting and exchanging good practices in sustainability, contributing to preparing and disseminating guidelines for the O&G industry. IPIECA has 44 oil and gas companies and 30 industry associations as members.

In 2022, IPIECA approved the "IPIECA principles", a document that came into force on July 1, 2022, as a new condition for the association. By setting sustainability expectations for its members, the IPIECA Principles reinforce the institution's role in inspiring action and leading the global oil, gas, and alternative energy industry through a sustainable energy transition. The eight principles are grouped under the four pillars of IPIECA's 2021-2024 strategy, providing a shared ambition for members to support its vision: Climate, Nature, People, and Sustainability.

Regarding the Climate pillar, we endorse its two Principles: (i) Support the Paris Agreement and its aims and (ii) advance emissions reduction and innovation and enable adoption of low-carbon products and solutions in oil, gas and/or alternative energy.

With IPIECA, we participate directly in the Climate Change Group (CCG) and Reporting Working Group.

IOGP

The International Association of Oil and Gas Producers (IOGP) has been operating for 45 years, representing the upstream of the O&G industry, promoting the sharing of knowledge and practices related to safety, health, environment, and climate.

IOGP has more than 80 members, which together are responsible for supplying more than 40% of the world's demand for oil and gas. At IOGP, we participate in the Low-Carbon Operational Efficiency Committee (LCOE) and their respective subcommittees on Flares and Venting and Methane Management, Energy Efficiency, Electrification, and Energy Transition Metrics, and the Carbon Capture and Storage (CCS) Committee.

We participated in the preparation of the following publications by the IOGP Energy Transition Directorate in 2022:

- On the LCOE Committee, Flares and Venting subcommittee, of which we are the lead operator: Guidelines for the design and operation of flare gas recovery systems – IOGP Report 647;
- On the LCOE Committee, Electrification subcommittee: Recommended practices for electrification of oil and gas installations – IOGP Report 653;
- On the LCOE Committee, Energy Efficiency subcommittee: Review of 13 IPIECA-IOGP Energy efficiency compendiums: Combined-cycle Gas Turbines; Combined Heat and Power; Compressors; Cooling System; Ejectors; Energy Efficient Design; Energy Performance Monitoring and Optimization; Fuel Fired Furnaces & Boilers; Heat Exchangers; Open Cycle Gas Turbines; Alternative Thermodynamics Cycles; Pinch Analysis; Pumps;
- In the Carbon Capture and Storage Committee: (i) Recommended Practice for Measurement, Monitoring and Verification (MMV) Plans Associated with Geologic Storage of Carbon Dioxide – IOGP Report 652; (ii) Gap analysis of standards and guides for carbon capture, transport and storage – STA028.

ARPEL

The Regional Association of Oil, Gas, and Biofuel Companies in Latin America and the Caribbean (ARPEL) was founded in 1965 as a means of cooperation and mutual assistance between industry companies. Its main purpose is to actively contribute to industrial integration and competitive growth, and sustainable energy development in the region.

Currently, its members represent a high percentage of upstream, midstream, and downstream activities in Latin America and the Caribbean and include national and international operating companies, suppliers of technology, goods and services for the value chain, and national and international sectoral institutions. Its declared mission is to promote integration, growth, operational excellence, and the effective socio-environmental performance of the sector in the region, facilitating dialogue, cooperation, the development of synergies between actors, and the shared creation of value among associates through the exchange and expansion of knowledge.

Cooperation in other sectors

We also seek to cooperate outside our industry, with dialogue and the search for solutions, working together with reference institutions for the promotion of sustainable development, such as the Organization for Economic Co-operation and Development (OECD), the World Economic Forum (WEF), the Brazilian Business Council for Sustainable Development (CEBDS), the National Confederation of Industry (CNI), the Brazilian Forum on Climate Change.

Throughout 2022, we participated for the second time in the annual cycle of FGV Business Initiatives (FGV *Iniciativas Empresariais*), an opportunity to discuss with several other companies about good governance, planning, and management practices to structure business goals for mitigating climate change, now and in the coming years, towards Net Zero. The combination of the exchange of experiences between the companies and the research carried out by the Center for Sustainability Studies at the Fundação Getúlio Vargas School of Business Administration (FGV EAESP) resulted in the creation of the practical guide "*Boas práticas empresariais para metas de mitigação da mudança climática*" (Good business practices for climate change mitigation targets, in free translation), available on the FGV website (only in Portuguese), as a reference for ways companies in any sector can use for the development of their climate agendas. (https://eaesp.fgv.br/producao-intelectual/boas-praticas-empresariais-para-metas-mitigacao-mudancas-climaticas)

In May 2022, in partnership with Banco do Brasil and institutional support from the Ministry of the Environment and the Central Bank of Brazil, we held the "Global Carbon Market Congress – Decarbonization and Green Investments", which discussed and presented strategies on sustainability, reduction of carbon emissions and technological innovations.

At the United Nations Conference on Climate Change (COP 27) in Sharm el Sheik, we announced the launch of the RFP "Floresta Viva", in partnership with BNDES, an initiative aimed at recovering native vegetation in Brazilian biomes. Still, in 2022, we launched our Biodiversity Supplement at the 15th UN Biodiversity Conference in Montreal, Canada.

Workforce Engagement

Themes related to sustainability and climate change are part of our cultural transformation project. Therefore, we develop actions to engage our own employees and other professional service providers to increase knowledge and encourage reflection on the subject. Awareness of these issues helps our workforce understand and collaborate in discussions about our corporate choices and can correlate their daily activities with our goals and challenges.

In 2022, our main initiative to extend knowledge and opportunities for personal and professional development to employees on the subject was the launch of two Distance Education modules on Climate Change Mitigation. In the first module, we discussed the concept of climate change, the scientific basis that describes the greenhouse effect, the consequences for the environment, related entities and agreements, and the importance of an emissions inventory. In the second module, we reflected on the treatment given to the climate issue by the energy industry and presented our commitments, strategies, indicators, and ongoing actions for the reduction and neutrality of our emissions.

By the end of 2022, around 70,000 people had successfully completed the two training modules, including employees and service providers. Considering only our own employees, participation in training reached 95%.

We also included the Climate theme in our leadership training program, "Corporate Challenges for Leaders 2022". The program comprises essential corporate topics for all of our leadership, and the 2022 edition had more than 6,000 participants.

The concern with climate change was also present in the third edition of "*Game da Saúde*" (the Health Game), an internal health promotion initiative aimed at our employees and service providers. In this edition, we created 5 Climate Challenges and prepared a Booklet on Carbon Footprint, intending to make our workforce aware of the impact of routine personal choices on reducing greenhouse gas emissions. In the 21 days of the initiative, the participants' engagement resulted in more than 100,000 actions for the climate, related to the use of energy, transport, food, and waste disposal, avoiding the emission of approximately 138 tCO_2e.

Supplier Engagement

We have developed a set of initiatives focused on implementing the sustainability commitments outlined in our Strategic Plan 2023-2027 with our suppliers of goods and services.

Improvement of communication channels and ESG direct contact

The communication channels with the market were improved to facilitate the supplier's engagement with ESG aspects. The redesign of the Supplier Channel (www.canalfornecedor.petrobras.com.br) and the implementation of the new SAP Ariba Procurement Portal are two important projects in this journey of improving the relationship with the market. Additionally, we provide a direct channel for our suppliers who wish to present new ideas and technological solutions focusing on decarbonization, which can be accessed through the email address: cc-suprimentosesg@petrobras.com.br. Our suppliers can also indicate interest in participating in the CDP Supply Chain initiative through this channel.

Live Sessions with Suppliers

To expand the capillarity of our communication actions, we hold monthly meetings through live casts with subjects of interest to the supplier market. For these meetings, we invited all suppliers in our base to establish direct and frequent communication and share relevant information about our supply processes and other topics related to the supply chain, including those associated with ESG. In 2022, these meetings had more than 6,000 participants.

Best Suppliers Award

Annually, the Petrobras Best Suppliers Award recognizes suppliers that stand out in their market niches for their high performance in supplying goods and services to Petrobras, based on several criteria, including those related to ESG, such as quality, management, HSE, compliance, and integrity.

>> Click here to see details of the award

ESG Journey for Suppliers

In 2022, we started the ESG Journey for Suppliers to promote the engagement of suppliers in the ESG theme through distance learning initiatives associated with Environment, Safety, Health, and Climate Change, including decarbonization and mitigation of GHGs, Human Rights, and Compliance, among others, to improve Petrobras' sustainable contracting practices and supplier management.

>> Click here and access the collection

Carbon Neutral Program

The Carbon Neutral Program includes the Supplier Chain dimension, through which we develop engagement actions with the supplier market, encouraging the reduction of GHG emissions in the different links in the chain. The Program has also fostered interaction between different areas of the company and the swift advancement of initiatives, collaborating with the progress of the ESG culture at Petrobras.

Mapping Supply Chain Emissions

We joined the *CDP Supply Chain* initiative in 2022 to map the emissions of a significant sample of our main suppliers selected based on criteria of financial representativeness and critical role for our operations. In this first year, more than 240 suppliers effectively participated, sharing information about their GHG emissions and mitigation plans. The participation of suppliers in this survey is voluntary, so we reinforce the importance of engagement in our interactions with suppliers.

Guide to Ethical Conduct for Suppliers

We are committed to the highest standards of integrity, social and environmental responsibility, and ethical conduct. Likewise, our suppliers must provide safe working conditions, treat their workers with dignity and respect, act with integrity and ethics, and be in full compliance with applicable laws and regulations. Before signing a contract with us, every supplier must acknowledge the Declaration of Compliance with the Guide to Ethical Conduct for Suppliers. In this Guide, we incorporate the Mitigation of Climate Change theme along with the principles, values, and guidelines of Health, Safety, and the Environment. Recently, we included an item on guaranteeing the traceability of the origin of wood used directly or indirectly in the execution of activities by suppliers and their (sub) suppliers to inform that it comes from a production process managed in an ecologically correct, socially fair, and economically viable way. This document also provides guidance on caring for life and the environment and promoting ethical and safe behavior.

>> Click here to read the document

Bibliographical References

bp. *bp Statistical Review of World Energy 2022*, 71st edition, 2022. Available at: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html. Accessed in Jan/2023.

BRASIL. Ministério da Ciência, Tecnologia e Inovações, Technology and Innovation. *Estimativas anuais de emissões de gases de efeito estufa no Brasil*. 6. ed. Brasília, DF: Ministério da Ciência, Tecnologia e Inovações, 2022. Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/estimativas-anuais-de-emissoes-gee/arquivos/6a-ed-estimativas-anuais.pdf. Accessed in Jan/2023.

BRASIL. Ministério do Meio Ambiente. *Diretrizes para uma Estratégia Nacional para Neutralidade Climática*. Brasília, DF: Ministério do Meio Ambiente, 2022. Available at: https://www.gov.br/mma/pt-br/assuntos/climaozoniodesertificacao/ clima/diretrizesparaumaestrategianacionalparaneutralidadeclimatica_vdefeso.pdf. Accessed in Jan/2023.

EPE – EMPRESA DE PESQUISA ENERGÉTICA. *Análise de Conjuntura dos Biocombustíveis - Ano 2021*. Rio de Janeiro: EPE, 2022a. Available at: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-688/NT-EPE-DPG-SDB-2022-02_Analise_de_Conjuntura_dos_Biocombustiveis_2021.pdf. Accessed in Jan/2023.

EPE – EMPRESA DE PESQUISA ENERGÉTICA. *Balanço Energético Nacional 2022: Ano base 2021*. Rio de Janeiro: EPE, 2022b. Available at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2022. Accessed in Jan/2023.

EPE – EMPRESA DE PESQUISA ENERGÉTICA. Plano Decenal de Expansão de Energia 2031. Brasília: EPE, 2022c. Available at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/plano-decenal-de-expansao-de-energia-2031. Accessed in Jan/2023.

GWEC – GLOBAL WIND ENERGY COUNCIL. *Global Wind Report 2022*. Brussels: GWEC, 2022. Available at: https://gwec.net/gwecs-global-offshore-wind-report. Accessed in Jan/2023.

IBAMA – INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS. *Complexos Eólicos Offshore - Projetos com Processos de Licenciamento Ambiental Abertos no IBAMA*. IBAMA, 2022. Available at: http://www.ibama.gov.br/phocadownload/licenciamento/2022-12-07_Usinas_eolicas_offshore_Ibama.pdf. Accessed in Jan/2023.

IEMA – INSTITUTO DE ENERGIA E MEIO AMBIENTE. *2º Inventário de Emissões Atmosféricas em Usinas Termelétricas*, 2022. Available at http://energiaeambiente.org.br/wp-content/uploads/2022/12/termeletricas_IEMA_2021.pdf. Accessed in Jan/2023.

IEA – INTERNATIONAL ENERGY AGENCY. *World Energy Outlook 2022*, 2022. Available at: https://www.iea.org/reports/world-energy-outlook-2022. Accessed in Jan/2023.

IEA – INTERNATIONAL ENERGY AGENCY; EPE – EMPRESA DE PESQUISA ENERGÉTICA. *Transporte Rodoviário de Cargas – Brasil 2021 – Benchmarking Internacional*, 2021. Available at: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-626/IEA-EPE_Brazilian_Road_Freight_Transport_Benchmarking-2021.09.09%20[PT].pdf. Accessed in Jan/2023.

IRENA – INTERNATIONAL RENEWABLE ENERGY AGENCY. *World Energy Transition Outlook 2022*, 2022. Available at: https://www.irena.org/Digital-Report/World-Energy-Transitions-Outlook-2022. Accessed in Jan/2023.

ILO – INTERNATIONAL LABOUR ORGANIZATION. *Guidelines for a just transition towards environmentally sustainable economies and societies for all*, 2015. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/—emp_ent/documents/publication/wcms_432859.pdf. Accessed in Dec/2022.

OECD-FAO. *OECD-FAO Agricultural Outlook 2022-2031*. Paris: OECD Publishing, 2022. Available at: https://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2022-2031_f1b0b29c-en. Accessed in Jan/2023.

ONS – OPERADOR NACIONAL DO SISTEMA ELÉTRICO. *Resultados da Operação*, 2023. Available at: https://www.ons.org.br/Paginas/resultados-da-operacao/historico-da-operacao/geracao_energia.aspx. Accessed in Feb/2023.

REN21. *Renewables 2022 Global Status Report*. Paris: REN21 Secretariat, 2022. Available at: https://www.ren21.net/reports/global-status-report. Accessed in Jan/2023.

WORLD ECONOMIC FORUM. Nature and Net Zero. Geneva: World Economic Forum, 2021. Available at: https://www3.weforum.org/docs/WEF_Consultation_Nature_and_Net_Zero_2021.pdf. Accessed in Jan/2023.

WORLD RESOURCES INSTITUTE. *This Interactive Chart Shows Changes in the World's Top 10 Emitters*, 2020. Disponível em https://www.wri.org/insights/interactive-chart-shows-changes-worlds-top-10-emitters. Accessed in Jan/2023.

Map for TCFD Requirements

TCFD recommendation	Publicity	Location
Disclose the organization's governance around climate-related risks and opportunities.		
a) Describe the board's oversight of climate-related risks and opportunities	**Governance, Incentives and Risk Management**	pp. **62 - 63, 65**
b) Describe management's role in assessing and managing climate-related risks and opportunities	**Governance, Incentives and Risk Management**	pp. **62 - 63, 65**
Strategy: Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material		
a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term	**Governance, Incentives and Risk Management**	pp. **66 - 70**
b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning	**Governance, Incentives and Risk Management**	pp. **66 - 70**
c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.	**Scenarios and Resilience**	pp. **42 - 44**
Risk management: Disclose how the organization identifies, assesses, and manages climate-related risks		
a) Describe the organization's processes for identifying and assessing climate-related risks.	**Governance, Incentives and Risk Management**	p. **65**
b) Describe the organization's processes for managing climate-related risks.	**Governance, Incentives and Risk Management**	pp. **65 - 69**
c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	**Governance, Incentives and Risk Management**	p. **65**
Metrics and Targets: Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material		
a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.	**Targets, Metrics and Performance**	pp. **37 - 38**
b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.	**Targets, Metrics and Performance**	pp. **20 - 34**
c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.	**Targets, Metrics and Performance**	pp. **18 - 31**

Disclaimer

This document may contain predictions about future events. These forecasts only reflect expectations of the Company's management regarding future conditions of the economy, in addition to the industry in which it operates, the performance and financial results of the Company, among others. The terms "anticipates", "believes", "expects", "forecasts", "intends", "plans", "projects", "aims at", "should", as well as other similar terms, are intended to identify those predictions, which, evidently, involve risks and uncertainties foreseen or not by the Company (such as risks related to changes in general economic and commercial conditions, prices of crude oil and other commodities, refining margins and current exchange rates, uncertainties inherent to estimates of our oil and gas resources and reserves, risks related to our Strategic Plan and our ability to implement it, developments in the Brazilian and international political, economic, legal and social scenarios, government approvals and licenses and our ability to obtain financing) and, consequently, are not guarantees of the Company's future results. Therefore, the future results of the Company's operations may differ from current expectations, and the reader should not rely exclusively on the information contained herein.

The Company is under no obligation to update presentations and forecasts in light of new information or future developments. The values reported for 2023 onwards are estimates.

The goals, commitments, ambitions, and perspectives presented throughout this Supplement may be reassessed due to external and/or internal factors. The commitments presented herein do not constitute guarantees of future performance by the company and are subject to assumptions that may not materialize, and to risks and uncertainties that are difficult to foresee. Among the factors that could cause future results to differ materially from our expectations, we refer to the factors described in the "Risk Factors" section of Form 20-F and Petrobras Reference Form referring to base date December 31, 2022.

Additionally, this document contains financial indicators that are not recognized by BR GAAP or IFRS. These indicators do not have standardized meanings and may not be comparable to similarly described indicators used by other companies. We provide these indicators because we use them as metrics of the company's performance; they should not be considered in isolation or as a substitute for other financial metrics that have been disclosed in accordance with BR GAAP or IFRS.

The performance results in emissions in 2022 presented in this supplement will still be verified by a third party, therefore, variations may occur, and no significant changes are expected.

This Climate Supplement follows the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), being structured according to the four thematic areas of the initiative: Governance, Strategy, Risk Management, Metrics and Targets.

Translation of a report originally issued in Portuguese. In the event of a discrepancy, the Portuguese language version prevails.

STAFF

General Coordination, Production, Editing and Layout
Executive Management for Climate Change
Institutional Relations and Sustainability Board

In partnership with:
Strategy Executive Management
Investor Executive Management

Graphic Design
Flávia da Matta Design

Photographs
Stock Images, Petrobras

Cover page
Vivian Patrícia Cruz Palmeira
P-52 Platform
Roncador field

www.petrobras.com.br