CLIMATE TRANSPARENCY POLICY PAPER: ENERGY TRANSITION IN BRAZIL

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PRESENTATION

This document provides a qualitative analysis of the context and policies of the Energy Transition developments in Brazil in order to subsidize the preparation of a comparison paper on Energy Transition in three Latin America G20 countries: Brazil, Argentina and Mexico.

ABOUT CLIMATE TRANSPARENCY

Climate Transparency is a global partnership with a shared mission to stimulate a 'race to the top' in G20 climate action and to shift investments towards zero carbon technologies through enhanced transparency.

Climate Transparency brings together the most authoritative climate assessments and expertise of stakeholders from G20 countries. Jointly, these experts develop a credible, comprehensive and comparable picture on G20 climate performance: The Brown to Green Report covers easy-to-use information on all major areas such as mitigation and climate finance and includes detailed fact sheets on all G20 countries. It is published on an annual basis on the eve of the G20 Summit. Climate Transparency is made possible through support from the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative, ClimateWorks Foundation and the World Bank Group.

ABOUT CENTROCLIMA

CentroClima/LIMA, linked to the Energy Planning Program (PPE), is part of COPPE, at the Federal University of Rio de Janeiro (UFRJ). Since 1997 CentroClima/LIMA was responsible for the execution of around 250 research projects, many of which for international institutions. Throughout this period, agreements, partnerships, cooperation agreements and contracts were signed with public bodies of the federal, state and municipal administration, as well as companies and non-governmental organizations. These research activities led to the publication of approximately 320 scientific papers, 75 articles in national and international journals, 70 books or book chapters, 140 papers in Annals of Congresses and 25 articles in magazines and newspapers. In addition, they provided material for the preparation of more than 50 Master's dissertations and 30 PhD thesis.

KEY POLICY INSIGHTS

- Energy efficiency and change of consumption patterns must play a major role in decarbonization, contributing to a very significant decrease in energy demand by 2050.
- Brazil must avoid the lock-in in carbon-intensive technologies, especially in long lifespan infrastructures as refineries, fossil-fuel fired power plants, and interrupt fossil fuel subsidies as soon as possible.
- Prepare a comprehensive energy efficiency program to foster investments in this area.
- To foster the energy transition in Brazil, and to meet the targets of the Paris Agreement, it is necessary to redirect investments, reduce subsidies to fossil fuels, and create a long-term low carbon strategy.

1. INTRODUCTION

Brazil stands out with one of the world's cleanest energy matrix, with great use of hydropower plants. Low-interest incentive and financing policies, as well as fair prices made possible by electric power auctions, have led the wind power industry to grow significantly recently. Currently, the insertion of the solar source for distributed generation is getting stronger, but there is still a concern about the regulation of these new sources, especially in the free market. The large use of flex-fuel cars makes ethanol widely used (27,5% blend mandate on the gasoline plus the possibility of running on 100% ethanol), and biodiesel blending policies already reached 10% in 2018. Studies show that natural gas might be a transition fossil fuel by 2050, aiming to reduce the use of coal and other fossil fuels in the country. Thus, this document presents the general framework on Brazil and identifies drivers, challenges and opportunities to achieve GHG mitigation goals, presenting policies and legislation to support a robust transition of the energy sector.

Renewable energy sources in Brazil accounts for about 42% of total primary energy supply and 85% of the power sector production. There is a great potential of renewable sources such as hydropower, wind, biomass, and solar, which begins to be exploited for electricity generation. Non-renewable sources account for about 57.2% of total primary energy supply, and an important part of it is used in the transport sector (32.7%), (EPE, 2018a). Brazilian energy intensity has remained practically stable since 1990, below 4 TJ / million US$ according to the IEA cited by B2G (2018), (Figure 1).

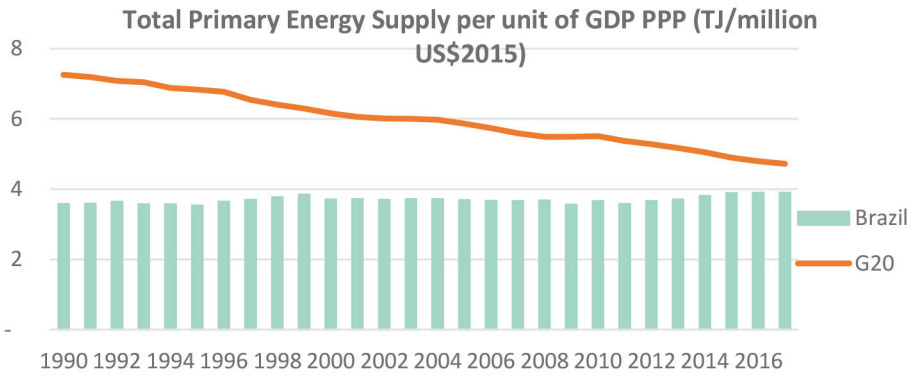

Figure 1: Energy intensity in Brazil compared to G20 average

Source: B2G (2018)

Even though Brazilian energy intensity is about 20% below the average of other G20 countries, the gap has reduced a lot since 1990. Thus, to direct the country towards the desired trend followed by other G20 countries, not only energy efficiency policies should be implemented, but also, for economic and social reasons, the country must review its economic policies in order to produce and export products with more value added. Brazilian total GHG emissions are around 1.6 billion tons of CO_2eq. The energy sector appears only in third place in total emissions, after land use change and agriculture sectors, however, to avoid lock-in, the energy sector must start its transition now.

Due to its extensive territory and natural resources, for a long time, Brazil relies on an important part of its energy mix in renewables, mainly hydropower, biomass and biofuels, and wind. With the invention of the flex-fuel[1] car, ethanol production regained importance after 2004. Today, flex-fuel cars represent about 90% of the new sales and around 80% of the light vehicles fleet. But after the discovery of large oil reserves in the pre-salt layer (2007), the federal government redirected its efforts in investments in E&P, and subsidized oil derivatives consumption to reduce inflation at the beginning of the 2010s. As a result, oil consumption grew fast after 2010, and the share of renewables was kept stable (Figure 2).

With greater political support and the launch of the PROINFA program, more than 40% of the total investments in the power sector were in renewable energy between 2000 and 2013. Between 2014 and 2016, the highest share of investments in the power sector was in wind power. In 2016, investments in solar energy increased significantly to around 35% of total investments in the power sector (Figure 3).

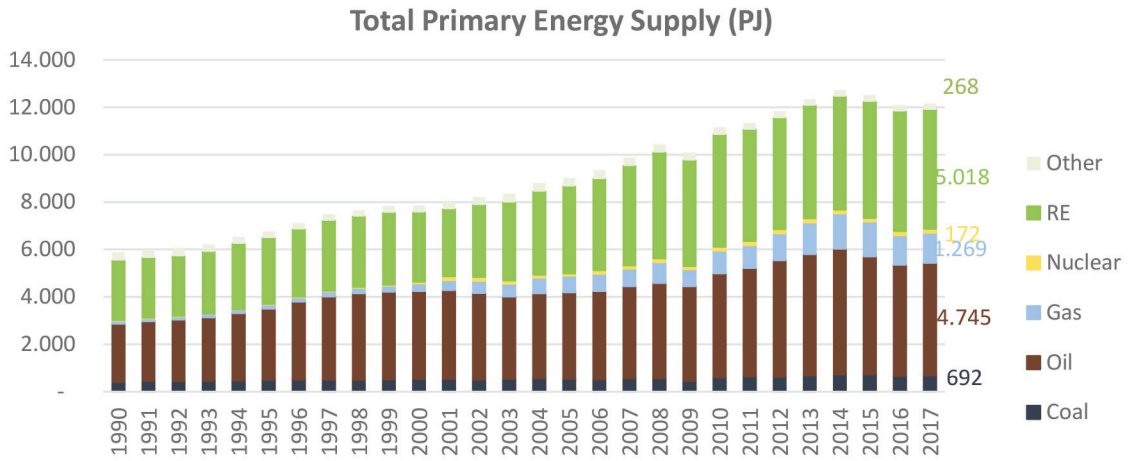

Figure 2: Total Primary Energy Supply in Brazil

Source: B2G (2018)

[1]Flex-fuel cars can run either with ethanol or gasoline, or any mix between the two fuels.

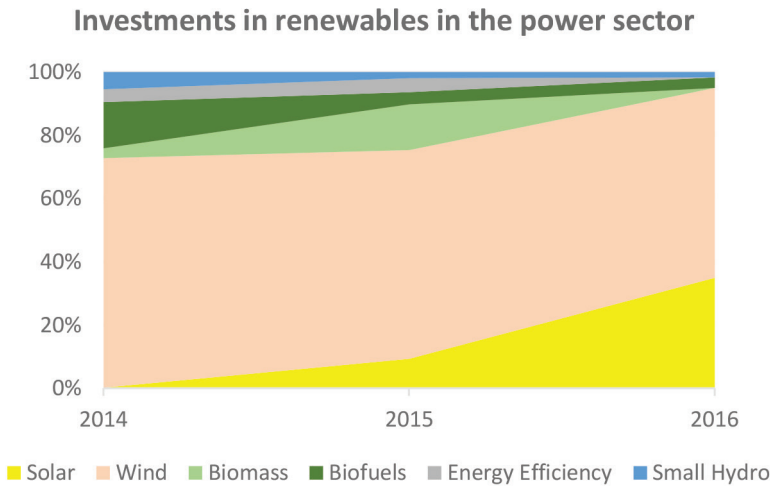

Figure 3: Investments in renewables in the power sector
Source: Adapted from UN Environment and Bloomberg New Energy Finance (2018)

One of the most comprehensive studies in Brazil regarding an ambitious Energy Transition was the "Energy [R]Evolution", prepared by Greenpeace (2016) with the participation of the German Aerospace Center and COPPE, at the Federal University of Rio de Janeiro. In the study, researchers developed two scenarios: a conventional reference scenario (Base) and the progressive Energy Revolution scenario - E[R]. The reference scenario reflects current developments in the energy industry and policies. In contrast, the Energy Revolution scenario simulates an energy sector that does not use any nuclear power and fossil fuels by 2050.

It is important to highlight that the study is very ambitious regarding technological development, and energy efficiency gains, decreasing GHG emissions from the energy sector to zero by 2050. Figure 4 presents total energy demand by source, electricity generation by source, energy demand by energy source in the transport sector, and GHG emissions by source, for both scenarios.

Among the main findings of the study, we can cite:

- Energy efficiency and change of consumption patterns must play a major role in decarbonization, contributing to a 47% decrease in energy demand by 2050.
- The electrification of the energy mix, along with the diversification and decentralization of power generation is also key to the E[R] scenario.
- Among other benefits, 12% more jobs will be created in the energy sector in Brazil in the E[R] scenario.

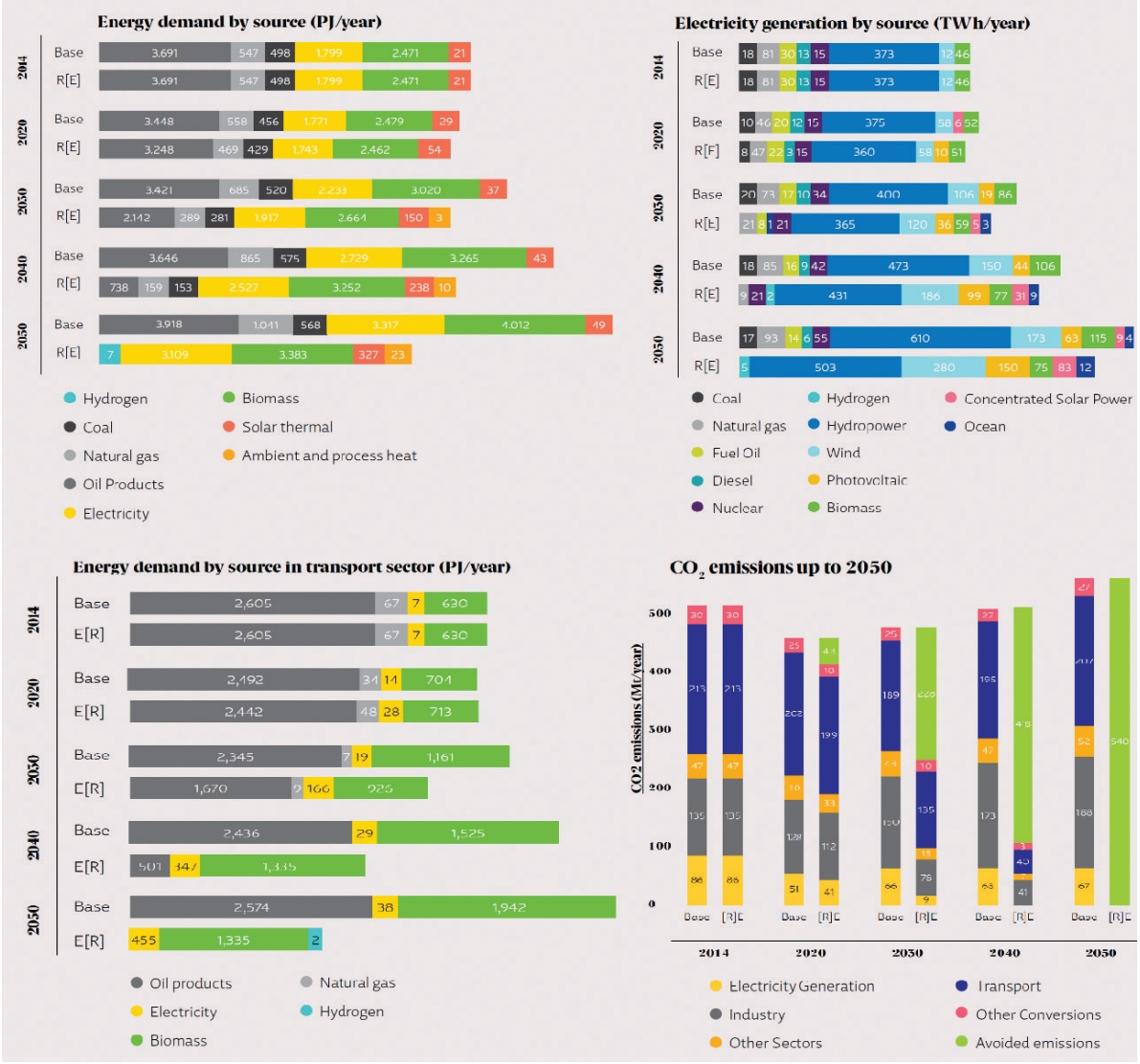

Figure 4: Energy sector according to Energy [R]Evolution

Source: Adapted from Greenpeace (2016)

2. KEY POLICIES TO FOSTER THE ENERGY TRANSITION IN BRAZIL

Political and financial incentives are key to the energy transition. Some selected initiatives in Brazil are presented below.

Policies to foster renewable energy

Policies or initiatives	Comments
Renewable Energy in Power Generation	
Program for the Incentive of Alternative Energy Sources - PROINFA - Decree nº 5.025, of March 30, 2004. Predicted the expansion of alternative sources (wind, SHP, solar and biomass) with priority dispatch for wind energy. Guarantee of purchase of energy by Eletrobrás (Feed-In tariff).	Despite delays due to the lack of adequate infrastructure at the time, it was an important initial impulse for investments in alternative energy in the country.
New Energy Auctions and Alternative Energy Auctions - define the prices of the contracts, as well as the value of the tariffs paid by consumers, and the participation of the energy sources used (Brasil Energia, 2018)	The Installed Capacity contracted in the period from 2009 to 2023, is of 7,568 MW for Biomass thermoelectric plants, 4,033 MW for Solar energy and 16,739 MW for Wind energy (Instituto Acende Brasil, 2018). In 2018 there will be the 1st auction of biogas plant (cane residues) of 21 MW, to start operation until 2021 (Canal Energia, 2018).
Distributed Generation	
Law 5.163 / 2004 updated by Decree 786/2017. The DG can be connected to the distribution network or be in the consumption centre, which reduces the need for power transmission structure and avoid losses;	Improved regulation of the market after the Energy Reform, Law 10.848 / 2004 (free and regulated markets), stimulation for energy self-producers and special incentive to foster solar photovoltaic energy.
Program for the Development of Distributed Generation (ProGD): aims to expand and deepen the actions to stimulate the generation of energy by the consumers, based on renewable energy sources (in particular solar photovoltaic), such as tax exemption for auto producers and economic incentives (BNDES) for public buildings, hospitals, etc. (MME, 2015).	Various tax incentives and special financing conditions (Pronaf, Finem BNDES, Proger (BB), Climate Fund etc.) for energy self-producers.
Biofuels	
National Ethanol Program - PROALCOOL, Decree 76.593 / 1975: It aimed to intensify the production of ethanol fuel to replace gasoline in Brazil after the first oil crisis in the 1970s.	Proalcool increased the production of ethanol from 0.9 billion litres in 1975 to 27.8 billion litres in 2017 (Nova Cana, 2018a). The replacement of gasoline with alcohol saved US$ 61 billion and created about 1 million direct jobs and a few million indirect ones in 30 years (Bertelli, 2016). Currently, Brazilian regular gasoline contains 27.5% ethanol. Ethanol can also be used directly in flex-fuel cars, which are 80% of the fleet.
National Program for the Production and Use of Biodiesel - PNPB (2004): aims to introduce biodiesel into the Brazilian energy matrix through (1) social inclusion of family farmers (social seal); (2) guarantee competitive prices, quality and supply; (3) produce biodiesel from different oil sources, strengthening the regional potentialities for the production of raw material (SEAD, 2018).	
Law 11,097 / 2005 - Introduces the biodiesel in the Brazilian energy matrix, stipulating the minimum percentage of 5% in the diesel mixture.	As a result, 59 auctions were carried out and 31.6 billion litres of biodiesel were sold, avoiding the importation of 27 billion litres of diesel equivalent, or 30% of diesel imports (Coelho, 2018). The National Energy Policy Council (CNPE) anticipated the increase of biodiesel blend in diesel to 10% in March 2018 (Agência Brasil, March 2018). Scenarios of PNE 2050, from EPE, estimate a 20% mix of biodiesel in the diesel (B20) until 2030.
Law 13,576 / 2017 - Establishes the National Biofuels Policy (RenovaBio) and encourages the production of ethanol and biodiesel: Establishes annual greenhouse gas reduction targets. **After its regulation, decarbonisation credits (CBIOs) will be issued by producers and importers that operate with biofuel (Nova Cana, 2018c).**	The National Energy Policy Council (CNPE) will define a series of criteria and a value for companies for environmentally correct production, after analyzing the entire production chain (Royal FIC, 2018).

Policies to reduce fossil fuel consumption

In the power sector, the use of fossil fuels will still be essential in Brazil until at least 2035 (Chambriard, 2017) due to economic and technological issues. However, in order to comply with the Paris Agreement (Cop-21), important steps are already being taken to discourage the use of fossil fuels in the sector, as shown in the following table.

Policies or initiatives	Comments
Increase the use of Natural Gas	
In 2016, BNDES, the Brazilian Development Bank, announced that it will no longer finance fuel oil and coal thermopower plants, directing investments with the long-term interest rate for projects with high social and environmental returns (BNDES, 2016).	For the peak-load service, the trend is to use more natural gas from the pre-salt (Goldemberg and Lucon, 2007).
Law 12.351 / 2010, called the "pre-salt regulatory framework", establishes the end of Petrobras' natural monopoly and allows the participation of private agents in oil and gas exploration in these areas.	With this initiative, the government looks, among other objectives, to increase the feasibility of exploration and transportation of natural gas to the shore.
GHG emissions control of fossil-fuel-fired power plants	
Normative instruction by IBAMA in 07/2009	Links the previous environmental license (LP) of new projects of coal or oil thermopower plants to the Carbon Dioxide Emission Mitigation Program, requiring the planting of trees to mitigate emissions or investments in renewable energy or energy efficiency.

Policies to promote energy efficiency and research and development

Since the 1980s, Brazil has been encouraging energy efficiency measures. Although there is a National Energy Efficiency Plan since 2011, Brazil has difficulties in making it happen, and should invest more in energy efficiency programs and focus on: the modernization of industry, the diversification of the transportation network, the implementation of policies to combat energy wastage and establish more stringent energy efficiency standards (Altoé et al., 2017).

Policies or initiatives	Comments
Energy Efficiency (EE) Incentives	
Law 10.295 / 2011 (EE Law): provides the National Policy on the Conservation and Rational Use of Energy and establishes maximum levels of energy consumption or of EE for machinery and in the country.	
Procel - National Energy Conservation Program: Since 1985, it works on several fronts: information, education, industries, public buildings, energy efficiency labelling, appliances, banning of incandescent lamps etc.	With the various Procel actions, from 1986 to 2017, approximately 2 million tons of CO_2 were avoided, generating savings of R$ 3.8 billion. The Program cost R$ 2.97 billion and saved 128 billion kWh (PROCEL / Eletrobras, 2018).
Research and Development	
Law 9,991 / 2000 - Compulsory investments in Research and Development: 1.0% of Net Operating Revenue (ROL) of companies in the electricity sector. As of 2016, the distributors must allocate 0.75% to R&D and 0.25% for Energy Efficiency.	The average annual investment of these companies for R&D is R$ 380 million and for Energy Efficiency is 420 million (ANEEL, 2015).

Financing and other incentive mechanisms to promote renewable energy

The Brazilian Development Bank (BNDES) is the main financier of alternative energy projects in the country, with specific financing conditions with long-term interest rates, being able to finance up to 80% of the renewable energy project at an annual interest rate of about 10% (or 0.97% per month), through its subsidiary Special Agency for Industrial Financing (FINAME). Starting in 2016, the alternative energy line finances projects that worth more than R$ 20 million. BNDES provides other special funds for alternative energy sources, which support small-scale projects in isolated areas and for residential use (Rennkamp and Westin, 2017).

Recently the BNDES decided to increase its participation in financing the generation of solar energy (from 70% to up to 80%). For energy efficiency projects, participation continues to be 80%. For wind power plants, biomass, cogeneration and small hydroelectric plants, the share is 70%. Investments in coal and oil fuels, which are more polluting, will not be supported and the participation limit in large hydroelectric plants has decreased from 70% to 50%. The bank will also subscribe up to 50% of the value of the debentures.

CPFL Renováveis was certified by the Climate Bonds Initiative by the wind power criterion to issue debentures in the amount of R$ 200 million. It is the first company in South America to issue a green bond with international certification and the first in the power sector to issue a certificate (CPFL Energia, 2017).

Demand for Renewable Energy Certificates (RECs) also skyrocketed in 2016, and according to the Totum Institute, which coordinates the Renewable Energy Certification Program, in one year, demand rose from 13.4 thousand to 107.5 thousand certificates. The idea of the certification is to receive energy in the traditional way and to acquire the equivalent energy volume through these Certificates (each certificate equals 1 MWh generated from clean sources), (ABRAGEL, 2018).

3. ECONOMIC CHALLENGES AND OPPORTUNITIES

3.1. Opportunities

According to the MME cited by Ambiente Energia (2018), investments that are already authorized for 2021 includes 14 solar photovoltaic plants (Ceará), 8 wind farms, 2 hydroelectric plants and a biomass-fired thermopower plants (bagasse), adding 883 MW to the National Integrated System (SIN). Investments are of R$ 4.5 billion and 4,040 direct Jobs are expected to be created.

Wind power value chain

Wind power emerged as an alternative for the diversification of the electrical matrix after the 2001 energy crisis and today is the ninth largest global capacity (13GW), an average capacity factor of 40%, representing today about 8% of the Brazilian power matrix in terms of installed power. Total potential in the country is around 300 GW. The Ministry of Mines and Energy forecasts an expansion of 125% by 2026 when 28.6% of the electricity produced in Brazil will be from a wind power source. The Brazilian Industrial Development Agency (ABDI) estimates that by 2026 the wind power chain could generate approximately 200,000 new direct and indirect jobs (ABDI ***apud*** ABEEólica, 2018).

The value chain of wind energy has been growing with the incentives provided by the federal and state governments (Tax exemption, long-term financing, etc.). In recent years, Brazil has evolved significantly its industrial model of the wind power sector. Currently, the wind turbine assembly and the manufacture of various components (towers, blades, subcomponents of the hub and nacelle) are carried out in Brazil, with a reduction in the number of imported items compared to previous years. It should be noted, however, that progress in local knowledge does not follow this same pace. The knowledge that is most widespread in the country covers mainly the technology for the processing of goods: the assembly of wind turbines, the steel making (cutting, bending, welding and painting), concrete manufacturing processes and the manufacturing processes of large components. The specific knowledge for the design development of most of these components is still small and, given the potential for technology generation in the country, could considerably increase (ABDI, 2014).

Wind energy has decreased costs in Brazil since the beginning of the expansion cycle and the revision of the nationalization content requirements of the Development Bank (BNDES) that was fundamental to accelerate the implementation times of wind turbines in the country.

The metal-mechanical industrial base already established in the Southeast region was of great importance in the process of establishing the wind turbine industry in Brazil. After the national content requirements were implemented, there was a regional deconcentration of manufacturing, and some companies started to settle in the Northeast and South regions. There are currently more than 100 companies in the supply chain, six major wind turbine manufacturers with established manufacturing plants and one national wind turbine manufacturer. The Brazilian production stands out for the components of low and medium technology like towers, shovels, nacelle etc. There was also a great evolution in logistics infrastructure in the last decade.

However, by 2021 a significant drop in the demand for wind turbines is estimated and the production chain will have to adjust itself, trying to be more competitive in the international market, and investing in export of components to Latin America, etc., despite the high industrial cost in Brazil and the existing export difficulties (logistics, for example). The repowering of parks and the O&M industry could provide support for companies as well as the start of offshore exploration of wind power in the northeast region (Schaffel, Westin and La Rovere, 2017).

Solar power value chain

Brazil has high solar potential throughout the year and has reserves of important raw material for the solar industry (silicon) and some materials (aluminium and acrylic), as well as components and equipment already established, depending on the importation of few components (cells, thin films etc.).

However, to face the technological and economic barriers, it will depend on a large-scale production. According to SEBRAE (2017), it is still about 60% more expensive to produce the photovoltaic modules in Brazil than it imports them, besides it is necessary to improve the productivity of the Brazilian workforce and reduce the average cost of electricity to the industry. Despite those difficulties, more than 7,500 distributed solar generation plants in companies and industries were built by the end of 2016 to meet part of their electricity consumption, and the trend is that this value chain will multiply. Today more than 1,600 companies (small and medium installers) already operate in this segment in the country. Through mergers and acquisitions, solar companies, energy distribution concessionaires and international investors are entering the solar generation market in Brazil, driven by the energy auctions and in the Free Contracting Environment.

The forecast of a new policy with flexibilization of nationalization index announced for the photovoltaic industry by BNDES should favour the expansion and consolidation of the national photovoltaic production chain. It is estimated that around 30% of the electrical matrix will be of solar photovoltaic energy in 2040 (SEBRAE, 2017).

ABDI (2014) provided several suggestions to foster the development of the productive chain of wind power in Brazil, the ones cited below are also applicable to the solar photovoltaic generation:

- Development of a broader industrial policy, covering aspects of competitiveness, productivity and with emphasis on technological development.
- Better connect industrial policy with the country's energy policy, in order to give better conditions (security) for companies to make their investments.
- Encouraging the adoption of collaborative Supply Chain strategies, establishing partnerships and long-term contracts.
- Adequacy of the metalworking chain in order to meet the high levels of quality and productivity demanded by the solar sector.

3.2. Barriers

Between 2013 and 2017 subsidies in the area of fossil fuels reached R$ 342 billion related to subsidies and tax exemptions to direct expenses for the production of oil, natural gas and coal, as well as for the final consumption of gasoline, diesel and cooking gas representing in average 1% of GDP (INESC, 2018). About 8% of this amount refers to financial support and 92% of tax exemptions. Although the themes of fiscal reform and the reduction of inefficient fossil fuel subsidies have been discussed since Rio + 20 as one of the Sustainable Development Objectives, there is currently the permanence and expansion of subsidies, such as the extension of REPETRO until 2040 and creation of the Special Tax Regime (MP 795/17). According to the INESC adviser, there is no transparency regarding the investments, since these are not registered as official tax expenditures by the federal revenue as the Repetro (Special Customs Regime), (Radio Brasil Atual, 2018).

According to the World Resources Institute - WRI Brasil Report (Lucon, Romeiro and Fransen, 2015), the 62% of the investments in the Brazilian energy sector from 2014 to 2023 will be directed at fossil fuels, against 23% for renewables, as presented in figure 5.

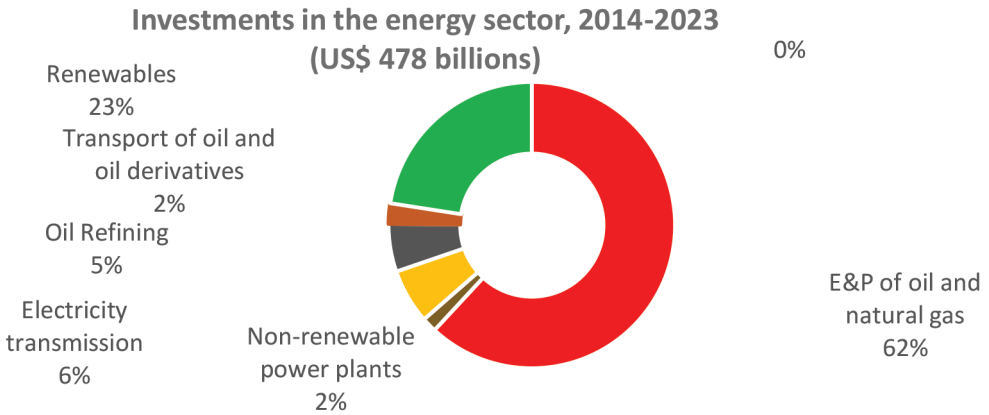

Figure 5: Investments in the Brazilian energy sector from 2014 to 2023

Source: Adapted from Lucon, Romeiro and Fransen (2015)

The Brazilian Ministry of Science and Technology (MCTIC) stated that the low competitiveness of biomass compared to imported coal, high access costs and lack of knowledge of the option of cogeneration with sugarcane bagasse are important barriers to a more comprehensive use of biomass in the power sector. To transpose them, a series of measures must be taken, starting with specific auctions with differentiated price-ceiling for plants operating with renewable fuels. MCTIC also suggests to change the regulation for thermoelectric plants to biomass up to 30MW, the creation of cooperatives to collect biomass and the holding of events for the sector in order to discuss renewable generation and carbon pricing schemes (MCTIC, 2017).

The most recent official plan of the energy sector (EPE, 2017), estimates that until 2026, the largest share of investments in the energy sector will still be directed to the oil and natural gas sector (71.4%), while the power sector will receive 26.2% (including renewable and non-renewable) and the liquid biofuels sector will receive only 2.4% of total investments, that is estimated at US$ 423 billion from 2017 to 2026.

- To foster the energy transition in Brazil, and to meet the targets of the Paris Agreement, it is absolutely necessary to redirect investments and reduce subsidies to fossil fuels.

4. SOCIAL ANALYSIS

Despite the large share of renewable sources in the power sector, there are still social and environmental conflicts with respect to large hydropower plants. The still available hydraulic potential are in areas of great ecological and social relevance (legal Amazon), where the criticism is with respect to the loss of terrestrial ecosystems and fishing resources and losses of fertile lands, historically inhabited by traditional populations.

In this regard, new renewable sources such as wind and solar have gained more empathy, however, problems related to the alteration of coastal dune dynamics, landscape interference of wind turbines and privatization of land near the beach were reasons for discontent among the local population (Porto and Ferreira, 2013).

Assessment on just transition

The debate around just transition in Brazil is not very popular yet, despite the importance of this topic in a developing country. From the government perspective, the Ministry of Environment published the National Adaptation Plan to Climate Change in 2016 (MMA, 2016), which recognized the challenge to achieve a just transition; however, the report did not present any clear strategy to achieve it.

Green jobs are jobs created in a variety of activities that have direct or indirect positive impacts on the environment, with objectives to achieve sustainable development goals from economic practices with lower environmental risks and poverty reduction (UNEP, 2008 ***apud*** Ansanelli and Santos, 2016). In Brazil, about 2.5 million jobs in 2008 were considered green (6.73% of total jobs), according to the ILO. There was a 22% increase in the number of green jobs from 2009 to 2015, according to the Brazilian Ministry of Labor (Ministério do Trabalho, 2017).

International Labour Organization (ILO, 2018) stated that if appropriate policies are adopted, the transition of the world economy to a greener and more sustainable model should create 620 thousand new jobs in Brazil, which more than compensates for the 180 thousand jobs that could be lost. ILO recommends that countries should adopt with urgency a policy mix that includes income transfers, stronger social security, limits on the use of fossil fuels, and offer new training programs to anticipate the skills needed for the transition.

Investment in renewable energy sources, associated with incentive policies (tax reductions and attractiveness in financing) in addition to reducing GHG emissions, can create an important number of jobs. In the wind power sector alone, 150,000 direct jobs were criticized in 2016, currently counting 13 GW, or 8.6% of the national electricity matrix (ABDI cited by ABEEOLICA, 2018).

Regarding the eradication of poverty, the "Light for All" program stands out with success in seeking the universalization of access to electricity in rural areas, prioritizing traditional populations and areas of extreme poverty. Launched in 2003, it benefited more than 16 million people and was invested by 2016, about R$ 23 billion so far, using funds from the Energy Development Account (CDE), as well as state resources and concessionaires (Drummond, 2016). In 2019, an investment of more than 250 million USD is planned to install 95,540 new electric power connections in 17 states (Agência Brasil, April 2018). Resources will be used to install photovoltaic systems. The Program was extended until 2022 and aims to reach another 500 million USD for full.

Wind power also contributes to increasing the income of landowners in poor regions. The contracts provide fixed payments for more than 20 years and are renewable. Some "wind farms" can earn 15,000 USD per month. Many apply the income in agriculture, generating more jobs and productivity in places that were not very productive or for sale. In addition, there is a compensation for the passing of the Transmission Lines (Cerne cited by Gibson and Carvalho, 2015).

Environmental benefits

The reduction of fossil fuel consumption will be of great value for the improvement of the quality of the air, especially in big cities. To address this serious problem that is the main cause of respiratory diseases in major cities in Brazil, the energy transition should also encourage greater use of public transportation, bike paths and electric cars.

In addition, a smaller participation of thermopower plants in the power sector would contribute to the improvement of air and water quality. As a recent example, the thermopower plant "Pecém II" had to remove the surrounding population because of the poor air quality due to the coal dust, affecting even the quality of the water in the surroundings (Assembleia Legislativa do Estado do Ceará, 2015).

Distributed generation and the free energy market will contribute greatly to the power supply of basic sanitation systems, which is deficient in sewage treatment, for example. Currently, Brazil consumes 12.1 TWh of electricity to move the machines and equipment for water and sanitation companies and current expenditure is estimated at almost 1 billion USD per year. One of the reasons of such high energy costs is that the Brazilian system was basically designed in the 1970s and 1980s when there was a huge subsidy on electricity for basic sanitation (of the order of 75%) and no concern about energy efficiency and costs (Corrêa, 2001).

Distributed generation

With almost 8,000 connections in the country at the beginning of 2017, it is estimated that by 2030 around 2.7 million consumer units may produce their own energy, including households, businesses, industries and the agricultural sector, which could result in 24 GW installed of clean and renewable energy (MME, 2015). Among current investment initiatives for distributed generation are solar energy floating in hydroelectric lakes (25 million USD in research and development from 2016 to 2019) and complementary power generation in public buildings (more than 100 thousand kWh / year), (MME, 2015). However, most of the distributed generation facilities are in the residential sector.

By 2050, photovoltaic generation capacity is expected to become thousands of times bigger, reaching an installed capacity between 78 and 128GW, as the cost of production is becoming increasingly competitive. EPE predicts that 78 GWp will be installed in distributed generation systems by 2050, with a strong focus on residential microgeneration (Portal Solar, 2018).

Barriers to a fair energy transition

Planning processes are not always transparent. Many developments are decided before a public hearing has been held about possible alternatives, what is required by law. However, the tendency is to decentralize energy planning, with greater social participation and transparency, at the municipal level, despite the difficulty of funding (Collaço and Bermann, 2017).

Recently, projects such as small hydropower plants and some wind farms considered to be of small environmental impact potential, are able to obtain a simplified environmental license, carried out in a single phase, without the need to develop detailed environmental studies. Also, the public hearing is replaced by an informative technical meeting (CONAMA Resolution 279/2001).

The development of decentralized alternative energy enables the supply of energy in isolated areas of the country, not having to invest in costly transmission and distribution lines. Thus, millions of families were benefited, as well as health, education and sanitation institutions, bringing a greater quality of life with the arrival of electric light.

Some cases of corruption can be found in the country in connection with the payment of bribes and to third parties to obtain illegal benefits. An example in the state of Mato Grosso was related to 12 sugar and ethanol companies that were processed by the State Finance Secretariat (SEFAZ), based on the Anti-Corruption Law (Federal Law 12,846 / 2013) for alleged payment of 5 million USD of bribes to state public agents for the reduction of tax burdens from 2010 to 2015. As a consequence, if convicted, those companies will have to pay a fine of 20% of gross revenue in the year prior to the proceeding, full compensation for damages caused to the public administration, as well as the restriction of the right to participate in bids and to enter into contracts with the public administration (Silveira quoted by Nova Cana, 2018b).

Corruption schemes related to the company Oderbrecht through plea bargains also show that to build a large hydroelectric plant in Brazil it was sufficient that there were bribe payments and behind-the-scenes actions, making this development "much more relevant than efficient and economically viable projects." Aiming to accelerate the release of funds from the Brazilian Development Bank or the granting of environmental licenses, influential politicians requires "tips" at the national congress, as, for example, in the case of UHEs of the Madeira River (Jirau and Santo Antônio), according to a report by Calixto (2017). Thus, it is argued that this acceleration of the licensing process is the "need of the electric sector on pain of the risk of lack of energy" (MPF, n / d);

In order to reduce problems of this nature, the new energy model foresees the obligatoriness of the new generation projects only to go to the bid after having the previous environmental license - PL 401/2013 that aims to change the Bidding Law n. 8666/1993, making the annexe to the bidding notice mandatory with the prior environmental license or required by applicable legislation. Another bill, PL 3729/04, calls for simplification of the licensing process (greater legal certainty is expected for entrepreneurs and more investments), (Senado Federal, 2017).

For greater transparency in the planning of the electricity sector, it is necessary according to the MME (2017):

- Foster access to information.
- The regulation should lead to the establishment of the fair and equitable competition of economic agents and of different energy sources, also evaluating the electrical and socio-environmental externalities.
- The isonomic treatment should require the modernization of the incentives policies or subsidies for a given technology, and these incentives must have clear and limited objectives, with transparent mechanisms.

CONCLUSION

Brazil is one of the countries with the cleanest energy matrix in the world and its energy intensity has remained stable since the 1990s. It was one of the main G20 countries investing in renewable energy in the last decade. However, more than half of its energy matrix is still represented by fossil fuels, far from what is needed to maintain climate change under control.

Many programs were created in Brazil in order to diversify the Brazilian energy matrix, with Proalcool and Proinfa as its main milestones. These programs allowed the success of the country's biofuels and wind energy sector respectively. Fiscal incentives and public funding of alternative energy sources played a crucial role in the growth of the sector and in establishing the country's wind energy value chain. Now, similar measures would be important for the growth of the solar energy value chain, coupled with a greater investment in research and development.

Brazil, as a country of continental dimensions, needs comprehensive social policies that promote the universalization of access to electricity and has been fulfilling its goals with the "Light for All" Program. The energy sector reform in 2004 brought the figures of the free and regulated market, which was important for the expansion and planning of new sources, especially for Distributed Generation, and a greater incentive in energy efficiency programs such as PROCEL is necessary, given the low investment verified in EE in recent years.

Regarding the energy sector, the Brazilian NDC is a bit shy, as most of the GHG emissions reduction will come from the reduction in deforestation and agriculture. For 2030 it is fairly enough, but for the long-term, a low-carbon strategy should be developed as energy is key for economic development.

As a sum-up, renewable energies in Brazil are advancing rapidly and the energy transition will inevitably take place along with the country's technological-economic evolution, but the question that remains is: Will it be fast enough?

Policy Recommendations

- Avoid the lock-in in carbon-intensive technologies, especially in long lifespan infrastructures as refineries, fossil-fuel fired power plants, etc.
- Start to redirect investments from E&P in the oil sector to other promising renewable energy sources.
- Increase solar distributed generation through a comprehensive national plan that addresses regulation and taxes issues, and helps the poor population to invest in its own solar generation with facilitated financing conditions.
- Prepare a comprehensive energy efficiency program to foster investments in this area.
- Implement economic instruments, either a carbon tax, a carbon market, or a hybrid instrument to accelerate the energy and economic transition to a low carbon society.
- To foster the energy transition in Brazil, and to meet the targets of the Paris Agreement, it is absolutely necessary to redirect investments and reduce subsidies to fossil fuels.
- To sum up, Brazil needs to create a long-term low carbon strategy in order to meet the targets of the Paris agreement

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