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CASE STUDY: POLICY DIALOGUE ON JUST ENERGY TRANSITIONS 2.0

Resilient, but not yet Transformative: Brazil's Oil and Gas Sector in a Decarbonising World

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About the case study

This publication was commissioned by Climate Strategies to support the **Policy Dialogue on Just Energy Transitions 2.0: Identifying Pathways to Prosperity Post-Fossil Fuels** (PPFF)**.** This is a multiannual dialogue convening policymakers, researchers, and practitioners from oil and gas (O&G) producing and consuming countries to build mutual trust, explore shared interests, and address barriers to just energy transitions. The views expressed in this report do not necessarily represent those of the project partners or the dialogue participants.

As part of the dialogue, Climate Strategies commissioned a lead report as well as five case studies exploring the implications of demand decline for O&G exporter countries, and providing policy recommendations to support domestic just energy transitions across Brazil, Canada, Malaysia, Namibia, and Nigeria. Find out more here.

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1. Introduction

1.1 Context of the domestic oil and gas sector

Brazil has rapidly expanded its production of crude oil in recent years, following the discovery of ultra-deepwater “pre-salt” reserves. Since the first pre-salt oil field came online in 2008, production of oil and – mostly associated – gas has increased from 2.4 million barrels of oil equivalent per day (mboe/d) to 4.3 mboe/d in 2023 and 2024.[1] The production of crude oil alone increased from 1.8 million barrels per day (mbd) to 3.4 mbd.[2] This places Brazil as the ninth largest global producer, above Kuwait (2.6 mbd) and just below the United Arab Emirates (3.4 mbd). In 2024, Brazil’s US$ 45 bn in crude oil exports made it the country’s number one export product.[3] Expanding oil and gas production is dominated by state-controlled oil company Petrobras, which operates over three-quarters of total production.

Figures for 2023 show that, out of a total of US$ 43.8 bn in crude oil exports, US$ 19.8 bn (45.2% of the total) were directed to China. The European Union (EU) was the second largest export destination at US$ 10.3 bn (23.5%), while the United States (US) came third with US$ 4.8 bn (11.0%).[4]

Forecasts for the oil sector’s trajectory depend on decisions regarding the extension of Brazil’s exploration frontier. Oil production is set to peak at between 5.3 and 5.4 mbd in 2029-30 and, unless new exploration frontiers are opened, to decline by 30.2-0.3 mbd per year thereafter.[5] The replacement of these reserves is largely expected to come from the Equatorial Margin, a tract of the Atlantic Ocean located off Brazil’s northern coast and parallel to the Equator Line, which shows promising exploratory potential. However, exploration in this region – particularly the recently approved license for exploration in the “mouth of the Amazon” basin (located around 500km from the actual mouth of the Amazon River and at least 160km offshore) – has become a highly contentious issue in Brazil’s domestic politics due to its potential environmental and climate implications.

Unlike most other major producers, and similarly to the US, Brazil’s large population and economy imply a limited dependence on the oil sector for employment and public revenues. Employment estimates, mostly provided by associations of oil service providers, put total jobs generated by the sector at around 600,000. Even upper bound estimates of 1 million jobs would still

represent less than 1% of Brazil's total workforce.[6] The dependence of public revenue on oil is similarly limited, standing at around 5% of the total in 2024.[7] The main exception to this pattern is found among the royalty-dependent municipalities adjacent to oil-producing basins in South Eastern Brazil, as well as the state government of Rio de Janeiro, which derives close to one-quarter of its revenues from oil royalties.[8]

1.2 Status of the domestic energy transition

Brazil stands out internationally for its predominantly renewable electricity mix. Contrary to most countries, where energy emissions predominate, over three-quarters of Brazilian emissions are attributable to agriculture and land use change.

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Accordingly, a preliminary version of Brazil's new National Plan on Climate Change (the first to include sectoral mitigation targets) foresees that, out of the targeted 839 $MtCO_2e$ (metric tons of CO_2 equivalent) reduction in GHG emissions between 2022 and 2030, a full 959 $MtCO_2e$ – or more than the total reduction – are expected to come from nature conservation (expected to have net negative emissions of 317 $MtCO_2e$ in 2030), agriculture, and livestock. This reduction aims to compensate for planned emissions increases from industry, energy production, and transportation.

The transportation sector deserves particular attention, as it constitutes the country's second-largest source of emissions. Several plans intended to decarbonise transportation are currently in place, including the Brazilian National Biofuel Policy (RenovaBio); the National Program for Green Mobility and Innovation (Mover); and the "Fuel of the Future" (Combustível do Futuro) program, itself comprising subprograms dedicated to green diesel, sustainable aviation fuel (SAF), biomethane, and carbon capture and storage (CCS), besides provisions for higher blends of ethanol and biodiesel in gasoline and diesel, respectively. The weight of biofuels is in fact a distinguishing factor in Brazil's energy mix. This harks back to policy choices made in the aftermath of the 1973 oil price shock.[9] Yet despite the widespread use of "flex fuel" light vehicles that can run on both ethanol and gasoline, there are still no cost-effective alternatives for fully decarbonising the long-haul fleet, which accounts for most cargo and passenger transport. As a result, economic growth is predicted to increase emissions from transportation.

2. Demand Reduction: Implications and Opportunities

2.1 Exposure to international oil & gas demand reduction and fossil fuel transitions in key consumer countries

Brazil is exposed to fossil fuel transitions in its key consumer markets, namely China and the EU. The exact impact will depend on the trajectory of global prices and the ease of redirecting Brazilian crude towards other refineries. Despite its status as a net oil exporter since 2016, Brazil remains a net importer of refined products, particularly diesel for domestic road transportation (imported primarily from Russia and the U.S.).[10] Thus, how declining demand impacts Brazil's production will depend on the characteristics of specific oil fields, including production costs, the density and sulphur content of different types of crude and, potentially, the emissions-intensity in oil extraction.[11]

Petrobras' projections are the most informative source on how demand decline will affect the trajectory of Brazil's oil and gas sector. The company claims that its portfolio is consistent with an IEA Announced Pledges Scenario (APS) in which global warming reaches 1.7C (with 50% probability) by 2100 and Brent prices stabilize at USD 45/bbl. According to these calculations, and possessing an average breakeven price of USD 28/bbl, 98% of Petrobras' current exploration and production (E&P) portfolio would still generate value under the IEA's APS; under the IEA's Net Zero scenario (1.5C), 65% of E&P investment projects would generate value.[12]

Independent analyses paint a slightly different picture, in which only 89% of Petrobras' E&P portfolio is viable under APS, and 60% in a Net Zero scenario.[13] New fields, whose amortization requirements raise breakeven costs, are even less viable: 74% under APS, and only 15% in a Net Zero scenario. Overall, figures for the viable share of Brazil's total oil production (including other operators) are only slightly lower than those for Petrobras alone (2-3 percentage points in each scenario). Despite these differences, likely linked to the time horizons and price assumptions used in each scenario, the available figures show that even if decarbonisation efforts were to accelerate, most of Petrobras' current and planned production would remain cost competitive, and Brazil would hence gain international market share.

However, a lingering issue is the status of global oil markets beyond 2050. This is most applicable to plans for new exploration frontiers, particularly in the Equatorial Margin. Were a successful discovery to take place today, first oil would only arrive after at least 5-10 years. Given expected lifespans of around 30 years, production in any new offshore fields would likely extend into the 2060s or even 2070s. Depending on the size of the global oil markets at that date, then the risk of stranded assets would be higher.

Besides breakeven prices, the ease of placing oil in international refining markets influences the trajectory of oil transitions. Petrobras' ongoing investments in refining capacity will reduce, but not eliminate (due to projected demand increases) the dependence on imported fuels such as naphtha, gasoline, diesel, and aviation kerosene.[14] Given that Brazil will continue producing more crude than it can refine domestically, there will be limited scope for repurposing excess crude towards the domestic market.[15] Still, Brazil's pre-salt fields generally produce medium to light, sweet crude, which is appreciated in international markets. Although discoveries in the Equatorial Margin are yet to be made, any reserves found there are likely to be of a similar type, as also seen in analogous basins in West Africa. This suggests that the country is unlikely to have trouble in finding international buyers for its crude, even in a context of lower global demand.

Finally, the Brazilian government has repeatedly argued that, at a level of 15-20 kg CO_2/boe, emissions at the point of extraction are below the global average as well as below the levels of major producers such as Canada, Russia, Iran or Iraq. Petrobras has goals of eliminating flaring and reducing methane emissions by 70% (relative to 2015) by 2030. In addition, its "RefTOP" program aims to place it among the world's most energy and operationally efficient refiners.[16] Meanwhile, the government has encouraged the entire oil sector to further reduce emissions in exploration and production,[17] including methane emissions.[18] This can be seen as a way of positioning the country more favourably in a future scenario where emissions gain ground as a criterion for gaining access to oil export markets.

2.2 Domestic implications of declining fossil fuel demand and exports

Given the expected medium-term production decline in currently operating oil fields, and the expected resilience of domestic demand for petroleum products, the decline in external demand will only impact the country if plans to increase reserves by opening new exploration frontiers come to fruition. Yet even in that scenario, Brazil is expected to expand its global market share, suggesting that the domestic oil industry would likely maintain its scale in the medium term.

Instead, the primary impact of declining demand would materialize through reduced public revenues due to lower oil prices. Oil-dependent municipalities in the southeastern


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states of Rio de Janeiro, Espírito Santo and, to a lesser extent, São Paulo, would be the most affected, as would the state governments themselves (again, less so in the case of São Paulo). Moreover, prospective Equatorial Margin producers in northern and northeastern Brazil might receive lower royalty payments than initially expected. The federal government would also lose funds from its share of tax and royalty payments, as well as lower dividends from its ownership share of Petrobras (which amounted to around US$ 7.3 billion in 2024).[19]

2.3 Opportunities arising from declining oil and gas demand

In a world still expected to increase total energy consumption in the coming decades, declining oil and gas demand implies increased demand for clean energy sources. While electrification is expected to replace much of the demand for gasoline in light-duty vehicles, the decarbonisation of international aviation, maritime transport, and heavy-duty freight is more likely to rely on the adoption of low-carbon fuels such as sustainable aviation fuel (SAF), green hydrogen, e-fuels, and advanced biofuels. Brazil possesses the technology, renewable energy resources, and agricultural feedstocks availability to be a globally dominant player across these different low-carbon fuels. It also possesses many of the rare earths and critical minerals required for the electrification of the global energy system. Thus, while not significantly imperilling the country's hydrocarbon economy in the medium term, declining oil and gas demand can open up new export markets that could support economic diversification.

The benefits of Brazil's huge clean energy potential are yet to reaped. Firstly, global markets for most low-carbon fuels are not mature yet, given high costs relative to incumbent energy sources, timid decarbonisation mandates for aviation and long-haul transport (but not shipping), and limited availability of feedstocks for biofuels, as well as a lack of international certification. Brazil has set public policies for the development of each of these sectors, as well as a number of biorefinery and green hydrogen projects under development.[20] However, the government has so far been unable to allocate the same resources for technological innovation or for the development of pilot projects as the US or the EU, undermining Brazil's ability to position itself competitively in international markets. The shortfall is even starker in the minerals sector, where the country lacks a concerted strategy or even adequate mapping.[21] In the absence of more purposive public policies, the country risks reproducing its position as a mere exporter of raw materials and not capitalizing on its clean energy potential to achieve technological upgrading.

2.4 The role of modelling tools

Modelling can provide essential inputs to Brazilian policymaking on the oil and gas transition. Research by the Centre for Energy and Environmental (Cenergia) group, based at the Energy Planning Program of the Federal University of Rio de Janeiro, touches on many of the themes raised in this briefing, including the effects of different climate scenarios on the geography of crude oil production,[22] stranded assets risks,[23] the role of upstream emissions in continued oil production,[24] and how the refining and petrochemical sectors can adapt to climate change.[25]

Existing research, as well as the questions raised in this briefing, point to additional potential applications of modelling tools:

1. **Planning adequate levels of investments in refining and in E&P in new frontiers under different climate scenarios.** Most estimates based on IEA scenarios only provide evaluations of the viability of investments in production and refining until 2050. However, considering the unlikely prospect of achieving Net Zero by 2050 and the long timespans needed to recoup investments in oil fields and refineries, longer-term projections might be needed to evaluate the desirability of opening new exploration frontiers.
2. **Modelling the optimal allocation of investments in low-carbon fuels and their feedstocks.** Agricultural crops, waste products, and animal oils can be used for biofuel production through different routes for the production of ethanol, biodiesel, biomethane and biogas, and different types of SAF. The optimal allocation of these feedstocks will depend on the pace of domestic and international decarbonisation. However, absent greater coordination, the sector risks suffering from the same problems that afflicted it in the early 2010s, when Brazil's international biofuels ambitions were cut short by a domestic crisis of underproduction.[26]

Modelling tools can supplement policy by helping anchor the currently dispersed efforts of government actors. Moreover, by displaying different scenarios accompanied by transparent assumptions, modelling tools can help overcome highly polarised debates on the expansion of the oil frontier and inform the public on the issue. Similarly, the Brazilian government has been opting for an "all-above-of-the-above" approach to selecting technological routes across different areas of decarbonisation policy. While an agnostic approach to predicting technological change has its merits, it also disperses policy efforts and hinders the ability to support strategic bets at the scale required to achieve international competitiveness. Modelling can support more open debates on the future of Brazil's decarbonisation efforts in sectors such as biofuels, green hydrogen, and e-fuels, among others.

3. Domestic Policy Priorities and Recommendations

Improve management of current and future oil revenues, particularly for investing in climate mitigation and adaptation. It is well-documented that the current framework for distributing oil revenues is dysfunctional. A handful of municipalities and states adjacent to offshore oilfields receive the bulk of royalty payments, while the portion of oil revenues accruing to the federal government is used to pay for the policy priorities of the day, with little by way of accountability. While the recent re-regulation of the federal government's "Social Fund" essentially rules out reforms to institutionalise the allocation of oil-derived expenditures, there is scope for increasing transparency and accountability at the local level, including through work with regulatory agencies. Moreover, legislative proposals currently in parliament set requirements for transparency and minimum expenditures on protection of the Amazon by municipalities receiving royalties.[27] These proposals should be supported and extended.

Having a serious debate on the role of oil in Brazil's energy transition, particularly the continued reliance on petroleum-based fuels for domestic transport. Arguments grounded in energy security that support continued investment in oil extraction and refining assume a limited extent of decarbonisation within the domestic energy sector. It is likely that more can be done to reduce energy emissions, particularly in transportation. Solutions for decarbonising domestic transportation could potentially also provide demand at sufficient scale for gaining competitiveness in clean energy technologies, such as in the electrification of heavy-duty vehicles or, even more promisingly, renewable diesel (hydrotreated vegetable oil, HVO). There are opportunities for pursuing more ambitious decarbonisation goals in Energy Planning Agency (EPE) scenarios and in the National Energy Transition Plan currently being developed by the Ministry of Mines and Energy. In addition, the "Fuel of the Future" law could be amended to include HVO as a decarbonisation solution for heavy-duty transport. This could be coordinated with efforts to develop the biofuel value chain, as described below.

Integrated planning on how to better integrate renewable resources (biomass, green hydrogen) and hydrocarbon infrastructure (refineries, pipelines) to catalyse the development of low-carbon fuels. While biomass, predominantly from agricultural crops, is produced mostly in the central and southern parts of Brazil, the burgeoning green hydrogen sector is located primarily in the Northeast, capitalizing on its abundant endowments of solar and wind energy.[28] There is a case for coordinating and better structuring the value chains for these feedstocks to ensure that low-carbon fuels can achieve the scale and security of supply necessary to serve global markets, while serving equity goals.[29] In parallel, repurposing and retrofitting existing fossil fuel infrastructure can serve the low carbon economy, with co-processing (of renewable and non-renewable feedstocks) and biorefineries for production of SAF and biodiesel being the most prominent examples.[30]

Leveraging domestic renewable energy mandates, as well as Petrobras' technological know-how and financial resources, to build strategic green value chains. While laws on biofuels, green hydrogen, or offshore wind provide a basic regulatory framework for these sectors, they still lack the financial resources and pilot projects needed to get off the ground. Petrobras' planned US$ 8.9 bn expenditure in clean energy technologies over the 2025-29 business plan period could be better coordinated with Brazil's overall energy and industrial policy, in order to catalyse the sectors seen as holding the greatest potential in global and domestic green energy markets. This will require examining financial, technological, and public policy trends, which underscores the need for greater coordination between Petrobras, relevant government agencies, and the private sector.

Adapting to the retreat of multilateralism by adopting a foreign policy that attracts the investment and technology necessary to strengthen clean energy sectors. China and the EU, the top destinations for Brazilian crude oil exports, also happen to be leaders in clean energy technologies. They are also partners with whom Brazil maintains solid economic and diplomatic relationships. These can be leveraged to create cooperative programs for post-oil diversification. Cooperation with China appears particularly promising. There is already a track record of technological cooperation in clean energy,[31] and bilateral ties have deepened in recent years, as demonstrated by the wide range of sectoral cooperation agreements signed during the Chinese Premier's state visit to Brazil in November 2024. In the case of the EU, beyond cooperative frameworks specific to the energy sector – such as the partnership between the Brazil's Ministry of Finance and Germany's Fraunhofer Institute on the development of green hydrogen technology – the warming of economic relations, exemplified by the ratification of the EU-Mercosur free trade agreement, could also help unlock new opportunities for economic diversification.

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