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Energy in a world in transition

Challenges, opportunities, and perspectives

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Preface

After its first edition, in which the attractive prospects for the diversification of the energy matrix — through the new gas market, incentive for renewable sources, among other measures, — were highlighted, although with the challenges of the COVID-19 pandemic, we reach the second edition of the CEBRI-BMA publication facing new challenges, opportunities and perspectives, given the recent change in the global scenario.

The Russia-Ukraine military conflict raises new interrogations on energy security and the role of fossil fuels in this context, especially given the current agenda imposed by climate change and the COP-26 commitments, which require adopting public policies in line with the paradigm shift needed, in the short and medium term.

The role of new technologies and alternative energies, such as green hydrogen, is equally relevant, and already has known a significant evolution in other countries, while tentatively developing on Brazilian lands, even though it is part of our energy planning.

We are facing a world in transition, in which the very energy that will foster its development is gaining new contours, in Brazil and around the world. The intention of the collection of articles contained in this publication is to discuss this particular scenario.

We believe that publications like the present one foster debate, thereby benefiting the entire industry. Have a pleasant reading.

Julia Dias Leite
CEO of CEBRI

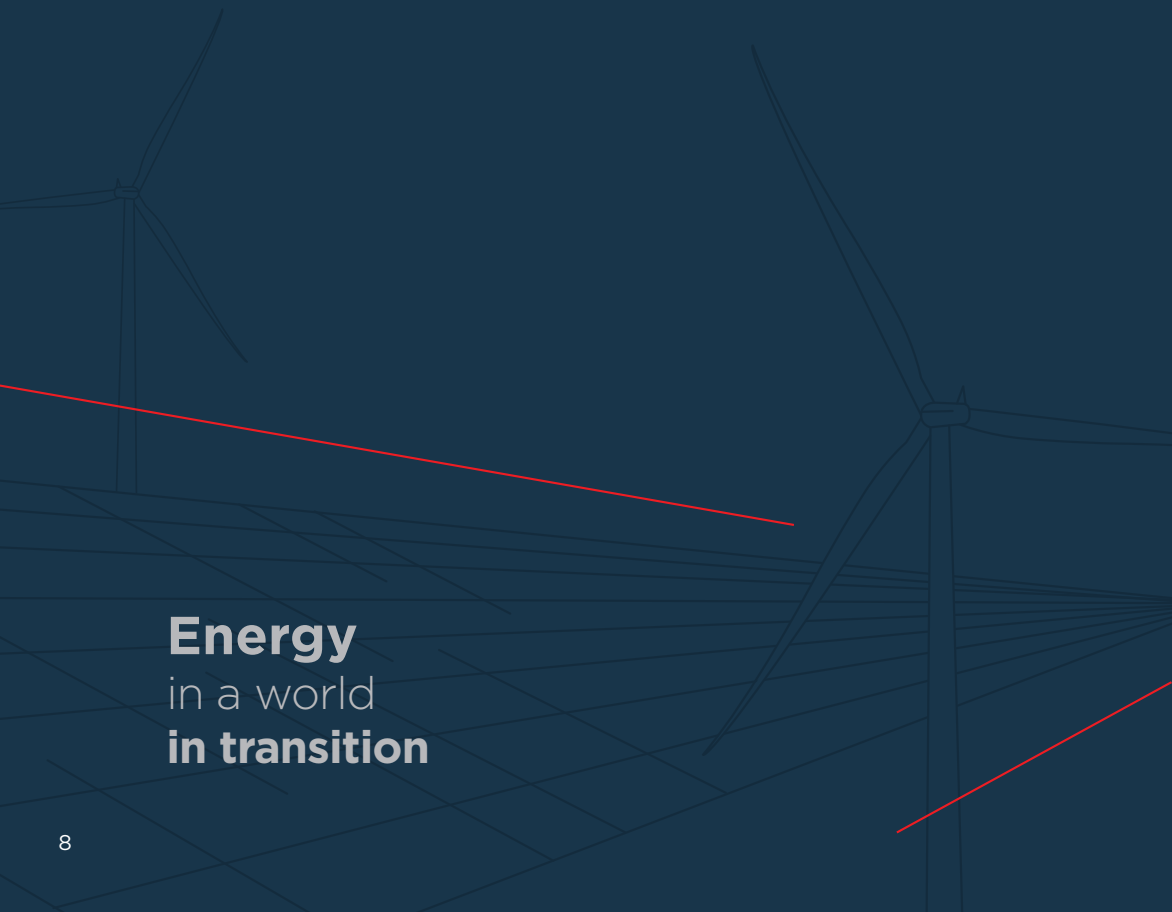
Carlos Frederico Lucchetti Bingemer
Partner in BMA's Corporate practice and Energy areas

Table of Contents

III. OPPORTUNITIES

SECTION I

CHALLENGES OF THE TRANSITION



Energy
in a world
in transition

01

Notes on the course of the energy transition in the 2020s, 2030s and 2040s

By **Pedro Malan**, Trustee Emeritus at CEBRI, and
Jorge Camargo, Vice-Chairman of the Board of Trustees of CEBRI

I[1]

The transition to a low-carbon economy is reflected in a gradual change in the energy supply and demand structures. This change would take several decades, but the growing concerns about climate change have accelerated the pressure for more speed in this process, and especially the demand for firm commitments (by governments and companies) to metrics that can be transparently monitored for 2030, 2040 and 2050, on the grounds that it is in this window that lies the only hope of keeping the globe's average temperature rising only in the range of 1.5 to 2.0 degrees Celsius this century.

The Paris Agreement was hailed as an extraordinary breakthrough in terms of international cooperation: 195 countries signed it and took on their "nationally determined objectives", not always comparable

1. Authors' Note: Sections I through IV of this article were submitted for publication in the early days of January 2022, thus before the serious escalation of tensions that led to the invasion of Ukraine by Russian troops. Section V was added at the end of March, when uncertainties about when and how the conflict might be contained, and on what negotiation terms, were intense. What seemed certain a month after the Russian invasion in late February and the economic sanctions imposed on Russia by the West (US and Europe) is that the transition to a lower carbon economy will most likely have become more costly and slower.

or compatible, but an ingenious way to avoid the "imposition of common rules". It is the "international community", or at least most representatives of its governments who seemed to have convinced themselves that the goal of avoiding global warming exceeding 1.5 - 2°C was an imperative and required immediate action, even if the transition could extend over a few decades. But there is urgency, even in gradualism.

For the world as a whole, in an ex-post sense (i.e. after price adjustments), global energy demand and supply are in balance today at about 14 billion tons of oil equivalent (if stock variations, errors and omissions, statistical discrepancies, carryovers from one year to another, etc. are included). As the global demand for energy will continue to grow, it will have to be met by a supply that is also growing, even if its composition is altered. The purpose of these brief notes is only to stimulate the debate about the challenges and directions of the energy transition in the 20s, 30s and 40s.

This transition, which, as we saw at COP 26 (Glasgow) is of enormous complexity when we consider the extraordinary diversity and asymmetry of information observed in the world - and, therefore, the far from trivial problems of "collective action" involved in the necessary and more difficult international cooperation without which it will be very difficult to move forward. Problems that, as is well known, were strongly accentuated in the last 5 years, and have evidenced with more clarity the relative weight of 6 main (and interconnected) channels, mechanisms and instruments listed below as absolutely relevant in the transition process of the next 2-3 decades.

II

Without concern for hierarchy, here are the six points with comments on each one:

a) Price Signals:

The prior energy transitions were driven by new and increasingly efficient forms and sources of energy. Yet they took decades to come to fruition. In this current one, in addition to the greater urgency - it's a task for a generation - we won't have clean energy in quantities and at costs comparable to fossil energy any time soon. The world today still depends on coal, oil, and gas for about 80 percent of its energy consumption. The new renewable energies, despite all the recent advances - the growth and competitiveness of renewable energies,

especially solar photovoltaic, are impressive - still meet only about 9% of world demand. Even today, most forms of low-carbon energy are more expensive than fossil fuels. Part of the economic advantage of fossil energy occurs because the environmental damage caused by atmospheric emissions is not accounted for. Therefore, the search for approximation between the production costs of goods and services with and without greenhouse gas emissions, which translates into price signals to the consumer, will be crucial, both to reduce the demand for fossil energy and to set the pace of energy transition towards the inexorable future carbon-neutral economy.

b) Actions by Governments

The energy transition to a carbon-neutral economy will be complex, long, and expensive. It will require international cooperation and coordination, as well as realism, pragmatism and a sense of urgency. It is difficult to establish a hierarchy of actions that will lead to an energy transition as deep and accelerated as the one intended. It will require bold public policies that penalize emissions, and that are effective and understandable, in order to receive society's support. Government actions are as indispensable as they are diverse. Because they are subordinated to economic and political circumstances, ideological and geopolitical purposes, local and international contexts, they must vary in form, rhythm and objectives: Government actions that manifest themselves through systems of incentives and disincentives that alter relative prices of different energy sources. Government actions are always limited by political, socio-economic and population assimilation constraints of extra taxes and costs in the present in exchange for mitigation of climate risks in the future. The challenge of political leadership should not be underestimated as the uprising of the "yellow vests'' in France has well demonstrated. Government actions that have impacts beyond national borders, such as the establishment of mechanisms for an international carbon market and import tariffs on carbon-intensive products ("carbon border adjustments"). The environment as a critical factor in access to markets and international agreements, such as the free trade agreement sought by Mercosur with the European Union. The very concept of national sovereignty, on which the foundations of international relations are based, is increasingly being confronted and subordinated to responsibilities to face the global climate challenge.

c) Actions by Regulatory Agencies

Among government actions, those led by regulatory agencies - in the form of publicity and transparency and the setting of standards and

commitments - are capable of significant impact, both in controlling emissions and in directing investment, innovation, and technological development. A good example is the California Air Resources Board (CARB), a state agency that from the initial efforts in 1967, aimed at improving air quality in the city of Los Angeles, has consolidated itself as a world leader in actions aimed at reducing greenhouse gases. By establishing carbon regulatory mechanisms aimed at producing zero or low emission vehicles and clean fuels, it has already reduced state emissions to pre-1990 levels. In the process, it has made California an example of climate awareness and a billion-dollar carbon market for low-carbon energy and products[2].

d) Actions by Market Agents

One of the main highlights of the recent COP-26 in Glasgow was the active and intense participation of the most diverse global business and financial sectors. The perception of the alarming dimension of systemic risks and the growing pressure of the most affluent and influential public opinion agents, especially in Europe, have put climate change at the center of investors', entrepreneurs', bankers', and insurers' attention. The more than 450 companies representing $130 trillion in assets that have committed to the Glasgow Financial Alliance for Net Zero (GFANZ) led by Mark Carney, former president of the Bank of England, give a good measure of the extent of the international private sector's engagement in combating climate change. Such engagement should increasingly be reflected in principles, specific strategies, investment decisions, targets, and metrics that together should define the costs and capital flows to decarbonize the real economy.

e) Technological Innovations and Climate Change

Technological innovations have been the main driving force behind energy transitions in the past. In this climate-driven transition they will also be key. Much of the technological solutions that will lead us to a low carbon future already exist. Solar and wind technologies are good examples. The challenge is to accelerate the scale of deployment and the replacement of technological legacies that are less efficient environmentally and in terms of energy use[3]. We also have other technologies that are mature but depend on the abatement of the so-called "green premium", the cost differential in relation to equivalent products of fossil origin. This is the case with hydrogen, carbon capture

2. OFGEN (Office of Gas and Electricity Markets) can be noted as a good example in the UK. During COP 26, they launched the Regulatory Energy Transition Accelerator a global initiative to encourage regulatory agencies in different countries to accelerate the energy transition.

3. Ensuring the dispatchability of the system with the increasing participation of intermittent sources is also a major challenge.

and storage, renewable diesel, bunker and QAV, technologies considered essential on the path toward zero carbon, especially in sectors that are difficult to decarbonize, such as steelmaking, cement, fertilizers, air transport, and maritime transport. Clean energy and climate-related technological developments demand exponential growth in global R&D investments - private and public.

f) Actions by the Oil Industry

The oil industry - this vast world made up of professionals and scientists from a wide variety of specialties, of organizations and companies either privately or state-owned (national and international) - will play a key role in making the transition happen in time to avoid the risks of accelerating climate change. No other industry has the technological base, the financial means, and the ability to attract and develop the talent that will be so necessary to meet such a challenge. In response to strong pressure from investors, customers and public opinion, International Oil Companies (IOCs) are pursuing strategies to reduce the carbon intensity of energy production, with increasing selectivity and divestments in oil and gas. Some, mainly European, are adopting renewable energies as a new and main growth vector. As a result, the National Oil Companies (NOCs), which are more protected from external pressures by their respective governments and hold the lowest cost oil and gas reserves on the planet - not necessarily those with the lowest environmental cost - shall increasingly meet the remaining world demand for fossil energy.

III

To answer these questions or doubts and about the "relative weights" of each of the six items above, it is fundamental to disaggregate: supply and demand by major energy types; to disaggregate supply and demand by major regions and countries; to disaggregate by type of provider: national governments of global relevance through their NOCs; the major international oil companies - IOCs, and globally relevant independent companies.

Because if the world were centrally managed by a super-efficient GOSPLAN, the transition to a global low-carbon economy would begin with the determination to significantly reduce the use of the "dirtiest" source - coal - with a view to eliminating its use at a future established date (like Germany 2038). Coal would be progressively replaced by gas as the transitional source while investing heavily in wind and solar power production among other renewables.

The fact is that coal, oil and gas represent (or represented in 2016) 89% of energy demand in both China and the "Asia Pacific Industrial Area"; 82% in "North America"; 73% in both the European Union and India; 69% in "other countries in America" and 78% in the "Rest of the World".

There is not and never will be a global super GOSPLAN ruling over the transition. The degree of dependence on the three "fossil fuels" above is extremely high, considering the markedly different speeds with which the transition to a lower carbon economy is moving. While the direction of movement and strategy is clear, the journey will be long and tortuous. For the world as a whole, coal, oil and gas account for over 80% of global energy demand, while new renewables (wind, solar) still account for just over 9% of the total (out of 14 billion tons of oil equivalent).

Over the past 5/6 years since Paris, it has become clear that the path, from a political standpoint, could be even more tortuous than it seemed, since the newly elected (2016) President Trump loudly announced the US "withdrawal" from the Paris Agreement and engaged his Administration in a direction radically opposite to that which had been advocated over the eight years of the Obama Administration (and, indeed, by many US states).

Biden's victory allowed the US to return to the Paris Agreement and thus ensured the country's return to international forums and multilateral cooperation, but the fact is that Biden faces domestic opposition to his environmental policy. And, in the US, prevails a position virtually shared by Republicans and Democrats on the great challenge posed by China in the technological and military areas in the medium and long run.

Republicans could regain a majority in at least one, perhaps two houses of Congress in the 2022 elections. If they do, a Trump candidacy in 2024 could make a strong comeback - with all the known implications for the effectiveness of international cooperation for the energy transition toward a low-carbon economy. It seems that in Europe, for Europeans, and large private companies, including some in the oil business (Shell, Total, BP, Eni, Equinor, Repsol) hopes continue to lie in the fact that the process can move forward in this decade and the next. After all, to reach "NET zero emissions" in 2050, certain goals must be surpassed in 2030 and 2040.

What about China, which together with the US accounts for 38% of the world's greenhouse gas emissions? With its reliance on coal for 60 percent of its total primary energy supply; and coal, oil and gas together accounting for 89% of the total, how fast can it realistically

advance in the transition to a low-carbon economy? How involved is China with global commitments? The Chinese government has already moved its commitment to net zero to 2060, but we must recognize that Xi Jinping continues to affirm his commitments to multilateral cooperation. What about industrial Asia, also 89% dependent on the 3 "fossil fuels"? What about India? At 78%, with 44% on coal.

IV

It is a shame that another relevant part of the world, «Other Americas», which in 2016 already had 31% «clean» sources and the lowest dependence on the three «fossil fuels» is missing the opportunity to play a constructive role in this issue of transition to a low-carbon economy - in a timely or at least reasonable timeframe.

This is a pity because no other country of relevant economic size in the world has the same diversity as Brazil in terms of potential sources of energy supply to meet its growing demand. No other major country in the world has today, and for the foreseeable future, the proportion of clean energy sources in its total supply. Few, very few, have the same potential for a successful transition to a low-carbon economy over the next three decades.

Brazil has, therefore, all the conditions, if and when it has the appropriate political leadership, to resume a constructive role of international leadership in the areas of energy transition, climate change and environmental conservation. We have competent people in these areas and an enormous «soft power» potential, which we knew how to explore in the past (since the Rio conference in 1992). There is no reason for us not to explore it again, once the difficult phase of recent flagrant regression is over.

V

The tragic crisis caused by the war in Ukraine, with its extent and impacts that are certainly profound but still difficult to measure, also has consequences for the energy transition process.

Faced with the risk of disruption of oil and gas flows from Russia - the source of more than 10% of global production and the supplier of 40% of European demand - energy security became top priority. The global, and particularly European, focus fell on identifying and reactivating

sources of supply capable of urgently replacing the loss of Russian production, even if they imply greater environmental costs, such as reactivating coal-fired power plants. Energy security prevails when in conflict with climate ambition.

It is unclear whether this crisis will speed up or slow down the energy transition. There are arguments for both sides. It will probably produce different effects depending on geography and timeline. In Europe, short-term prioritization of energy security, long-term acceleration by replacing reliance on Russian oil and gas with cleaner sources. Globally, the geopolitical fragmentation, inflation, economic slowdown and turbulence that seem to emerge from this crisis do not favor an energy transition that depends on multilateral agreements and an enabling environment for infrastructure investments.

Brazil's advantageous geostrategic position is added to its credentials as an environmental power and a relevant, competitive and reliable energy producer, as already commented in Section IV. Whether Brazil will seize the opportunity remains to be seen. ■

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Jorge Camargo

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He has held executive positions at Petrobras, including as a member of the Executive Board, responsible for the International Area, and at Equinor, initially as Senior Vice President, at the company's headquarters in Norway, then as Chair of Equinor in Brazil.

Author of *Letters to a young oil maker* (Cartas a um Jovem Petroleiro. Elsevier, 2013) and *Petroleum, Texts and Contexts* (Petróleo: Textos e Contextos. Edições de Janeiro, 2018).

02

Brazil: energy transition in a peculiar climate context[1]

By **Clarissa Lins**, Trustee at CEBRI and founding partner of Catavento Consultoria, **Guilherme Ferreira**, partner at Catavento Consultoria, and **Bruna Mascotte**, senior partner at Catavento Consultoria

Article written on December 8th 2022

I. Introduction

The world is facing one of the greatest cross-generational challenges in its history. The increasing frequency and intensity of extreme weather events places the issue of climate change at the center of global discussions and reveals the need for profound transformations in current economic activities.

According to a recent study by Nature[2], 80% of the planet's land area, where 85% of the global population resides, has already experienced physical impacts from climate change. At the same time, the new generation, born after 2020, may experience 2 to 7 times higher incidence of fires, droughts, floods, and tropical storms during their lifetime, compared to generations born in 1960[3].

1. Authors' note: This article was prepared throughout the month of November and submitted for publication in the first days of December 2021. Thus, the implications of the energy crisis in Europe (2021), driven by high gas and electricity prices, as well as the consequences of the conflict between Russia and Ukraine for global energy geopolitics, were not analyzed. The authors would like to thank Christian Felix, intern at Catavento Consultoria, for his help in writing this article.

2. Nature. Machine-learning-based evidence and attribution mapping of 100,000 climate impact studies. 2021

3. Science. Intergenerational inequities in exposure to climate extremes. 2021

In this context, there is a growing perception of risk associated with the issue, mobilizing players from the public, private and financial sectors, as well as civil society. Recently, during the COP26, countries committed to more assertive public policies regarding technological development and market tools, such as carbon markets, in order to accelerate the transition to a low-carbon economy.

II. Global perspective - climate relevance and recent developments

The urgency of the climate change issue was highlighted by the latest report of the Intergovernmental Panel on Climate Change (IPCC)[4], which brings together the world's leading scientists and climate experts and was released in October 2021. According to the study, human action is responsible for the increase of approximately 1.1°C in the global average temperature since the pre-industrial period due to greenhouse gas (GHG) emissions.

The message from science is clear: If the world is to mitigate climate risks, it must limit the average temperature increase to 1.5°C by the end of the century. However, given the current emissions trajectory (59 $GtCO_2e$ in 2019), the remaining carbon budget (400 - 500 $GtCO_2e$) could be exhausted in up to 8 years[5]. In this context, the energy sector is key. According to the latest survey by the IPCC, greenhouse gas emissions (GHG) from the energy sector account for three quarters of the global total, followed by the agriculture (13%) and the industry (8%)[6] sectors.

In face of this complex scenario, politicians, diplomats, businessmen, and civil society gathered in Glasgow, Scotland, to discuss effective measures and more ambitious climate targets during the COP26. At the end of two weeks of negotiations, the 195 participating countries signed the Glasgow Climate Pact. Based on the new commitments assumed, 2030 emissions are projected to be approximately 42 $GtCO_2e$, compatible with an average temperature increase of 2.4°C and still far from the 26.6 $GtCO_2e$ required for the 1.5°C trajectory. In a scenario considering long-term net zero commitments, the average temperature increase tends to be limited to up to 1.8°C[7].

4. Science. Intergenerational inequities in exposure to climate extremes. 2021

5. IPCC. Climate Change 2021 – The Physical Science Basis. 2021

6. IEA. CO2 emissions from fuel combustion. 2021

7. IEA. COP26 climate pledges could help limit global warming to 1.8 °C, but implementing them will be the key. 2021

Although the advances are not yet compatible with the 1.5°C ambition, the consensus reached around Article 6 of the Paris Agreement and some commitments made were noted as important advances in the global climate agenda.

1. **Global Methane Pledge:** signed by more than 100 countries, representing more than 2/3 of the global economy and approximately 50% of methane emissions[8], has established a target to reduce CH4 emissions by 30% by 2030. The target is estimated to have the potential to avoid a 0.2°C temperature increase by 2050;
2. **Forest Agreement**[9]: representatives from more than 140 countries, including China and Brazil, have committed to zero deforestation by 2030. The signatory countries represent more than 90% of the global forests. In addition, the agreement aims the allocation of US$ 19 billion in public and private resources for initiatives to fight deforestation;
3. **Coal Pledge**: agreement to end the use of coal for power generation by 2030 (developed countries) or 2040 (developing countries), made by more than 40 countries, including Canada, Chile, Poland, and Ukraine[10]. However, the commitment has been questioned by the absence of countries such as the US, China, and India, major global consumers that together account for 70% of coal consumption[11];
4. **Mobilization of the financial sector**: the Glasgow Financial Alliance for Net Zero - GFANZ initiative, led by Mark Carney, announced that institutions with over US$ 130 trillion in assets under management intend to align their portfolios to the net zero scenario[12].

The Conference was also marked by unprecedented participation from the business sector and an increasingly vocal civil society made up of youth, indigenous, black and women leaders. COP26 therefore represents an important milestone for global climate ambitions. Now, the new commitments need to be implemented and translated quickly into effective action.

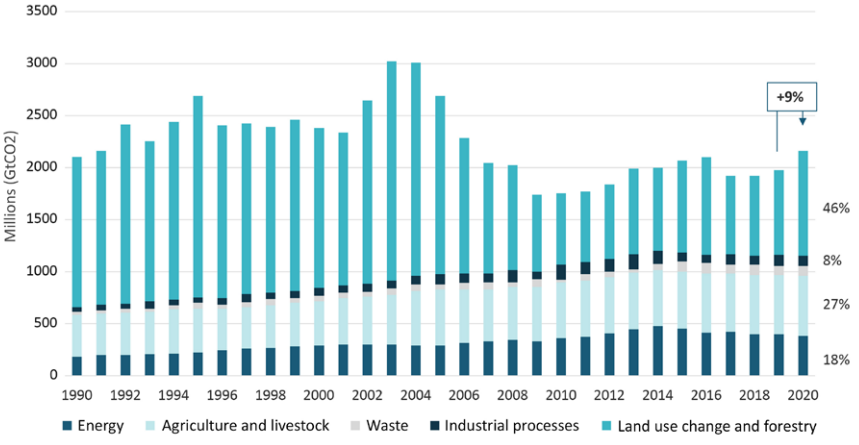
8. European Commission. Launch by United States, the European Union, and Partners of the Global Methane Pledge to Keep 1.5C Within Reach. 2021
9. UKCOP26. Glasgow leaders' declaration on forests and land use. 2021
10. UKCOP26. Accelerating the transition from coal to clean power. 2021
11. BP. Statistical Review of world energy. 2021
12. Financial Times. Carney-led finance coalition has up to $130tn funding committed to hitting net zero. 2021

III. Brazil: climate and energy

Brazil ranks fifth among the largest emitters of greenhouse gases (GHG), responsible for approximately 3.2% of the total, behind China, the United States, Russia, and India. Additionally, as an aggravating aspect, Brazil's per capita emissions are higher than the global average. In 2020, for example, the average of CO_2e emissions per Brazilian individual was 10.2 million tons, against 6.7 in the world [13].

Different from other global economies, where emissions are mostly linked to energy use, a large part of the national emissions are associated, directly or indirectly, with deforestation and agricultural and livestock production[14]**.** In 2020, total emissions in Brazil were 2.16 GtCO2e, the highest level since 2006, and were distributed as follows: 46% from land use change and forestry; 27% from agriculture and cattle ranching; 18% from energy; 5% from industrial processes and 4% from waste [Fig. 01].

Fig. 01: **Evolution of the Brazilian emissions profile (1990-2020) ($GtCO_2e$)**



Source: SEEG, 2021.

After years of decline (2003 - 2010) and stabilization (2014 - 2018), gross emissions from land use have shown an upward trend in recent years. Between 2019 and 2020, for example, these emissions grew by approximately 24% (190 $MtCO_2e$) due to deforestation rates. Considering deforestation in the Amazon biome alone, deforestation

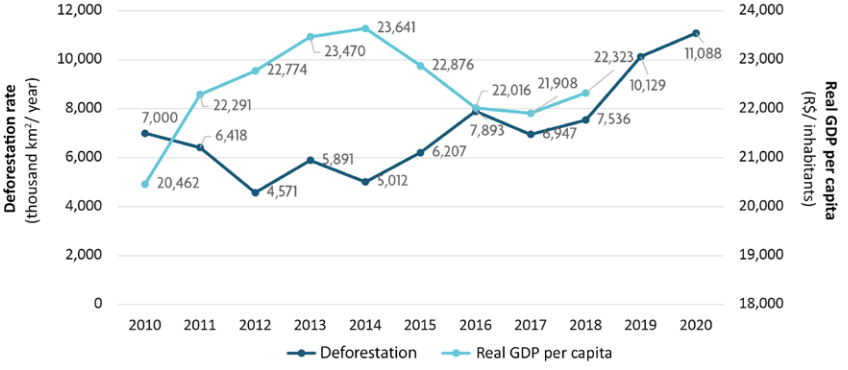
13. SEEG. Analysis of Brazilian greenhouse gas emissions and their implications for Brazil's climate targets 1970 – 2020. 2021

14. SEEG. Analysis of Brazilian greenhouse gas emissions and their implications for Brazil's climate targets 1970 – 2020. 2021. Prodes. Deforestation map. 2021

reached 9,810 km² in 2020, more than 55% higher than the average level for the decade (6,830 km² between 2010 and 2020)[15].

According to experts, approximately 99% of deforestation in Brazil is illegal[16], thus not contributing to the economy and well-being of society in general. **Furthermore, since 2010 there has been an inverse correlation between the GDP per capita curves in the Legal Amazon and deforestation, showing that the destruction and degradation of forest coverage does not generate economic development** [Fig. 02].

Fig. 02: **Deforestation rate and real *per capita* GDP in the Legal Amazon region (2010 – 2020)**



Source: Amazônia 2030. Facts about the Amazon 2021. 2021

If the deforestation trajectory is not reversed, sectors that contribute directly to socioeconomic development, such as the energy sector, tend to suffer greater pressure from society and other stakeholders to reduce their emissions. This aspect is associated with the fact that Brazil has an economy-wide target for reducing emissions, that is, it concerns the economy as a whole and not just a few sectors. Therefore, as the carbon budget is consumed by activities related to land use, the amount available for other sectors of the economy is reduced, generating inefficiency in the allocation of carbon to Brazilian society.

Currently, the Brazilian energy mix is characterized by the abundance and diversity of energy sources [Fig. 03], with significant participation of renewable energy (46%)[17], approximately 3 times higher than the

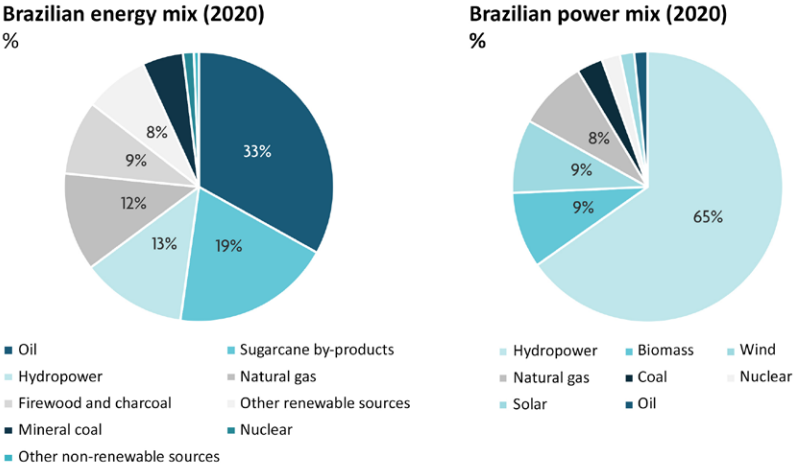
15. Amazônia 2030. Facts about the Amazon 2021. 2021

16. Amazônia 2030. Facts about the Amazon 2021. 2021; Mapbiomas. Annual deforestation report, Brazil 2020.2021

17. EPE. Balanço Energético Nacional (BEN). 2021

global average (14%)[18]**.** The country is the G20 member with the largest share of renewable energy in its matrix. This characteristic is even more evident when considering the power mix, with predominance of the hydropower source (65%). The national power mix has 85% of renewable energy sources [Fig. 03], compared to 16% globally.

Fig. 03: **Energy and power mix – Brazil (2020)**



Source: EPE. National Energy Balance (BEN). 2021

Given this scenario, it becomes necessary to consider the possible paths for Brazil in the context of the global energy transition. For most countries, the transition implies profound changes in the structure of the energy mix, due to the extreme relevance of fossil energy sources, particularly coal. In the last 30 years, for example, despite the significant growth of renewable sources, the dependence on coal in the global energy matrix has remained constant, with its input supplying a quarter of all energy consumed globally[19].

On the other hand, in view of the Brazilian particularities already mentioned, such as the high deployment of renewable energy, three major vectors for the Brazilian energy transition can be pictured:

1. **The increase in demand for energy,** driven by the desired socioeconomic growth, and the consequent need to ensure **energy security and access;**

18. IEA. World Energy Outlook 2020. 2021
19. IEA – "World Energy Balances", 2021

2. The ambition of maintaining a **high percentage of renewable sources**, based on the Brazilian competitiveness for hydropower, bioenergy, solar, wind and disruptive technologies such as hydrogen;

3. The opportunity to develop the **country's vast oil and gas resources in the medium term**, notably in the pre-salt, **in a responsible manner and with low carbon intensity**.

Regarding the first aspect, the EPE estimates that the primary demand for energy should grow 28% by 2030 and could double by 2050[20]. Such projections would be in line with a scenario of economic recovery - GDP growth of 3.1% by 2050 - that enables the country's economic development. For this to occur, it is necessary to guarantee that the supply of energy occurs in a safe way and at competitive prices. In 2021, the country experienced a scenario of water crisis that put at risk the supply of hydropower and significantly increased the country's power tariffs, highlighting the need to consider climate risks when modeling for the country's energy security.

Secondly, the energy planning for 2030 indicates the continued relevance of renewable sources in the energy mix (48%) and power mix (87%)[21]. Despite small changes in share terms, when considering the absolute growth for the period 2020 - 2030 (+25%), we see that renewable sources will be the protagonists of the Brazilian energy sector in the coming years. Solar and wind, for example, are responsible for more than 23% of the growth in the internal energy supply and 38% of the internal electricity supply[22]. Such growth is driven by the significant Brazilian competitiveness in both sources, with high-capacity factors in Brazil for solar (31% vs. 16% worldwide)[23] and wind (49% vs. 36% worldwide)[24] and significant reduction of LCOE[25] in the last decade (-85% and -48%, respectively)[26].

Moreover, the country is also in a position to assume a relevant role in key technologies for decarbonization, such as offshore wind, second-generation ethanol and low carbon hydrogen. Considering the latter, essential for the reduction of emissions in hard-to-abate sectors (ex:

20. Reaching 562 Mtoe in 2050 in the Expansion Challenge Scenario, versus 288 Mtoe in 2021. EPE. National Energy Plan 2050. 2020

21. EPE. Ten-Year Energy Expansion Plan 2030. 2020

22. EPE. Ten-Year Energy Expansion Plan 2030. 2020

23. World Bank. Global Solar Atlas. Global Wind Atlas. 2021

24. IRENA. Renewable Power Generation Costs in 2020. 2021

25. LCOE – levelized cost of energy

26. Gov projections. 1. ONS. Weekly operations bulletin. 2021

steel industry, shipping), estimates point to a production cost in Brazil below US$ 0.6/kg by 2050[27], the lowest projected globally. In face of this potential, the public sector, through the National Hydrogen Plan, and the private sector, through the development of industrial hubs, have been mobilizing[28].

Lastly, Brazil has the opportunity, leveraging on the high productivity and low carbon content of the pre-salt, to responsibly exploit its non-renewable resources. Globally, even in a scenario of emission neutrality by 2050, the demand for oil tends to remain at about 72 Mbd in 2030 and 24 Mbd in 2050 (compared to the current 90 Mbd in 2020) according to the International Energy Agency (IEA)[29]. Experts point out that in a more restricted market, the barrels produced with lower cost and less carbon intensity will be the most competitive. The large Brazilian pre-salt fields, for example, have an extraction cost in the range of US$ 3.7/boe and carbon intensity of approximately 10 $kgCO_2e$/boe produced, placing it in the 1st quartile of carbon competitiveness of the global offshore O&G industry[30]. Therefore, in this scenario, it can generate wealth and income for the country, as long as it is explored in a responsible manner and adheres to international best practices, including the reduction of fugitive methane emissions.

Thus, the energy transition, for Brazil, is an opportunity to consolidate an energy sector with diversity of sources, competitiveness, attractiveness for future talents and abundance of resources [Table 01]. The business environment requires attractiveness, stability and predictability of rules, as well as openness to technological innovation. These ingredients, in turn, presuppose clear public policies, aligned with the changes underway and with market principles, weighing the goal of energy security at an efficient cost for Brazilian society with the paramount low carbon emissions.

27. BloombergNEF. 1H Hydrogen Levelized Cost Update. 2021
28. Catavento. An executive guide to the hydrogen economy: current progress, views and expectations. 2021
29. IEA. Net Zero by 2050. 2021
30. Petrobras. Plano Estratégico 2022-2026. 2021

Table 01: **Key aspects of the main energy sources in Brazil**

	Contribution to the diversity and abundance of the energy/power mix	Challenges to be addressed and considered in planning
 Hydropower	Promotion of **energy security for the sector**. During the 2021 water crisis, the three structuring plants* supplied approximately 10% of the country's power[1]	**Climate change and deforestation** tend to impact rainfall patterns in Brazil. The 2021 water crisis was influenced by the lowest levels of rainfall in 91 years[2]
 Biofuels	Currently, Brazil is the **third largest global producer of biofuels, with a significant share in the transport sector** (20% of energy consumption)[3]. In addition, it has growth potential until 2024, second only to China in production.	Growing need to **mitigate the impacts of biofuels**, associated with the expansion of cultivated areas, food shortages and impacts on biomes[4]
 Other renewables	**High capacity factors** in Brazil for solar (31% vs. 16% globally) and wind (49% vs. 36% globally)[5] and significant reduction in the LCOE*** over the last decade (-85% and -48%, respectively)[6]	Clean technologies (e.g. solar panels and wind turbines) **demand on average 13 times more critical minerals** than fossil equivalents. The **reserves of these minerals are geographically concentrated** in regions that are often vulnerable (e.g. Congo)[7]
 Oil and gas	Direct contribution to the **collection of royalties** (R$ 85 billion in 2021**). Pre-salt with one of the **lowest carbon intensities** in the offshore O&G industry[8]	Fossil fuels contribute **393 MtCO2e, 18% of the country's emissions (2020)**[9]. O&G activity is also **associated with methane emissions** (34 times more powerful than carbon for global warming)[10]

* Belo Monte, Santo Antonio and Jirau **CBIE and ANP projection ***Gov projections 1.ONS Weekly Operations Bulletin, 2021; 2.EPE. Water scarcity and electricity supply in Brazil, 2021 3. Gov. Brazil: Brazil advances in the biofuels sector, 2021; 4.WWF: Brazil is capable of supplying biofuels and food without harming the environment, 2021; 5.World Bank. Global Solar Atlas. Global Wind Atlas, 2021; 6.IRENA. Renewable Power Generation Costs in 2020. 2021; 7.Catavento. Critical minerals and the transition to a low-carbon economy, 2021; 8.Petrobras. Strategic Plan 2022-2026, 2021; 9.SEEG. Analysis of Brazilian greenhouse gas emissions and their implications for Brazil's climate targets 1970-2020, 2021; 10.WRI. How methane emissions contribute to climate change, 2021.

By having this set of elements in place, and understanding the importance of proving to be an attractive and stable place for private investment, Brazil will be able to exploit the existing potential and develop the various energy sources in a competitive way, assuming a position of unequivocal leadership in the new geopolitics of energy.

IV. Final remarks

Brazil is in a unique position in the global context of energy and climate change. There is a unique opportunity for the country to lead the transition to a low-carbon economy. This leadership necessarily includes an end to deforestation, as well as the efficient management of abundant energy resources.

From the 3 elements explored - increasing the supply of energy in a secure and competitive way, maintaining the high share of renewable sources, and responsibly developing the O&G industry - the Brazilian energy transition can reconcile economic development, business opportunities, and the transition to a low-carbon economy.

We must diligently and continuously maintain an attractive and predictable business environment to capture investments in innovative technologies, in order to confirm Brazil's position as an unequivocal leader in the energy world of the future. ■

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03

ESG challenges in the management of the O&G industry

By **Cristina Pinho**, Chairman of the Board of the Luisa Pinho Institute and **Raquel Filgueiras**, Senior Economist at the Brazil Institute of Oil and Gas (IBP)

ESG is a set of environmental (E), social (S), and governance (G) metrics or standards that encompass aspects beyond a company's operations. Used as criteria by many investors, the ESG agenda represents risks and opportunities that will affect a company's ability to create long-term value, including factors such as climate change, resource scarcity, data security, diversity, and transparency[1]. In broad terms, ESG investing is an approach that seeks to incorporate environmental, social, and governance factors into asset allocation and risk decisions in order to generate sustainable financial returns[2].

If before, the requirement for this agenda was an increasingly relevant aspect for ensuring the financeability of a company or segment, the view of ESG metrics as an opportunity for business generation, efficiency improvements, attracting talent, and establishing a better dialogue with society has now been consolidated. Research by McKinsey[3] further reinforces that ESG practices are related to cash flow

1. PWC, 2021 – "Create value through ESG"

2. OECD, 2021 – "ESG Investing: Practices, Progress and Challenges"

3. McKinsey, 2021 – "Práticas ESG podem criar valor de cinco formas" (Five ways in which ESG practices can create value)

in five key ways: (i) facilitating revenue growth, (ii) reducing costs, (iii) minimizing regulatory and legal interventions, (iv) increasing employee productivity, and (v) optimizing investment and capital spending.

The Covid-19 pandemic has corroborated the importance of actions towards a more sustainable relationship with the planet and contributed to reinforce the relevance of the ESG agenda, which has among its main approaches the inexorable energy transition underway. This is a challenge from the economic point of view, and has, as its main reason, the containment of climate change caused by human action on the planet[4]. In this respect, emissions management represents an additional challenge to the economic logic of increasing production and consumption, as the environmental cost starts to be tallied.

The Russia-Ukraine conflict has contributed to add even more fragility to the already complex geopolitical scenario. The first issue refers to energy security. In this sense, it is urgent to harmonize the diversification of energy matrices - and the increasingly pronounced participation of renewable sources - with the security of supply. In this regard, the O&G industry, in addition to its responsibility to ensure energy delivery, must invest in decarbonizing its operations under penalty of prematurely restricting its participation in the global energy scenario.

Additionally, the recent crisis strengthens the understanding that demand is a participant in the context of emissions. Until now, the debate about the responsibility of fossil energy segments in the context of energy transition was guided by the view of managing greenhouse gas emissions (GHG) through the supply. In this regard, Priyadarshi Shukla, co-chair of IPCC Working Group III, stresses that *"the right policies, infrastructure and technology to enable changes in our lifestyle and behavior can result in a 40-70% reduction in GHG emissions by 2050[5]"*. This significant potential is still slowly being tapped, both from a consumer behavior and energy efficiency standpoint. The International Energy Agency (IEA) estimates that Brazil can limit the growth of energy use to only 22% between 2020 and 2040, according to its *Efficient World* scenario[6]. Energy savings would come mainly from the transportation sector, with advances in fuel efficiency, and from the industrial sector, with greater adoption of energy management systems.

The latest report of the Intergovernmental Panel on Climate Change (IPCC) reinforces that greenhouse gas emissions (GHG) in the world

4. IPCC, 2021 – "AR6 Climate Change 2021"

5. EPBr, 2021 – Diálogos da Transição. "IPCC: Políticas climáticas adotadas até 2050 levam a aquecimento de 3,2ºC" (Transition Dialogues. "IPCC: Climate policies adopted by 2050 lead to 3.2°C warming)

6. IEA, 2021 – "E4 Country Profile: Energy Efficiency in Brazil"

reached 59 Gt (giga tons) in 2019, a figure 12% higher than in 2010 and 54% higher than in 1990, with the last decade recording the highest emissions growth in human history – an increase of 9.1 Gt CO_2 over the previous decade. Moreover, the public policies established until 2020 lead to the scenario of a 3.2ºC increase in the Earth's temperature, more than double the limit set by the Paris Agreement. Thus, for humanity to have at least a 50% chance of stabilizing global warming at 1.5ºC above pre-industrial levels, as determined by the Paris Agreement, global greenhouse gas emissions need to peak between 2020 and 2025 and fall by 43% by 2030. However, since 2010, these emissions have grown by 12%. In this context, without immediate and deep reductions in GHG emissions in all sectors, the goal of limiting global warming to 1.5ºC is out of reach. Also according to the report, the next three years will be decisive for achieving net zero emissions in 2050. Responsible for about 3/4 of GHG[7] emissions, the global energy sector is at the core of this debate.

In this context, several scenarios have been outlined, either with the objective of identifying the result of a set of policies or to establish possible trajectories to reach a desired future. The energy transition scenarios - which consider the attainment of the global warming target of less than 2ºC in relation to pre-industrial levels - project a greater insertion of renewables in the energy matrix. One of the main references is the International Energy Agency's (IEA) Net-Zero by 2050 (NZE2050), which discusses the main strategies to ensure a trajectory compatible with climate objectives by 2050. NZE2050 includes the first detailed IEA modeling of what it would take over the next ten years to put global CO_2 emissions on a path to net zero by 2050[8]. It draws an 8% drop in energy demand even with an economy twice as large and 2 billion more people. The difference is the result of behavioral changes, efficiency gains, electrification and a massive insertion of renewables, which will account for 67% of the global energy matrix in 2050[9]. According to this scenario, we have a short but possible window to achieve net zero emissions in 2050.

However, even though renewable energies have reduced their costs in recent decades[10] - with solar energy costs falling by 40% to 50% and wind energy by 15% to 30%[11] - fossil fuels still account for the largest share of the global energy mix today.

7. IEA, 2018 – "World Energy Outlook"

8. IEA, 2020 – Press Release - "World Energy Outlook 2020 shows how the response to the Covid crisis can reshape the future of energy".

9. IEA, 2021 – "Net-Zero by 2050"

10. IEA, 2021 – "Financing Clean Energy Transitions in Emerging and Developing Economies"

11. IEA, 2021 – "Financing Clean Energy Transitions in Emerging and Developing Economies"

In this regard, the O&G industry could play a key role in bringing clean technologies for capital-intensive sectors to technological maturity. NZE2050 projects that 50% of the emissions reductions needed to achieve net zero climate targets in 2050 will come from technologies still under development[12]. Thus, industry resources and skills can play a central role in helping to tackle emissions from some of the hard-to-abate sectors. This includes the development of carbon capture storage and utilization (CCUS), low-carbon hydrogen, biofuels, and offshore wind energy. Expanding these technologies and reducing their costs will depend on large-scale engineering and project management capabilities, qualities that match perfectly with those of large oil and gas companies[13].

The reduction of greenhouse gas emissions depends, therefore, on an unprecedented articulation between investors, private sector, individuals and government[14]. In this context, the success of decarbonization strategies depends on the increased use of clean technologies[15] and improvements in energy efficiency, especially through innovation[16].

On the other hand, the world's energy and climate future will increasingly depend on decisions made in emerging and developing economies, particularly with regard to managing emissions on the demand side. Given their economic development prospects, these economies will account for most of the growth in emissions over the coming decades, and despite representing 2/3 of the world's population, they account for 1/5 of clean energy investment and only 1/10 of global financial wealth[17].

However, Brazil is already much closer to the desired energy profile for the global matrix in the next decade. While the NZE2050 foresees that renewables should make up 30% of the world's energy matrix in 2030[18], Brazil has today 48% of its energy matrix supplied by renewable sources - compared to a global average of 14%[19]. In the Brazilian electric matrix, the insertion of renewables is even greater - 85%[20] in 2020 -

12. IEA, 2021 – "Net-Zero by 2050"

13. IEA, 2020 – "The Oil and Gas Industry in Energy Transitions"

14. IEA, 2020 – "World Energy Outlook"

15. As ditas "tecnologias limpas" referem-se àquelas que viabilizam fontes de energia com baixa ou nenhuma emissão de GEEs, dentre as quais estão: viabilização do hidrogênio, ampliação da participação dos biocombustíveis, desenvolvimento de baterias com ampla capacidade de estocagem e adoção de técnicas de captura e armazenagem de carbono (CCUS, na sigla inglês).

16. IEA, 2020 – "World Energy Outlook"

17. IEA, 2021 – "Financing clean energy transitions in emerging and developing economies"

18. IEA, 2021 – "Net-Zero by 2050"

19. EPE, 2021 – Balanço Energético Nacional (BEN)

20. EPE, 2021 – Balanço Energético Nacional (BEN)

compared to 23% of the world average. Even in the transportation sector, responsible for over 45% of anthropogenic emissions associated with the Brazilian energy matrix - 179,8 Mt CO_2eq - the participation of renewables accounts for a quarter of the total consumed[21]. It is also estimated that Latin America will account for 40% of the US$20 billion in investments in biofuels and biogas for transportation expected by 2030, with a share sustained by Brazil, the second largest market for biofuels for transportation after the United States[22].

Given the significant participation of renewable sources in the Brazilian matrix, the average emissions per inhabitant in Brazil - 1.9 tCO2eq - represent 1/7 of the emissions per inhabitant in the United States or 1/3 of those of a European citizen. For each ton of oil equivalent, we emit 72% of the emissions of the European Union, 64% of the United States and 47% of China[23].

Regardless of the favorable Brazilian context, the major O&G companies, which also operate in Brazil, are keeping aggregate investments in oil and gas stable in 2021, despite higher international prices. Global upstream spending is projected to account for 25% of these companies' overall spending, in contrast to the nearly 40% share of E&P in the mid-2010s. In this context, the O&G chain seeks, with continuous investments, to develop and improve innovations to generate greater energy density and productivity, in addition to ensuring the effectiveness of its policies for low carbon and diversification of renewable sources for generation.

On the diversification front, the focus has been on solar and wind sources, which account for about 90% of all the overall investment that companies in the sector made outside the O&G chain in 2019[24]. It is estimated that the percentage invested by O&G companies in renewables will quadruple by 2021, with investments in offshore wind in the first quarter exceeding the total investments made by the sector in this mode throughout 2020[25].

In addition to private sector initiatives, public sources of financing will continue to play a vital role, especially for infrastructure and transitions in emission-intensive sectors. The provision of blended capital from development banks will also be critical in attracting private investment into markets and sectors that are in early stages of maturity, or in situations where risks are difficult to mitigate. Boosting financing at the

21. EPE, 2021 – Balanço Energético Nacional (BEN)

22. IEA, 2021 – "Financing Clean Energy Transitions in Emerging and Developing Economies"

23. EPE, 2021 – Balanço Energético Nacional (BEN) / National Energy Balance

24. IEA, 2020 – "The O&G industry in energy transitions"

25. IEA, 2021 – "World Energy Investment (WEI)"

scale needed will require a wide range of instruments and approaches. Dealing with the challenges of transitions will therefore require a focus on transparent public dialogue, the development of programs to strengthen skills in all aspects of energy transition, and support for the growth of new employment opportunities in more sustainable economic activities, particularly in developing countries[26].

Jared Diamond[27] reinforces that humanity's next challenges will be climate change, depletion of the planet's resources, and inequality. On all these issues companies will be called to act, at the risk of losing their licenses to operate.

In this context, inequality constitutes a fundamental threat to business. The reduction of purchasing power by the majority of society brings economic impacts - and consequently affects consumption patterns, wealth, and income. It also has ramifications for education, with scenarios in which more and more companies find themselves short of skilled labor, or at least labor that has the potential to leverage knowledge of new technologies and contribute to the implementation of digital transformation. Inequality also impacts political regimes, with the growing polarization of opinions about government regimes, which may favor greater state interference, causing imbalances in competitiveness and reducing investments. Inequality goes hand in hand with violence, which also affects workers' lives, motivation, and performance.

It is, therefore, necessary that companies act beyond philanthropy. In this sense, the sustainability of the social project and the risk assessment associated with the company's business that define the barriers and the actions to be implemented to mitigate these risks. The impacts caused by the companies' activities in a certain region, besides those already assessed in the environmental context, must also be analyzed in their social context. The goal should be to promote economic development in a sustainable way and with a view to the future in order to absorb local labor, intensify consumption, or even create new business models that contribute to reducing migration.

Internally, the leaderships must seek cognitive diversity in the perception of problems and in the search for their solutions, bringing to relevant management levels the diversity of gender, race, geography, and discipline. This diversity must make sense for the business strategy, and contribute to innovation in products and processes.

26. IEA, 2021 – "Financing clean energy transitions in emerging and developing economies"

27. Diamond, 2021 – "Will civilization survive the 21st century?"

It is worth pointing out that the acronym ESG does not define stagnant processes: on the contrary, they are fluid and interconnected. Actions should be seen in a connected way and should be the fruit of a dense analysis of inter- and extra-agenda impacts - as in the case of the energy transition. Despite its inexorable character, this transition must be seen as transitional. The understanding about possible ruptures and their consequences on energy prices and the restrictions resulting from this context must be clear. In a recent article[28], Daniel Yergin recalls that the transition from coal to oil took 101 years, and even today we consume three times more coal than in 1960. Yergin reinforces that the energy transition process is a *transition adding*, and not just an *energy transition*. In this sense, we will be adding new forms of energy to the mix in the coming years, with nations responding to more cost-effective strategies for their respective economies. This means that the pathways to net zero emissions by 2050 have to be designed taking into account the different realities and particularities of each country, but these metrics must converge in order to ratify the global commitment. In this transformation we cannot abandon the S, at the risk of jeopardizing our business and the generation of wealth for society.

While wealth generation depends on the insertion of new technologies, innovation is often associated with perceptions of process safety. In this sense, the oil exploration and production industry has been challenged in the last 20 years to adopt rigorous procedures with regard to safety. Major accidents that resulted in countless deaths and damage to the environment were the sparks for the construction of a culture focused on the preservation of human life and the environment. In this context, a new industry is born, where there is no longer room for safety indicators to be dissociated from financial indicators. Just as there is no longer any justification for eventual oil spills or gas leaks.

The association between safety management and meeting the ESG agenda is intuitive. Thus, the actions required are the same for us to have companies integrated into this new reality imposed by shareholders, investors, employees, and society. In this sense, the oil industry already presents a very favorable corporate environment to make the connections and strengthen its governance.

It is increasingly clear to companies and their leaders that weak governance also contributes to the occurrence of high potential accidents, whether financial or operational. Just as it is necessary to intensify the risk culture in order to attend the process safety management, the insertion of this culture must be led by the companies'

28. Yergin, 2021 – "Why the energy transition will be so complicated"

top management. The engagement of top management for the engagement and coherence of the processes is crucial in this context.

In this understanding, the new governance will not only pay attention to compliance with laws, regulations, and rules. But it must also promote attention to the rights of its employees and its supply chain, analyzing the political risks of the region where it operates and establishing metrics for human rights, welfare, and the environment. This menu includes the application of anti-corruption measures and ethical business practices, the adoption of regulations, booklets, the promotion of training to better qualify and educate employees, and the formatting of indicators. Third-party certifications and continuous internal audits are also tools that reinforce the robustness of governance. In this context, it is worth implementing reporting channels and effective control, including of business partners. All of this with continuous reporting to the board through its committees.

More recently, for many companies, the pandemic was the trigger for actions to strengthen compliance. But, for many others, serious accidents that deteriorated their image in the countries where they operate unfolded into more attentive management to compliance and their respective sustainability reports - today so demanded by investors and shareholders.

If on the one hand compliance has been increasingly the object of a close look by corporate management, the digital world has also been growing stronger and has started to have more space in companies' day to day, erasing prejudices in relation to remote work. While this represents a great opportunity, the growth of digital participation has also proved to be a threat, with more and more cyber attacks and the challenges of compliance with data protection law by customers and suppliers. A survey by the International Energy Agency (IEA) reveals that between 2009 and 2019, the number of cyber accidents worldwide will more than quadruple[29]. In this context, corporate governance has been challenged to also take this risk into account when implementing its strategies and analyses.

More and more stakeholders, investors, interest groups, and employees will work for more transparent indicators that truly demonstrate the transition from traditional balance sheets to value creation and its impacts on society, as well as complete and traceable sustainability reports[30]. Thus, the journey to governance that meets the ESG agenda is gradual. Many institutions have been dedicated to helping companies

29. IEA, 2021. "Report extract cyber resilience"

30. OECD, 2021 – "ESG Investing: Practices, Progress and Challenges"

around the world by developing documents through booklets and guides to enable comparisons and benchmarking, and by evaluating the integrity of their indicators.

The Association of International Certified Professional Accountants (AICPA) and the Center for Audit Quality (CIPA) have issued a guide with three key points so that ESG topics really be considered in your strategies, namely[31]:

1. Map the risks and identify the materialities that affect the company in ESG aspects

2. Involve the board in the discussion of the materialities found, as well as in the monitoring of mitigation actions

3. Integrate and align the materialities in the business risk management process

4. Integrate ESG into the company's strategy

5. Implement internal controls over ESG data, monitor the processes for meeting the strategy and the sustainability report indicators

Like the energy transition, addressing all the other issues that permeate the ESG agenda will be part of companies' strategy as they analyze their risks and opportunities in this rapidly changing world. This is not a fad, like many other waves in corporate management. It is a demand from a society that has realized the threats that come with inequality and the deterioration of the planet's biodiversity. ■

31. Items are in order of employment

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SECTION II

PERSPECTIVES OF THE ENERGY SECTORS IN BRAZIL

Energy
in a world
in transition

04

Pathways for the Energy Transition

By **Nonato Castro**, CEO of Light, **Alessandra Amaral**, Director of Regulation, Energy and Commercialization at Light, and **Marcos Kessler**, Superintendent of Asset Management for Generation, Market and Purchase of Energy at Light

The energy transition is one of the most relevant topics pertaining the debate on the future perspectives for the sustainable development of the electricity sector, both nationally and internationally. The recent transformations in the energy matrix, the digitalization of services, the focus on sustainability, renewable energy sources and the new role of consumers in the energy market are elements already present in our daily lives. However, the integration of all these innovations is still a challenge to be faced and will require the agents of the energy market to reflect on which path to follow in view of opportunities and risks of this movement called “Energy Transition”.

The need to preserve the environment has produced significant transformations in the world’s energy matrix in the last decades. Alternative energy sources have increasingly replaced traditional ones, especially the use of fossil fuels. This movement was accelerated by society’s engagement with the principles of sustainable governance (ESG - Environmental, Social and corporate Governance).

The vigorous process of technological innovation in the electricity sector, a result of digitalization and the massification of online services, has created new business environments and rapidly changed the behavior of electricity consumers. Those consumers are now market agents. They have the possibility to consume, produce and also commercialize

their own energy, as well as to choose the service that best suits to their needs. In many countries, this reality is already present on a daily basis and the markets function dynamically. In Brazil, there is still a critical path to be followed to achieve it.

The consumer's new role is guided by a set of values that are closely linked to this transformation process, which is a guiding thread for the energy transition. Consumers now are looking for sustainable energy resources, they value reducing greenhouse gas emissions, and are often willing to pay more for low-carbon energy. For this public the relationship with suppliers must be transparent, and there is a greater appreciation of diversity, as well as quality, safety, and products and services reliability.

The electricity industry is undergoing numerous changes due to the digital transformation in service provision. In the operation of electrical systems and networks, the equipments digitalization has enabled large-scale automation. Different technologies have been integrated and, due to artificial intelligence, the services quality has improved. These changes have provided a new customer experience, with the customization and virtualization of service environments.

In the wake of digitalizing services and products, the decentralization of energy generation is emerging, with the accelerated entry of distributed generation through micro and mini generation. Soon, with the participation of storage resources, the integration of diverse energy sources will be possible on large scale.

This movement has caused a drastic change in the business arrangement for the electricity sector, which traditionally was characterized by being a unilateral organization flow of the production chain - from generation, through transmission, then distribution, to finally reaching the final consumer - the latter being only a taker of the services offered to him. This arrangement no longer makes sense for a growing number of consumers, whose relationship with the energy market is active, complex and dynamic. After all, they are now market agents, making choices according to their needs and ability to pay.

The opening of the market is one of the vectors of this new consumer behavior, more attuned and empowered. The modernization of the electricity sector, led by the Ministry of Mines and Energy since 2019, has created an important environment for discussions regarding the design of a new legal framework. This includes the expansion of the free market, aiming to ensure the attractiveness of the sector to investors and the efficient allocation of costs along the sector's production chain.

The modernization of the electricity sector is inspired by the energy transition, solving institutional bottlenecks that produce distorted economic signals and inefficient cost allocation. It seeks to introduce a business model that meets the new characteristics of the country's energy matrix, which, with the consistent growth of wind and solar sources, will require robust planning if the national energy demand is to be met on a continuous basis.

This process of transformation of the Brazilian electricity sector must confront legacies from the past that today are hurdles to its development. It is necessary to create a business environment that is dynamic, efficient, and connected with the movements of the energy transition. Some of the objectives and challenges of this agenda are (i) to correct inadequate price signals; (ii) to rationalize subsidies and charges; (iii) to ensure energy security in line with the expansion of renewable sources; (iv) to diversify the commercialization markets for generation (for example, with ballast and energy separation); and (v) to enable the opening of the market with security and predictability for rules adequacy. It is a challenging agenda that must be addressed to improve the legal framework and align it to expectations of market agents, ensuring fair and balanced remuneration to all links for their contribution along the energy production chain.

In this new scenario, all links in the chain will have to reinvent themselves. The distribution utilities, for example, must continue to offer services with quality and continuity, providing reliable networks and automation so that outages are resolved in the shortest possible time, but they must also assume new roles as providers of diverse network services (DER - distributed energy resources).

As for generation, the discussion that permeates the energy transition, with the gradual replacement of fossil fuels for renewable sources, finds in Brazil a particular case that requires attention and care. After all, our electricity matrix was developed on a hydrothermal basis, with centralized operation and dispatch. However, with the continuous expansion of alternative sources, which have a lower degree of "dispatchability", the operation of the interconnected system has become more complex. It is, thus, necessary to think about the new dynamics of operation and expansion planning in order to enable the development of all the new technologies available (storage, reversible, hybrid, etc.).

Our country has a strong vocation for hydroelectric generation as a result of abundant water resources. It is crucial that the discussion on energy transition includes a reflection on the strategic role of

hydroelectric power plants in the expansion of supply in the future. The preponderance of hydroelectric power plants in the electricity matrix will continue for a long time to come. This leading role in the national scenario of electricity generation must be considered in any reflection on the role of this energy matrix in the coming decades.

Hydroelectric power plants have essential operating attributes for the national interconnected system. However, due to the characteristics of the current contracting model, these attributes are not adequately remunerated. In the context of the transformations of the country's energy matrix, it is expected that advances will be implemented to enable the proper pricing of the sources' attributes. It is therefore desirable (perhaps necessary) that the attributes of hydroelectric power plants are made clear and that a business environment is developed for commercialization apart from the energy market, characterized as a commodities market (separation of ballast and energy).

A first step in this direction was taken recently, in December 2021, with the first long-term capacity reserve auction. However, in this case, only thermal power plants were authorized to participate. Hydroelectric, as well as thermal power plants, can also provide power and energy security to the system. It is expected that next year the auction will be extended to other sources.

Among the opportunities for improvement, we can also note the diversification of the commercialization model, which has the benefit of expanding the markets and products offered by the generating agents, bringing more transparency and improving the allocation of the costs of attributes associated with energy security, and, consequently, eliminating the price distortions that currently exist between the regulated and the free environments.

The defense of the hydroelectric power plants' leading role in the new design of the Brazilian energy matrix should not be confused with any kind of resistance to the importance of the continued growth of alternative sources. The energy transition is characterized by the transformation and integration of traditional energy sources with the relevant growth of renewable sources, in association with new technologies that enable new services and products accessible to an increasing number of customers, as the free market gradually expands.

The future will be integrated! In order to move forward, the Brazilian electricity sector's legal framework must be improved to make viable the conditions that ensure financing of sustainable expansion of supply.

The Light company is in tune with energy transition. For us, the future

has already arrived and we are committed to taking benefits of new technologies and renewable energy generation to those with more needs and fewer resources. Important initiatives are underway with a focus on energy efficiency and the expansion of renewable sources aimed at consumers in situations of greater social vulnerability.

Recently, Light launched the "Responsible Energy" plan, which consists of a healthy competition among selected communities that will compete for the highest consumption reduction during the summer. The project encourages the rational use of energy by means of a great award to the winners.

In line with the energy transition process, Light recently obtained authorization from ANEEL (Brazilian Electricity Regulatory Agency) to implement the first solar energy generation park financed entirely with resources from the Energy Efficiency Program. The energy generated by this project will be allocated to consumers in socially vulnerable areas to reduce the cost of their energy bill. This initiative was only possible with ANEEL's understanding of the need to bring technological innovation and the creative use of existing solutions to face the challenge of social complexity in Light's concession area.

For us, at Light, energy transition is a reality. We are connected with the future and with addressing the environmental sustainability challenges, with the expansion of renewable energy sources and the accelerated introduction of new technologies as vectors for the transformation of the Brazilian electricity sector. We believe in Brazil's hydroelectric vocation, which for a long time to come will still be the pillar that sustains the country's energy supply. However, there are important advances to be achieved for the development of diverse markets and for the countless attributes provided by the various energy sources, making the Brazilian electrical industry an increasingly dynamic, diverse and integrated environment. ■

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05

Upstream (O&G): growth and new players, a Brazilian perspective

By **Décio Oddone**, CEO of Enauta

Energy transition must be accelerated and the energy matrix must change. We have seen it change since ancient times, when virtually all energy was supplied by burning trees, sticks, grass or manure. Following biomass, coal became the first major energy source and enabled the industrial revolution. It was an important source in the global energy matrix in the mid-19th century, and fifty years later, it was oil's turn to become the leading energy source.

Abundant and cheap energy has enabled transportation, industry, modern medicine, and more recently computers, the Internet, and wireless communications to develop. Air-conditioning made it possible for cities to grow in the tropics.

Two hundred years ago, nighttime illumination was scarce. In 1800, a worker had to work six hours to buy a candle that lasted 60 minutes. In 1880, with the kerosene lamp, 15 minutes was enough. Today, the cost of an hour of light is equivalent to a fraction of a second of an average worker's pay. The radical reduction in the cost of lighting has had extraordinary effects on education, inclusion and the modernization of society.

Life expectancy has skyrocketed. In the pre-modern world, it was 30 years; Since 1900, it has risen to 70, and, today, people in every country

live longer than they did in the most developed regions in 1800. None of this would have been possible without hydrocarbons. The oil and gas industry has had other positive impacts as well. Whale oil appeared as a material for candles and as fuel for lamps. When the oil industry was born, the sperm whale was sought after for its oil, which was replaced by kerosene when two-thirds of the species' population had been decimated.

Before the internal combustion engine came along, the horse was a public health hazard in the big cities. There were 130,000 horses in New York City and about 15,000 carcasses were removed from the city annually. Flies attracted by the dung spread diseases such as typhus, cholera, tuberculosis, and infantile diarrhea, which caused the death of more than 20,000 people a year. In London, 300,000 horses served as a means of transportation. In 1894, the Times estimated that in 50 years the city might be covered by a one-meter layer of manure. The automobile solved these problems.

In the second half of the 20th century, natural gas began to emerge, and, more recently, we have seen the rise of renewables. However, the greatest transformation in the energy sector in the last decade did not derive from a new source, but came from unconventional oil (shale). Production has grown dramatically. The United States became the world's largest producer and underwent a reindustrialization process.

Although fossil fuels account for nearly 80% of the energy supply, the absolute consumption of primary biomass has doubled since 1800. For about 1.1 billion people, biomass is still the primary source of energy. As 2.5 billion citizens rely on firewood, coal and kerosene for cooking, domestic pollution causes the death of 2.8 million individuals each year.

Abundant and cheap energy has enabled people to live more comfortably. Since the year 2000, 1.2 billion people have gained access to electricity, 70% of which was generated by fossil fuels. Yet 750 million people still live without it. The world is 100 times richer than 200 years ago. In the past 25 years, more than 1 billion people have escaped extreme poverty. Amenities such as electric light, air conditioning, and TV, which were not available to the elite 150 years ago, are enjoyed by billions of individuals today. This gigantic process of inclusion must continue. While respecting contemporary issues.

While the need to develop more efficient sources to replace biomass and animal traction was the challenge in the past, it is now necessary to increase the supply of affordable energy and, at the same time, decrease CO_2 emissions and impacts on the environment.

The changes will be profound, energy efficiency will improve, renewable sources will grow faster, the availability of energy will increase, and the energy mix will become more diversified. The reduction in emissions will be gradual and the transformation will occur without disruption. In the same way that primary biomass still plays an important role, despite the activism surrounding environmental issues, oil and gas will continue to be important for a long time and will be crucial in maintaining the quality of life during the transition to a low-carbon economy. As has happened since Man left the caves, the great advances will come from innovation and the application of new technologies. They will also be prompted by credit for the use of renewable sources and by taxing the most polluting sources.

Impacts on the oil industry will be immense. The victors will be those countries and companies that produce at lower extraction and emission costs. Since the 1950s, the oil and gas industry has experienced periods in which supply or demand dominated. From the late 1990s to the early 2010s, the increase in consumption in China induced the production of higher-cost oils. This represented the "end of cheap oil". The consolidation of shale, starting in the early 2010s, ushered a period of increased supply, which can be defined as "the end of expensive oil". These cycles were relatively long, facilitating industry planning and encouraging the execution of long-maturity projects, such as those located in deep waters or the exploration in frontier zones.

Covid-19 produced an immediate drop in consumption. The industry's initial reaction repeated the recipe adopted in every crisis: Cutting costs and investments and postponing plans. The increased concern with carbon emissions brought varied repercussions. Large companies decided to anticipate the sale of mature fields, concentrate their oil and gas activities in the most profitable areas and diversify their portfolio, betting on renewable energies. With this, smaller companies have the opportunity to take over fields that are less attractive to the giants in the sector. Financial institutions have become more selective when funding oil and natural gas projects. Investments in renewable energy have become a priority for many companies and financiers to the point that specialists are beginning to discuss whether peak oil demand is now behind us.

This has led to a second consequence of the pandemic, increased uncertainty about demand. In an environment of greater insecurity, there should be less investment, reduced supply and higher prices. Higher prices will lead to increased production in countries with spare capacity and of the American shale. The greater availability of oil will put pressure on prices, which will then fall again. And so on, in shorter

cycles. Therefore, greater price volatility is to be expected from now on. In this way Covid-19 may also have accelerated "the end of long oil price cycles".

This new dynamic will affect investment plans in countries such as Brazil, which has been undergoing transformations. The country has conducted a series of successful auctions. Petrobras sold stakes in hundreds of fields. New companies have started to explore and produce here. After years, the Brazilian stock market has seen the emergence of companies in the sector.

The global scenario does not favor exploration in frontier zones, such as some of the most promising areas available on Brazil's eastern and equatorial borders, nor the sanctioning of long-term maturing projects, such as those for deep-water drilling in provinces such as the pre-salt in the Campos and Santos Basins.

The competition for investment will deepen. Realizing that significant volumes of oil and natural gas may never be extracted, countries like Norway and England have taken measures to increase the attractiveness of investments in their territories. This reality has not yet taken hold in Brazil. Part of society continues to believe that nature´s generosity will always be enough to make any opportunity that is offered interesting. It disregards the impact of legislation; regulation and taxation, the so-called above ground risks on investments, as if only the conditions existing underground were relevant. Not even some recent exploratory failures in the pre-salt seem to change this perception.

The main objective should be to ensure investments in the contracts already signed. The tax regime could be more progressive. The permanent offer should cover all available areas, including those located inside the pre-salt polygon. The contracting regime should be that of concession. While there are sharing agreements, the National Council for Energy Policy (CNPE, in its Portuguese acronym) should deliberate on the definition of the strategic area. Petrobras' right of first refusal should be extinguished. Investments in mature fields and in sub-commercial accumulations should be encouraged. The environmental licensing process must be improved and accelerated. The regions in which activities would be banned and those that would remain open to exploration should be pre-established.

In ten years, Brazil may become one of the five largest oil producers, with impacts on tax revenue and job creation. In the same way that poverty hinders the preservation of the environment, the greatest enemy of energy transition is poverty. Thus, because there cannot

be a low-carbon energy matrix without investments and technology, rich societies are more likely to adopt clean energies. Brazil needs the resources generated by the extraction of hydrocarbons to improve the quality of life for millions of people, increase energy inclusion and further the reduction of carbon emissions. It cannot afford to lose this opportunity any longer. ■

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Décio Oddone

Mr. Décio Fabricio Oddone da Costa has a bachelor degree in electrical engineering from the Federal University of Rio Grande do Sul. He studied petroleum engineering at Petrobras, and attended the Advanced Management Program at Harvard Business School and the Advanced Management Program at Insead (Institut Européen d'Administration des Affaires). Among other recognitions, he was awarded the title of doctor honoris causa in Education by the Universidad de Aquino.

He was CEO of Petrobras Bolivia, Chairman and CEO of Petrobras Energia (NYSE: PZE, Merval: PESA), Vice President of Braskem, Director of Prumo Logística and General Director of the National Agency of Petroleum, Natural Gas and Biofuels (ANP). He was a member of the Board of Directors of the Institute of the Americas, in the USA, and chaired the Bolivian-Brazilian Chamber of Commerce and the Argentine Chamber of the Petroleum Industry.

He assumed the position of CEO of Enauta in September 2020.

06

The Downstream Market's Needed Transformation[1]

By **Pedro Wongtschowski**, Chairman of the Board of Directors of Ultrapar Participações S.A.

Everyone agrees that the energy transition is a priority agenda when countries, companies and society are seeking solutions to curb global warming. The downstream fuel chain in Brazil has great potential to lead the journey of transformation to a low-carbon economy in the most efficient way possible for our society. But for this to happen, it will be necessary to change crucial points in this long chain.

One of them, where there seems to be consensus, is the country's current tax and regulatory model for fuels, which inhibits investments, provides little incentive for innovation and leads to a volatile and inefficient pricing process. Facing this issue will bring greater competitiveness and new and necessary investments in production, not only of oil sub-products, but mainly of current and new biofuels, and in the logistics and distribution infrastructure.

There are many projected and planned investments. For economic agents to feel motivated and secure, these actions will need to be preceded by less political interference in pricing, a more transparent

1. The oil and fuel industry is structured around the world in two main chains: the "Upstream", covering exploration and exploitation of crude oil and gas, and the "Downstream", from refining to consumption, including logistics (also known as midstream), distribution and resale of fuels and lubricants.

and predictable regulatory evolution process, and decisive tax simplification, as well as effective combating of irregular trade.

The downstream investments that built Brazil's existing structure began with the founding of Petrobrás in the 1950s and gained momentum between the 1970s and 1990s with the construction and expansion of the big refineries under state monopoly and operation. This exclusivity only ended in 1997, with the Oil Bill (*Lei do Petróleo*), which simultaneously put an end to a side effect: an inefficient policy of fixed prices, which worked as a counterincentive to productivity improvements, passing on costs of operations and investments that were not optimized.

Also in the late 1990s, the Brazilian National Agency for Petroleum, Natural Gas and Biofuels (ANP) was created, marking the beginning of a path of evolution, but one in which there is still a long way to go, with the substitution of specific, governmental policies for structural, state policies. It was the initial milestone for greater legal security for productive investment, a topic that continues on the agenda of any serious discussion about promoting investment.

Now, after nearly half a century of an effective monopoly, first de jure and more recently *de facto*, the downstream segment glimpses a historic opportunity. It is as a renewed starting point that the private sector sees in the Petrobras divestment program, which brings new players to industrial stages where there was still no competition and new investments, inducing gains in productivity and competitiveness, with potential for prices to drop.

In this scenario of complexity and plurality, the IBP - Brazilian Petroleum and Gas Institute, a reference in the sector, created in 2020 the Brazilian Downstream Association (ABD, in its Portuguese acronym), in order to build a systemic view of the industry, with the purpose of "contributing to the opening, transformation, and ongoing evolution of the downstream sector of the Brazilian Oil and Gas Industry to bring energy and value to society, based on a modern, competitive, fair, and sustainable business environment".

The robustness of the system is undeniable. The integrated industry chain - from oil extraction to the production of sub-products and biofuels, distribution and resale of goods - accounts for 9% of Brazil's industrial Gross Domestic Product (GDP). Brazil is also the 10th largest oil producer in the world and the second largest in biofuels, behind the United States, according to data from the Brazilian Petroleum and Gas Institute (IBP).

This industry is also responsible for 47% of the primary energy supply

in the country, as a result of the activity of more than 19 refineries, 408 biofuel plants and industries, 160 distributors, 420 retail resellers, and more than 42,000 gas stations, which in addition to giving capillarity to the fuel supply, employ thousands of people; And which, just in the decade ending in 2020, paid R$1.8 trillion in taxes, royalties, bonuses, and other similar charges.

So many resources have grown in the midst of a complex and distorted tax system, which has not been able to prevent evasion and fraud by a malicious minority, which competes unfairly and drives away relevant investments. According to figures from the Getúlio Vargas Foundation (FGV), the fuel market has annual losses of about R$ 40 billion from operational and tax fraud.

It is not so much the weight of the tax burden, which is high but not so different from that of many comparable countries, but the complexity and shape of its anachronistic and inflationary model that has brought to light the urgent need for tax simplification, and is driving some actions in this direction.

We are talking about initiatives such as Bill 284/17, which addresses the characterization of the defaulting debtor, currently being debated in the Federal Senate and, especially, the recent Complementary Law 192/2020, which brings significant progress in the simplification of the fuel tax model. These are critical agendas that aim to simplify, provide transparency, reduce costs of verification, collection and inspection while mitigating the gaps for fraud and evasion in the country, allowing stabilization and perhaps even the reduction of the tax burden and prices, without loss of revenue.

The path to simplify the taxation of the sector is that of a single-phase tax levied on the first link in the chain, i.e. the producer or importer, as is already the case in most developed countries. Evolve to fixed rates (ad-rem), which reduce price volatility and do not generate inflationary residues in high cycles, like the percentage rates (ad-valorem). Finally, the unification of the rates for each fuel throughout the country brings a leap in logistical efficiency while ending tax wars and competitive distortions that drive away structural investments.

This recent and fundamental regulation imposing single-phase taxation, with single and *ad-rem* rates is, without a doubt, the intelligent way out. It is now up to the Governors and Confaz (Brazilian tax policy body) to implement the new legislation with agility and completeness, and to the economic and political agents to continue to pursue similar simplification for Hydrous Ethanol, excluded from regulation at this

stage, recognizing the importance of this production chain for the economy and its impact on the country's energy transition.

These are measures that bring enormous benefits to the country, due to their potential for efficiency and predictability, reduction of competitive distortions, greater dynamics and freedom among agents, enabling sales from producers to consumers through different channels and, in particular, the potential to attract investments in high-volume logistics modals. And with this, and not with artificial schemes in fuel pricing, we will achieve a structural reduction of prices in the country, boosting economic growth.

In the administrative realm, regardless of the complex political agenda, the great opportunity for the sector to advance is in the regulation of the Regulatory Impact Assessment (RIA), via Decree No. 10.411, June 30, 2020. This is important because the regulator has a fundamental role in the transparency and predictability of regulatory evolution, and the ANP (Brazilian National Agency for Petroleum, Natural Gas and Biofuels) has the tools to ensure this.

Political will is needed to keep this agenda moving forward. There are many bills coming from the Legislative branch, as well as provisional measures and decrees from the Executive, that propose specific approaches, without tackling the core of the problem in a systemic way, a practice that creates insecurity and drives away potential investors, weakening the regulatory process.

There are still many serious bottlenecks, which will only be solved in a way that allows the country's sustainable growth if investments are made. IBP's survey[2] points to a gross need for more than R$ 85 billion in investments in infrastructure over the next 10 years, to eliminate supply risks and solve operational bottlenecks.

It is urgent to ensure the regulatory and tax conditions for investments to take place. As one of the world leaders in biofuel production, and with a growing logistical network to allow its transportation and distribution throughout its territory, Brazil has the conditions to lead an orderly and efficient energy transition, without severing production chains, driving away investments, affecting supply and, at the limit, harming economic development.

For this window of opportunity not to be missed, it is necessary to avoid the temptation of excessive protection, focusing on stimuli for investments in infrastructure and new technologies for the development

2. Study conducted by IBP with support from consultants Leggio and BCG.

and production of new paths for sustainable fuels. It is also necessary that the tax adjustment, already advocated here, encompasses equal treatment among renewable alternatives: second-generation ethanol, green diesel, HVO, corn ethanol, Biodiesel, BioQAV, among others.

There is no reason to delay the opening of the biofuel market to free importation, currently allowed only to producers, nor to continue restricting the freedom of contracting among economic agents, a serious side effect of the biodiesel commercialization model through auctions, as was in effect in the country until 2021. The increase in supply and the reduction in costs of renewable fuels, which will have an increasing participation in our energy matrix, is a way to structurally reduce prices across the country.

In 2020 and 2021 we saw historic records being beaten in biodiesel production, as well as a significant increase in the share of corn ethanol, a real leap over 2019. We also saw the very important beginning of the commercialization of decarbonization credits in the organized market, the CBios of the RenovaBio program. These are important milestones of the biofuels sector's potential contribution to the country's development in parallel with the achievement of the UN Sustainable Development Goals (SDGs) projected for 2030.

The IBP is also committed, under this environmental agenda, to work proactively for the energy transition and this includes electrification, especially of the transport sector, both light and heavy vehicles. The hybrid solution is perhaps the most immediately appropriate and possible in Brazil, with electric engines and engines running on biofuels at the same time in different compositions. Anfavea, the Brazilian National Association of Automotive Vehicles Manufacturers, estimates that in 2035 Brazil will have the same level of electrification as the European market in 2030. The EPE - Energy Research Office, also predicts that the electrification will gain body in the coming years, helping in this sustainable transition.

Brazil has one of the cleanest transportation energy matrixes in the world and is a powerhouse in biofuels. These predicates must be taken advantage of by society in order to lead its transition to a low-carbon economy in the most efficient way.

Once again: all this is possible with a combination of new supply sources, decisive tax simplification, regulatory maturation, combating irregular trade and opening the biofuels market. In this way, the transformation of the downstream market can and must be the fuel that will drive the country's resumption of economic growth. ■

ABOUT THE AUTHOR

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Born in São Paulo, Pedro Wongtschowski, is a chemical engineer, with a M.Sc. and PhD in engineering from the Polytechnic School of the University of São Paulo. He has worked as Project Coordinator for PROMON Engenharia (1972-1977) and ULTRA, as Project Coordinator, Development Director and President of Oxiteno S.A. (1992-2006). Between January 2007 and December 2012, he was President of ULTRAPAR Participações S.A.

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07

Natural gas expansion in South America – Challenges and opportunities in the energy transition

By **Marisa Basualdo**, Manager of Legal Affairs and Compliance at TotalEnergies Gas Cono Sur S.A.

I. Introduction[1]

In the transition from a fossil energy matrix towards a more sustainable paradigm, natural gas plays a key role to ease the way for public and private players in the energy chain to address the environmental hurdles without resigning the need to achieve security of supply.

The dilemma is not a simple one, despite the commitments taken by relevant stakeholders for the decarbonization of the atmosphere as evidenced by the outcome of COP 26[2], collision of interests and contradiction may arise in this new landscape, as we have recently seen

1. The chapter presents the views of the author and does not represent the opinion of the companies or the group where the author works or acts as board member or legal representative. The objective of the chapter is purely academic. It is not intended for commercial purposes nor to provide any advice or recommendation.

2. United Nations Climate Change Conference held in Glasgow, Scotland between October 31 and November 12, 2021

in Europe, where restrictions to finance projects exceeding certain carbon emissions coexisted with the need to restart certain power plants fired by fossil liquids during the abrupt increase of the liquified natural gas (LNG) prices.

On the way to a more sustainable pattern, the growth of natural gas in the global energy matrix, far from being a problem, appears as a solution. Indeed, as the cleanest fossil supply source, the widely spread use of natural gas may replace more contaminant fuels, as it was the case in USA with the massive development of non-conventional natural gas, as well as provide hybrid alternatives combined with renewable investments to make the intermittent provision of the latter more reliable and efficient.

In the current energy transition scenario of geopolitical volatility, where unpredictable offer and demand shifts may appear, as occurred during the pandemic Covid-19 with the oil demand collapse first and the spike of the LNG prices later, aggravated by the condemned Russian military aggression against Ukraine, the sound planning of new natural gas projects in the region becomes essential to allow the progressive growth of affordable renewable schemes.

In this context, South America, privileged compared to other regions for its diverse and abundant renewable resources and natural gas reserves, but still with a strong deficit in infrastructure and unequal access to basic public utilities, will certainly encounter challenges to accompany the path toward the energy change, but at the same time may find exceptional chances to boost its economy through the expansion of its natural gas trade and renewable investment.

II. Main Challenges for the Development of Natural Gas Projects in South America[3]

Natural gas projects are exposed to many challenges mainly because of the intensive nature of the investment, especially when they involve different jurisdictions and above all, if they are located in vulnerable political and economic environments, such as South America.

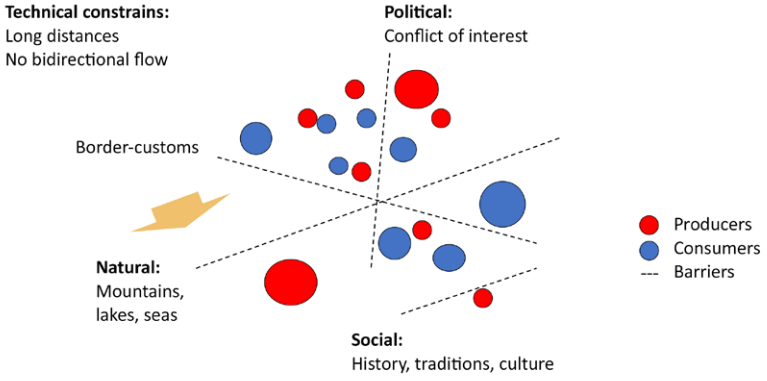
One of the main factors conditioning large investments in natural gas developments and relating infrastructure is the lack of predictable rules.

3. Marisa C. Basualdo, "Transboundary Energy and Infrastructure Projects—Alternatives for Gas Market Interconnection and Integration in South America," *65 Rocky Mt. Min. L. Inst.* 7A-1 (2019).

Typically, the main proponents of the construction of interjurisdictional gas network facilities are (1) the gas producers with an interest in reaching the demand, and (2) the consumers in need of supply[4]. In addition, the transportation companies as key drivers for the flexibilization of the gas trade.

Beyond the relationship between transporters, shippers, and consumers, other actors such as marketers, governments, financial institutions,[5] and local communities are also important players in the development of transnational projects. The involvement of multiple stakeholders and competing interests in the gas chain introduces various obstacles that must be navigated to obtain approval and operation of cross-border infrastructure projects[6].

Figure 1: **Market integration barriers**



Source: author's elaboration.

As shown in Figure 1, numerous factors may condition and alter the integration of adjoining gas markets. It is possible to mention certain relevant features that have conditioned the evolution of international gas projects in the region. Among them, geographical constraints, such as the long distances between the supply and the demand as it is the case between the Argentinian Austral basin and the concentrated demand in metropolitan area of Buenos Aires in Argentina, bringing complexities to balance the transportation capacity cost and the

4. Martha M. Roggenkamp et al., "The Role of Networks in Changing Energy Markets and the Need for Innovative Solutions," in *Energy Networks and the Law: Innovative Solutions in Changing Markets* 417–18 (Martha M. Roggenkamp et al. eds., 2012).

5. Roggenkamp et al., supra note 1, at 418.

6. Stevens, *supra* note 2, at 20.

molecule pricing. Also, technological barriers, such as the loss treatment and harmonizing design parameters at interconnecting points in long systems; for example, the technical challenges of operating a long high-pressure system such as the Transportadora Brasileira Gasoduto Bolivia-Brasil (TBG) pipeline[7]. Or the design constraints that the GasAndes pipeline crossing the Andes Mountains from Argentina to Chile had to achieve to be ready to stand earthquakes up to eight points on the Richter scale.

However, on top of the above-mentioned factors, the underlying legal and regulatory structure is key to triggering the decision to invest in the infrastructure necessary for connecting the gas supply and demand across regions and to overcome the above-mentioned boundaries. Depending on the strength and predictability of the regulations at stake, the applicable framework may either serve to resolve conflicts or act as a barrier to investment and create further constraints.

As transnational gas projects involve different jurisdictions, one of the most important challenges to address from a legal perspective is the existence of multiple legal standards for an interconnected development.

The more deeply rooted these barriers are, the more difficult it is to navigate the legal framework for a sustainable integrated gas market. Clearly, the mere physical interconnection of gas pipeline systems between two or more countries does not automatically lead to the integration of the respective energy markets, if other ancillary factors affecting the supply and demand on each side of the border are not adequately synchronized by regulation.[8] Integrated gas markets offer a number of upsides for all market participants. Producers benefit from selling to a broader group of customers and spreading demand risks across different countries, while consumers also gain from a stable and secure supply by interconnected networks.

Moreover, an integrated gas region permits greater efficiency in infrastructure operation and larger economies of scale shared by the market participants: "as capacity increases, average fixed costs fall rapidly."[9] In the end, opening the markets helps not only to reduce disparity in the access to the infrastructure already in place, but also to moderate the costs of expansions and new investments.

7. TBG, "Technical Information," http://www.tbg.com.br/en_us/the-gas-pipeline/technical-informations.htm.

8. Ariel A. Casarin & Luciana A. Nicollier, "Gas Market Integration in the Southern Cone: An IGU Study," at 11 (June 2009).

9. Stevens, *supra* note 2, at 15.

Figure 2: **Full market integration**

Source: author's elaboration.

In summary, the main risk from a regulatory angle is the change of the rules in the middle of the game, which inevitably alters the allocation of risks conceived at the origin of the project. The direct consequence of this interference is mistrust in the underlying legal system, which can be very costly for the development of an interconnected project[10].

III. New Perspectives in Transboundary Gas Projects in South America

The potential of *Vaca Muerta* in Argentina, the second largest non-conventional gas reserve in the world,[11] besides the important *pré-sal* reserves in Brazil and the supply from Bolivia on one hand, together with the growing level of gas consumption in the region; and the existence of interconnected infrastructure along with LNG regasification terminals placed on the Atlantic and Pacific shores, on the other hand, besides the elevated LNG prices, create an optimal environment to rethink new legal forms for energy integration in the Southern Cone.

Consequently, the transition from specific interconnected operations that could be based on bilateral agreements between two states toward an integrated region of multiple states requires the jurisdictions involved to reach common understanding on certain basic premises that may prevail the individual crisis of each of the parties and could be achieved by deepening the roots of innovative approaches to access to the existing cross-border infrastructure. With the purpose of securing supply, the resulting consensus should be based on reciprocal treatment and mutual benefit of the stakeholders.[12]

10. Beato & Benavides, *supra* note 3, at 275

11. *Id.*

12. José Juan González, "Law and Regulation Governing Electricity Networks in Mexico in the Context of Regional Integration with North and Central America," in *Energy Networks and the Law: Innovative Solutions in Changing Markets* 42 (Martha M. Roggenkamp et al. eds., 2012).

One way to open new regional gas markets is to provide incentives to new forms of transportation capacity allocation such as the entry-exit system inaugurated in South America by TBG open season in 2019; the creation of virtual trading points and hubs to provide flexibility to transactions, the possibility to reverse the flow of pipelines on a seasonal basis as occurred between Argentina and Chile and any other innovative strategies for accessing gas facilities to attain market liquidity and flexibility already put in place in more mature schemes, such as the European integrated market. Likewise, the possibility that the gas may flow in transit as occurred with the import of gas in transit into the Argentinian LNG terminal to be then exported into Brazil to generate electricity during the dry summers in 2016 and 2017. Similarly, that players may agree on time or commercial swaps to cope with infrastructure deficits finding creative tariffs and tax treatments that otherwise would impair those transactions.

All these alternatives require to be encompassed with innovative and sustainable regulatory schemes that favor gas developments through the optimization of existing infrastructure.

"The grid has to become smart and this requires smart legal solutions."[13].

IV. Conclusion

At first glance, it might be preliminarily concluded that public policies for the de-carbonization of the atmosphere may not be a priority in the agenda of the South American countries in a context of more urgent needs of the population. However, the advantage of focusing on this topic is quite clear. Indeed, proper planning of natural gas developments in the long run may provide universal access to reliable and affordable energy resulting in turn in visible improvements in the living conditions of the region.

In addition, faced to abrupt changes in the LNG pricing and fostered by the energy transition paradigm, new forms of accessing natural gas facilities might trigger natural gas investments at an interregional level that hardly would have been admissible from a business perspective in different circumstances. However, to reach the goal of an integrated gas market, it is essential to consolidate the regulation into a robust regulatory framework to be aligned at least in concept by the South American countries and to reach the necessary consensus by the different stakeholders in the gas chain, in order to grasp the opportunity

13. Roggenkamp et al., *supra* note 1, at 434.

to develop gas fields combined with more technologically advanced sustainable sources of supply such as hydrogen while they are still in a developmental phase.

All in all, in a context of the global commitments for the reduction of carbon emissions and volatile energy pricing, South American countries should steadily cooperate to enhance the tools for a solid integrated gas market and align in policies not to miss the trend for the use of cleaner sources of energy. Otherwise, each country would continue implementing domestic measures to cope with its own needs, that eventually may result in short-term or limited solutions.

With plenty of natural gas resources, South America has the opportunity to deploy its vast potential for developing an integrated gas market in order to mitigate its long lasting social and economic hurdles and at the same time become an alternative source of clean energy to the rest of the globe. ■

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08

Brazilian sugar-energy industry and the low carbon economy

By **Evandro Gussi**, President of UNICA, and **Luciano Rodrigues**,
Director of Economy and Strategic Intelligence at UNICA

The ability to adapt - especially to institutional and technological changes – has determined the success or failure of companies and nations throughout history. Successful leaders anticipate trends, mobilize resources, and must make bold decisions to ensure an organization's long-term viability and success. History has countless examples of entire sectors and companies that have either grown exponentially or ceased to exist based on the ability to adapt.

In the energy sector, we know that an unprecedented change will lead to a low-carbon energy future. Environmental protection and climate change mitigation are at the center of public debate and reflect society's aspiration, thus driving business actions in a myriad of areas.

The Brazilian sugar-energy industry has understood this trend and its urgency. It foresaw that the Brazilian Biofuels Policy (RenovaBio) was an opportunity of a structural change: being more than a sustainable business, the industry recognized "sustainability" as a new business. It is consensus that there will not be a single solution for tackling global warming issues and that bioenergy could be presented as one of the most efficient and already available options for the task.

The sugar-energy industry has undergone profound changes in recent decades and represents the foundational source of Brazil's renewable energy. Sugarcane products accounted for about 20% of all primary energy supplied domestically[1]. In the transportation sector, sugar and corn ethanol was responsible for almost 50% of all fuels consumed by the light vehicle fleet[2].

We reached this pinnacle without negatively impacting food production or harming Brazilian natural resources. Currently, sugarcane crops occupy nearly 10 million hectares, or 1.2% of the nation's territory. If we consider the area used exclusively for ethanol production, this figure is only 0.8% of Brazilian territory, with 5.7 million hectares of sugarcane and 1.2 million hectares of corn destined for biofuel production.

Furthermore, RenovaBio established a "cut off line" that excludes any property where native vegetation was converted to produce biomass for energy after the established deadline. The Program goes "above and beyond" what is outlined in current environmental federal regulations, creating traceability requirements and a zero-deforestation reality with respect to biofuels.

RenovaBio also introduced other important incentives for biofuel sector to improve energy and environmental efficiency. The Program put in place a decennial decarbonization target for the transportation sector, with annual limits on the carbon intensity (CI) of the Brazilian fuel mix. This approach offers greater predictability to agents and investors associated with this industry.

The second innovation of RenovaBio refers to the mechanism for evaluating the avoided carbon emissions when fossil energy is replaced by renewable biofuels. This valuation is given by the permission to issue the Decarbonization Credits (CBios) in proportion to the commercialized volume of biofuels and to the certified production score. On the other hand, fuel distributors must acquire CBIOs to offset the emissions of its fossil fuel market in the previous year.

This framework corrects an important market flaw that characterizes the world of renewable energy: the presence of externalities that result in a sub-optimal level of production and consumption of renewable sources and overinvestment in fossil fuels. In essence, what was a positive

1. BRAZILIAN ENERGY RESEARCH OFFICE (EPE National Energy Balance, 2021. Available at. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-601/topico-596/BEN2021.pdf

2. BRAZILIAN NATIONAL AGENCY FOR PETROLEUM, NATURAL GAS AND BIOFUELS (ANP). Sales of oil by-products and biofuels. Available at: https://www.gov.br/anp/pt-br/centrais-de-conteudo/dados-estatisticos

externality becomes an economic return to the biofuel producer. Conversely, negative externality becomes an additional private cost to fossil fuels. It is up to the consumer to make their choice based on the relative and now corrected prices of each energy source.

This dynamic also allowed the creation of the first regulated market for decarbonization credits in Brazil and offered the bioenergy industry the possibility of selling decarbonization services through the emission of CBIOs. In 2021, the commercialization of CBIOs has generated more than 1 billion reais (USD 200 million) purchased by distributors in order to comply with their individual targets and also by third parties as a voluntary market to offset greenhouse gas emissions (GHG).

The third and final RenovaBio development refers to the link between the energy-environmental efficiency of production and the number of CBios that can be generated by the biofuel producer. By quantifying emissions according to the characteristics of each producer, the Program recognizes the different stages of the production process, allowing more efficient producers (those with better capacity to generate clean energy with lower GHG emissions) to generate a greater volume of CBIOs.

This system rewards efficiency gains in production by inducing investments in new practices and products that reduce GHG emissions. These gains, in turn, may be transferred to the final consumer through competition between different fuels, both fossil and renewable. Since the beginning of the Program, roughly 60 ethanol producing units (out of a total 361 units) voluntarily have recertified their production process increasing, on average, their RenovaBio score by 25%[3].

The positioning of bioenergy as a decarbonization tool in the country should also be reinforced in the coming years in view of the new perspectives for the agricultural and industrial areas, as well as innovations in the use of the energy sources offered by the sector.

Big data and other decision-making support tools are bringing about major revolutions in crop monitoring and management. These technological advancements build upon the use of more productive and resistant varieties of sugarcane, developed from modern techniques associated with biotechnology and genetic engineering.

In the industrial area, the importance of generating bioelectricity from sugarcane bagasse and straw should be highlighted, as well as the

3. BRAZILIAN NATIONAL AGENCY FOR PETROLEUM, NATURAL GAS AND BIOFUELS (ANP). Dynamic panel of RenovaBio certifications. Available at: https://www.gov.br/anp/pt-br/producao-de-biocombustiveis/renovabio/painel-dinamico-de-certificacoes-de-biocombustiveis-renovabio

advance announced for the expansion of second-generation ethanol production. The circular economy and the use of the sector's by-products also stand out in the consolidation of biogas and biomethane manufactured from sugarcane vinasse and filter cake.

These advances in production technology, associated with innovations in the automotive sector, should promote new paths to sustainable mobility with the use of ethanol in the country.

It is worth noting that the flex-fuel fleet using hydrous ethanol is already comparable to the World Class technologies in terms of GHG emissions considering life cycle analysis. Since 2003, when flex-fuel vehicles were launched in Brazil, the use of ethanol fuel has prevented the release of nearly 600 million tons of CO2eq. in the atmosphere, or the equivalent of all the annual emissions of countries like France and Poland combined.

Brazil's policy approach is being emulated by other major countries. In India, Prime Minister Narendra Modi has announced the goal of blending 20% ethanol into gasoline by 2025, five years earlier than initially planned. The country also recently announced that it would promote flex-fuel vehicles, the way it has been done in Brazil.

Low-carbon mobility will be achieved through multiple approaches and electrification with ethanol will occur in the form of flexible-fuel electric hybrids, but also through fuel cell technology that will allow onboard electric power generation - or through the production of green hydrogen. These are options adapted to the characteristics of the Brazilian economy, promoting low GHG emissions with accessibility and generating jobs and income.

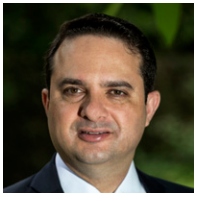
We have many opportunities to strengthen the position of the country and the sugar-energy industry in the face of the new challenges of a low-carbon economy, with optimized production systems, cleaner technologies, by-products, better use of natural resources, opportunities for innovation, and stimulus for new processes, products, and business models.

The improvement of RenovaBio, its integration with other domestic policies through the Fuel of the Future Program, the consolidation of CBios as an emissions offsetting mechanism, and the expansion of communication actions are some of the paths that need to be explored.

Brazil has proven results and is well-positioned to help lead the world to a low carbon energy future. In the sugar-energy sector, the next few years will be of hard work to take advantage of the opportunities

outlined in this new world. This is an important challenge for an industry that has shown capacity to reinvent itself and has advanced far beyond the traditional role of agriculture as a food provider. ■

ABOUT THE AUTHORS



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09

Energy transition and the perspectives for green hydrogen in Brazil

By **Bruna de Barros Correia**, Lawyer in the department of Infrastructure, Regulation and Governmental Affairs and Energy at BMA Advogados, and **Carlos Frederico Lucchetti Bingemer,** Partner of the Corporate and Energy practice area of BMA Advogados law firm

The energy transition reflects a paradigm shift in the energy system, bringing about structural changes to the world energy matrix from transformations in primary energy sources and in the technologies used in the industry.

Whether this opportunity is seized depends on a number of factors, and how well the risks are allocated. In any case, the lessons of the past and present teach us that new technologies need time to mature, and insisting on promising sources is usually worthwhile.

As is well known, the Industrial Revolution, in the 18th century, marked the first great energy transition. The development of the steam engine initiated a phase of demand for natural resources never before seen in history, and fostered the sophistication of science and technology developed up to that time. At that time, coal became the most used and essential source of energy to supply the countries' industrialization process.

The post-World War II period, marked by the economic and development dispute that characterized the Cold War, also reflects a moment of energy transition, in which oil took the place of coal and became the most used energy source, essential to consolidate a development model directly linked to economic growth.

These two historical milestones lead to the perception that energy, as well as the concept of energy transition, is characterized as one of the pillars for the economic and strategic development of countries.

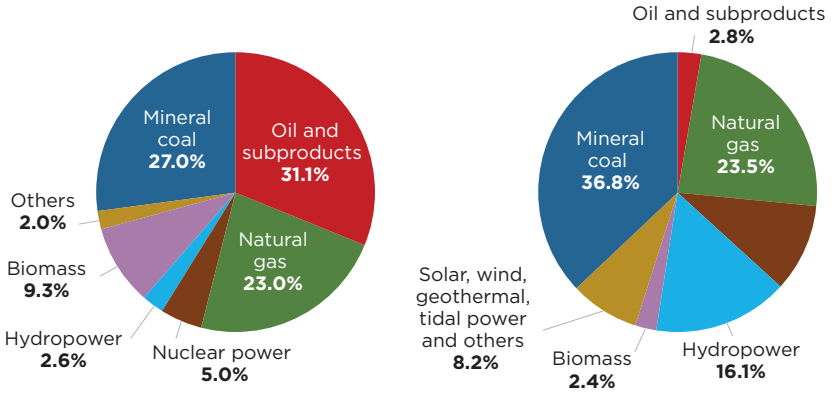
As discussed in the Brazilian National Energy Plan 2050 (PNE 2050), energy transitions are complex processes, so it is common to have variations in stages and paces of transformation among different countries, regions and localities. In other words, the paradigm shift in the energy system does not occur through a linear and disruptive process. Rather, it is based on a long coexistence between the sources and technologies that characterize the transition and those that are progressively replaced.

The energy transition that is currently on the agenda brings a perception that transcends economic development and also reflects a concern for sustainable development, global warming, and climate change.

The burning of fossil fuels is characterized as one of the main anthropogenic activities responsible for greenhouse gas emissions. The concentration of these gases in the atmosphere has resulted in the gradual increase of the Earth's average temperature (global warming), which, in turn, leads to environmental impacts (deleterious, irremediable, cross-border, and intergenerational), consolidated by climate change. This context accentuates the urgency of the energy transition, since it requires an even more intense change in the world energy matrix: the replacement of fossil fuels for renewable energy sources.

The challenge is set, since conventional energy sources represent 86% of the world's energy matrix. In relation to the electric matrix, fossil sources account for 73%.

Figure 1. **World Energy Matrix and World Electricity Matrix**



Source: World Energy and Electricity Matrix, Brazilian National Energy Balance (BEN) 2021, Energy Research Office (EPE).

The urgency surrounding global warming, with impacts that are already being felt around the world, brings the need for an unprecedented speedy energy transition. This transition requires sectorial innovation, where new technologies must be developed and disseminated at commercially competitive prices.

The consolidation of international norms, through the Climate Regime, has been essential to foster this transition, but unfortunately it is not enough. There are significant hurdles that require the institutionalization of the concept of sustainability, in addition to the internalization of the commitments made in multilateral negotiations. This will only be possible through sectorial innovation, with the insertion of new technologies. This requires the joint action of several sectors (such as: governments, international organizations, stakeholders, financial institutions, social and environmental movements, NGOs, academia and civil society), at different levels (international, national, regional and local).

The COP-26, which took place in Glasgow, Scotland, from October 31st to November 12th, 2021, resulted in the signing of the Glasgow Climate Pact. This document recognized that global warming has already reached 1.1°C compared to pre-industrial levels and thus reaffirmed the need for a rapid reduction in greenhouse gas emissions in order to limit warming to 1.5°C.

In this sense, the goal of the Glasgow Climate Pact is to reduce carbon dioxide emissions by 45% by 2030 (compared to 2010 levels) and

neutralize them by 2050. To this end, the document listed the energy transition as an essential action to combat greenhouse gas emissions.

Aside from the issues associated with climate change, another aspect that is already bringing new perceptions to the sector, as well as prompting the urgency of the energy transition, is the war taking place in Ukraine. Russia is the world's largest exporter of natural gas and the second largest oil exporter. The strong energy dependence of the European continent on Russia has become evident. The European Union's strategy has been based on the search for greater energy independence, which requires energy efficiency actions and the diversification of the energy matrix, with the increasing insertion of renewable sources and new technologies. This means that investments in new technologies should be intensified in the short term, which tends to accelerate the changes in the composition of the world energy matrix.

When contextualizing the international trends that characterize the energy transition with the Brazilian scenario, it is clear that Brazil has the possibility of assuming a leadership role in this process, given the country's territorial extension, the abundance of natural resources, the presence of a consolidated regulatory environment, and the existence of a mostly renewable electricity matrix.

Regarding the last aspect, it is worth noting that electric energy has gained even more importance in the energy transition process, as the energy matrix electrifies and sectors historically based on fossil fuels, such as transportation, tend to migrate to electric energy.

Once again, Brazil stands out, considering that, according to data presented by the National Energy Balance (BEN, 2021), 83% of the Brazilian electricity matrix is represented by renewable energy sources.

Historically, the Brazilian electricity matrix has had a predominance of hydroelectric sources combined with thermoelectric dispatch. However, some transformations have been occurring over the last decade. In 2011, hydroelectric power plants accounted for 82% of the Brazilian electricity matrix (BEN, 2011). Currently this number reaches 65%. These nearly 20% difference in the representativeness of the hydroelectric source has been suppressed by an exponential growth of wind power plants (whose share went from 0.5% to 9% in ten years) and by the growth, albeit more timid, of natural gas, solar energy and biomass (BEN, 2021).

Such changes in the Brazilian electricity matrix in the last decade indicate that Brazil has already started the process of diversifying the matrix, keeping it mostly renewable, thus contributing to the transition in the light of a low carbon economy. The expectation is that the share

of intermittent sources (wind and solar) will increase in the Brazilian electricity matrix, especially due to the reduction of costs for the installation of photovoltaic panels, the expected deployment of offshore wind power plants, and the regulation of hybrid and associated power plants.

A point of attention, however, is that the strong insertion of renewable sources considerably reduces the level of control over the supply of electricity. Because they are intermittent sources, generation depends on the availability of natural resources, such as sunshine and wind, due to the impossibility of storing the renewable energy resource in its original form. In this scenario, the system operator must respond to changes in the consumption profile and also to changes in the generation profile of intermittent sources.

It is precisely in this context that the flexibility offered by green hydrogen technology stands out and becomes very promising towards energy transition.

The PNE 2050 (Brazilian National Energy Plan) listed hydrogen as a disruptive technology, since it presents itself as an element of interest in the context of decarbonization of the energy matrix. The document also highlights the need to consolidate an appropriate legal and regulatory framework to encourage the deployment of technologies applicable to the entire hydrogen energy chain (production, transport, storage and consumption), and the need for Brazil to maintain an articulated and coordinated interaction with international institutions such as the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA).

It should be noted that there are different technological routes to produce hydrogen. The great expectation is based on the expansion of green hydrogen production through water electrolysis. For this process to be fully sustainable, energy must be generated from renewable sources. Through this technological route, excess electricity from renewable sources is transformed into green hydrogen: renewable, storable, and transportable energy.

The possibility of producing hydrogen from various inputs places it as an element of integration between various technologies (YOU et. al., 2020). This characteristic fits the perspective on the expansion of wind and solar power plants in Brazil, given the abundance of primary inputs in the country. The fact that it is a renewable, storable and transportable energy, places green hydrogen as a promising technology to diversify and renew the energy matrix of other countries. This context gives rise

to the possibility of consolidating an international market for hydrogen, with Brazil expected to be one of the main exporters.

The obstacles to be overcome are, however, significant and fall mainly on the economic and commercial viability of the technology, in addition to the risks associated with transport, due to the low volumetric energy density of hydrogen and its flammability.

The Brazilian National Hydrogen Program (PNH2), published in July 2021, states that hydrogen technology has become a priority in the energy and climate strategy of several countries, especially for providing an alternative for sectors with difficult greenhouse gas emission abatements, besides favoring the coupling of the energy sector with the industry and transportation sectors.

The document also highlights that without the technical and economic feasibility of zero or low carbon hydrogen, it will be very difficult for developed countries to achieve the national commitments and ambitions of the Paris Agreement and net carbon neutrality in 2050. On the other hand, the development of the hydrogen economy can bring benefits to countries in the areas of energy security and technological innovation. Since 2019, there has been an international movement around hydrogen as a decarbonization solution in important electricity production markets such as the European Union (especially Germany), Japan, South Korea, and the United States.

These countries have been working to consolidate public policies and build a hydrogen infrastructure. These countries' experience in promoting this technology can contribute to the challenges faced in Brazil, especially regarding the cost of producing hydrogen.

To conclude, it is worth reiterating that the war in Ukraine has highlighted Europe's strong energy dependence on Russia and should intensify investments in the development of technology for the production of green hydrogen in Brazil in order to accelerate the energy transition on the European continent, thus increasing the expectation for the consolidation of an international market for this technology. The objective is, therefore, to follow the developments in the international and national context and to monitor the construction of the legal-regulatory framework necessary to bring security to the investments that should be made in Brazil. ■

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SECTION III

OPPORTUNITIES

Energy
in a world
in transition

10

ESG in the Corporate World

By **Carlos Frederico Lucchetti Bingemer**, Partner of the Corporate and Energy practice area of BMA Advogados law firm, and **Júlia Calgaro Moreira**, Corporate and Energy Lawyer at BMA Advogados law firm

In recent years, the ESG (Environmental, Social and Governance) agenda has gained increasing importance in determining the business models, products, and services of national and international organizations.

Objectively speaking, ESG can be defined as a set of corporate market management initiatives and practices that describe the quality of the environmental, social, and governance performance of organizations. As such, ESG works as a metric to identify whether an organization's business is sustainable, socially responsible, and well managed.

A company that complies with ESG is, therefore, concerned with the positive impact on the environment, with being socially engaged - for example, with diversity policies in the workplace or even adopting a compliance program, in order to guide its employees and partners - and with taking care of its governance, investing essentially in actions that convey integrity, transparency, and compliance.

The ESG movement is gaining more visibility, largely as a result of investors. This is because the social, environmental and governance practices adopted by organizations are increasingly being considered in analyses for future investment decisions. The more discussions about

ESG practices advance, the more the new investor tends to look for companies that can adhere to such practices and are transparent in disclosing the measures adopted.

The logic behind this investor preference for ESG companies is directly related to the lower possibility of a sustainable, socially responsible, and transparent company being susceptible to environmental damage, labor conflicts, or even involvement with corruption, which is interesting to the investor because, in the final analysis, it generates the possibility of investments with reduced risks, reduced capital costs, among others.

Along these lines, financial institutions have not been left out and are starting to fit into this new reality, requiring ESG practices as criteria for granting financing and access to capital. There are several reports of large banks that have become involved with the ESG agenda.

In 2021, the Inter-American Development Bank - IDB and IDB Invest launched the so-called "Green Bond Transparency Platform" (GBTP), aiming to facilitate the harmonization and standardization of reports and information on green bonds, to expand the market for these bonds, and help governments, financial institutions, and companies from the most diverse sectors to access financing that fits this new dynamic.

Also in 2021, as a way to encourage cleaner energy alternatives, the Brazilian National Development Bank ("BNDES") made two major announcements. First, that it would no longer finance energy sources that depend on coal; and second, that it would launch its new credit line linked to sustainability, with support for transactions of up to R$150 million per economic group, through the "BNDES Crédito ASG" program, whose target would be organizations committed to goals for advancing their ESG performance and improving their sustainability indicators.

The Central Bank of Brazil ("BACEN"), among other measures, launched a sustainability agenda that gathers initiatives linked to socio-environmental responsibility, climate risks, and sustainability to develop the National Financial System (SFN, in its Portuguese acronym). As part of its sustainable agenda, BACEN signed a memorandum of understanding with the Climate Bonds Initiative ("CBI") - an international organization that encourages the stock market to seek solutions against climate change -, and became a member of the Network for Greening the Financial System (NGFS), a global network of central banks and authorities created to mitigate risks associated to climate change in the financial market.

Several discussions on ESG practices also take place in international

forums, as was the case of the 26th United Nations Climate Change Conference ("COP-26"), where major countries discussed less harmful actions to the environment and society. The topics discussed at COP-26 generate a great impact on the private sector as a whole and are of such importance that, at the end of the COP-26, their repercussions were reflected in the celebration of the agreement called "Glasgow Climate Pact", which emerges to define a global agenda on climate change for the next decade.

Another outcome of the COP-26 was the creation of the International Sustainability Standards Board (ISSB), a council responsible for developing a global baseline for corporate sustainability reporting, to be overseen by the IFRS Foundation - the international organization that dictates accounting standards for financial statement disclosures for companies around the world, including Brazil. The IFRS Foundation announced in February this year that the first drafts of new ESG accounting norms should be released in the coming months.

Equally relevant was the disclosure by the SEC - Securities Exchange Commission, in March of this year, of a normative project that will require publicly traded companies in the United States to disclose in their reference forms and periodic information, climate related issues that may affect their business. If approved, this rule will come into effect as of next year.

In Brazil, the subject is not entirely incipient. As Luiz Antônio de Sampaio Campos points out in his article "In the Corporations Law, Bulhões and Lamy foresaw the ESG", since the Proposed Bill 6,404/76 - the Corporations Law, publicly or closely-held companies - are in some way suited to deal with ESG issues, reflecting in its text terms such as "social interest", and compliance with "the requirements of the public good and the social function of the company", which unequivocally comprise the ESG agenda.

In other words, ESG has been a reality in the Brazilian corporate world for quite some time and was intensified recently by the global trend. As is well known, the Brazilian market has experienced a growth in the issuance of Green Bonds and Sustainable-Linked Bonds, which are debt securities tied, respectively, to projects that promote the progress of environmentally sustainable activities, and to the commitment to environmental and/or social goals within a certain timeframe. These bonds have proven to be an important tool to support organizations, public or private, that have committed to reducing Greenhouse Gas (GHG) emissions and improving ESG performance.

According to the latest CBI report "Latin America and the Caribbean Sustainable Finance Market Analysis 2021", regarding the issuance of debt securities labeled as Green, Social and Sustainability (GSS) - in which Green Bonds and Sustainable-Linked-Bonds are included - Brazil was considered the second largest market in Latin America, with issuances of about 11.7 billion dollars, second only to Chile, with 17.8 billion dollars. Also according to the report, Brazil was the largest Green Bond market in Latin America, with 44 Green Bond issuances, corresponding to an issuance of about $10.3 billion between 2015 and 2021.

In Brazil, the Securities and Exchange Commission of Brazil ("CVM") is also following the new ESG trends, having published in 2021 a new instruction (CVM 480) on what information needs to be included in the reference form of publicly traded companies, requiring more detail on ESG practices adopted by companies in order to ensure greater transparency to the investing public.

In the scope of the Legislative branch, the House of Representatives is analyzing Proposed Bill PL 528/2021, which aims to regulate the Brazilian Market for Emission Reduction (Mercado Brasileiro de Redução de Emissões - MBRE,), for the purchase and sale of carbon credits in Brazil, defined in Article 2, I of the bill's text as a "right over assets that are intangible, incorporeal, transactional, fungible and that represent the reduction or removal of one ton of carbon equivalent". Another highlight of the bill is Article 8, which proposes to exempt privately owned companies and businesses from paying federal taxes (PIS, COFINS and CSLL) on transactions in the voluntary market for carbon credits.

In short, it is possible to note that several initiatives have been taken in Brazil and abroad to encourage the adoption of ESG practices by companies. This trend, however, generates debate, due to energy security and the recent events brought about by the war in Ukraine.

From the Brazilian perspective, even if the appeal and abundance of renewable energy projects are present, seducing investors, financiers and stakeholders focused on the ESG agenda, it is impossible to ignore the need to control and manage the production and intermittency of the energy base generated from these sources.

To what extent will it be possible, in the long run, to renounce sources that, though not having the ESG label, guarantee the reliability of the electricity system by being activated when renewable generation is weakened and cannot supply the system, is still a question without a definitive answer.

In any case, it is clear that we are still at the beginning of a long path on the ESG agenda. However, faced with the uncertainties around the world and the impacts on energy security, it is essential to remember the words of poet Mario Quintana: *"it is the steps that make the paths"*. ■

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11

Infrastructure expansion: the case of the Port of Açu

By **Carlos Tadeu da Costa Fraga**, Member of the Boards of Directors of Prumo Logística, Açu Petróleo and the Brazilian Institute of Oil and Natural Gas (IBP)

As a continental country with historical limitations to the development of its infrastructure sector, Brazil still faces basic logistical bottlenecks. Overcoming these bottlenecks represents an opportunity to increase the competitiveness of key sectors of our economy, both economically and environmentally, since the optimization of logistics ultimately results in the reduction of emissions, an increasingly relevant goal in the agenda for the transition to a low-carbon economy.

If, in addition, we consider the expansion of infrastructure as an opportunity for social development and improvement of good governance practices, the contribution can be even more significant.

As critical components of this logistical infrastructure, ports have a special role in this context. The world's most developed port complexes concentrate in their vicinity industrial activities from different segments, going beyond the traditional purpose of transporting people and cargo. They are strong inducers of social development for local communities, and are at the forefront of the technological innovation, environmental protection, and energy transition agendas.

In the wake of other initiatives in different geographies, the Port of Açu, located in the northern part of the state of Rio de Janeiro, is an industrial port complex included in the logic of private investments in infrastructure, with the purpose of contributing to the improvement of the country's competitive position through the reduction of logistical bottlenecks.

As a result of investments totaling more than R$ 20 billion, the Port of Açu is home to the third largest iron ore terminal in the country, handles about 30% of Brazil's oil exports and hosts one of the main offshore logistics support bases in the world. In the last quarter of 2021, the complex started operating its first power plant and began building its second one, totaling 3 GW of energy generation from natural gas, which is enough to supply 14 million homes and represents an important energy source in the context of the Brazilian transition, complementing the growing potential of renewable sources.

Also installed at Açu are two of the world's largest manufacturing plants of flexible pipes for the flow of oil and gas, an equipment of high technological complexity, and the largest manufacturing and loading base for rigid pipes in the southern hemisphere.

In a little over 7 years of operation, the 10 private terminals that make up the Port of Açu have already handled more than 50 million tons/year. Among Brazilian public ports, only the Port of Santos, the largest in the country, exceeds this mark.

The fact that it is located far from large urban centers allows it to expand its facilities with relative ease, an attribute that will be of high relevance in the coming decades, considering the limitations of ports located in metropolitan regions and already operating at the limits of their capacity.

The expansion plans underway foresee investments of around R$ 20 billion over the next 10 years in new thermoelectric power plants, a natural gas processing unit, gas pipelines, oil pipelines, oil storage, expansion of road access, and the feasibility of integrating the port with the rail network.

These investments are crucial for the country, which (i) is already one of the ten largest oil producers in the world and could be among the five largest in the next ten years, (ii) could double the supply of natural gas in the next ten years, a strategic opportunity for the country's social and economic development, including through a new cycle of industrialization, and (iii) has agribusiness as one of the main pillars of its economy, reaching successive production highs, which will continue

to require expansions in all logistics modes.

Nevertheless, it is important to consider that this expansion will occur concomitant with the transition to a low carbon economy and the increase in demands from different stakeholders regarding the environmental, social and governance (ESG) performance of companies. Therefore, these transition vectors must be contemplated in all business strategies, including in the infrastructure area, to allow their proper translation into business models and practices.

Climate issues and, more broadly, the environmental, social and governance dimensions, should be observed even more closely as factors that, together with the economic dimension, will bring the desired sustainability to corporate growth plans.

The Covid-19 pandemic and the recent discussions at COP26 shed even more light on the subject and on the role that companies have vis-à-vis society. This is an inescapable change that requires companies to take a new stance on the major environmental and humanitarian challenges facing the world. This is the greatest challenge of the contemporary world, the great catalyst of the required transition.

Given this context, and following the example of other organizations, the growth strategy of the Port of Açu began to strongly contemplate elements of the ESG agenda. In addition to the expected expansion of its natural vocations, the possibility of developing low-carbon businesses and optimizing the use of natural resources became part of its strategic positioning. As examples of this new priority agenda, it is worth highlighting the studies conducted alongside partners, who are leaders in their segments, for the development of solar energy, offshore wind farms, and green hydrogen projects.

Also noteworthy are the advances in the implementation of the ESG strategy, which seeks to align the management of the port complex with the best global practices in the pillars of (i) safety, (ii) people and community, (iii) environment and climate, (iv) governance and compliance, and (v) sustainable business.

Besides the insertion of such aspects in the business strategy, it is essential for organizations that their ESG practices are subject to constant external assessment. In this sense, Açu has several communication channels with the local community and has constantly submitted itself to third-party evaluations, obtaining relevant recognition and indications of opportunities for improvement.

In 2021, Açu became the first port in Brazil to receive the EcoPorts

certification - the industry's main global initiative, which acknowledges ports with good environmental management practices. The International Association of Ports and Harbors (IAPH) also acknowledged Açu and granted it the international sustainability award for two consecutive years. The award is the most important global recognition of good sustainability practices in the port sector. Also in 2021, Açu obtained important acknowledgements in the areas of people management and compliance, with the Great Place to Work certification and the Pro-Ethics seal, which acknowledge institutions that successfully implement voluntary measures aimed at preventing corruption.

However, more important than certifications and acknowledgement is the process of continuous improvement vis-a-vis the best international practices, and it is certain that the opportunities identified will bring a valuable contribution to the organizations.

More than describing the strategic positioning of the Port of Açu in a world in transition, this article aims to highlight the opportunities that the ongoing transition offers for the sustainable development of infrastructure projects, traditionally intensive in capital and personnel. These opportunities include the possibility of a transformative strategic contribution, where the benefits transcend the increase in competitiveness, in the strictly economic sense.

The ongoing transition requires much more: current stakeholders expect more than competitive costs - the equation includes the externalities generated by infrastructure projects in the environmental, social, and governance dimensions and excellence in management and in conducting business. These are the attributes demanded by contemporary society, which seeks a low-carbon future where public and private business is conducted within the best ESG practices. ■

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12

Planning and the Future of the Brazilian Energy Sector in line with the COP 26 concerns

By **Giovani Machado**, Director of Economic-Energy and Environmental Studies at EPE

Energy transitions are processes associated with significant changes in the structure of the world's primary energy mix. They are complex processes, and may present variations in the stage and pace of the transformations in different countries, regions or localities. The new energy transition has been underpinned by conditioning factors such as climate change, sustainable development and technological innovations associated with electronics and the beginning of the digital age. This energy transition process is often summarized as the "3Ds": decarbonization, decentralization, and digitization.

In this process, Brazil is in a privileged position with a primary energy matrix significantly composed of renewable or non-emitting sources: almost 50% of renewable sources (48.4%), in contrast to 14% of the world average (EPE, 2021a; IEA, 2021). In the case of the electricity matrix, the situation is even more privileged: 85% renewable, against 23% of the world average and 27% of the OECD average (EPE, 2021; IEA, 2021).

GHG emissions from the Brazilian energy sector total about 400 MtCO2eq (million tons of carbon equivalent). However, Brazil's energy-related emissions per capita are 1/3 of those of the European Union and China and 1/7 of the USA (EPE, 2021). This differential is due to the high share of renewables in the country's energy mix, associated with a per capita consumption of energy at a much lower level than that of more advanced economies, because of Brazil's stage of socio-economic development.

Even with all of the country's efforts, GHG emissions from the energy sector will still grow, due to the country's development needs, as access to and moderation of energy services are guaranteed and expanded to the Brazilian population with lower income and energy consumption levels, as discussed in the National Energy Plan 2050 (PNE 2050, in its Portuguese acronym).

Foreseeing this, Brazil has established market designs and policies to reinforce this process of energy transition and decarbonization of the power sector over the last two decades, ensuring that this geopolitical asset (low carbon energy sector) is maintained and strengthened in order to contribute to the achievement of Brazil's carbon emission neutrality by 2050. More recent examples of market designs and government programs in this direction are: RenovaBio, Modernization of the Electricity Sector, New Gas Market (which also incorporates biogas/biomethane), Abastece Brasil (fuel up Brazil), Combustível do Futuro (Fuel of the Future), National Hydrogen Program - PNH2, among others.

There are also government actions for: Micro and Mini Distributed Generation; energy efficiency (whose institutional and legal arrangement was strengthened by Law No. 10.295/2001, the Energy Efficiency Law, and Law No. 13.280/2016, which changed the governance of Procel (National Energy Conservation Program), guaranteeing a resources base and creating the tool for the Resource Application Plan - PAR); the revitalization of the nuclear industry (resumption of the construction of Angra III, site studies for new plants, redesign of the institutional framework with the National Authority for Nuclear Safety - ANSN, studies on SMR in international research cooperation under the IAEA and the US-Brazil Energy Forum for World Commerce and Development, among others); the consideration of environmental benefits of the electricity sector under Law no. 14.120/2021 (including carbon pricing); studies for structuring the carbon market with a comprehensive scope (studies in the scope of the Partnership for Market Readiness - PMR with the World Bank, and of Law no. 14.120/2021), as well as support to the

discussions of bills in the National Congress for the implementation of a comprehensive regulated carbon market as the legislation project PL 528/2021, which regulates the Brazilian Market for Emissions Reduction (MBRE, in its Portuguese acronym)), determined by the National Policy on Climate Change - Law no. 12.187/2009, which was added to the PL 2.148/2015.

These ongoing efforts to structure a more comprehensive carbon market in Brazil aim to provide long-term carbon price signals and enable lower emissions abatement costs for the Brazilian economy, in addition to generating new business opportunities and attracting domestic and foreign investments, as acknowledged by the country at COP26. In the energy sector, there is already a CBIO market and, as mentioned, a quest to implement instruments to consider environmental benefits in the electricity sector, integrating it with carbon market designs with the most comprehensive scope, in order to ensure the effectiveness of the mechanism (avoiding the collapse of the certificate's price due to the wide offer of renewable sources in electricity generation), as well as the energy security and reliability of the electricity sector.

The fact is that Brazil has been on the path of energy transition and decarbonization for quite some time and the PNE 2050 establishes the strategy for deepening this process of transformations towards a low carbon economy and sustainable development, making the most of existing competitive advantages, requalifying assets and infrastructures while creating new low carbon competitive advantages for the country.

The electrification of converters, and innovation in low carbon fuels such as biofuels (in particular, advanced biofuels) and synthetic fuels (e-fuels), variable renewables (onshore and offshore wind, solar photovoltaic and centralized solar, etc.), nuclear energy (in particular, SMR), waste-to-energy (including biogas/biomethane) and low carbon hydrogen for industrial processes and sectors with difficult GHG emissions abatement, are alternatives with good prospects for the future. This set of alternatives will contribute significantly for Brazil to reach net neutrality of carbon emissions in 2050 and to achieve the goals of access to energy services related to the Sustainable Development Goals - SDGs.

The Ten Year Energy Expansion Plan 2031 (PDE 2031) projects that around 2/3 of energy-related carbon emissions will be in industry and transportation (EPE, 2022). Hence, the current focus on promoting a range of technologies to change this scenario. Technological neutrality and the availability of diverse alternatives are crucial, since not all segments and businesses are equal in terms

of technical and financial capacity to reorganize industrial processes and transportation systems and to adopt the most advanced and often more expensive technologies. The challenges are enormous, imposing realism and care so that there is no technological lock-in or picking-up winners.

Low technological risk solutions (such as energy efficiency, electrification with renewables and distributed generation), "drop-in" (such as sustainable biomass, biofuels, low carbon fuels like HVO and pyrolysis oil, biogas/biomethane, waste-to-energy, etc.) and transition to the lower carbon economy (such as using natural gas instead of other higher emitting fossil fuels, especially if mixed with biomethane) will be essential to advance the decarbonization of economies in the medium term. It is clear that to reach the end-goal and achieve climate neutrality by 2050, new technologies will be required such as electrification of transportation, harnessing the potential of offshore wind power and solar power, synthetic fuels (e-fuels), small modular reactors (SMR), low-carbon hydrogen, energy storage, and carbon removal technologies.

Certainly, on this path of energy transition and towards carbon neutrality by 2050, there are many opportunities for Brazil, but also enormous challenges.

To overcome these challenges, Brazil has strengthened its international partnerships to:

- Develop and/or improve market designs aiming at energy security (including system reliability), decarbonization, decentralization, insertion of innovation and competitiveness, as well as inclusion, access and affordability for vulnerable households (fair and inclusive transition);

- Catalyze processes of development and insertion of innovation (technological and business model) and for the promotion of business environments and attraction of investments in energy efficiency and low carbon emission sources.

Examples of international cooperation in Brazil are the collaborations and energy partnerships with: The International Energy Agency - IEA, the Clean Energy Ministerial, Mission Innovation, Biofuture Platform; with the International Renewable Energy Agency - IRENA; as well as cooperation with USA, UK, Germany, India, Mercosur, BRICS, World Bank, IDB and others.

In its Nationally Determined Contribution, Brazil committed to an ambitious reduction of GHG emissions for a country with a low carbon economy:

- 2025: 37% below 2005 levels (submitted 9/20/2016);
- 2030: 50% below 2005 levels (NDC updated on 04/07/2022; previously, indicative and 43%);
- 2050: climate neutrality (long-term objective).

These are absolute emission targets in relation to a base year (2005), covering the entire national territory, for the economy as a whole (economy-wide) and through flexible pathways. Furthermore, in the second update of its NDC, Brazil included a commitment to achieve climate neutrality in 2050, confirming the intention announced in the Leaders' Climate Summit (04/22/2021), which anticipated by 10 years the indication included in the NDC update (12/08/2020).

In line with the IPCC (IPCC Special Report - Global Warming of 1.5ºC), Brazil visualizes that there are several possible paths to carbon neutrality. Brazil has the potential to expand its energy market with competitive abatement costs in renewable energies, including biofuels. The structuring of a broad carbon market could also further reduce the abatement cost of emissions.

In addition, "Carbon Removal" can also reduce abatement costs for the energy sector, the economy and the society. The application of technologies for carbon capture, storage or usage, as well as forest offsets such as afforestation and reforestation, will play an important role in achieving net neutrality of emissions in 2050. Forest offsetting can also benefit the local and regional climate of watersheds, helping to recover the water regime and the potential use of hydroelectric power plants, as well as to ensure their role of flexibility for the electric power system with the increasing insertion of variable renewables. The Eletrobras Capitalization Law, the partnership between the Brazilian National Development Bank - BNDES and the Energy Research Office - EPE to develop financial instruments that facilitate the migration of resources from the energy sector, especially O&G, to the forest sector (already with concrete results as the Floresta Viva program) and several other financial instruments that have been structured in Brazil aim to address this issue and will play an important role in the energy transition process and in achieving climate neutrality by 2050.

The O&G sector still plays a relevant socio-economic role in Brazil and has been innovating and investing in energy transition and decarbonization, reducing its carbon footprint and progressively changing its business portfolio. The wealth generated in this sector has contributed and will contribute to finance the energy transition and the necessary innovations for carbon neutrality in 2050, including carbon removal with CCUS, greater energy efficiency (including electrification and digitalization of equipment, processes and production units) and insertion of renewables in the O&G value chain (onshore and offshore wind, solar and waves in E&P or as new business projects, biorefining, etc.), low carbon hydrogen and forest offsetting. Therefore, both carbon emissions reduction and "carbon removal" are important for the Brazilian strategy. Brazilian oil presents double resilience (economic and environmental), being one of those with the smallest carbon footprint in the international market. In this way, the Brazilian commodity contributes to the mitigation of global GHG emissions, and should be one of the last oils to exit the market. It is important to keep this in mind: by displacing O&G with a larger carbon footprint in the international market, Brazilian O&G contributes to mitigating GHG emissions, because its production is one of the lowest GHG emitters in the world and will be even lower in the coming years with energy efficiency, insertion of renewables and carbon removal (CCUS and forest offsetting). Producing oil in another country instead of Brazil increases global emissions, so it makes no sense not to produce O&G in the country even from a climate standpoint. Nevertheless, it is crucial to speed up the decarbonization of these activities.

Natural gas, in particular, will play an essential role in the energy transition and decarbonization processes in Brazil. On the one hand, its emissions are lower than other fossil sources required to ensure the reliability of the Brazilian electricity system (with a high share of renewables) and to meet the thermal demands of sectors that have more difficulty to reduce emissions in the short and medium term. On the other hand, the expansion of the gas pipeline infrastructure will not only promote access to modern, low-carbon energy to economic sectors and the population, but may also be the basis for the dissemination of low-carbon biogas/biomethane and hydrogen potentials in Brazil, including using and offering CCUS services in geological structures.

In other words, the strategy is to prevent that investments in nationally or regionally relevant fossil industries in the short to medium term (for fair and inclusive transition) create stranded assets. This could be achieved by requalifying such assets over time through co-firing with renewables, waste, hydrogen or synthetic low-carbon fuels and/or with

CCUS, adoption of other hybrid technologies, and forest offsets, while developing new technological capabilities and low-carbon markets in the energy transition.

In short, the energy transition and energy sector decarbonization strategy was outlined in the PNE 2050 to make the most of the country's competitive advantages while creating new competitive advantages and inserting itself in the new global energy value chains. It is fully aligned with Brazil's ambitions in the Paris Agreement and its goals of climate neutrality in 2050. ■

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13

Building the "Silicon Valley" of energy during the Energy Transition

By **Hudson Mendonça**, Leader of the MIT REAP program in Brazil and researcher at LabrInTOS at Coppe/UFRJ

15 years ago it was the O&G companies that dominated the top of the list of the world's most valuable companies. Today there is an undisputed dominance of technology companies like Google, Facebook, Apple, NVidia, TMC, Amazon, and Tencent among others. This change can also be seen in the automobile sector, where Tesla, with a car production almost 10 times smaller than GM, is already worth, alone, more than the 10 largest traditional automakers combined, being the 6th company in history to reach a valuation higher than USD 1 trillion. The energy transition has begun and the market already sees and appraises this change.

And how do these trends relate to building a "Silicon Valley" of energy? The first step is to understand that many of today's most valuable technology companies emerged predominantly in a specific region (California's Silicon Valley) and at a specific time (late 1990s and early 2000s) when there was a certain common knowledge that the Internet would be key in the future, but there was not yet a consensus about which business models would prevail (content portals, search engines, social networks, e-commerce, etc.).

Furthermore, we are experiencing something similar in the energy sector. There is consensus that the energy sector will undergo profound changes directed by the macro direction of the "4 Ds" (decarbonization, decentralization, digitalization, and democratization), but there is uncertainty about the pace and path that will guide this energy transition, including intense debate about new sources, new technologies, and new business models. This similarity of contexts makes comparison almost inevitable, and a few questions about Silicon Valley's origins can bring important insights into how to navigate the energy transition as well.

Central to this chapter is understanding who was responsible for transforming Silicon Valley from a desert into one of the most developed regions on the planet. Was it the governments, the top universities, the big tech companies, the hundreds of startups, or the tech investment funds? The answer is none and all at the same time, through innovation ecosystems, also known as i-ecosystems.

To build a "Silicon Valley" in energy it is crucial to understand the role of each of these players and know how to integrate them efficiently. Let's look at the roles of each player in a structured i-ecosystem and their specificities in the context of the energy sector.

The Role of the Government: If, on the one hand, excessive leadership by governments can hinder the development of healthy i-ecosystems by creating high dependence on policies and reducing the sense of belonging of other local players), on the other hand, the government should act as a facilitator: (i) generating consensus on legislations and regulations; (ii) providing financial resources for the higher risk stages or those that are not yet mature enough to attract the private sector; (iii) articulating actors around common objectives and policies; (iv) financing databases and studies to support decision making, especially of investors.

In the energy sector specifically, these aspects are even more relevant considering that the sector is highly regulated and environmental issues are critical. The model of concessions, exploration rights, legal and regulatory constraints are essential to enable (or constrain) new business models and leverage new technology applications. An example of this is the recent Legal Framework for Startups and Innovative Entrepreneurship (Supplementary Law No. 182 of June 1, 2021), which opens up the possibility of applying regulated R&D resources (ANEEL and ANP) to startups. This change will enable relevant investments in the coming years in startups related to the energy sector, which will bring a competitive global-scale differential for energy startups installed in Brazil.

The Role of Universities: In today's world, the greatest base of wealth generation is knowledge. In this context, universities, which are the great hubs of generation and structuring of complex knowledge, gain even more prominence. In a thriving i-ecosystem, universities play critical roles such as (i) training qualified people, (ii) transferring to the market technologies generated in their laboratories, and (iii) accelerating the process of creation and development of startups.

Universities play an even more critical role in the energy sector, as technological development in the sector demands complex, often multidisciplinary knowledge and large volumes of investment in laboratory infrastructure, machinery and equipment. Unlike Internet applications, many of the developments in the energy sector involve significant investments that cannot be fractionalized, as are often the minimum viable products (MVPs) of the digital world.

The Role of Corporations: The demand of corporations is one of the main reasons that sets them up as key agents for i-ecosystem formation. However, another fundamental aspect of their performance is their ability to elaborate a long-term strategic vision, less vulnerable to changes in political cycles (like governments), and with the capacity to make larger long-term investments (unlike startups). They are also able to scale the diffusion of technologies through their production capacity and distribution network like none of the other players.

More recently another factor has made the role of corporations in i-ecosystems even more critical: the phenomenon of open innovation, which replaces "innovation in closed centers" with a more collaborative approach. In this "new mainstream," large corporations expand their cooperation with universities, governments, investors, and startups. With the latter, interaction has grown so much that it has generated a 5th wave of corporate venture capital (CVCs), whose investment volume is already nine times higher than the previous peak, and has increased fivefold in the last 5 years, from USD 32.9 billion (2016) to USD 169.3 billion (2021).

In the energy sector, both the chains of exploration, production, refining, and distribution of oil and oil products, and the chains of generation, transmission, and distribution in the electricity sector are substantially dense and a relevant locus for innovation. With very relevant purchasing power, large corporations in the energy sector often play the roles of directing R&D efforts, of financing the innovative efforts of other links in the chain, and of consolidating market demands. In the context of the changing and uncertain outlook of the energy transition, the ability to see - and direct - long-term investments is increasingly critical.

The Role of Venture Capitalists: As of the 1990s, the advances in telecommunications and globalization generated a massive diffusion of knowledge, but the investment capacity to transform new ideas into businesses still remained concentrated. This context was fundamental for venture capital (VC) fund managers to act and to prove that they were crucial in making entrepreneurs with good ideas and execution capacity find the necessary resources to implement them, generating the boom of startups that have changed our world in the last 30 years. A survey conducted by the NVCA (National Venture Capital Association) pointed out that 556 "VC-backed" companies carried out IPOs between 1974 and 2015 (42% of the total). At the same time they accounted for 85% of R&D investments in the period and 63% of market value.

In an i-ecosystem, venture capitalists are key to mapping and enabling trends (when faced with investment proposals, they are able to have an insider's view on disruptive sectorial changes), and are fundamental to connecting good ideas and technologies with the capital needed to turn them into successful innovative businesses.

However, this importance of venture capital is not yet felt in the energy sector. VC funds have found more stable models for both the short cycles of information technology companies and the long cycles of the pharmaceutical industry. However, these funds have not yet found a consistent path that enables growth with sustainable returns for energy companies. This challenge is also a great opportunity, especially considering the growth of Corporate Venture Capital funds (CVCs) in the sector and new models such as Corporate Venture Builders (CVBs) and Venture Debt mechanisms.

The Role of Entrepreneurs: Entrepreneurs and their startups are today the driving force of this increasingly VUCA (Volatile, Uncertain, Complex and Ambiguous) world. In a developed i-ecosystem, successful entrepreneurs are essential to "teach the way" to new candidates, to articulate common demands to this great mass (in Brazil there are already more than 21 thousand startups according to ABStartups), convey the experience of those who are doing it in practice to public policy makers, and, of course, continue to undertake and innovate, generating jobs, income, and economic and social development to the region where they are located.

In the energy sector, its importance expands, as there is still no successful model to be followed in the energy transition, and many startups seek to "challenge" the status quo by bringing a vision from outside the sector capable of breaking pre-established paradigms. A trend from other sectors that can be important in the energy sector is

the “unbundling” movement, which basically consists of startups that seek to break down complex systems into smaller parts and offer better individual solutions, but that can be easily integrated at a later point in time. This movement has generated cost savings and performance improvements in several areas, especially in segments of capital-intensive supply chains, which is the case of the energy sector.

Open Innovation and the i-Ecosystems

In the traditional innovation process, the common mindset is to seek to benefit alone from your R&D efforts through instruments such as non-compete clauses, exclusivity, intellectual property, trade secrets, etc. Investing in initiatives that are not strictly under your control was not an option in most cases. In the open innovation paradigm, however, the worldview is increasingly collaborative and integrated, where trying to control everything can represent huge management costs and lost opportunities.

If the closed innovations game was focused on creating your own value, the game of open innovations refers to an important need to learn to capture value from the surroundings. We see that in platform companies such as Facebook, Youtube, Uber, Airbnb, Google, and Apple that have been skillful in creating operational models capable of capturing much of their value from external agents, generating mutually beneficial gains for both. In the same way that these companies gain value by creating and developing communities in their orbits, the opposite would occur in cases of mass disengagement.

And what does this have to do with i-ecosystems? Everything! The companies mentioned above, as well as leading universities and globally thinking governments, know the importance of creating and maintaining a fruitful environment not only for themselves, but also for the other stakeholders that form their value capture and generation network.

As mentioned in the beginning, in a successful i-ecosystem, there is a natural and healthy interdependence among the players that compose it. In the energy sector this fact is evident through the profile of the entrepreneurs. An unprecedented research conducted jointly by LabrInTOS/COPPE/UFRJ, FGV/EAESP, EDP and ABStartups with ANEEL resources, identified that the majority profile of entrepreneurs in the energy sector is formed by researchers from universities and/or research institutes or by former executives from the industry. In other words, the formation of the i-ecosystem and the integration

of stakeholders is predominantly carried out by the individuals who currently form the sector, even if they operate in different roles. Therefore, if one of the players is left behind, it is fundamental that the others are aware that this external limitation will also be a limitation to their own development.

Beyond Silicon Valley: From Kendall Square Biotechs to São Paulo Fintechs

In Silicon Valley one can easily see the importance of the pro-innovation US and California governments, top universities like Stanford and UC Berkeley, visionary funds like Sequoia Capital and Kleiner Perkins, innovative corporations like HP and Apple, and recent startups like Uber and Zoom. But in other regions, can you also identify this interdependence between government, academia, corporations, investors, and entrepreneurs?

Starting outwardly from the notorious Kendall Square ecosystem in Cambridge, MA, we can see that it is possible. The region is home within a few blocks to none other than Harvard and MIT; two of the world's top five universities according to the Times Higher Education World University Ranking (in addition to almost 60 others in the so-called greater Boston area). The government incentives to transform this knowledge into wealth and prosperity via innovation are also noticeable in many ways and encouraged considering that 38% of people employed in Massachusetts are connected to the innovation economy.

As for its vocation, unlike Silicon Valley, the region has a greater focus on healthcare and biotechnology. The region houses the American headquarters and R&D centers of several large global pharmaceutical companies such as Pfizer from the United States, Takeda, from Japan, the French Sanofi, the British GlaxoSmithKline, and the Swiss Novartis among others. According to Startup Genome's global ecosystem ranking, the region is the 5th most valuable startup ecosystem in the world and the number one in life sciences, with more than 1,100 startups and many investors - from angel investors to venture capital funds - specialized in the area.

Looking at Brazil, we see this pattern replicated in the well-known São Paulo i-ecosystem. Of the five universities that were alma mater of many founders of successful startups in the country, four were in São Paulo (USP, FGV, Unicamp, and ITA), showing the importance of

universities in this ecosystem. The same study by the accelerator ACE also identified that 100% of the founders had college degrees and 60% had post-graduate degrees. About the importance of local government, São Paulo is the only state in the country in which the main public universities (USP and Unicamp) are state managed and not federal, a result of the investment policy that created the obligation to transfer almost 10% of the ICMS tax collection to R&D and to state universities.

In sectorial terms, São Paulo has been standing out globally as an important ecosystem of startups in the financial sector. According to the Global Fintech Index City Ranking 2020, São Paulo is already the 5th leading fintech hub in the world. The success of the i-ecosystem, however, originates long before the emergence of fintechs such as Nubank, C6, Creditas, and PagSeguro. The state of São Paulo was already the main financial center, home to the country's ten largest non-public banks, major assets, and also to B3, Latin America's main stock exchange. A natural movement that followed was to receive the headquarters of the main international venture capital funds interested in investing in the country.

The Kendall Square and São Paulo i-ecosystem is an example that it is possible to replicate the Silicon Valley effects outside California, although it also shows that each region must seek its own trajectory, based on its own characteristics and competitive advantages. In this aspect there is a problem that can become a great opportunity: There is still no "Silicon Valley" focused on energy, although there are some candidate regions. Among them we can highlight Singapore, Stockholm (Sweden), Austin (Texas, USA), Calgary (Canada), Pittsburgh (Mobility, USA), Bilbao (Spain) and now Rio de Janeiro (Brazil), one of the eight regions selected for the 2021-2023 cycle of the Regional Entrepreneurial Regions Acceleration Program of the Massachusetts Institute of Technology (MIT REAP), which arrives for the first time in Brazil and already has the support and engagement of major institutions in the sector.

MIT REAP Rio de Janeiro and the Energy Silicon Valley

Thinking through the current paradigm of open innovation, the decision to invest in the creation and development of an i-ecosystem can become a major long-term competitive advantage. In a world where innovation is increasingly a matter of survival, moving to a relevant i-ecosystem (or contributing to the construction of one around it) is increasingly an idea that cannot be ignored, especially in the energy sector, which

is currently experiencing the uncertainties of the energy transition process that promises to rebuild the sector on new bases.

But what would be the fundamental factors for the construction of an i-ecosystem in the energy sector? The first is the presence of relevant players linked to the sector in the five areas previously described. If the region does not have one of these players, or is unable to meet the growth rate of the other four, it must be able to seek ways to attract and/or develop these players.

In the energy and sustainability i-ecosystem under construction in Rio de Janeiro (MIT REAP Rio de Janeiro), key representatives of each of these stakeholders came together to develop a plan and implement strategic interventions in an integrated way with the goal of transforming Rio de Janeiro into a global reference in the subject in the coming years. LabrInTOS of COPPE/UFRJ (representing the university), Furnas, Petrobras and Vibra Energia (corporations), Federal Congressman Paulo Ganime (government), MSW Capital (investor) and Fábrica de Startups and Energy Hub/SDP (entrepreneurs) came together to make this initial diagnosis as well as to engage other players in this mission to transform Rio de Janeiro into the "Silicon Valley" of Energy and Sustainability.

Rio de Janeiro has excellent starting conditions as it is home to major corporations in both the O&G and electricity sectors. It hosts important government institutions such as EPE, ANP, BNDES, Finep, and INPI. It has academic excellence in STEM areas (science, technology, engineering and mathematics) and in energy related businesses. And it already has relevant venture capital activity and successful entrepreneurs, although this is still incipient in the energy sector (which is observed not only in the region, but also nationally).

However, just having these organizations is not enough. They have to be efficient at what they do, act in an integrated and cooperative way, and have indicators (human capital, infrastructure, funding, demand, and culture/incentives) that measure the region's capacity to generate innovations and transform this knowledge into successful ventures.

With integration and diagnosis, the next step is to design and implement joint strategic interventions that address the deficiencies and leverage the region's qualities and competitive advantages. The energy sector in Brazil, for example, has a regulation that requires energy companies to invest part of their revenues in R&D (ANEEL, in the electric sector, and ANP, in the O&G sector). Listening to the market, universities and other industry players (including the MIT REAP Rio de Janeiro team),

the agencies have been updating their regulations to make them more adequate to the current context of entrepreneurship and startups in the sector. Part of this result can be seen in the Legal Framework for Startups and Innovative Entrepreneurship (Supplementary Law No. 182 of June 1, 2021), which allows a number of new uses for these regulated resources, as well as creating the possibility of testing technologies through Public Contracts for Innovative Solutions (CPSI, in its Portuguese acronym) and regulatory sandboxes that will be crucial to the first experiments linked to autonomous electric mobility and the use of blockchain and smart contracts in the sector.

Another example of this joint process of diagnosis and development of strategic interventions is energINN, which was born as the largest program for the generation of proofs of concept (PoCs) and training of entrepreneurs in the world in the energy and sustainability sectors. Conceived from the diagnosis made by MIT REAP Rio researchers, the survey identified that less than 2% of the Brazilian startups operate in the energy sector (297 out of a universe of more than 21 thousand startups according to ABStartups); that the CSE (Corporate-Startup Engagement) initiatives in the energy sector, such as corporate accelerators and Corporate Venture Capital funds, have been growing in quality and quantity; and that Rio de Janeiro is capable of producing cutting-edge knowledge, but is not efficient in transforming this knowledge into new businesses (it ranks 2nd in publishing scientific articles in the country, but only 11th in generating innovative enterprises).

These findings pointed to a future "lack of energy startups" 4 years from now, similar to what is currently experienced regarding the lack of qualified software developers in the country. It was realized that no single player in the ecosystem was capable of adequately taking care of this "top of the funnel" stage, since it was not yet economically advantageous for any player to do it alone. That is why LabrIntos/COPPE/UFRJ, Emerge, Fábrica de Startups, Energy Hub/SDP, Energy Future and Tec Institute got together to build the program that will be free of charge for entrepreneurs and supported by sponsors interested in having priority access to the new technologies and startups that will be created under energINN.

In the Workshop that took place in Boston in November 2021, the MIT REAP Rio Team observed the need to create, as of 2022, a "MIT REAP Rio Institute" to act as a think tank, with a holistic and integrated view for energy transition, and that will serve as locus for structuring actions of the ecosystem, in a similar way to Spain's MIDE (Madrid Innovation Driven Ecosystem) and Scotland's Entrepreneurial Scotland, both created in previous MIT REAP rounds.

These actions can give a significant boost, but, in isolation, will certainly not turn Rio de Janeiro into a Silicon Valley of Energy and Sustainability. Team Rio has already identified more than 28 necessary PPIs (Policy and Program Interventions) that must be conducted by other players in order for Rio to reach its full potential as an ecosystem. Certainly the other players that will join the group after 2022 will be able to conduct some of these, as well as bring new and relevant contributions.

From MIT's methodology and from past experience stemming from the Internet revolution we can draw one final message: those regions that are able to better develop their five players (universities, corporations, government, startups, and venture capitalists), as well as efficiently integrate them, will come out ahead in the energy transition and in their new business models/technologies. In the current paradigm, innovation goes far beyond R&D centers, and entrepreneurship goes far beyond startups and their entrepreneurs. ■

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Mr. Mendonça is an evaluator/mentor of several startup programs such as InovAtiva Brasil, 100 Open Startups, FGV Value Chain Initiative, NASA Space Apps, Hacking.rio and Finep Innovation Award. He was also Director of the Cleantech Committee of the Brazilian Association of Startups (ABStartups), member of the Higher Council of AEB and the Innovation in Services Committee of ANPEI.

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14

Financing Investment Opportunities in the Transition

By **Winston Fritsch**, Trustee Emeritus and Expert at CEBRI's Environment and Climate Change Program

This chapter addresses the transition to a low-carbon economy with emphasis on the role of the financial sector. The first section discusses why the international financial sector's late but growing participation in debates about the challenges of the transition has been caused by a progressive shift in perceptions - first by regulators and multilateral agencies - of the risks of the repricing of assets during the transition, and more recently, by a growing number of more activist large private institutions, also as an opportunity.

We then argue in the second section that certain features of the Brazilian economy allow us to take advantage of this new positive stance of the international financial sector in the search for impact investments, transforming the challenge of the transition, in historical perspective, into, perhaps, the greatest opportunity that the country has had since World War II to substantially contribute in the multilateral arena to the solution of the great problem of the century, in a manner completely aligned with the national strategic interest. The last section briefly reviews the policy challenges in the crucial first decade of the transition and concludes with the importance of clean energy financing policies and land use reforms.

The financial world and climate change: from agnosticism to activism

The evolution of the interest and, especially, the leadership of the financial sector in discussions about the impact of global warming in the 30 years since ECO-92 in Rio de Janeiro, can be divided into two phases. The first lasts until the eve of the Paris agreement and is marked by agnosticism about the seriousness of the problem, lack of interest and little engagement in its solution.

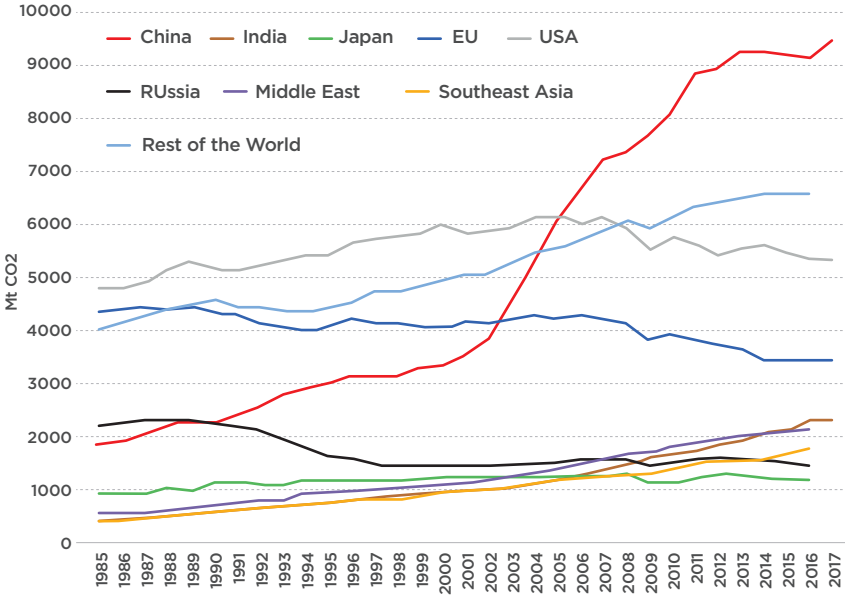
This long period of benign neglect was not specific of the financial sector. It was shared by most of its clients, reflecting the widespread view in the corporate world and among major investors that the problem of global warming, while real, was not urgent. And it was consolidated in the context of the progressive collapse of the promising and ambitious Kyoto Protocol's mechanisms agreed at the 1997 climate conference - the inevitable result of the lack of commitment by some major emitters - and of the crisis of the pioneering EU carbon credit system implemented in 2005, under the unforeseen and devastating impact of the Great Recession of 2008-2010.

This attitude begins to be reviewed in the years leading up to the COP 21, held in Paris in 2015, as a consequence of the explosion of global emissions caused by the dizzying growth of China, a natural hostage of a coal-based energy matrix, as shown in Figure 1, below. Even with the very favorable evolution of emissions in developed countries, which benefited from the positive effects of the rapid fall in prices of cleaner energies with the spread of the use of natural gas to replace coal and of new technologies for solar and wind-based electricity generation, the increase in the global emission rate was staggering.

And here again science has sounded the alarm: improved computer techniques have allowed much more accurate modeling of the link between warming caused by increased CO2 emissions and complex climatic phenomena, allowing for a rare scientific consensus on the real risks of the global emissions trajectory for life on the planet. Here begins a renaissance of political ambition that flows into the Paris Agreement and, ultimately, the engagement of the financial sector in climate action policy, initially led by its regulators, concerned about climate as a systemic financial risk.[1]

1. The symbolic landmark of this engagement is the now historic speech by Mark Carney, then Governor of the Bank of England, at Lloyds of London shortly before the Paris COP. See Breaking the Tragedy of the Commons; speech by Mark Carney at the Lloyds of London, 2015; https://www.bing.com/videos/search?q=mark+carney+lloyds+speech&docid=607998594346126565&mid=FA7190DE6AC768AF0C6EFA7190DE6AC768AF0C6E&view=detail&FORM.

Figure 1. **Evolution of emissions by region**



Source: CDIAC/GCP

It is true that undeniable progress has been achieved since 2015 in the sphere of regulation of the financial system, largely led by the influential Financial Stability Board of the G-20 and its multilateral members such as the IMF and, in particular, the OECD and the World Bank. These measures - aimed at creating greater quality in the analysis of systemic financial risks and integrity in contracts linked to emissions certification - have naturally managed to attract the attention of private financial institutions and some large corporations, generating the adherence of a number of them to voluntary public commitments to reduce emissions.

But unfortunately, the enthusiasm created by the Paris Agreement did not immediately affect the entire private financial sector. The disaster of the limited but powerful spread of anti-multilateralism in the Trump era undermined, despite continued EU interest, the effectiveness of subsequent COPs to address the main unfinished business of Paris: its Article 6, the main potential interface of the UN framework with the private financial world.

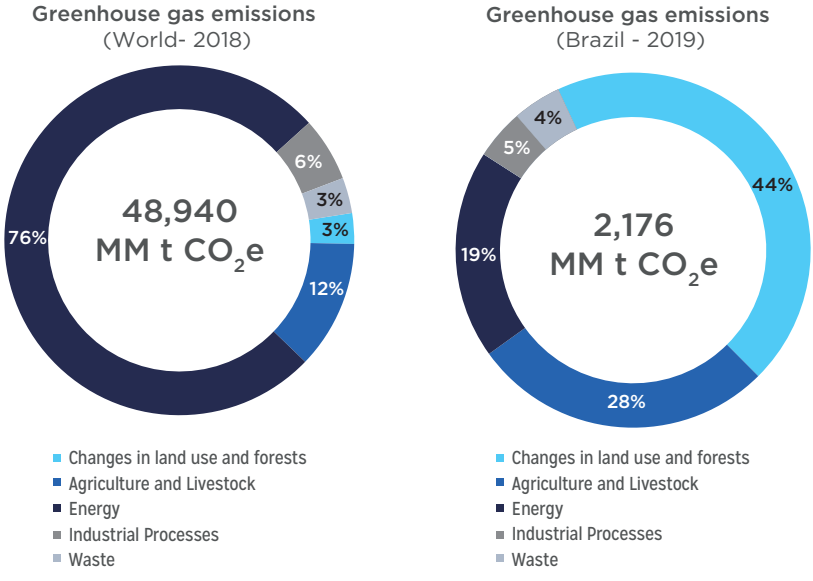
The engagement of the financial sector in a relevant and enthusiastic way is a more recent phenomenon. It is part of the resurgence of the issue as a political consensus on the "climate urgency" created by the latest reports of the UN panel of scientists (IPCC), reinforced by climate disasters around the world and the new American engagement. But, specifically, the recent leading role of the financial sector at COP26 can only be explained by the conjunction of the effects of regulatory advances that, since 2020, have generated powerful pro-climate financial lobbies such as the iconic Glasgow Alliance for Net Zero (GFANZ), created in 2021, that comprises more than 450 major institutions. This movement of greater activism of the global haute finance had a decisive influence on the fight against greenwashing and the recovery of the luster and effectiveness of UN conferences, as demonstrated in Glasgow, in addition to placing the G20 in de facto co-leadership of global multilateral action, creating a new forum capable of promoting a more effective commitment of the major emitters with their goals.

The transition as an opportunity

However, the recent activism of the private financial sector has also resulted from the realization that repricing the assets of the activities most affected by the need for a transition to low carbon does not only imply risks, but also points to enormous opportunities created in the sectors that may lead the investments required for the transition. These opportunities are already visible in the advances in new emission-free electrical generation technologies with strongly decreasing investment costs; in the expectation of a possibly rapid transition to the use of electrolytic (green) hydrogen to replace coal or hydrocarbons both as an energy source and in industrial processes and transportation; in nature-based solutions such as large-scale reforestation, among others. This generates positive attitudes towards the acceleration of an effective and convergent regulatory environment, as required to materialize these investment opportunities and the introduction of innovation, creating a virtuous circle of globalization of solutions. We are, therefore, on the threshold of a new era in financing the diffusion of the so-called enabling technologies. It is no coincidence that financial institutions that are signatories to the GFANZ and responsible for assets that total more than USD 130 trillion, are boasting about emission targets consistent with the goals set by COP 26. Understanding this moment is important for Brazil.

As already shown in other chapters of this book, Brazil is what we can call a climate idiosyncrasy. It is, without a doubt, a great emitter, responsible for 3.4% of global emissions, and today ranks 6th in the world. However, our energy matrix, unlike the other big villains, is relatively clean. As can be seen in Figure 2, while the energy sector is responsible for 76% of total emissions in the world, in Brazil it represents only 19% of the total. No less than 72% of Brazilian greenhouse gas emissions come from "land use", a euphemism used for the sum of emissions coming mainly from a shameful large-scale deforestation and, to a lesser extent, but very relevantly, from methane emissions produced by livestock.

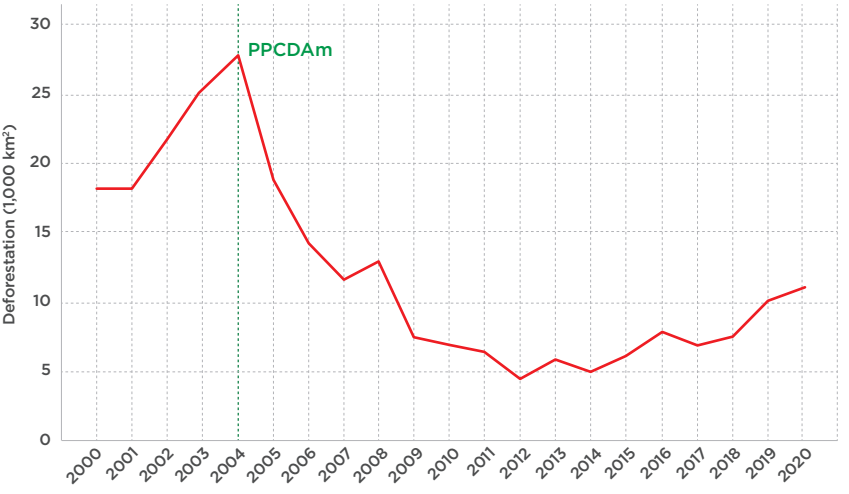
Figure 2: **Composition of emissions in the world and in Brazil**



Source: CEBRE-IDB-EPE – Energy Transition Program, 1st cycle – Diagnostics, 2021 – https://cebri.org/media/documentos/arquivos/PTEP_Whitepaper_21dez_PT.pdf

This historical peculiarity gives us two advantages over other major emitters. First, the costs of controlling emissions to meet national commitments do not seem as high as for other major emitters, where the gases result from energy generation and industrial activities central to their economies. Controlling deforestation, as seen in Figure 3, has already been shown to be possible, and the continued refinement of effective remote monitoring methods makes this control a matter of political decision and use of the correct incentives.

Figure 3: **Amazon deforestation evolution**

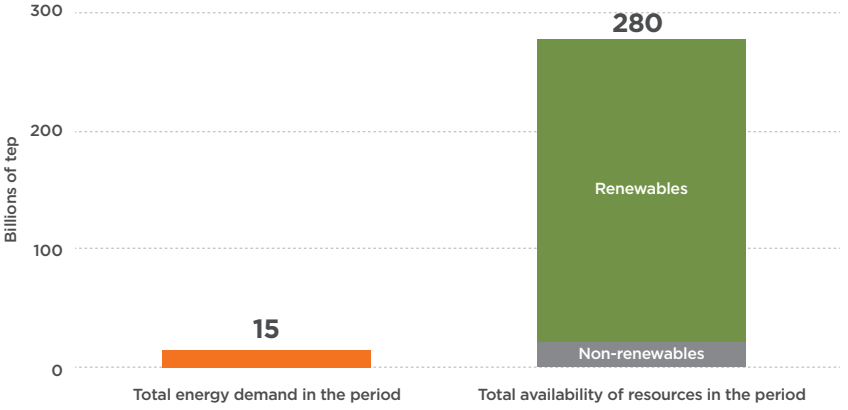


Note: The vertical line in 2004 marks the year the PPCDAm, federal government action plan to combat deforestation in the Legal Amazon region was launched.

Source: CPI/PUC-Rio with data from PRODES/INPE, 2021

Secondly, our climate peculiarity, coupled with the availability of certain natural resources, creates a unique opportunity to exploit competitive advantages in two of the most important areas for the crucial first decade of the transition. On the one hand, in emissions-preventing investments, such as clean wind and solar power generation that, for their potential magnitude - as shown in Figure 4 - could create gigantic surpluses of electricity at falling prices, stimulating the efficient production of various electro-intensive articles, and “green” hydrogen, which could also be used as a “clean” reducing agent in industrial processes such as metallurgy - where we have almost completely lost competitiveness - or in the ammonia chain, the basis, among other things, for the production of almost totally imported nitrogen fertilizers.

Figure 4. **Comparison between resource potential and energy demand from 2015 to 2050**



Source: National Energy Plan 2050 / Ministry of Mines and Energy, Energy Research Office. Brasilia MME/ EPE 2020

And also, in the complementary but essential investments to extract existing carbon from the atmosphere, such as forest restoration, especially in the Atlantic Forest and the Amazon, two world-class hot spots for restoration. And permanent and quality large-scale forest restoration generates, besides carbon sequestration, great additional economic benefits, such as local quality employment with low formal training requirements and restoration of the water balance, as well as greater biodiversity.

In summary, the challenge of the transition to low carbon offers a double opportunity to Brazil. On the one hand, it can be the pivot of a development policy that would allow the creation of a platform of green energy surpluses to accelerate economic growth and at the same time contribute to the global transition. On the other hand, it can help resume our traditional leadership role in addressing multilateral climate policy if we definitively reverse the growth of deforestation in the Amazon. In fact, this may be the greatest opportunity that the country has had since World War II to contribute substantially to the solution of a global problem in a manner completely aligned with national interests. We cannot miss this chance.

Regulation and Financing

Global warming results, in economic jargon, from negative "externalities" caused by the "market failure" to price the producer's costs for the gases emitted. The correction of this "externality" should be done in two ways. Either by "pricing the carbon" - through taxation or auction mechanisms for emission permits or carbon credits - or by direct intervention mechanisms, simply by limiting the amount of emissions allowed. It is inevitable that in the coming years Brazil will adopt one or a combination of these carbon pricing mechanisms and consistently eliminate subsidies to fossil fuel consumption.

However, while the development of carbon markets must become a central element of regulation in transition policy, particularly on the issue of land use, they are not a panacea and, even if effectively deployed, they are not sufficient to signal an intertemporal efficient transition. This is because, as the historical experience of the EU proves, political influences or forecast errors create uncertainties and imbalances that affect the intertemporal consistency of investment and production decisions. And, even if credible and predictable, they are efficient only in inducing choice among technologies that are already in the diffusion phase. Processes that are still in the development phase are not necessarily affected by these price signals and should be subject to other policies such as incentives focused on research and development and, in particular, the financing of impact investments[2].

Financing policy as an inducer of the transition should be particularly important in Brazil, supporting the potentially large private investments in clean energy and associated green hydrogen production, which have in common a heavy initial investment and long construction and maturation periods. And since the large component of the cost results from initial capital expenditures, the cost of capital, and in particular the debt and collateral guarantees component, is critical, this calls for a complementary but relevant role for financing risk mitigation mechanisms and public co-investment.

In this sense, in terms of public policies, it would be important to create public-private blended finance platforms to support all impact investments where the BNDES could act in cooperation with regional and multilateral development institutions, now increasingly engaged

2. See Daron Acemoglu; What Climate Change Requires of Economics, Project Syndicate, September 2021. https://www.project-syndicate.org/onpoint/what-climate-change-requires-of-economics-by-daron-acemoglu-2021-09?barrier=accesspaylog

in climate action[3]. And, finally, these actions should be complemented by quality regulation as an inducer for investment in leading sectors: through the improvement of the regulatory environment to support potentially huge investments in clean electric generation and, in the area of reforestation, through an effective implementation of the Forest Code, enforcing the legal provisions of forest protection in land use. ■

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3. GFANZ itself estimates that the public sector should contribute about 25%, ideally in blended finance schemes in co-investment with the private sector to reach the necessary US$3.2 trillion per year by 2030 in investments for the global transition (the figure for Brazil is US$70 billion, about 7% of GDP). For a definition of the basic concepts of blended finance and on the potential of the Brazilian Development Bank (and other development finance institutions) for the construction of these structures, see https://www.oecd.org/dac/financing-sustainable-development/blended-finance-principles/.

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