THE BRAZILIAN PARTICULARITY: PRE-SALT IN THE ENERGY TRANSITION[1]

A ESPECIFICIDADE BRASILEIRA: O PRÉ-SAL NA TRANSIÇÃO ENERGÉTICA

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Abstract

This paper aims to analyze the challenges imposed by exploring Brazil´s deep-water oil reserves (pré-salt) since 2007 and Petrobras's role in the global energy transition context. A qualitative methodology is used, which includes a bibliographic review, collection of statistical data, and systematic analysis of the characteristics of the Brazilian energy sector. We argue that the challenge for Brazil is to balance the economic gains of the pre-salt with policies to support national development and, at the same time, encourage the use of other energy sources. We argue that depending on the national policies implemented, pre-salt might not necessarily conflict with the aims of an energy transition. However, if a clear strategy is not implemented to take advantage of such resources, oil revenues might be only appropriated by short-term private financial interests. Petrobras play a key role in this process.

Keywords: Brazil; Pre-salt; Energy transition; Energy sovereignty.

Resumo

Este artigo tem como objetivo analisar os desafios impostos pela exploração das reservas brasileiras de petróleo em águas profundas (pré-sal) desde 2007 e o papel da Petrobras no contexto de transição energética global. É utilizada uma metodologia qualitativa, que inclui revisão bibliográfica, coleta de dados estatísticos e análise sistemática das características do setor energético brasileiro. Argumentar-se que o desafio para o Brasil é equilibrar os ganhos econômicos do pré-sal com políticas de apoio ao desenvolvimento nacional e, ao mesmo tempo, incentivar o uso de outras fontes energéticas. Argumentamos que, dependendo das políticas nacionais implementadas, o pré-sal pode não necessariamente entrar em conflito com os objetivos de uma transição energética. No entanto, se uma estratégia clara não for implementada para aproveitar esses recursos, as receitas do petróleo podem ser apropriadas apenas por interesses financeiros privados de curto prazo. A Petrobras desempenha um papel fundamental nesse processo.

Palavras-Chave: Brasil, pré-sal, transição energética, soberania energética.

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1. INTRODUCTION

The global energy transition is, in practice much more complex and uncertain than usually presented. This suggests a non-linear path to a zero-carbon emissions economy capable of keeping global warming under control. The existing natural resources, the technologies available, the institutional structures, the political scenario, and the historical path in energy use will shape the way for different types of energy transition in each country and region. In this paper, we explore the case of energy transition in Brazil.

Developed countries carry a historical responsibility for Greenhouse Gas Emissions (GGE), however, the most affected tend to be the least developed countries. They face a more significant challenge due to their reduced ability to adapt to emerging environmental problems and the lack of resources to solve the issues coming from climate change (Bernauer, 2013). At present, among the developing countries with high emission levels are China, India, and Brazil. However, in Brazil, most emissions come from illegal logging and not from fossil fuels.

International negotiations, agreements, and implementation on climate change need to encompass a large majority to be effective, efficient, and equitable. However, one can identify a conflict of interest between developed and developing nations, as developing countries claim the right to develop, leading to an increase of the GGE, as was done in the past by developed countries (Streck & Terhalle, 2013). Technology transfer and financing might reduce this increase in GGE without compromising the right to development.

The International Renewable Energy Agency (2022) defines the energy transition as *"a pathway toward transformation of the global energy sector from fossil-based to zero-carbon by the second half of this century. At its heart is the need to reduce energy-related CO2 emissions to limit climate change"*. In addition, energy transition is a technological revolution that involves control over patents and knowledge (Criekemans, 2018). Therefore, growing competition between countries for leadership in technological knowledge and mineral resources related to renewable energies is part of the process (Scholten, 2018). This scenario can increase tension between developed and developing countries on technology transfer and infrastructure, mainly if the energy transition results in new asymmetric dependency relationships (O'Sullivan et al., 2017; Sabatella & Santos, 2020).

In the case of Brazil, the country ranked third in renewable energy generation capacity in 2020, with 515,449 gigawatt-hours (GWh), behind only China and the United States (IRENA, 2021, p. 7). According to the Energy Research Office (EPE in its Portuguese acronym), the share of renewables in Brazil's energy matrix accounts for 48.4% of the internal energy supply in 2020. Worldwide this share is equivalent to 13.8%. Among the Organization for Economic Co-operation and Development (OECD) countries, the share is only 11% (EPE, 2021a, p. 12). The predominance of renewables is greater if only electricity is considered, representing 84.9% (compared to 22% in the

world average), of which 65.2% correspond to hydraulic energy, followed by biomass (9.1%), wind (8.8%), and natural gas (8.3%) (EPE, 2021b, p 16-p.17).

The challenge for Brazil is to balance the economic gains of the pre-salt with policies to support national development and, at the same time, encourage the use of other energy sources. It will be argued that depending on the national policies implemented, pre-salt might not necessarily conflict with the aims of an energy transition. However, if a clear strategy is not implemented to take advantage of such resources, oil revenues might be only appropriated by private national, and international interests. The role of Petrobras is considered crucial in this process. A qualitative methodology is used, which includes a bibliographic review, collection of statistical data, and systematic analysis of the characteristics of the Brazilian energy sector.

The paper is structured in five sections, including this introduction. The following section explores the specificity of pre-salt. Section three discusses the developments in the other energy sectors to evaluate the possible impact of the pre-salt exploration on Brazil's energy matrix. The fourth section makes a critical analysis of the policies implemented since 2016 regarding the role of the state-controlled Petrobras and the legal framework of the pre-salt exploration. It also discusses the position of the transport sector. The paper ends with concluding remarks.

2. THE PRE-SALT AS A STRATEGIC ASSET IN THE ENERGY TRANSITION

A new reality emerged for the oil industry when significant oil and gas reserves were discovered in deep waters off the Brazilian coast, in November 2007. As a result, the country's position in the world market changed significantly and international oil companies started to look at Brazil as a new investment opportunity. The announcements of proven resources indicated that reserves could reach 100 billion barrels of oil (Sauer & Estrella, 2019, p. 3). This would make Brazil not only self-sufficient but an important oil exporter.

In the energy transition regions with higher extraction costs could become less attractive or even commercially unviable, and the remaining demand will be supplied with oil with competitive production costs (O'Sullivan et al., 2017). However, oil still plays a central role in enabling the change in the existing production and consumption paradigm and the energy transition itself. This oil tends to maintain its high value for a long time, at least three decades (Sauer, 2016, p. 316-7). And even if oil loses its leading role, it will continue to be an essential energy source, just as the decline in coal in the 20th century did not eliminate it from the world energy matrix. Fossil energies will likely remain a relevant part of the global energy matrix, coexisting with renewables far beyond the demand oil peak (Paltsev, 2016; Scholten, 2018).

Regarding peak demand, one can differentiate between international and domestic demand. The global analysis of oil consumption data shows that there was a cyclical drop in the level of

demand concerning the previous year, in five cases: in 1930 related to the Great Depression (-5%); in 1942 related to the Second World War (-5.7%), in 1975 related to the impact of the boycott of Arab producers and the price shock (-5.5%); in 1981 related to the second oil shock and the Iran-Iraq War (-6.4%); and, in 2020, related to Covid (-9.3%). In the latter case, global demand reached its lowest level since 2012 (BP, 2021). It is observed that global demand in absolute numbers had increased by 67.43 million barrels per day, in 1992, the year of the United Nations Conference on Environment and Development, also known as the Rio de Janeiro Earth Summit, to 97.6 million barrels per day in 2019. In 2020 there was no lack of speculation that the pandemic would have accelerated the peak of demand, while the fall in prices generated insecurity regarding investments (Klare, 2020). In 2021, the still slow recovery of the economy led, however, to a 5.7% increase in global demand for oil, according to the US Energy Information Administration, which forecasts a global demand of 102.5 million BPD for 2023. (EIA, 2022).

There are structural factors that increase global energy demand (demography, income), and this means that the loss of oil's relative importance can coincide with a nominal increase. Even more important is to consider the impact of depletion. As the International Energy Agency argued: “Production from existing fields declines at a rate of roughly 8% per year in the absence of any investment, more significant than any plausible fall in global demand.” Consequently, investment in existing and new fields remains part of the picture. However, as overall investment falls back and markets become increasingly competitive, only those with low-cost resources and tight control of costs and environmental performance would be in a position to benefit (International Energy Agency, 2020, p. 60 and p. 82). This is precisely the case with the pre-salt layer.

The pressure for energy transition and the uncertainties on medium- and long-term developments have not stopped investments in oil and gas but have led to a selective approach by the oil companies, focusing on efficient, low-cost, and reliable sources, among which Brazil.

Petrobras operations with technological innovation have reduced the average cost of extracting pre-salt oil in a relatively short time. For example, the lifting cost went from US$ 9.1 per barrel of oil equivalent (oil + gas) in 2014 to US$ 8.3 in 2015 and reached a value of less than US$ 7 per barrel in 2018, and in 2019 it reached a value between US$ 6 and US$ 5 per barrel (Petrobras, 2019). No surprise, that international companies, like Shell and Equinor, have inserted the pre-salt as a fundamental part of their strategy. In an interview about ExxonMobil's expectations for pre-salt exploration, Stephen Greenlee, the company's global president of exploration and production, stated that the pre-salt

> it is an entirely different type of investment, but the returns are comparable to the best unconventional assets. Today there is nothing better to bring to our portfolio than these reserves that Brazil has discovered in recent years. That is why we are so excited (PAMPLONA, 2018).

In addition to oil, the importance of pre-salt natural gas reserves for the energy transition in Brazil must also be considered. Natural gas is considered a bridge fuel that can promote the reduction of emissions, while cleaner energy solutions are developed and implemented (Ladislaw et al., 2014). However, in the medium term, for the survival of the oil companies, they will have to transform themselves into energy companies by also investing in renewable projects. In the next section, an analysis is made of the evolution of renewable energy sources in Brazil since the exploration of the pre-salt reserves started.

3. THE GROWTH OF RENEWABLE ENERGIES IN THE CONTEXT OF PRE-SALT EXPLOITATION

Differently from what common sense might assume, the rapid expansion of Brazilian oil production from the exploration of pre-salt reserves did not prevent the development of renewable sources in the Brazilian energy matrix by itself. The Brazilian government, while invested heavily in the oil industry since 2007, has put into action a policy of financial incentives that has enabled, in a few years, the accelerated growth of electricity generation from intermittent energy sources – wind and solar energy. The most increased energy source in the country is wind energy, whose installed capacity grew from 1,326 MW in 2011 to 19,962 MW in 2021 (EPE, 2021). In 2021 alone, this increase was 3,051 MW, according to data from the National Electric Energy Agency (ANEEL). Wind power plants account for 11% of electricity generation in Brazil, surpassed only by hydroelectric power (Machado, 2021).

In 2020, 66 new wind farms were inaugurated in Brazil and, in 2021, despite the Covid-19 pandemic, another 54 had already begun operating by November, totaling more than 750 installations of this type installed in the country (Vasconcelos, 2021). The installed capacity reached 21,03 GW.

Among the causes that explain the success of the expansion of wind energy in Brazil stands out, first, the characteristics of the Northeast region, where the winds present favorable constancy conditions and intensity for electricity generation. Currently, the Northeast accounts for 90% of the wind energy generated in Brazil. Another important factor is the complementarity between wind energy and the dominant hydroelectric energy source. Periods of higher incidence of rainfall correspond to unfavorable winds for energy generation, and vice versa (Losenkann & Hallack, 2018).

Photovoltaic solar energy has also rapidly expanded its participation in the Brazilian energy matrix, despite its relatively late development compared to wind energy. The production of this type of energy only becomes significant from 2017, when Brazil had an installed capacity of 935 MW, growing vigorously since then. In 2021, the installed capacity of solar energy reached 4,3 GW (EPE, 2021a).

The data presented here refer to the generation of photovoltaic solar energy, obtained in large plants, which has become economically viable with the purchase of energy supply by the federal government through specific auctions and, more recently, by the direct purchase of large consumers in the free market (Vasconcelos, 2021). Another 7,3 GW of installed photovoltaic solar energy capacity (not counted in the official calculation of the electric matrix) correspond to distributed generation – that is, 800,000 consumers who produce their energy from solar modules installed on the roofs of homes and businesses and small lands (Vasconcelos, 2021).

As for Brazil's electric power, fears of a negative impact of pre-salt oil expansion to make the Brazilian energy matrix "dirtier" have not occurred so far. The share of renewable sources in the generation of Brazilian electricity has grown in the last decade, thanks to the expansion of wind and solar energy infrastructure and, even more importantly, a process of increasing electrification in the general use of energy in the country is underway – a trend that converges with global expectations related to the transition to a "low carbon" economic model.

On the other hand, state planners in the energy sector expect a decline in the share of water sources in total electricity generation from 83% around 2000 to 46% by 2031, well below the current 65% (EPE, 2020). This decline is due to rising costs and restrictions, for environmental and social reasons, to the construction of new dams in the Amazon, the only region of the country where large new hydroelectric plants are still possible. The main reasons for resistance to new water energy enterprises in the Amazon are (i) the need for the displacement of populations and rural economic activities; (ii) damage to flora and fauna, especially in areas where endangered species are found; (iii) changes in the water of the reservoirs themselves as a function of the remaining submerged vegetation; and (iv) the change in the river regime. As it turns out, none of these restrictions have to do with oil (Leite, 2007).

As for biofuels, sugarcane ethanol and biodiesel have maintained their central position in the energy supply for transport despite Brazilian self-sufficiency in oil production and the increase in natural gas production. Brazil has a long history of the use of ethanol, starting in the mid-1970s with a massive state program for the production of sugarcane alcohol in place of gasoline to face fuel prices from the first "oil shock". This program was later abandoned when falling oil prices since the 1980s and the fiscal crisis of the Brazilian state, which made subsidies to ethanol mills and sugarcane producers unfeasible. Biofuels resumed their role as an energy alternative from 2000, when oil prices rose again (Barros et al., 2012). A sustained policy of encouraging ethanol and biodiesel began, which has remained unchanged to date, throughout governments of different political and ideological options. This longstanding policy helped to contain pollution. The sugar and ethanol agro-industry is also important in the Brazilian energy matrix by burning waste from ethanol production – sugarcane bagasse – as a fuel for the generation of electricity in thermal plants. About 12% of all electricity consumed in the country is obtained from this energy source.

The generation of renewable energies in Brazil presents, due to its diversity and its high levels of production, a wide range of possibilities to be explored by energy transition policies. The export of Brazilian renewable energy using hydrogen as a means of storage and transportation is on the agenda of many international energy companies as will be explored in the next sections when we explore the policies for exploration of the pré-salt, the role of Petrobras, and the international oil companies.

4. CHANGES IN LEGAL FRAMEWORK FOR THE PRE-SALT EXPLOITATION

In 2016, a think tank linked to former president Fernando Henrique Cardoso, organized an event entitled "The end of oil triumphalism and the definition of new directions for energy in Brazil", with the participation of specialists in the field and leading members of the neoliberal government in the 1990's including the former presidents of Petrobras and the National Agency of Petroleum and Biofuels (ANP), and the former Minister of Foreign Affairs. The seminar addressed "doubts about the viability of the pre-salt layer." The drop in investments in P&G exploration was presented as a "global trend," to which Brazil should adapt. These experts unanimously concluded that exploring the pre-salt layer would go against the grain of history and delay the necessary energy transition in Brazil. These arguments dominated the political debate about Petrobras and the pre-salt layer during much of the Dilma Rousseff government (2011-2016).

Part of this reasoning was also the idea that the rationale behind the insistence on prioritizing the pre-salt would have been to create the conditions for setting up corruption schemes. The world would rapidly get out of oil, and the concentration of scarce resources for pre-salt exploration would distance Brazil from the global trend. In the previous section, we showed that Brazil did not fail to make investments in expanding the supply of renewable energies in parallel with those destined for the pre-salt layer.

The uncertainties related to the pace of the transition, strongly accentuated by Covid-19, were also reflected in investment decisions. It should be remembered that the approximate interval between prospecting and production is about ten years and between the development of explored fields and total production about five years, on average. Thus, while the oil price increases in 2021 and the first two months of 2022 are related to cycles of the pandemic and the conflict in Ukraine, the new upswing cycle also reflects the lack of investment that generated a very tight supply and limited excess capacity. Therefore, the pre-salt layer is not part of the problem but the solution. Table 1 shows how the country has become a relevant exporter over the past decade.

Table 1 - EVOLUTION OF OIL IMPORT/EXPORT IN BRAZIL IN SELECTED YEARS

	2005	2010	2021
Oil exports	100.2 million barrels	230.5 million barrels	484.6 million barrels
Oil imports	138.2 million barrels	123.6 million barrels	59.6 million barrels
Import derivatives	68.7 million barrels	172.2 million barrels	226.6 million barrels

Source: ANP (2022).

Data from the Brazilian Institute of Oil and Gas (2022) show a steady increase in exports from 0.4 million bpd in 2013 to 1.4 million bpd in 2021. The leading destination is China, and in 2020 Brazil became the fifth largest exporter, after Saudi Arabia, Russia, and Iraq, and practically tied with Angola (Workman, 2022). At the end of 2021, it was the seventh-largest producing and exporting country, with the prospect of reaching fifth place in both categories by 2030.

4.1. PRIVATIZATION AND ENERGY SOVEREIGNTY

While during the Dilma Rousseff government (2011-2016), the critics were directed to the pre-salt layer itself (Schutte, 2016), soon after its fall, the discourse changed. Exploring the pre-salt layer was indeed a priority, but the energy transition became the argument for implementing two policies articulated with each other during Michel Temer (2016-2018) and Jair Bolsonaro (2019-). First, an accelerated opening of the pre-salt layer to multinationals should help the effort before the reserves lost their value. Second, Petrobras itself should shrink and focus only on exploration, the pre-salt layer in the process of de-verticalization and de-horizontalization.

These measures are part of an operation to dismantle the policy for the pre-salt as it was developed by the Luiz Inácio Lula da Silva government (2003-2010), which President Dilma, continued. At the time, the aim was to ensure state control and direction of the exploitation of wealth in the context of a national development project. The new regulatory framework of 2010, known as Partilha, established the monopoly of Petrobras in the operation of new ventures in the pre-salt area. In addition, there was a vigorous local content policy to ensure that the massive investments required for oil and gas exploration would translate into income and employment generation in the country (Schutte, 2021).

Already in 2016, the Michel Temer government met the demands of international oligopolies by drastically reducing local content requirements, anticipating the renewal, and expanding the scope of the tax exemption regime for imports of goods destined for oil and gas exploration (Repetro), and sanctioning the law that removed the obligation of Petrobras leadership in all pre-salt fields. In addition, it started the process of selling assets, including the pre-salt layer itself, with the sale of Petrobras' stake (66%) in the Carcará field in the Santos Basin where Petrobras had already found oil in large quantities and of excellent quality.

Then, in less than two years, the government carried out six Bidding Rounds: four as Partilha (in the pre-salt area) and two as Concession (in theory outside the pre-salt area). They all aroused

great interest from international companies, especially Shell, Equinor (formerly Statoil), and Exxon. Exxon, which had even left Brazil when the Lula administration adapted the new 2010 legislation for exploration of the pre-salt oil, returned with huge investments, snapping up the right to explore a total of 22 blocks in 2017-2018, even putting itself ahead of Petrobras successful biddings in this cycle. The Temer government's determination was so great that faced with the possibility of a government with another vision winning the October 2018 elections, it anticipated the 5th Pre-Salt Round, initially scheduled for the 3rd quarter of 2019, to 29 September 2018.

The deverticalization process included the withdrawal of distribution with the privatization of the subsidiary BR Distribuidora (now called Vibra Energia), which was the market leader, and the withdrawal of the petrochemical sector (although the sale of the 47% stake in the petrochemical company Braskem encountered problems with execution) and the partial withdrawal of refining. Nevertheless, by the end of 2021, the government had managed to sell the Mataripe Refinery in Bahia and the company Acelen, controlled by the Sovereign Fund Mubadala of the United Arab Emirates (UAE). Petrobras also sold most of its assets abroad.

The bidding rounds increased the participation of foreign, private, and state-owned companies. As shown in table 2, Petrobras went from a share of 93% in 2010 to 84% in 2016 to reach 73.7% in 2020 (ANP, 2021, p.82).

Table 2 – PARTICIPATION OF CONCESSIONAIRES IN BRAZIL – (2020, % OF TOTAL PRODUCTION)

	Oil	Gas
Petrobras	73.7%	75.2%
Shell	12.4%	11.6%
Petrogal	3.5%	3.5%
Eneva	-	2.9%
Repsol/Sinopec	2.2%	2.2%
Enauta	-	0.9%
Petronas	1.5%	0.4%
Equinor	1.3%	0.8%
Total	1.2%	0.8%
Outros	4.2%	1.7%

Source: ANP (2021).

However, Petrobras is still the most significant player, and the progress of other concessionaires does not explain by itself the fact that, paradoxically, the country, instead of taking advantage of the pre-salt layer to strengthen its energy sovereignty, ended up diminishing it. This is evident when we consider that the decision to privatize most of the refining park is taken after abandoning the projects aiming for expansion of the refining capacity initiated under the Lula government.

Even before the pre-salt discovery, there was concern about the lack of refining capacity, given the prospect of strong growth in demand caused by a growth in the economy with income

distribution. The growth in domestic consumption of petroleum products in volume between 2006 and 2014 was 56%, with emphasis on diesel oil (with 54%), gasoline (with 85%), and kerosene for aircraft (with 68%) (ANP, 2015).

Petrobras' original refining park, containing 12 units, was built between the 1950s and 1980s, with a capacity of just over 2 million barrels per day, which was enough for another two decades, especially in the face of the poor performance of the economy during the following two decades. The Lula government planned an expansion to reach 3,6 million barrels per day with investments to increase the capacity of existing refineries (from 2 to 2.2 million bpd), and, most importantly, the construction of four new refineries, of which only half of one (the Abreu e Lima Refinery, in the Northeast) was delivered, at the end of 2014, before political turmoil provoked the policy change (Schutte, 2020).

The Temer government canceled the expansion of refining capacity and deliberately reduced the use of installed capacity, from an average of around 85% between 2000 and 2015 to 72.7% in 2018 (Gonçalves et al., 2019). Along with this was the introduction of Import Parity Prices (PPI), which means that fuel prices were required to follow international prices and incorporate the dollar's fluctuation, even though the country had become, with the pre-salt, a significant producer and exporter with low domestic production costs. The Temer government-sanctioned Law 13,703/2016, known as the State-Owned Companies Law, basically obliges Petrobras to behave as if it were a private company concerned solely with the financial interests of its shareholders.

The PPI's logic was to create a market for imports and prepare for privatization. This policy was implemented when prices were relatively low, but it had to be softened when rising prices provoked a nationwide strike by truck drivers in May 2018. Nevertheless, the PPI logic was not abandoned and was vigorously endorsed and reinforced under the Bolsonaro government. At the end of 2021, Brazil had about 400 importers, and about 75% of the derivatives imported were from the USA (ANP, 2021, p. 128).

Although the net imports as a percentage of domestic consumption did not exceed 15% in this period, there will necessarily be a strong increase in this dependence when the country returns to growth. More importantly, the international import price determines domestic prices, generating extraordinary profits for Petrobras and record dividends for its shareholders.

As a result, in 2021, on the one hand, there was a consolidated net income of R$106 billion generating a transfer of R$101,4 billion to shareholders, a historical level for the company (Petrobras, 2022, p. 4). It is worth mentioning that only one-third of Petrobras' social capital is State-owned and approximately two-thirds of the shares are in private hands, half of whom are foreigners. On the other hand, increases in the price of cooking gas have caused the number of households using wood for cooking to exceed gas, an example of energy poverty.

The exit from petrochemicals, part of the deverticalization, also means giving up the ability to use the leverage power of Petrobras and the pre-salt reserves to expand investments and generate income and employment in the downstream sectors.

The de-horizontalization refers to the decision of the Temer and Bolsonaro governments for Petrobras to focus exclusively on oil and gas exploration in the pre-salt layer. Moreover, contrary to the general trend, to withdraw from other areas of energy. An example is Petrobras Biocombustível (PBIO), a subsidiary created in 2008 that had become a significant producer, mainly of biodiesel and ethanol. As of 2016, Petrobras began selling assets in this segment, such as its 45.97% stake in the Guarani ethanol plant, to French company Tereos, in 2017. In 2020, the sale of 100% of the subsidiary was announced, including the three biodiesel plants, still under the company's control. Legal challenges and the pandemic delayed this privatization. Likewise, the company renounced any solar, wind, or green hydrogen involvement. The Strategic Plan 2021-2025, released in November 2021, provides for the payment of a quarterly dividend, and announces the forecast of distribution of US$ 60 and US$ 70 billion in the form of dividends between 2022 and 2026. But, no commitment to investment in renewables. The strategy is clear: to transform Petrobras into a cash cow with only short-term financial objectives.

With that, Petrobras is moving in the opposite direction of the global trend, with the big oil companies transforming themselves into energy companies and not assuming their potential to be a central actor in the energy transition. At the same time, international oligopolies are taking advantage of opportunities in Brazil in renewables. The following figure is a sample of this trend. All these companies also invest heavily in the exploration and production of P&G in Brazil, notably in the pre-salt layer.

Table 3 – INVESTMENTS BY FOREIGN OIL COMPANIES IN RENEWABLES IN BRAZIL

Equinor	Investments in solar via participation in Scatec Solar (the largest company in the segment in Norway), operator of the Apodi Complex in Ceará with 162 MW (it is the first photovoltaic plant in the company's global portfolio). another solar energy project at the Port of Açu. the company declared Brazil as one of the leading markets for onshore renewables. aims to direct 50% of its global investments to renewables by 2050.
BP	Joint-venture with Bunge Bioenergy, the second largest company in the sugar-energy sector in Brazil. solar projects for 2 GW. agreement with the ECB group to acquire more than 1 billion liters of advanced biofuels. global target: 50 GW of installed capacity in renewable energy by 2030.
Shell	Investments of R$ 3 billion by 2025 in renewables. six projects for solar energy (total capacity of 2 GW).
Total	Projects for 1 GW in Brazil in progress: three solar projects in São Paulo and Bahia and development projects for wind energy. Global goal: to be one of the five largest producers of renewable energy

Source: Magnavita (2021).

In addition, the country is on the horizon for investments in green hydrogen (H2V) aimed at exporting to Europe to contribute to achieving the increasingly stringent goals of participation of renewables in the transport sector. Green hydrogen uses solar and wind energy to produce fuel (electrolysis), with zero GGE. Therefore, many announced projects are located close to the port structures. Examples are the investments in the northeastern state of Ceará by Engie and EDP, a company of Portuguese origin with the participation of the Chinese CTG. Engie, a French company, is Brazil's largest private producer of electricity and aims to reach a global capacity of 4 GW in H2V by 2030, with Brazil as one of the leading destinations for these investments. Furthermore, it is not just electricity companies how developing projects for H2V in Brazil. Total Eren, the renewable energy arm of French oil company Total, began operations in early 2022 at the Terra Santa wind farms, with 92.3 megawatts (MW) of capacity, and Maral, with 67.5 MW, both located in the Rio Grande do Norte. The company pretends to link this capacity to H2V production (Machado, 2021). A study by the consulting firm McKinsey predicts that Brazil,

> for its potential of abundant wind and solar energy, an integrated, low-carbon electrical system, and an advantageous geographical position to reach Europe and the North American east coast, in addition to a relevant domestic industry, ... can become one of the world's leaders in green hydrogen production. (Mckinsey & Company, 2021).

4.2. THE TRANSPORT SECTOR

Although Brazil, as explained, has one of the cleanest energy matrices in international comparison, there is a structural problem moving forward: the transport sector. In 2019, it was the largest energy consumer in Brazil responsible for 32.7% of the total, ahead of the industry. However, while 58% of the energy consumed in the industry comes from renewable sources, in the case of transport, it is only 25%. The following table shows the share of each fossil energy source in consumption in the transport sector.

Table 4 – FOSSIL ENERGY CONSUMPTION IN BRAZIL AS A % OF TOTAL ENERGY CONSUMPTION IN THE TRANSPORT SECTOR (2019)

Source	% of total energy consumption in the transport sector
Diesel oil	42%
Gasoline	25.3%
Kerosene	3.9%
Gas	2.4%

Source: EPE (2019).

As mentioned above, there was a significant increase in the consumption of oil derivatives between the second half of the 2000s, mainly due to the increase in the fleet in all modalities, as can be seen in table 5. As a result, the total fleet more than doubled in this period.

Table 5 – VEHICLE FLEET EVOLUTION IN BRAZIL (2006-2020)

	2006	2020
Cars	27.7 million	58 million
Trucks	1.76 million	2.89 million
Motorcycle	7.9 million	23.9 million
Bus	352,000	660,400
Total	45 million	108 million

Source: IBGE (2022).

In the case of automobiles, Brazil managed to limit the expansion of gasoline consumption with the supply of hydrated (100%) and anhydrous ethanol (with a 27.5% mandate). Brazil has long been the only country globally that offers hydrous ethanol throughout its distribution network, and by now almost the entire car fleet uses an engine capable of running on gasoline or ethanol.

A report by researchers from the Brazilian Center for International Relations (CEBRI) points out, based on Data from EPE, that "while in the world the automotive industry has been developing new models and investing in battery capacity aiming at the decarbonization of the fleet of light [vehicles] in Brazil, the light transport fleet is already strongly renewable, with biofuels accounting for more than 40% of the energy consumed in the segment" (CEBRI, 2021, p.23) Nevertheless, the explosion in consumption did put pressure on the gasoline demand.

It is more complicated in the case of trucks, as shown in table 4. Biodiesel is not very competitive, and the industry does not invest in preparing engines to increase the mandate.

Biodiesel – a product obtained mainly from soybeans and animal fats – is mixed with diesel, in proportions defined by law. This mixture went from 2% (B2) in 2005 to 7% (B7) in 2014, reaching 10% (B10) in 2018 (Tavares, 2019). In 2021, the government even retreated and lowered the mandatory mix from 13% to 10%, notwithstanding the goal of reaching 15% in 2025. The fight against inflation justifies this measure, but it generates unpredictability for producers and does not consider the positive externalities of biofuels.

In this case, there is a total lack of a comprehensive policy that sets perspectives for the short, medium, and long term. All automakers producing in Brazil, without exception, are multinational companies. Olmos (2022) argued that these companies are, in their countries of origin, pressured by emission standards, especially European ones, and have announced deadlines to stop producing cars with fossil engines, as, for example, in the case of Mercedes 2030 or VW 2033-235, while Stellantis announced that it would produce only hybrid or electric vehicles by 2025. Unfortunately, Brazil seems to be isolated from this transformation.

The lack of a clear forward-looking policy from the Brazilian government is reflected in the absence of robust investment plans in new vehicle production and the necessary infrastructure by the companies, and the tendency is to remain on hold. In this process, Ford even ended its activities

in Brazil, at the beginning of 2021, after more than 100 years of operations, and Mercedes announced the ending of its production of automobiles in Brazil in the same year.

It is also worth noting the text negotiated in 2019 between the European Union and Mercosur, which has not yet entered into force but establishes specific rules for the automotive sector. Mercosur's current tariff of 35% on imports of European cars will drop to 17.5% in up to ten years, with a temporary quota of 50,000 cars in the first seven years, of which 32,000 for Brazil. In 15 years, the rate will drop to zero without quotas. No mention is made of technology transfer investment. What does that mean? In the next 15 years, when the sector undergoes these drastic changes, Mercosur will open its market with no quota and zero tariff. This will lower the incentives to invest in the restructuring of the plants in Brazil.

An alternative would be a national project transforming the country into a production center for hybrid vehicles with ethanol. There is, therefore, a contradiction: the governments of Temer and Bolsonaro, who used the temporal argument to open pre-salt exploration to international interests and stop investments in refining capacity, showed no hurry to guide the country towards energy transition in the transport sector aimed at increasing the use of renewable sources. Instead, the energy transition discourse was used as a pretext to accelerate the sale of strategic assets in the energy sector and open it up to private international and financial interests.

5. CONCLUSION

Brazilian energy transition does not need to follow other countries' steps nor to adapt itself, mechanically, to policies and guidelines set by highly industrialized countries. Its broad margin of autonomy regarding the global energy transition is based, first, on the predominance of hydro resources in the electric sector, in such a way that makes Brazil one of the countries with the highest participation of renewable energy in its energy matrix. This is what makes the use of fossil fuels in electricity generation secondary, and the energy matrix is "cleaner" in comparison to international standards.

Another fundamental feature of the Brazilian energy model is the decisive role of biofuels in transportation and electricity. The wide use of sugarcane ethanol and even biodiesel allowed Brazil to control CO2 emissions in the transportation sector, although the strong expansion of consumption demands alternative solutions.

The rapid growth of wind and solar energies generation in the 2010tees reinforces the potential for a transition to a zero net carbon energy model without jeopardizing the perspectives of national economic development, which demands increasing volumes of energy. The contributions from the so-called "new renewable sources" can provide the additional energy to respond to the

demographic growth, industrial and urban development, and the access to higher standards of living for the unprivileged majority of Brazilians.

We present an analysis of the pre-salt oil reserves as a potential asset instead of a barrier in the route to a decarbonized energy matrix.

However much depend on the role of the state-controlled company Petrobras. The company can play an important role in two key challenges. First to put the oil and gas wealth at the service of a national development policy. This includes the generation of jobs and income along with the down and upstream production chain and also the availability of oil and gas derivatives at affordable prices for the end consumers, without compromising the ethanol and biodiesel mandates. Brazil has become an oil exporter with low operational production costs. However, the governments that followed the overthrow of President Dilma Rousseff opted to attend to big oil and financial interests. Expansion of refinery capacity was canceled, so Brazil become an exporter of crude and an importer of derivates. Although still a minor part of domestic production, the imports of derivatives are used as a justification for a price policy set by international quotations disregarding local production costs. This results in huge dividends for the private shareholders and high prices for consumers. This policy is part of a wider deverticalization strategy that was implemented in 2016.

Secondly, there was the de-horizontalization of Petrobras. Contrary to the general tendency in the sector, Petrobras sold its assets in renewable assets and doesn´t have any strategy to turn itself into a powerful energy company that could have a leading role in the transition process.

At the same time, no policies have been put in place to incentive changes in car production technology. The sector is entirely controlled by foreign car companies that are investing heavily at home in transforming the sector responding to strong incentives and mandatory goals set by the governments in their countries of origin. Without clear policies, Brazil is marginalized by this process.

In short, Brazil has huge potential of defining its energy transition agenda and Petrobras could play a leading role if present policies were reverted.

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REFERENCES

AGÊNCIA NACIONAL DE PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS – ANP. **Anuário Estatístico Brasileiro do Petróleo, Gás Natural e Biocombustíveis 2021**. Brasília, Ministério de Minas e Energia, 2021. Available at: https://www.gov.br/anp/pt-br/centrais-de-conteudo/publicacoes/anuario-estatistico/anuario-estatistico. Accessed on 22/12/2022.

AGÊNCIA NACIONAL DE PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS – ANP. **Anuário Estatístico Brasileiro do Petróleo, Gás Natural e Biocombustíveis 2015**. Brasília, Ministério de Minas e Energia, 2015. Available at: https://www.gov.br/anp/pt-br/centrais-de-conteudo/publicacoes/anuario-estatistico/anuario-estatistico-2015. Accessed on 22/12/2022.

AGÊNCIA NACIONAL DE PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS – ANP. **Dados estatísticos - Importações e Exportações**. Tabela (em barris). Brasília, Ministério de Minas e Energia, 2022. Available at: https://www.gov.br/anp/pt-br/centrais-de-conteudo/dados-estatisticos Access on 28/12/2022.

BARROS, P.S, SCHUTTE, G.R., PINTO, L.F.S. Além da Autossuficiência: O Brasil como protagonista do setor energético. **Texto de Discussão 1725**. Instituto de Pesquisa Econômica Aplicada (IPEA), Brasília, p.5-p.91, 2012.

BERNAUER, T. Climate Change Politics. **Annual Review of Political Science**, v. 16, 2013, p. 421-448. Available at: https://doi.org/10.1146/annurev-polisci-062011-154926. Accessed on 22/12/2022.

BP. **BP Statistical Review of World Energy**. 1965-2020. 70th Edition, July 2021. Available at: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html. Accessed on 22/12/2022.

CRIEKEMANS, D. Geopolitics of the Renewable Energy Game and Its Potential Impact upon Global Power Relations. In: Scholten, D. **The Geopolitics of Renewables**. Lecture Notes in Energy, v. 61. Cham: Springer, p. 37-73, 2018. Available at: https://www.springer.com/br/book/9783319678542. Accessed on 22/12/2022.

EMPRESA DE PESQUISA ENERGÉTICA-EPE. **Balanço Energético Nacional 2021**. Rio de Janeiro, Ministério de Minas e Energia, 2021a. Available at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2021. Accessed on 22/12/2022.

EMPRESA DE PESQUISA ENERGÉTICA-EPE. **Plano Decenal de Expansão da Energia 2031** – Versão para consulta pública. Rio de Janeiro, Ministério de Minas e Energia, 2021b. Available at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/plano-decenal-de-expansao-de-energia-pde. Accessed on 22/12/2022.

EMPRESA DE PESQUISA ENERGÉTICA-EPE. **Balanço Energético Nacional 2020**. Rio de Janeiro, Ministério de Minas e Energia, 2020. Available at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2020. Accessed on 22/12/2022.

CENTRO BRASILEIRO DE RELAÇÕES INTERNACIONAIS (CEBRI). **Programa de Transição Energética, 1º Ciclo – Diagnóstico**: Tendências e Incertezas da Transição Energética no Caso Brasileiro. Rio de Janeiro, CEBRI, 2021. Available at: https://www.cebri.org/media/documentos/arquivos/PTE_Whitepaper_PT_9dez21.pdf. Accessed on 22/12/2022.

GONÇALVES, Otávio G.; MERCEDES, Sonia S. P.; SANTI, Maria M. Considerações sobre o fator de utilização do parque de refino brasileiro e as importações e exportações de petróleo e derivados – 2000 a 2018. **Tecnologia e Sociedade**, Curitiba, v. 15, n. 37, p. 635-652, jul./set, 2019. DOI: 10.3895/rts.v15n37.9808.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATISTICA (IBGE). **Frota de Veículos**. Portal do Governo Brasileiro. Brasília, 2022. Available at: https://cidades.ibge.gov.br/brasil/pesquisa/22/28120. Accessed on 22/12/2022.

INTERNATIONAL ENERGY AGENCY. **The Oil and Gas Industry in Energy Transition.** World Energy Outlook. Special Report, Paris, Jan. 2020. Available at: https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions. Accessed on 22/12/2022.

INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA). **Renewable Energy Statistics 2021**. Abu Dhabi: IRENA, 2021. Available at: https://www.irena.org/publications/2021/Aug/Renewable-energy-statistics-2021. Accessed on 22/12/2022.

KLARE, M. T. The Beginning of the End for Oil? Energy in a Post-Pandemic World. **TomDispatch,** 2020. Available at: http://www.tomdispatch.com/post/176694/tomgram%3A_michael_klare%2C_a_silver_lining_in_the_global_pandemic/. Accessed on 22/12/2022.

LADISLAW, S., LEED, M., WALTON, M. **New Energy, New Geopolitics: Balancing Stability and Leverage**. Washington: Center for Strategic & International Studies, 2014. Available at: https://csis-website-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/140409_Ladislaw_NewEnergyNewGeopolitics_WEB.pdf. Accessed on 22/12/2022.

LEITE, A. **Energia no Brasil**. Rio de Janeiro: Elsevier, 2ª edição, 2007.

LOSENKANN, L, HALLACK, M, Novas energias renováveis no Brasil: desafios e oportunidades. In: Negri, J. A. D. et al. (orgs.), **Desafios da Nação**: artigos de apoio, vol. 2. Brasília: Instituto de Pesquisa Econômica Aplicada (IPEA), 2018. Available at: http://repositorio.ipea.gov.br/handle/11058/8446. Accessed on 22/12/2022.

MAGNAVITA, Mônica. Petroleiras aceleram iniciativas visando a transição energética. **Valor Econômico**. Especial Energia, F7, 27 de outubro de 2021. Available at: https://valor.globo.com/publicacoes/suplementos/noticia/2021/10/27/petroleiras-aceleram-iniciativas-visando-a-transicao-energetica.ghtml. Accessed on 22/12/2022.

MACHADO, N. Eólica tem expansão recorde no Brasil em 2021. **EPBR**, Rio de Janeiro, 2021. Available at: https://epbr.com.br/eolica-tem-recorde-de-expansao-no-brasil-em-2021/. Accessed on 22/12/2022.

MCKINSEY & COMPANY. Hidrogênio verde: uma oportunidade de geração de riqueza com sustentabilidade, para o Brasil e o mundo. Rio de Janeiro, **McKinsey & Company**, 2021. Available at: https://www.mckinsey.com/br/our-insights/hidrogenio-verde-uma-oportunidade-de-geracao-de-riqueza-com-sustentabilidade-para-o-brasil-e-o-mundo. Accessed on 22/12/2022.

OLMOS, Marli. Montadoras adiam seu feliz ano novo. **Valor Econômico**, Caderno A2, Rio de Janeiro, 6 de janeiro, 2022. Available at: https://valor.globo.com/brasil/coluna/montadoras-adiam-seu-feliz-ano-novo.ghtml. Accessed on 22/12/2022.

O'SULLIVAN, M.; OVERLAND, I.; SANDALOW, D. The Geopolitics of Renewable Energy. **HKS Working Paper**, Cambridge, n. 17-027, p. 1-71, jul. 2017. Available at: https://www.hks.harvard.edu/publications/geopolitics-renewable-energy. Accessed on 22/12/2022.

PALTSEV, S. The complicated geopolitics of renewable energy. **Bulletin of The Atomic Scientists**, v. 72, n. 6, p. 390–395, 2016. Available at: doi.org/10.1080/00963402.2016.1240476. Accessed on 22/12/2022.

PAMPLONA, N. 'Novo governo perceberá a importância dos leilões', diz executivo da Exxon. **Folha de S. Paulo**, Caderno Mercado, 2018. Available at: https://www1.folha.uol.com.br/mercado/2018/09/novo-governo-percebera-a-importancia-dos-leiloes-diz-executivo-da-exxon.shtml. Accessed on 22/12/2022.

PETROBRAS. **Financial Performance 4Q21**. Rio de Janeiro, 23 fev. 2022. Available at: https://www.investidorpetrobras.com.br/en/results-and-announcements/results-center/. Accessed on 22/12/2022.

PETROBRAS. **Plano Estratégico 2021-2025**. Rio de Janeiro, nov. 2021. Available at: https://petrobras.com.br/pt/quem-somos/plano-estrategico/. Accessed on 22/12/2022.

PETROBRAS. **Fact Sheet.** Out. Rio de Janeiro, 2021. Available at: https://www.investidorpetrobras.com.br/visao-geral/fact-sheet. Accessed on 22/12/2022.

PETROBRAS. **Relatório de Produção e Vendas**. 3º Trimestre, 2021. Rio de Janeiro Available at: https://www.investidorpetrobras.com.br/resultados-e-comunicados/central-de-resultados. Accessed on 22/12/2022.

PETROBRAS. **Pré-sal**. Rio de Janeiro, 2019. Available at: https://petrobras.com.br/pt/nossas-atividades/areas-de-atuacao/exploracao-e-producao-de-petroleo-e-gas/pre-sal/. Accessed on 22/12/2022.

SABATELLA, I., SANTOS, T. The IPE of regional energy integration in South America. In: VIVARES, E. **The Routledge Handbook to Global Political Economy**: Conversations and Inquiries. Londres: Routledge, cap. 42, 2020. Available at: https://doi.org/10.4324/9781351064545. Accessed on 22/12/2022.

SAUER, I. L. O pré-sal e a geopolítica e hegemonia do petróleo face às mudanças climáticas e à transição energética. In: Adolpho J. M. ; Aroldo M., Almeida Campos, D; Cordani.U.G. (Org.). **Recursos Minerais no Brasil**. Rio de Janeiro: Academia Brasileira de Ciências, p. 316-330, 2016.

SAUER, I., ESTRELLA, G. **Avaliação do leilão do óleo excedente dos campos da cessão onerosa.** São Paulo: Instituto de Energia e Ambiente (USP). Nota técnica, 2019. Available at: http://www.iee.usp.br/sites/default/files/anexosnoticias/NOTA%20T%C3%89CNICA%20%20IEE-USP%20-%20ILDO%20ESTRELLA%20FINAL.pdf. Accessed on 22/12/2022.

SCHOLTEN, D. The Geopolitics of Renewables – An Introduction and Expectations. In: SCHOLTEN, D. (Ed.) **The Geopolitics of Renewables.** Lecture Notes in Energy, v. 61. Cham: Springer, p. 1-32, 2018. Available at: https://www.springer.com/br/book/9783319678542. Accessed on 22/12/2022.

SCHUTTE, Giorgio R. Petrobras em marcha forçada. TEXTOS PARA DISCUSSÃO (NEEDDS), v. 01, p. 01-96, 2016. Available at: https://needds.ufabc.edu.br/17-publicacoes/39-petrobras-em-marcha-forcada. Access on 28/12/2022.

SCHUTTE, Giorgio R. A economia política do conteúdo local no setor petrolífero de Lula a Temer. **Economia e Sociedade**. Campinas, 30:1, p. 115- 140, 2021. Available at: https://doi.org/10.1590/1982-3533.2020v30n1art06. Accessed on 22/12/2022.

SCHUTTE, Giorgio R. La réglementation de l'exploration pétrolière au Brésil: quelle trajectoire? **Entreprises et histoire**, n° 99, p. 35 à p.52, 2020. DOI: 10.3917/eh.099.0035.

STRECK, C., TERHALLE, M. The changing geopolitics of climate change. **Climate Policy**, v. 13, n. 5, p. 533-537, 2013. Available at: http://dx.doi.org/10.1080/14693062.2013.823809. Accessed on 22/12/2022.

TAVARES, F. **Política energética em um contexto de transição:** a construção de um regime de baixo carbono. Tese de doutorado, Universidade Federal do Rio de Janeiro (UFRJ), 2019.

US ENERGY INFORMATION ADMINISTRATION (EIA). **Short-term energy outlook**. Washington, Feb. 8, 2022. Available at: https://www.eia.gov/outlooks/steo/pdf/steo_full.pdf. Accessed on 22/12/2022.

VASCONCELOS, Y. A força das renováveis – Energia eólica e solar fotovoltaica devem continuar aumentando a participação na matriz elétrica nos próximos anos. São Paulo, **Pesquisa FAPESP**, n.310, p. 36-p.39, 2021. Available at: https://revistapesquisa.fapesp.br/a-forca-das-renovaveis/. Accessed on 22/12/2022.

WORKMAN, Daniel. **Top15 Crude Oil Suppliers to China.** World´s Top Exports, 2022. Available at: https://www.worldstopexports.com/top-15-crude-oil-suppliers-to-china/. Accessed on 22/12/2022.