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Oil and Gas Companies — Are They Shifting to Renewables? A Study of Policy Mixes for Energy Transition in Brazil

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ABSTRACT

We argue that there is a need to advance further research that strengthens the analysis of policy mixes for the energy transition in major emerging economies. In this context, this article aims to answer the following question: How do Brazil's policies favor or hinder an energy transition of oil and gas companies (O&G) to renewables? To achieve this purpose, we conducted literature and archival research and interviews with experts to analyze (a) Brazil's energy policy mixes that address O&G and renewables issues; and (b) major O&G companies' activities and perspectives that influence the energy transition. Results demonstrated that though some of the O&G companies have made significant renewables investments in the last years, they continue focusing on O&G activities. We discuss the main policy mix features that hinder the prioritization of renewables by these O&G companies and that can undermine a sustainable energy transition in Brazil.

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INTRODUCTION

There is continuing interest in how policy mixes can favor energy transition (Haddad et al., 2022; Kern et al., 2019). Facing opportunities and threats in a global energy transition movement, oil and gas (O&G) companies started to diversify their business models to comprise new portfolios driven by renewables (Hartmann et al., 2021). O&G companies such as Shell, Total, bp, and Equinor have all created divisions for renewable energies. Former O&G company Ørsted completely divested its O&G segment in 2017, and it is now a renewable energy organization and one of the most sustainable firms in the world (Corporate Knights, 2022; Pickl, 2019; Stevens, 2016; Timperley, 2021). Public policies involve strategic instruments for an energy transition, as they directly affect firms' investment decisions (Markard, 2018; Rogge & Reichardt, 2016; Sovacool & Geels, 2016). In a statement about the 2021 IPCC report, UN Secretary-General António Guterres said, "... Countries should also end all new fossil fuel exploration and production, and shift fossil fuel subsidies into renewable energy" (United Nations, 2021). While most publications on this subject are from developed countries (Ghosh et al., 2021; Kern et al., 2019) and especially from European nations (Rogge et al., 2017), we found very few publications about the energy transition of O&G companies and policy mixes from major emerging economies — subsumed by the BRICS — that have idiosyncratic institutions and complex socioeconomic challenges compared to developed nations. We argue that there is a need to advance further research that strengthens the analysis of policy mixes for energy transitions in major emerging economies. This article aims to understand the features of Brazil's energy policy mix that favor or hinder a transition from O&G businesses toward renewables, moving away from fossil fuels. While the world renewables usage was merely 14% in 2021, Brazil's renewable energy sources shared 46% of its national energy matrix, backed by a large production of sugar cane derivatives (e.g., ethanol) and electricity from hydropower — which accounted for 19.1% and 12.6%, respectively, of the total energy supply. In addition, Brazilian renewables also comprise a fast-growing solar and wind energy systems market, which accounted for 1.7% and 8.8% in 2021, respectively (Empresa de Pesquisa Energética [EPE], 2022; International Energy Agency [IEA], 2021). However, the country still faces grand societal challenges regarding poverty and inequality issues, in which context the royalties from O&G can be a valuable resource to tackle them. By discussing policies for the O&G exploration and production (E&P), we inevitably study subsidies for fossil fuel production, which are less researched than subsidies for consumption (Rentschler & Bazilian, 2017). The central research question (RQ) in this article is: How do Brazil's policies favor or hinder an energy transition of oil and gas companies to renewables?

To answer this inquiry, we organized qualitative research around two processes. First, we relied on the policy mix framework proposed by Rogge and Reichardt (2016) to analyze Brazil's energy policy mix regarding its elements' consistency[1] with the transition goals toward renewables. Among the three building blocks of the framework, we analyzed *elements* (i.e., policy strategy and instrument mix) and *characteristics* (i.e., the consistency of the elements). Our analysis does not include *political processes* (i.e., the policymaking and implementation) because they are not relevant to our research question. Therefore, we studied the consistency of the elements to understand how aligned the policy strategy and instruments are toward the transition of O&G companies to renewables. This first stage contributes to enlightening how the policy mix impacts the O&G companies in Brazil. Second, we conducted archival research and interviews to gain reliability in our findings by drawing data from multiple sources. We performed archival research about seven major O&G companies in Brazil to find evidence of renewables and O&G activities. We conducted the interviews with O&G industry experts to capture their perceptions of Brazil's policy mix for energy transition and O&G companies' activities. We focused our research on public policies and O&G activities relevant to the exploration and production (E&P) segment. We leave other O&G value chain segments for future research (e.g., refining and distribution).

We discuss the main barriers in the Brazilian public policies that can hinder a transition toward renewables, including the fossil fuel subsidies that undermine the global efforts to shift resources to a cleaner and sustainable energy matrix. Brazil heavily subsidizes its O&G production because it stimulates short-term economic growth and creates tax revenue to address social issues. We further discuss if these subsidies have effectively accomplished these two (economic and social) objectives and if the country should still need them. However, at least in the short run, we found that Brazil keeps going in an opposite direction of a needed transition to renewables since it still relies on a fossil fuel exploration regime with plenty of subsidies. Finally, we propose directions for the Brazilian policy mix to favor the transition of the O&G companies toward renewables and to reform their fossil fuel subsidies.

THEORETICAL CONCEPTS AND FRAMEWORK

The transition of O&G companies

O&G companies have sustained their business-as-usual models by continuously searching for new reserves, executing enormous projects, and not worrying too much about their operations' externalities (like flaring). However, in a world of growing preoccupation with climate issues and commitment to reducing fossil fuels, their old businesses show signals of failure. One of the pillars of this business model is to maximize the company's proven reserves, which means constantly drilling and acquiring new oilfields to increase their expected future revenue. As the access to low-cost oilfields is getting scarce, companies have been exploring places like ultra-deep waters (e.g., the Brazilian pre-salt layer) or shale (typical in the USA). These oilfields increase the costs of adding new reserves and producing O&G, reduce profitability, and make it more difficult for O&G companies to increase their value (Fattouh et al., 2018; Stevens, 2016). Like Brazil's Repetro tax exemption program for O&G, production subsidies are essential to commercially make feasible many of the costly pre-salt layer fields (Centro Brasileiro de Infraestrutura [CBIE], 2019). Nevertheless, the growing number of legislations worldwide that restrict or phase out fossil fuels can favor energy transition policy plans. France and Spain's long-term decisions to date the end of all O&G production in their territory (for 2040 and 2042, respectively), and Canada, which has imposed restrictions for new licenses for offshore O&G in the Arctic (London School of Economics [LSE], 2021), are examples of the plans favoring progress in the energy transition.

Aware of the increasing difficulties of operating their oil and gas-based business model, many O&G companies diversify their portfolios. One common strategy is mergers and acquisitions or joint ventures with renewable energy companies, like bp with Bunge and Shell with Raízen in Brazil for ethanol production. Shell created a 'New Energies' division in 2016 to work with hydrogen, renewable energies, and electrical vehicles (Pickl, 2019), and Total plans to spend 20% of its capital expenditure (CAPEX) on renewables and electric mobility during 2022-2025 (Total Energies, 2021a).

O&G companies are unlikely to transition to renewables as Ørsted did ultimately. It is perilous to move out of their core business, and petroleum products will still be needed for many more decades (Hartmann et al., 2021; Stevens, 2016). As a first step to decarbonizing, O&G companies are likely to reduce their carbon intensity, deaccelerate their O&G exploration and production (E&P), and diversify their business portfolio with cleaner technologies (Fattouh et al., 2018; Stevens, 2016).

Intriguingly, national O&G companies (NOC), like Petrobras (the state-owned Brazilian O&G company, founded in 1953), seem to be behind the private companies, like Shell and Equinor (called international O&G companies, or IOCs), in the shift to renewables. According to one of the interviewees in this study — a petroleum politics researcher from an O&G multinational in Brazil —, NOCs have different concerns than the IOCs, like ensuring the nation's oil supply and resolving social issues. Indeed, NOCs are not driven by stock prices, and they are not pressed for climate actions as the IOCs are. Thus, IOCs are generally pushed to decarbonize faster than NOCs. The interviewee said, "you don't see protests at CNOOC and Gazprom's doors like you see at Exxon's." Cheon et al. (2015) argue that NOCs are generally oriented by their 'national purpose,' and that their political and economic goals come before profit. Petrobras, for example, is a NOC, and it has a clear strategy to focus on O&G production for the following years, with very few activities in renewables (Petrobras, 2021). The state should serve as an example, but these contradictions suggest that private O&G companies are more interested in the energy transition than governments of oil-exporting countries.

The Brazilian energy matrix

According to the Brazilian Company of Energy Studies (EPE, 2022), Brazil's energy matrix comprises 46% of renewables. In contrast, the world average is merely 14% (EPE, 2022; IEA, 2021). Table 1 presents the breakdown of each energy source in the matrix.

Table 1. Break down of the Brazilian energy matrix (in 2021).

Energy source	Share in the energy matrix
Petroleum products	33.1%
Sugar cane derivatives	19.1%
Hydropower	12.6%
Natural gas	11,8%
Wood and charcoal	8.9%
Other renewables	7.7%
Coal	4.9%
Nuclear	1.3%
Other non-renewables	0.6%

Note. Source: EPE (2022).

When it comes to the electricity matrix, the share of renewables is 83% in Brazil, and the world average is 27%. This high share of renewables comes from hydropower (65.2%), biomass (9.1%), wind power (8.8%), and solar power (1.7%) (EPE, 2022). In Brazil, the total hydropower production has slightly decreased from 34.6 Mtoe in 2010 to 34.0 Mtoe in 2020, while the petroleum production increased from 106.5 to 152.6 Mtoe in the same period (Empresa de Pesquisa Energética [EPE], 2021a). It is noteworthy that the capacity for hydropower electricity production is expected to increase only 4.2% from 2020 to 2030, while petroleum production is expected to grow 62.2% in the same period (Ministério de Minas e Energia, 2021a; 2021b). Therefore, to increase its share of renewables, Brazil needs to boost the development of additional renewable sources.

Oil and gas in Brazil

Until 1997, only Petrobras was allowed to produce O&G in Brazil. When the O&G monopoly ended, the government created public policies and subsidies to encourage foreign companies and new players to join the market. The Repetro program was created around that time, in 1999, to achieve those objectives, and it still is one of the most influential production subsidies for the O&G industry in Brazil.

The Repetro program is a special customs regime that exempts specific equipment and components for O&G activities from federal taxes,[2] thus increasing the feasibility and profitability of O&G projects (CBIE, 2019; PWC, 2022; Santos & Avellar, 2017). When the pre-salt layer reserves were confirmed, the government became even more interested in developing the oil business and increasing its production. Therefore, new taxes were created, like special participation fees and signature bonuses, and the Social Fund was formed, in 2010, to provide resources for social development (Agência EPBR, 2021; Jesus et al., 2017; Oliveira & Laan, 2010; Pereira & Neto, 2017).

Renewables in Brazil

Brazil has a long history of promoting the development of petroleum, biofuels, and hydropower. However, only in the past few decades the Brazilian government has made significant progress in supporting alternate renewable sources, like solar and wind power (Lozornio et al., 2017; Oliveira & Laan, 2010; Silva et al., 2020). Brazil's most traditional and vital renewable energy sources come from sugar cane derivatives and hydropower. The country benefits from a large hydropower capacity ranked only behind China (International Energy Agency [IEA], 2022). Its land is well suited for sugar cane production, standing as the number one sugar cane producer globally (Statista, 2023). While the country has had little growth and sometimes a decrease in its hydropower production in the last few years, the production of sugar cane derivatives is still growing (Empresa de Pesquisa Energética [EPE], 2021b).

Sugar cane derivatives include ethanol and its bagasse, which is widely used for heat production in industry and electricity generation. These two renewable energy sources have been under accelerated development since the 1970s. However, other modern renewables, such as wind and solar power, have only become significant to the energy matrix after the 2000s. Biomass energy production started to become a fast-growing activity in 2000, wind power in 2014, and solar in 2015 (EPE, 2021b). That was mainly due to successful policies created at that time, such as the PROINFA (*Programa de Incentivo* às *Fontes Alternativas de Energia Elétrica*, or Incentive Program for Alternative Sources of Electric Energy) renewables incentive program, the Reserve Energy Auctions (LER) for wind and long-term solar contracts, and regulations for net metering (EPE, 2021b; Lozornio et al., 2017; Silva et al., 2020). The country promotes these alternative renewable sources to diversify its energy matrix and to reduce its dependency on traditional energy sources. From 2020 to 2030, wind power capacity is expected to grow by 202% (from 15.9 to 32.2 GW), solar power by 270% (from 3.1 to 8.4 GW), biomass by 8.6%, and distributed generation by 583% (from 4.2 to 24.5 GW) (Ministério de Minas e Energia, 2021a; 2021b).

Policy mixes

Multiple policies that influence an energy transition comprise conflicting goals. Therefore, it is important to understand their interactions and influence on the overall goal when studying public policies. Policy mixes are essential in studying sustainability transitions because they guide the direction and pace of the transition (Gunningham & Sinclair, 1999; Kern et al., 2019; Rogge & Reichardt, 2016). *Policy mix* refers to a combination of multiple policy instruments such as a country's public policies. The *policy instrument* is a generic term to describe government programs, public measures, laws, regulations, and other tools used by the government to achieve strategic goals. Policy instruments can reduce taxes, directly provide resources, or indirectly mobilize other actors to spend their resources (Kern et al., 2019; Rogge & Reichardt, 2016). Examples of policy instruments are feed-in tariffs, carbon emissions regulations, and decarbonization credits.

Many authors use policy mixes to advance research on sustainability transitions, especially on energy transitions (Kern et al., 2019; Rogge et al., 2017). We use

Rogge and Reichardt's (2016) policy mixes framework to analyze the policies in this article. Their framework organizes terminology in policy mixes and offers sub-elements and categories for public policies, allowing a clear scope analysis. Rogge and Reichardt (2016, p. 1622) define "the policy mix as a combination of the three building blocks *elements*, *processes* and *characteristics*, which can be specified using different dimensions." *Elements* comprise two sub-elements: the *policy strategy* and the *instrument mix*. *Policy strategy* is divided into *policy objectives* and the *principal plans*. The first refers to long-term targets, such as Brazil's target to achieve 10% efficiency gains in the electricity sector by 2030 (International Energy Agency [IEA], 2018), while the latter indicates the general path that the government wants to take, such as the objective of Brazil's National Energy Policy to "increase the use of natural gas" (Lei No. 9478, 1997). The instrument mix is the combination and the result of the interaction of all policy instruments of a policy mix. *Policy processes* subsume the policymaking and implementation processes, and the last block refers to the *characteristics* of the elements and policy processes: (1) the consistency of elements, (2) the coherence of processes, (3) credibility, and (4) comprehensiveness of a policy mix. Moreover, their framework conceptualizes dimensions to delineate the policy mix: policy field (or domain) (e.g., transport, education, energy), governance level (e.g., federal laws, state laws), geography, and (4) time. All three building blocks influence social and technological change, but researchers can choose to focus on one block, a combination of two blocks, or some of their minor components. The framework helps define a focus or scope of analysis (e.g., the interaction between political processes and the policy strategy). Using this approach helps clarify the blocks, links, and scope of the policy mixes under study and avoids jeopardizing the research's findings and validation (Ossenbrink et al., 2019).

Connecting the theoretical framework to the methodology and results

Rogge and Reichardt's (2016) policy mix framework is used in this research because it suits the approach of studying not one but multiple policy instruments and analyzing its effects on the phenomenon of interest (i.e., the transition to renewables). The framework also allows the researchers to choose which of its blocks and components they will use or not in their research. This work allowed us to adhere only to the blocks and components relevant to study the actual status of the transition, leaving out specific elements to non-relevant subjects, like political processes, disputes of power, and policy implementation.

Carefully choosing the boundary settings of the study is very important to research. We understood that to answer our research question and 'draw a picture' of the status of the transition, we needed not only to address the policies that support the renewables' regime but also the encompassing regime (oil and gas) and the policies that support or put pressure on it.

The methodology section will show how we started by defining which blocks and components of the framework we used in the research to study our boundary setting and scope of analysis properly. Then, it shows how we captured the policy instruments, plans, and strategies relevant to our scope of analysis and their characteristics (i.e., their consistency).

The results, shown in the Results section, are organized by the policy mix framework. We show in each table the data for each component of the framework. For example, Table 3 shows the policy objectives, Table 4 the principal plans, and Table 5 the policy instruments, and all these tables also show the characteristics. This way of presenting the results helps readers familiar with the policy mix literature assimilate the results.

METHODOLOGY

This article's central question is: How do Brazil's policies favor or hinder an energy transition of oil and gas companies to renewables? We answer this inquiry by developing knowledge on two interwoven topics: (a) Brazil's energy policy mixes that address O&G and renewables issues, and (b) Brazilian O&G companies' activities and perspectives that influence the energy transition.

Regarding the first topic, we conducted literature and archival research to comprehensively analyze Brazil's policy instrument mix and its influence on the energy transition. Our analysis relied on the policy mix concept (Flanagan et al., 2011; Rogge & Reichardt, 2016) to understand not only a single instrument but also the combination and interaction between multiple policy instruments.

Sustainability transitions occur in complex political spaces with an extensive and sophisticated network of actors, comprising technological, economic, socio-cultural, and institutional changes. Therefore, researchers must eliminate irrelevant and biased elements to avoid an overly complicated and inefficient analysis. We borrowed terminology and analytical tools from the Rogge and Reichardt's (2016) policy mix framework to achieve better acceptance, validity, and uniformity, allow a more straightforward comparison of findings (Kern et al., 2019), and constitute a consistent set of in-

terwoven policy blocks (Ossenbrink et al., 2019; Rogge & Reichardt, 2016).

We first identified the policy mix framework's blocks and components of our research interest. Then, we concentrated our attention on the *elements* — the policy strategy (*policy objectives* and *principal plans*) and the policy *instrument* (goal, type, and purpose) — and their *characteristic* of consistency.

To understand the combined effect of the policy instruments on the transition of O&G companies, we analyzed the nature of their interactions — which can be positive, negative, or neutral. To study the interactions among the instruments and between the instrument mix and the policy strategy, we chose to analyze the *characteristic* of consistency because it focuses on the elements' current state and indicates contradictions in the policy mix that make it inefficient in achieving the transition's goals. We did not include the *political processes* in our analysis because this building block focuses on the policymaking and implementation processes. Our research question concerns the present state of the policy mix. We did not include the *design features* of the instruments because we did not intend to make an in-depth analysis of single instruments, but only to study their influence on each other toward the transition's goals. Table 2 presents the *dimensions* used in our search for policy instruments in Brazil. We adopted these dimensions because they capture the space in which interactions can occur in the scope of our research inquiry, which is related to the *present* in *Brazil* and is about *renewables* and the *O&G industry*. We chose to focus on the E&P segment because it is the first stage of the O&G value chain, so that it will generate more activity in the following stages. We analyzed *federal policies* because they have the most relevance to the Brazilian *energy production system*, and we left other governance levels for future research.

Table 2. Public policies' dimensions adopted in this study.

Dimensions	Values
Time frame:	Present
Geographical scope:	Brazil
Impact domain:	O&G industry, in the E&P segment; and renewable energy production (except for hydropower)
Governance level:	Federal policies
Policy field:	Energy production, related to O&G and renewables

Note. Source: The authors, based on Rogge and Reichardt (2016).

Guided by the public policies' dimensions in Table 2, we conducted archival research of policy objectives, principal plans, and instruments in the context of Brazil's energy system. We captured the policy objectives from the updated Brazilian national determined contribution (IEA, 2018). It is currently the official document that guides the national renewable energy targets, and we brought the principal policy mix plans from the National Energy Policy (Lei No. 9478, 1997). There are no federal-level policy objectives related to the development of O&G, only production forecasts. We searched for the relevant policy instruments on the IEA policy database. However, we also investigated government databases, executive reports, and strategic plans (e.g., Lei No. 9478, 1997), news, O&G private and public organizations' websites, and research institutions' libraries (e.g., CBIE, 2019; INESC, 2020a) to learn more about these instruments and their impacts on the energy system. Our archival research found policy instruments such as the Repetro O&G tax exemption and the PROINFA renewables programs. We then proceeded to classify all these policy instruments according to their *goal*, *type*, and *purpose*. Built upon the framework of Rogge and Reichardt (2016), Figure 1 presents a research design of the policy components and linkages within the policy mix framework as applied in this article.

We performed two consistency analyses to understand how the instrument mix contributes to our research question. A first consistency analysis between the Brazil National Energy Policy's objectives and the O&G companies' transition goals toward renewables (objective *versus* goals) is represented by the linkage 2 in Figure 1. A second one, between the energy policy instruments and the goals of the transition of O&G companies (instrument mix *versus* goals), is represented by linkage 3. These analyses are further examined in subsection "Energy policy mix in Brazil". Our research question lies in linkage 1, representing the policy mix's influence on the transition of O&G companies to renewables.

A consistent policy mix can have all its objectives achieved without trade-offs. We assume that the O&G companies' transition goals toward renewables are: (1) to reduce the efforts in O&G exploration and production (E&P), and (2) to increase renewable energy activities. They are defined as goals, not objectives because they are desired effects that contribute to the energy transition's long-term objective. We limited our research to

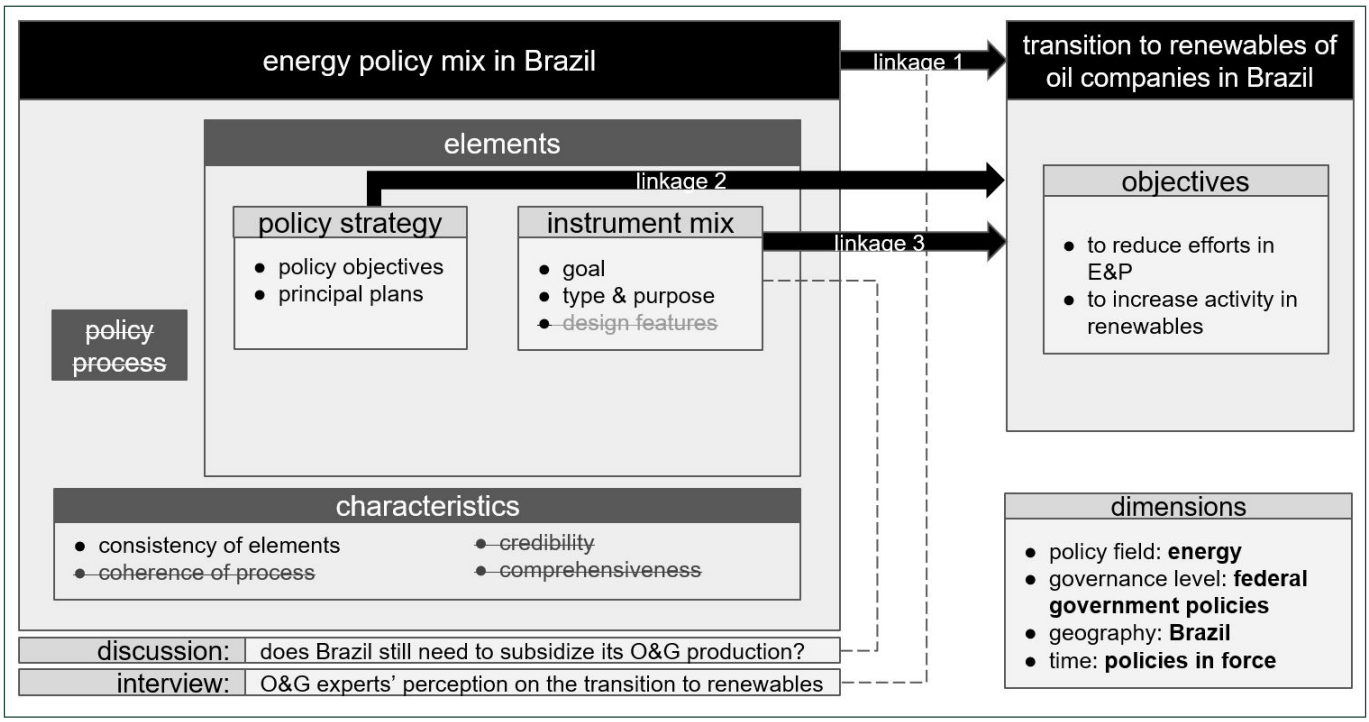

Figure 1. Research design to the analysis of the policy mix building blocks.
Source: The authors, based on Rogge and Reichardt (2016).

the E&P activities because they represent the first stage in the O&G value chain. Moreover, investments in E&P can favor progress in the subsequent stages, like refining and distribution.

To enrich the discussion of the policy mixes, we pay special attention to one of the most controversial types of policy instruments: fossil fuel subsidies. Section "Discussion on O&G subsidies in Brazil" debates the following question: Does Brazil still need to subsidize its O&G production? We also analyze if the tax revenues from O&G have been effective in developing the local community and addressing social issues.

Regarding the second topic, we carefully analyzed E&P and renewables activities of seven major O&G companies in Brazil. They are Petrobras, Equinor, Total, Shell, Galp, Repsol Sinopec, and bp. These are all publicly traded firms, and, except for Petrobras and Sinopec (from the joint venture Repsol Sinopec), they are multinational companies that originated in Europe. According to the National Agency for Petroleum, Natural Gas, and Biofuels in Brazil (ANP), this group of firms account for 95% of Brazil's oil production (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis [ANP], 2021a). It is noteworthy that this selection contains the O&G companies with the highest activity in renewables globally (Shell, Total, bp, and Equinor) (Pickl, 2019. We focused on renewable energy activities because it is an important proxy for the energy transition, and most O&G companies that have been acting on climate issues have made some investment in this sector. However, other actions, like improving energy efficiency and carbon capture and storage (CCS), are also important proxies for the energy transition.

We conducted archival research on these firms' annual and strategic reports (e.g., Equinor, 2021; Petrobras, 2021; Shell, 2021; 2022). We also searched for additional information on their website and the news (e.g., Reuters and the Brazilian executive magazine *Exame*). Furthermore, we read reports from energy and petroleum organizations that comprise the International Energy Agency (IEA), the U.S. Energy Information Administration (EIA), the Brazilian Energy Research Company (EPE), and the ANP. We gathered relevant information about investment, property, CAPEX, and budget forecasts of renewables and E&P in Brazil, as presented in subsection "O&G companies' activities in Brazil".

To foster our data gathering and strengthen analysis, we interviewed two senior professionals in the O&G industry to capture their understanding of policies and O&G companies' activities for an energy transition. The first interviewee is a VP of renewables at an O&G multinational operating in Brazil. The second is a senior researcher in petroleum politics who has worked in O&G companies in Brazil. We conducted semi-structured interviews, which lasted from 30 to 60 minutes. We focused our questions to find answers to our main research inquiry: How do Brazil's policies favor or hinder an energy transition of oil and gas companies to renewables? In the interviews, we focused on those two interwoven topics: (a) Brazil's energy policy mixes that address O&G and renewables issues; and (b) Brazilian

O&G companies' activities and perspectives that influence the energy transition.

Additionally, we built reliability in our study by assembling data from multiple sources. We searched for publicly available material involving written and video-recorded information from Brazilian managers and experts from these major O&G companies. The information included interviews, webinars, and workshops delivered and recorded for the 2019, 2020, and 2021 Rio Oil and Gas Congresses, and publicized by epbr agency and other O&G related institutions. These multiple data sources added information to our study especially on what those major O&G companies are doing regarding the energy transition in Brazil. All data, primarily from interviews and secondarily from archival research, were collected between April 2021 and January 2022.

RESULTS AND ANALYSES

Energy policy mix in Brazil

We started our analysis with the two components of the *policy strategy*: the *policy objectives* (Table 3) and the *principal plans* (Table 4) of Brazil's energy policies. They were retrieved from Brazil's Nationally Determined Contribution (NDC) (IEA, 2018) and the National Energy Policy (originally described in the Brazilian Law No. 9,478 from 1997) (Lei No. 9478, 1997), respectively. Then, we classified them regarding their consistency with the goals of the assumed transition of O&G companies to renewables (described in the Methodology section).

Table 3. Consistency of Brazil's policy objectives for energy with the transition's goals.

Brazil's energy policy objectives	Consistency with the transition's goals
Increase the share of sustainable bioenergy in the Brazilian energy mix to approximately 18% by 2030 by expanding biofuel consumption, increasing ethanol supply, including by increasing the share of advanced biofuels (second generation), and increasing the share of biodiesel in the diesel mix	Consistent
Achieve 45% of renewables in the energy mix by 2030	Consistent
Expand the use of renewable energy sources other than hydropower in the total energy mix to between 28% and 33% by 2030	Consistent
Expand the use of non-fossil fuel energy sources domestically, increasing the share of renewables (other than hydropower) in the power supply to at least 23% by 2030, including by raising the share of wind, biomass, and solar	Consistent
Achieve 10% efficiency gains in the electricity sector by 2030	Consistent

Note. Source: The authors, with data from IEA (2018).

Table 4. Consistency of Brazil's principal plans for energy with the transition's goals.

Brazil's energy principal plans	Consistency with the transition's goals
Ensure the supply of petroleum products in all the territory	Neutral
Ensure the supply of biofuels in all the territory	Consistent
Increase the use of natural gas	Inconsistent
Increase the share of biofuels in the energy matrix	Consistent
Use alternative energy sources	Consistent
Encourage biomass energy production, as it complements hydropower	Consistent
Promote R&D for renewable energy sources	Consistent
Mitigate GHG emissions, including the use of biofuels	Consistent
Promote a free market and draw new investment for energy production	Neutral

Note. Source: The authors, with data from Lei No. 9478 (1997).

The policy objectives (Table 3) are all consistent with the transition's goals, which is no surprise since they were presented in Brazil's NDC, which is a document that contains plans for climate action. Despite having some policy instruments with goals for O&G development, Brazil has no quantifiable objectives for this activity as the country has for renewables. The Program for the Revitalization of Onshore O&G (REATE), for example, has a goal to achieve 500 mboe/d by 2030, but this is an instrument goal, not a policy objective, so we did not include it in our tables.

As for the analysis of the principal plans (Table 4), most of the objectives of the National Energy Policy aim to increase total production and the share of renewables in the Brazilian energy matrix. Therefore, there are no contradictions with the transition's objective of increas*ing renewables activity by O&G companies*. Nevertheless, there is a contradiction in the transition's objective of *reducing E&P activity* with the energy policy's objective of *increasing the use of natural gas*. As for the objective of *ensuring the supply of petroleum products*, it is not necessarily a trade-off with the *reduction of activity in E&P*, as a reduction can occur, and the supply can still be guaranteed, so we defined it as neutral. With this consistency analysis, we conclude that most policy objectives and principal plans of Brazil's energy policy align with the transition.

For the second consistency analysis, between the instrument mix and the goals of the transition, we present all the policy instruments relevant to renewables and E&P found in our archival research from the IEA policy database and other complementary sources. We sorted them according to their consistency to the goals of the transition. Table 5 shows all the instruments consistent with the transition, and Table 6 shows the ones that are not. All the instruments were classified as per Rogge and Reichardt (2016) categorization of primary *type and purpose*.

Table 5. Group of policy instruments promoting renewables (consistent with the transition).

Instrument	Instrument description	Desired effect	Type	Purpose
PROINFA	Feed-in tariff program for wind, biomass, and small hydropower plants. 60% local content obligation for participants.	Demand generation for renewables and development of local industry.	Economic	Demand pull
Net metering	Allows consumers to generate their own electricity and connect it to the grid, generating credits and bill reduction. Mostly used with solar energy.	Promotion of renewable energy and increase of total energy production through small and medium players.	Economic	Demand pull
Tax incentives for solar, wind, and biomass	Tax incentives for the use of the energy grid, purchase of equipment and infrastructure.	Promotion of investment in solar, wind, and biomass energy production.	Economic	Demand pull
BNDES Finem	Federal financing program for renewable energy projects.	Promotion of investment in renewable energy.	Economic	Demand pull
INOVA Energia	Funding for R&D renewables programs.	Promotion of R&D investment in renewables.	Economic	Technology Push
EnergIF	Offers training for professionals in renewable energy.	Increased availability of trained professionals.	Information	Technology Push
Blend mandates	27% of ethanol blend in gasoline and 15% of biodiesel in diesel.	Increased of demand for ethanol and biodiesel.	Regulation	Demand pull
Tax incentives for bi-fuel and ethanol cars	Importation tax for industrialized products is reduced for ethanol and bi-fuel vehicle parts.	Promotion of the production of bi-fuel (flex) vehicles.	Economic	Demand pull
Tax incentives for production of ethanol	Some taxes, like ICMS (for services and goods), are reduced in the end price of ethanol, in comparison with gasoline.	Increased competitiveness of ethanol against gasoline.	Economic	Demand pull
ABC program	Government financing program for ethanol production.	Promotion of investment in ethanol production.	Economic	Demand pull
RenovaBIO and carbon credits	Carbon credit's trading system for biofuel producers, with annual targets of trading volume.	Promotion of biofuels and predictability for energy investments.	Economic	Demand pull

Note. Source: The authors.

Table 6. Group of policy instruments promoting E&P (inconsistent with the transition).

Instrument	Description	Desired effect	Type	Purpose
Repetro	Importation tax exemption for O&G goods.	Increase the volume and feasibility of local E&P projects.	Economic	Demand pull
Local content obligations	O&G companies have minimum quotas of local content in E&P projects for goods and services.	Protection and development of local industry.	Regulation	Demand pull
Act No. 13,586/2017	O&G companies can have a tax reduction based on depreciation of their machines (accounting).	Increase the volume and feasibility of local E&P projects.	Economic	Demand pull
BNDES financing	Financing program from federal government (BNDES).	Promotion of investment in the oil and gas industry.	Economic	Demand pull
Promar	Promotion of studies to increase the O&G production of brown offshore fields.	Increased production and income from brown offshore fields.	Information	Systemic
REATE[5]	Program to review taxation of onshore brown fields.	Increased production and income from brown onshore fields.	Economic	Systemic
New gas market	Committee to implement changes in the gas market and review of law and regulations.	Increased private investment, competition, and production; harmonization of regulations.	Economic	Systemic
R&D mandates	O&G companies have a mandatory budget to be spent locally in R&D.	Development of technologies in oil and gas in Brazil.	Economic	Technology push

Note. Source: The authors.

Analyzing the instrument mix against the transition goals, the group of policy instruments promoting renewables (Table 5) has synergy with the transition's goal of *increasing renewables activity*. In contrast, the group of policy instruments promoting E&P (Table 6) conflicts with the goal of *reducing activity in E&P*. Differently from the policy strategy, which has a good alignment with the transition, the instrument mix has many inconsistencies with the goals of the transition for it has many instruments aiming to promote O&G.

One of the interviewees, the oil company VP, said that "the oil business would secure our income while our company shifts to renewables," supporting that instruments that promote O&G may indirectly favor investments in renewables by O&G companies. In line with that view, the other interviewee said that O&G

companies have had "waves" of investment in renewables in the past, and all these waves happened in periods of high oil prices, and they ended when the oil crises came. This statement supports the idea that higher profitability in O&G activities motivates O&G companies to invest in renewables; thus, policies supporting E&P may indirectly allow more investments in renewables by these firms.

Table 7 presents some of the key interviewees' perspectives about the factors that slow down the most the energy transition from O&G toward renewables in Brazil.

Table 7. Interviewees' perspectives on policy features that hinder the energy transition from O&G to renewables in Brazil.

Factor	Comments / Quote
Lack of integrated planning for energy in the government	"We are missing a high-level plan. All public policies would be created from this plan. With that, the government can organize financial incentives, innovation instruments, infrastructure, and things will happen because you know the priorities. Today, the government is talking about hydrogen while they haven't even finished the New Gas Act. They have offshore wind farms requisitions, and they don't have its regulatory framework ready. This happens because the federal institutions are uncoordinated." (Interviewee, petroleum politics researcher).
Lack of regulations for new energy sources, for example, offshore wind	O&G companies are especially interested in offshore wind due to their know-how in maritime and subsea operations, which is an advantage against traditional energy companies (Pickl, 2019).
Lack of infrastructure	"In the case of offshore wind, transmission lines will be needed in the coast, which involves expropriation. On top of that, public construction in Brazil takes too long." (Interviewee, O&G company VP).
Lack of balance among different energy sources with regard to tributes and financial incentives for different energy types	Different energy sources have different levels of maturity and different cost of production, so politicians must work to create policies that favor a fair market for renewables in terms of taxes and incentives. "Policymaking takes too long in Brazil and renewables are not a priority in the congress." (Interviewee, petroleum politics researcher).

Note. Source: The authors.

According to the energy policy and Brazil's Decennial Energy Plan (Ministério de Minas e Energia, 2021a; 2021b), from the Ministry of Energy, the core energy fuels for Brazil will still be hydropower, biofuels, and petroleum products in the 2021-2030 period. Other renewables and natural gas are considered complementary fuels to the core ones, but the government still promotes them. The strategy for Brazil's energy policy is not to transition from fossil fuels to renewables, as there is no policy instrument to limit or reduce E&P activity. Still, it is part of the strategy to increase the share of renewables in the energy matrix.

Proposition 1. A policy mix with a policy strategy aiming to increase the share of renewables will be inefficient (in achieving this objective) if the policy mix has inconsistent policy instruments favoring progress in O&G.

Proposition 2. The lack of infrastructure, proper regulations, legal frameworks, and federal agencies for renewables holds back foreign investment in renewables in emerging countries, hindering a sustainability transition by O&G companies.

Proposition 3. If not supported by incentives and a fair taxation system, renewables will remain as secondary energy sources to fossil fuels in emerging countries that subsidize O&G.

O&G companies' activities in Brazil

Figures 2 and 3 present time distributions of the history of acquiring new O&G exploratory blocks in ANP bidding rounds for the seven selected major companies. Exploratory blocks are demarcated areas that are potentially abundant in O&G resources, so they are sold from the government to O&G companies for exploration and production rights. Figure 2 presents Petrobras' data, and Figure 3 presents the other six O&G companies (Equinor, Total, Shell, Galp, Repsol Sinopec, and bp). Each bar in the graphs shows the sum of participation shares that were acquired by those companies altogether in that year, where 100% is equivalent to an entire block, and 500% mean, for example, a total of shares equivalent to five blocks. Exploratory blocks do not have the same size or the same potential for O&G production, but we do not make distinction regarding these characteristics in this analysis. The period considered is from 2000 to 2021 (bidding rounds started in 1997). These distributions are based on the ANP database (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis [ANP], 2021b) and represent an important indicator of future E&P activity because if companies have purchased O&G blocks recently, they will develop them. Therefore, they are likely to produce O&G for decades.

We analyzed the acquisition rate of blocks per year of each company. Dividing the average of 2015-2021 and 2000-2021, we found the following: Galp (0.46); Petrobras (0.63); Total (0.68); Shell (1.53); bp (1.80);

Equinor (1.88); and Repsol Sinopec (2.74). This calculation allowed us to compare the recent acquisition rate with the historical average. Four of the seven companies have increased their acquisition rates in the last six years compared to the average of the last twenty-one years (i.e., a result higher than 1.0).

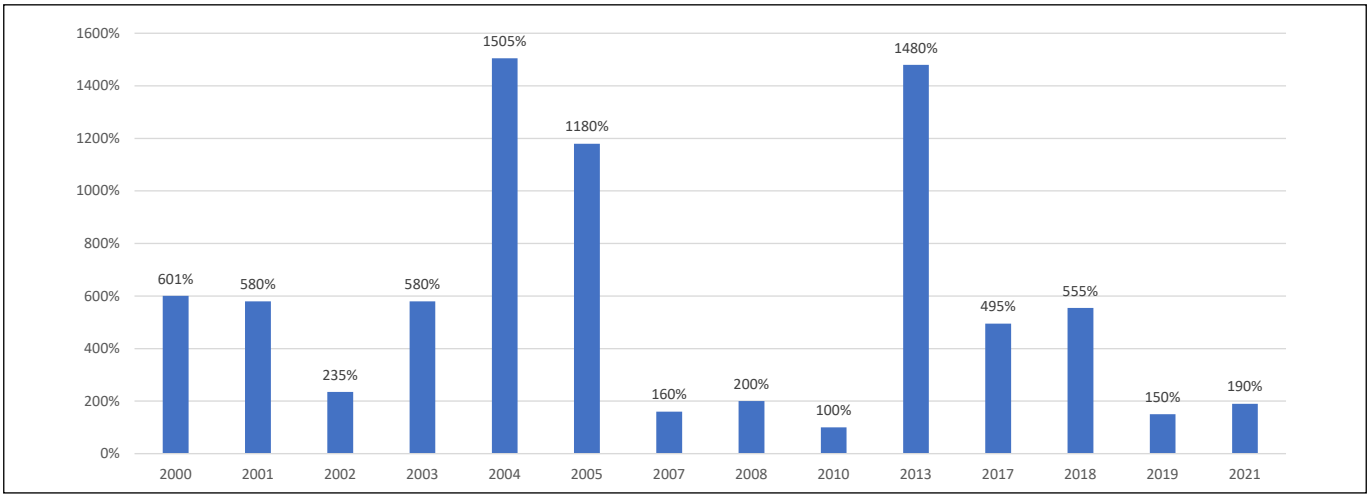

Figure 2. Acquisition of exploratory blocks per bidding round — Petrobras.
Source: Adapted from ANP (2021b).

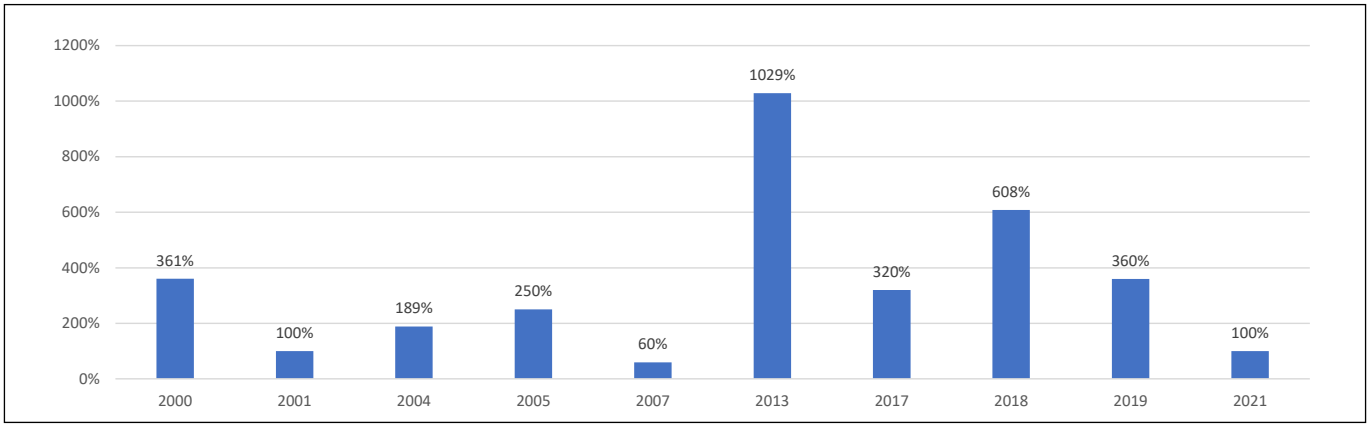

Figure 3. Acquisition of exploratory blocks per bidding round — sum of Shell, Galp, Repsol, Total, Equinor, and bp.
Source: Adapted from ANP (2021b).

When asked if O&G companies are transitioning to renewables or if they are trying to maintain the *status quo*, both the interviewees said that, in their opinion, the current focus of these companies in Brazil right now is O&G.

> "Honestly, the focus of O&G companies in Brazil today is to make money with fossil fuels. They have invested a large amount of money in Brazil buying fields, including Shell, Equinor, and CNOOC. They'll want a return on their investment." (Interviewee — oil company VP).

Galp has announced a target to increase by 25% its oil production in Brazil by 2025 (compared to 2021) (Siqueira, 2021). Total has a target to reach 150,000 boe/d, 150% more than 2021 (Total Energies, 2021a). Other companies did not inform a target, but they will keep developing their blocks, like Bacalhau and BM-C-33 for Equinor and Pau Brasil for bp. Although these companies do not show signs of reducing their E&P activity in Brazil in the next few years, most of them are increasing their renewables activity. Petrobras, Shell, Total, Equinor, and bp all have renewable energy assets already producing in Brazil, like biofuels, biogas, onshore wind, and solar power. Shell and bp are notable for ethanol production through joint ventures (with Raízen and bp Bunge, respectively). In solar and wind, Petrobras, bp, Total, and Equinor are already producing significant amounts of energy. Repsol Sinopec is the only one of the seven companies considered here that do not have any renewable's activities in Brazil (BP, 2021a; 2021b; Equinor, 2020; 2021; 2023; Galp, 2021b; Petrobras, 2021; Repsol, 2021; Shell, 2022; Total Energies, 2021b). Table 8 presents a summary of the O&G companies' renewables activities in Brazil.

Table 8. Summary of activities in renewables for the O&G companies in Brazil.

	Petrobras	Shell	Galp	Repsol S.	Total	Equinor	bp
Activities in renewables	Hydro, wind, and solar	Ethanol 1st and 2nd gen., biogas	None	None	Onshore wind, solar	Solar	Biofuels, solar
Planned activities for renewables in Brazil	Develop HBIO diesel technology	Achieve 1.8 GW of solar, ethanol production 3.75 bi liters per year	Start solar energy production	None	2 onshore wind plants under construction	Start offshore wind, increase solar cap.	2 GW of extra solar power capacity planned
Estimate of renewable power capacity in Brazil	Onshore wind 52 MW, solar 5 MW *(includes participations)*	2,5 bi liters/year ethanol; 21 MW biogas	None	None	Solar 140 MW; onshore wind in construction 160 MW	Solar 70 MW *(joint venture with Scartec)*	3.2 GW solar and biomass; 1.8 bi liter/year ethanol *(joint ventures)*

Note. Source: Petrobras (2021); Shell (2021); Galp (2021a; 2021b); Repsol Sinopec (2022); Repsol (2021); Total Energies (2021a; 2021b); Equinor (2021; 2023); BP (2021a; 2021b; 2021c).

It is important to note that O&G companies are relevant players in the renewables market. For example, in the ethanol market, Shell's joint venture with Raízen is the largest producer in Brazil, while bp Bunge is in the top four (UDOP, 2020), and Lightsource bp has a massive capacity of 2.2 GW from solar power. As we see that O&G companies in Brazil continue to make huge investments in the O&G business, even with the existence of various instruments favoring renewables, we propose that:

> **Proposition 4.** Inasmuch as an emerging country (like Brazil) has no plans or policies to phase out O&G production, O&G companies will continue producing O&G for the next decades on a large scale.

DISCUSSION ON O&G SUBSIDIES IN BRAZIL

The purpose of this section is to discuss if Brazil still needs to subsidize its O&G production and if the tax revenues from O&G have been effective in developing local communities and addressing social issues.

Fattouh et al. (2018, p. 5) argue that for oil-exporting countries "there is no conflict between renewable investment and hydrocarbon business in these countries" because with the increase of renewable energy domestic production, these countries are allowed to export more O&G. This may make sense in an economic view, but in an environmental point of view, exportation of O&G still hinders the global efforts for climate action. The interviewed petroleum politics researcher said, "each country will make the energy transition that it can afford." She argued that Brazil has poverty and inequality issues that developed countries do not have, and the tax revenues from O&G could change that. She said that Brazil's strategy for an energy transition could be to maintain and subsidize the O&G business. At the same time, the government can focus on reducing emissions in other areas, like energy efficiency and deforestation. As an illustration case, Hogarth (2016) showed that Brazil could decrease its GHG emissions significantly by reducing deforestation. Still, she agrees that the government does not efficiently use O&G taxes, and they failed to significantly change the situation of the poor in Brazil.

Fossil fuel subsidies are significant barriers that hinder the world's energy transition toward renewables. On one side, typical justification for them comprises poverty alleviation, industrialization growth, and economic development (Cheon et al., 2015; Rentschler & Bazilian, 2017). On the other side, they generate undesired effects such as increased carbon emissions, increased energy demand, and unsustainable fiscal burdens for governments (Moghaddam & Wirl, 2018; Oliveira & Laan, 2010; Timperley, 2021). In 2009, G20 countries (including Brazil) committed to phase out fossil fuel subsidies and reform inefficient subsidies. Although these countries still spend hundreds of millions of dollars annually on it, many oil-exporting countries successfully reform and reduce their fossil fuel subsidies, like India, Iran, and Mexico (Mason & Ennis, 2009; Moghaddam & Wirl, 2018; Rentschler & Bazilian, 2017; Timperley, 2021).

There are subsidies for production and for consumption of fossil fuels, and Brazil has both. On the one hand, consumption subsidies aim at reducing the final price of fuel for end users and to promote industrialization by supporting energy-intense industries with lower energy costs (Moghaddam & Wirl, 2018; Rentschler & Bazilian, 2017; Oliveira & Laan, 2010). On the other hand, production subsidies are meant to encourage companies to increase their production of fossil fuels, and they usually increase the profit for producers (INESC, 2020a; Timperley, 2021; Zhao et al., 2019). As this article is about policies that affect E&P, we are especially interested in discussing production subsidies. There has been little progress in reforming this type of subsidies, and they have received much less attention from researchers than consumption subsidies (Rentschler & Bazilian, 2017).

Most authors and organizations define subsides as the tax and financial policy instruments that directly reduce the price of fossil fuels for consumers or the production cost for producers (Coady et al., 2010;

INESC, 2020a; Timperley, 2017; Timperley, 2021), and by this definition, only the Repetro program and the Act No. 13,586/2017 are considered production subsidies among all the listed policy instruments in this study.

According to the Institute of Socio-economic Studies (INESC) (INESC, 2020a; 2020b), the cost of fossil fuel production and consumption subsidies in 2019 for the Brazilian government were R$ 36.27 billion (US$ 7.10 billion) and R$ 63.01 billion (US$ 12.6 billion), respectively. The cost of production subsidies came mostly from foregone tax revenues for O&G from Repetro program (77%) and Act No. 13,586/2017 (17%), while 83% of the cost of consumer subsidies came from diesel and gasoline tax reductions.

Does Brazil still need to subsidize its O&G production? Rentschler and Bazilian (2017) have analyzed subsidy reforms in many countries, and they argue that "in practice, the key rationale for implementing subsidy reform has typically been fiscal rather than environmental" (Rentschler & Bazilian, 2017, p. 2). They still add that "the necessity and urgency of reform can only be fully understood when considering the complete range of adverse environmental, social and economic side effects of fossil fuel subsidies" (Rentschler & Bazilian, 2017, p. 2). If not for environmental reasons, leaders can reform their subsidies for the benefit of their economies in the long-term.

As an economic justification to reform the subsidies, the INESC institute (2020a) claims that tax renounce from production subsidies largely reduces state revenues that are essential to the Brazilian population, like PIS (Social Integration Program) and COFINS (Contribution to Social Security Financing), which are fundamental for state pension and unemployment insurance. Dr. Fernanda Delgado de Jesus, petroleum politics researcher in Brazil, highlights that "all public policies need to be measured," and even though the production subsidies for O&G are costly, they bring large economic benefits to the population through royalties, special participation fees, and signature bonus, and many cities rely upon these taxes, so the positive effects from these subsidies must be considered (Núcleo WIN Brazil UFBA, 2021, 1h12m). In 2021, the O&G business in Brazil distributed R$ 37.6 billion (US$ 7.5 billion) in royalties and R$ 36.8 billion (US$ 7.3 billion) in special participation fees for the government, and part of this revenue is expected to be used in basic services, such as health and education (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis [ANP], 2022a).

Studies have shown that the government revenue from the O&G has failed to significantly reduce poverty and to improve the educational levels in cities that receive royalties from O&G (Martinez & Reis, 2016; Pereira & Neto, 2017; Poubel & Santos-Junior, 2017). Jesus et al. (2017) have studied the five cities in Brazil that are most dependent on the revenue from O&G and concluded that, in the period of 2005 to 2015, social inequality increased in all the five cities, and in some of these cities the educational and violence levels became worse. According to Oliveira and Laan (2010), poor families did benefit from subsidies in Brazil in the last decades, but the large industrial energy consumers were the ones benefited the most, while the common taxpayers are the ones that paid for all that. Even though fossil fuel subsidies are usually justified as a support to the poor, many times most of the subsidies are received by the rich, who tend to consume proportionally more energy than the poor population (Cheon et al., 2015; Rentschler & Bazilian, 2017).

When the Repetro program was created in 1999, it was supposed to develop the market and to expire in 2020. Whether Repetro was responsible or not, its goal to develop the industry and to bring new players to the market was certainly achieved. In 1997, Brazil's total petroleum production was almost 1 million boe/d,[3] and in January 2022, the daily production was around 3.8 million boe/d, being 74% of that production derived from the pre-salt area and coming from many new players in the market other than Petrobras (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis [ANP], 2022b; Agência EPBR, 2021). With such accomplishments, one could say that O&G would not need production subsidies after 2020 (when Repetro should expire). Still, in 2018, the government extended the scope of the Repetro program and its validity to 2040. The government's rationale behind this decision was that the subsidy would continue to promote new investment, increase the country's competitiveness, and bring more players to the market (Brasil, 2017).

We conclude that this subsidy's main goal is not to support a nascent industry, but to continually increase its production and have economic benefits. While Brazil may have been successful in its economic objectives for the pre-salt, we cannot say the same for the social development goals on poverty alleviation and inequality reduction. Indeed, business cases that prioritize short-term economic decisions will be disconnected to the long-term societal and environmental outcomes (Hahn et al., 2018). In section "Energy policy mix in Brazil", we showed that Brazil's energy policy mix has a policy strategy highly oriented to the progress of renewables, but it includes many O&G policy instruments that are inconsistent with it. In section "O&G companies' activities in Brazil", we show data from O&G companies supporting that the O&G instrument mix has been successful in its goals of developing the O&G industry.

In this section, we present a line of though suggesting that, although O&G instruments have achieved its short-term economic goals, they have failed to achieve social goals. As they also hold back the transition to renewables, they might not be beneficial to society in the end.

> **Proposition 5.** Policy instruments that artificially lower the production cost of O&G reduce the competitiveness of renewables and discourage investment in low carbon technologies, thus hindering a sustainable energy transition.

CONTRIBUTIONS AND FINAL REMARKS

One of the main expectations of the current global energy transition is to reduce GHG emissions from energy use radically. A clean transition will be done by quitting fossil fuels and replacing them with renewables and electrification. Brazil is ahead of most countries regarding total use of renewable energy, with a vehicle fleet that can run almost entirely with biofuels, a meager share of coal, and most of its electricity coming from hydropower (EPE, 2022). Unlike most developed countries, Brazil's GHG emissions do not come from energy use. Instead, they come primarily from land-use change and the forestry sector (Timperley, 2018).

Brazil's public policies seem to favor O&G more than renewables as the petroleum segment has more political benefits than other energy sources. Petroleum has federal institutions to coordinate the market (e.g., ANP and the Secretary of Petroleum, Natural Gas and Biofuels — SPG), a mature regulatory framework, tax benefits (e.g., Repetro and Act No. 13,586/2017), financing programs, and R&D mandates. Petroleum does not have infrastructure limitations for distribution as other sources like biogas and electricity.

According to Rogge et al. (2017, p. 2), transformative policy mixes for sustainability transitions "need to combine different instruments addressing multiple market and system failures by fulfilling different purposes, such as technology push and demand pull." In order to speed up investments in renewables in Brazil and similar emerging economies, the authors recommend that public policies should include: (a) regulatory frameworks for all renewable energy sources, which will allow developments in new projects, predictability for investment, and a competitive energy market; (b) regulatory agencies for all renewable energy sources; (c) established plans for the energy sector, which will guide the creation of new policies and instruments; (d) policies to speed up the development of infrastructure for energy; and (e) restrictions and removal of subsidies for fossil fuels while creating more subsidies for renewable technologies that are still not competitive, like second-generation ethanol and offshore wind — following Cheon et al. (2015) and Rentschler and Bazilian (2017).

The literature shows that subsidizing O&G is not efficient for the economy or social development in the long run. Fossil fuels subsidies may create short-term stimulus for the economy, but they normally cause detrimental effects for sustainability issues in the long-term.[4] They incentivize growth in energy consumption and discourage energy efficiency and low-carbon energy sources (Oliveira & Laan, 2010; Rentschler & Bazilian, 2017). Researchers showed that there are more efficient manners for a government to spend money to alleviate poverty than subsidies, such as direct cash transfer programs or investment in basic services for the population, and that is a major supporting argument for eliminating them (Cheon et al., 2015; Jain, 2019; Moghaddam & Wirl, 2018; Rentschler & Bazilian, 2017). According to Cheon et al. (2015, p. 376), the subsidies for fuel in Brazil "encouraged excess and inefficiency and benefited industries more than they did low-income households, widening the gap between the wealthy and the poor."

All these facts must be understood by the population and the political parties to avoid opposition to subsidies reforms. Politicians must clearly communicate the population what is being done to compensate the removal of subsidies and what are the long-term benefits. Society must understand that the extra revenues will be used in their benefit in more efficient manners, like cash transfer or social programs. The short-term fiscal benefits are exchanged for a long-term economic development. Not to say the environmental reasons. It is also important to create mechanisms that will protect the most vulnerable citizens from high prices, as the poorest cannot wait for long-term returns (Jain, 2019; Rentschler & Bazilian, 2017).

As for the main theoretical contributions of this article, we empirically studied how the interplay between building blocks of policy mixes (in this case, the *elements* and the consistency *characteristics*) affects the effectiveness of policy mix in directing a change toward sustainability objectives (i.e., the shift of O&G companies toward renewables). We validated the linkage between consistency, policy strategy, and the instrument mix of Rogge and Reichardt's (2016) framework in an empirical study in an emerging economy. Therefore, we expanded the geographical scope of policy mixes and sustainability transitions previously applied to European studies (Ghosh et al., 2021; Rogge et al., 2017) to a significant emerging country.

We identified some limitations in our work but that open new fruitful opportunities for future research. First, our scope of analysis is limited to national-level policies and the E&P segment only. There are also important policy instruments at the state government level and policies for other oil and gas segments that can largely influence our research question, for example, tax reduction on fuel price for end consumer policies and some local incentives for E&P and renewables. Second, we analyzed the consistency among the policy instruments. Nevertheless, Rogge and Reichardt (2016) show that other characteristics and design features of policies (like comprehensiveness, credibility, coherence, stringency, and depth) are influencers of the policy mix toward its goal. Therefore, these unexplored elements are subject to further research to encompass a more holistic perspective of the problem. Third, we focused our analysis on the shift of O&G companies from E&P to renewables, and there is space for a broader analysis of all the other actions that these companies have done regarding the energy transition, like energy efficiency, increase in natural gas use, CCS, and carbon offset measures. Petrobras, for example, has a clear strategy to focus its energy transition actions on these later technologies, and not on renewables. Furthermore, we suggest the need for additional research in emerging countries — and possibly those belonging to the BRICS — to test the validity of our propositions deduced from the policy mixes and O&G activities in Brazil.

As developed countries pressure their O&G companies to decarbonize, O&G companies might seek new projects in countries without restrictions and with subsidies to O&G, like Brazil. We should expect O&G companies in Brazil to maintain oil as their primary asset for the next decade, and renewables will be a complementary and a growing business. However, for now, O&G companies will most likely invest in renewables because they want to de-risk their future operations, not relying solely on petroleum products and because they want to keep their 'license to operate' to satisfy their stakeholders. Nevertheless, an energy transition toward renewables by the O&G companies will not occur if public policies do not lead that way.

We trust this article contributed with significant analysis and foundational propositions that opened novel perspectives to assist managers and policymakers' strategic decisions on the nature, opportunities, and threats of institutional policy mixes and O&G activities in a relevant emerging country. This research shed new light on advancing knowledge on tackling a grand societal challenge regarding the need to move toward a sustainable energy transition effectively.

NOTES

1. Consistency "captures how well the elements of the policy mix are aligned with each over, thereby contributing to the achievement of policy objectives" (Rogge & Reichardt, 2016, p. 1626).
2. The Repetro avoids the incidence of II (*Imposto de Importação*, or Importation Tax), IPI (*Imposto sobre Produtos Industrializados*, or Tax over Industrialized Products) and PIS (*Programa de Integração Social*, or Social Integration Program) and COFINS (*Contribuição para o Financiamento da Seguridade Social*, or Contribution to Social Security Financing) (PWC, 2022).
3. Boe/d means barrels of oil equivalent per day, accounting for petroleum and natural gas.
4. "Indeed, global warming and air pollution are sources of mortality, food insecurity, and diseases that mainly stress vulnerable populations by overshooting the need for medical treatment and hospitalization" (Nobre, 2022, p. 147).
5. REATE stands for *Programa de Revitalização da Atividade de Exploração e Produção de Petróleo e Gás Natural em* Áreas *Terrestres*, or Program for the Revitalization of Oil and Natural Gas Exploration and Production in Onshore Areas.

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