KONRAD ADENAUER STIFTUNG

Economic relations between Brazil and Germany:

The Geopolitics of Energy

Clarissa Lins, Senior Fellow of the CEBRI Energy Group and Founding Partner at Catavento Consultoria

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DIALOGUE

BRAZIL GERMANY

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DIALOGUE

BRAZIL GERMANY

The third workshop of the "Brazil Germany Dialogue" was held on September 4, 2018, in São Paulo. In partnership with the Konrad Adenauer Stiftung Foundation, the Europe Program of CEBRI – the Brazilian Center for International Relations - fostered insightful debate on economic relations between Brazil and Germany and opportunities arising from the global energy transition.

The event began with remarks by Ambassador Rubens Ricupero, followed by comments from Franziska Hübner, deputy representative of KAS in Brazil. The panel, "*Energy: Opportunities for cooperation and learning between Germany and Brazil*," was moderated by Clarissa Lins, senior fellow of the CEBRI Energy Group and founding partner of Catavento Consultoria, and André Clark, President and CEO of Siemens; Virginia Parente, Professor of the Institute of Energy and Environment at USP; and Ricardo Castanho, Director of Business Internationalization and Business Development at the Brazil-Germany Chamber of Commerce and Industry (SP), were panelists.

Summary

Executive Summary

The geopolitics of energy, of great relevance to international relations, is undergoing profound changes in a scenario of energy transition, especially with regard to the positioning of the US and the growing importance of China. Historically, issues related to energy geopolitics have been mostly associated with the global dynamics of the oil and gas industry (i.e. crises in the Middle East, European dependence on Russian gas). That is set to change in a scenario of energy transition and greater penetration of renewables. Leaders of the global climate agenda, such as Europe and the US, have lost relevance to new players, such as China, which is consolidating its position as a major investor in renewable sources and electrification.

Faced with the global challenge of an increasing demand for energy and the need to reduce emissions of greenhouse gases (GHG), Brazil and Germany start from different energy and climate realities. The global energy transition, marked by decarbonization, decentralization, and digitalization, will be different in every region of the world. While Germany already has one of the highest levels of economic development and per capita energy consumption, Brazil still has the challenge of regaining a healthy level of economic growth, in order to generate wealth and well-being.

In this sense, the Brazilian climate challenge entails success in combating deforestation, while leveraging a vast energy potential to maintain a diversified matrix capable of providing energy for growth and wealth generation. Currently, deforestation accounts for almost 50% of GHG emissions, while the energy sector accounts for only 19%[1]. In order to fulfill its climate commitments in a sustainable manner, consistent with the desire for economic growth and social welfare, the following energy opportunities for Brazil can be highlighted: (i) the building of a strategic vision for energy as a policy of State, (ii) the battle against deforestation, (iii) the diversification of the energy and electricity matrix, and (iv) the opportunity to become a global energy powerhouse.

In German case, its climate challenge involves the recovery of its credibility as a leader in the global energy transition, based on an effective replacement of coal, ensuring greater penetration of renewables, a reduction of emissions, and energy security. Currently, 80% of the country's GHG emissions come from the use of energy, thus highlighting the relevance of the Energiewende, the German energy transition strategy. In this sense, the country has historically been adopting measures to promote greater penetration of renewable sources through governmental incentive mechanisms. With great popular support, despite the high costs for government and society, the program has resulted in an increase in the share of renewables in electricity generation, including hydroelectricity, from 4% in 1990 to 33% in 2017. Nonetheless, the country still faces

1. OBSERVATÓRIO DO CLIMA. SEEG – Total Brazilian emissions, 2017.

the substantial challenge of phasing out coal, mainly because of (i) the commitment to deactivate nuclear power plants, an aftermath of the Fukushima disaster; (ii) the political weight and strength of the coal industry unions and (iii) the dependence on Russian gas imports, bringing geopolitical aspects to the coal phase-out equation.

Lastly, it is worthwhile to point out opportunities for partnership and learning between Brazil and Germany, in order to build an agenda for bilateral energy cooperation, mainly in technical, commercial, financial and technological terms, such as: (i) strategic and intergovernmental partnership for energy transition, to explore common possibilities and challenges, (ii) development of the renewable energy sector, (iii) infrastructure investments for electric mobility, (iv) technical partnerships for R & D focused on energy transition, and (v) workforce capacity building.

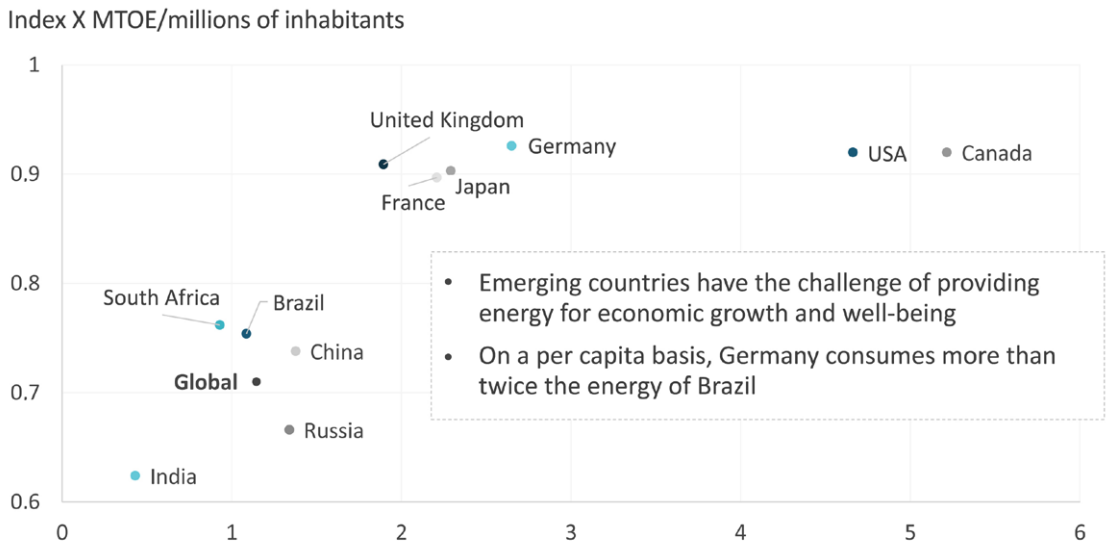
Introduction: The Geopolitics of Energy

Recent disruptive impulses have threatened the fundamental premises of multilateral relations. Globally, international relations are in a critical phase, since the strengthening of protectionist and nationalist ideologies is leading to the detriment of cooperation and trade liberalization. This deterioration is more prominently highlighted in the United States, the birthplace of multilateral organizations such as the United Nations and World Trade Organization. Thus, this is a good timing to promote informed debates that could foster a world order based on the concepts of international cooperation, multilateralism, and on norms and rules negotiated in a collaborative, rather than coerced manner.

Among the innumerable aspects that can channel opportunities for cooperation between countries are the climate and energy agendas that have historically been part of trade agreements and which, more recently, have taken a leading role in the global agenda. These opportunities arise from the challenge of simultaneously responding to the global increase in energy demand and limiting GHG emissions. It is widely recognized that energy is a foundation for development, namely forthe fight against poverty and social inequality. That said, the global challenge is to provide reliable energy without increasing net GHG emissions.

The graph below illustrates the correlation between the Human Development Index and per capita energy consumption:

Figure 1. HDI X final consumption of energy per capita



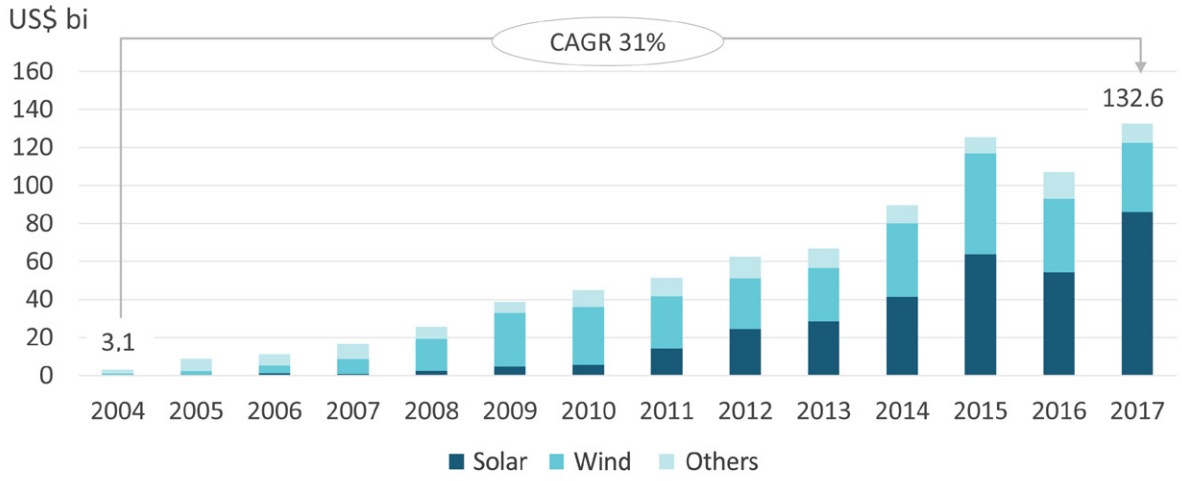
Source: Catavento analysis based on IEA – "IEA Atlas of Energy", 2018; WORLD BANK – "Population data", 2018; UNDP – "Human Development Index", 2017

Global leadership, demonstrated through the work of the G20 and bilateral agreements such as that between China and the United States during the Barack Obama presidency[2], was essential to the success of the Conference of the Parties (COP) 21 in December 2015, leading to the Paris Agreement. This agreement legally binds 195 countries to reduce GHG emissions with the objective of limiting the global temperature increase by 2 ° C, with the ambition of maintaining it at 1.5 ° C compared to pre-industrial levels[3]. It is worth mentioning that leadership from European countries, such as Germany, was crucial to instilling a greater sense of urgency and ambition to the commitments made in Paris.

More recently, however, considering the loss of the US climate leadership during the Trump government, businesses, cities, and states have demonstrated strong engagement with the transition to a low carbon economy, either through investment or through local regulations and policies. In addition, Europe has had its climate leadership questioned, mainly due to Germany's poor performance in meeting its targets, something that will be addressed in more detail throughout this document.

On the other hand, China has taken on a leading role, reflecting Xi Jinping government's geopolitical project, with massive investments in renewables. Driven by the high social and economic cost of pollution in urban centers[4], by 2017, the country was responsible for 40% of global clean energy investments, totaling US $ 133 billion, mostly for solar and wind energy[5]. With initiatives such as Belt and Road[6], China is consolidating its position as a partner of emerging countries in the transition to a low carbon economy, with a special focus on infrastructure and energy.

Figure 2. Chinese investments in clean energy



Source: BLOOMBERG NEW ENERGY FINANCE – Clean energy investment trends. 2018

2. COLUMBIA SIPA – CENTER ON GLOBAL ENERGY POLICY. Obama's Environment Legacy. 2017
3. ITAMARATY. Brazilian iNDC. COP 21. 2015
4. INTERNATIONAL ENERGY AGENCY – IEA. World Eenrgy Outlook. 2017.
5. BLOOMBERG NEW ENERGY FINANCE. Clean Energy Investment trends. 2018.
6. THE STATE COUNCIL, PEOPLE'S REPUBLIC OF CHINA. The Belt and Road Initiative. 2018

Finally, in times of exacerbated nationalism and protectionism, it is necessary to differentiate between the concepts of energy independence and security. The first assumes that the country is self-sufficient in the production of the energy sources necessary for its consumption, without the need for imports. On the other hand, the concept of energy security, according to the World Energy Council, encompasses "effective management of the domestic and imported energy supply, reliable infrastructure, and the ability to provide energy for current and future demand"[7]. In this context, it is possible to have more cost-effective and efficient energy security by promoting international commercial ties, as in the case of the North American Bulk Electric System (BES), which has 430,000 km of transmission lines between the US and Canada on the east and west coasts[8].

Based on this geopolitical energy scenario, Brazil is in a privileged position to be an investment pole in the transition to a low carbon economy. Partnerships in technical and financial agreements with countries such as Germany can be valuable in leveraging Brazilian potential and leadership among emerging countries. It is also appropriate to recognize similarities and differences in each country's energy trajectories, as well as lessons learned.

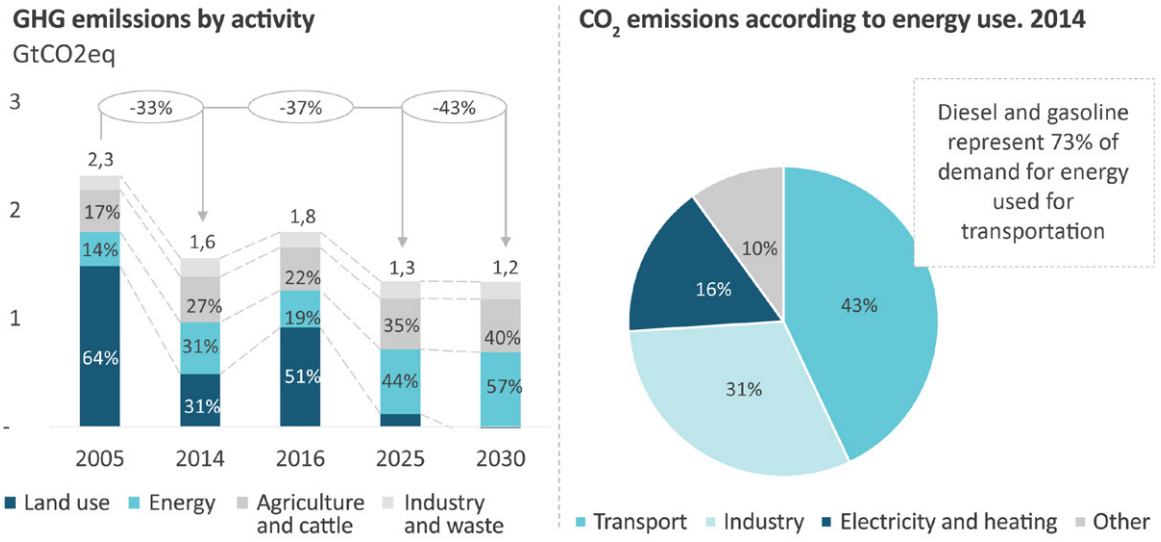
7. WORLD ENERGY COUNCIL – WEC. World Energy Trilemma Index 2017. 2018.

8. GOVERNMENT OF CANADA – NATURAL RESOURCES CANADA. Canada's Electric Reliability Framework. 2018.

Brazilian Energy and Climate Context

As opposed to the global climate scenario, the Brazilian GHG emissions profile is highly related to land use and agriculture, which together account for 73% of Brazilian emissions. The energy sector accounted for only 19% of emissions in 2016 and has a different emissions profile compared to the rest of the world: 74% of its emissions are related to transport and industry[9], while globally, electricity generation from coal is the main source of emissions.

Figure 3. Emissions in Brazil



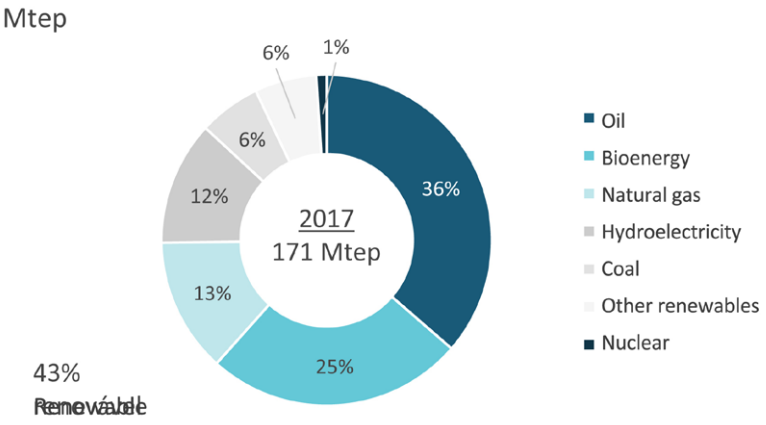
The path to reducing Brazilian emissions, different from the rest of the world, requires **combatting deforestation and reducing emissions from transportation**

Source: Analysis by Catavento based on data from OBSERVATÓRIO DO CLIMA – Emissões totais. 2017

These differences can be explained by the profile of the Brazilian energy matrix, where renewable sources already account for43%of total energy demand, notably biomass and hydroelectricity, and for 80% in the case of the power matrix[10]. The relevant weight of the transport sector in the Brazilian energy emissions is derived from the continued dependence on long-distance road transportation, based on diesel and gasoline consumption.

9. OBSERVATÓRIO DO CLIMA. SEEG – Brazilian total emissions. 2017.
10. EMPRESA DE PESQUISA ENERGÉTICA – EPE. National Energy Overview 2017. 2018.

Figure 4. Brazilian energy matrix



Source: EMPRESA DE PESQUISA ENERGÉTICA – EPE. National Energy Overview 2017. 2018

Based on this scenario, Brazil agreed, under the Paris Agreement, to reduce its total emissions by 37% by 2025, with the ambition of a 43% reduction by 2030, vis-à-vis 2005 levels[11]. To meet its commitments in a sustainable manner and in line with the desire for economic growth and social welfare, the following Brazilian energy and climate opportunities can be highlighted: (i) building a strategic vision for energy as a State policy, (ii) combating deforestation, (ii) diversifying the energy and electricity matrix, and (iv) taking advantage of opportunities to become a global energy powerhouse.

By taking an integrated view of energy as a State policy rather than a government policy, Brazil will be able to develop a long-term vision of its energy objectives, in line with climate commitments. Through clear guidelines, greater predictability and a robust governance model, including the participation of the private sector, the Brazilian energy sector can thrive and provide safe and affordable energy to fuel growth[12].

It is important to emphasize that effectively fighting deforestation must be a priority, including for the energy sector. Data from the National Space Research Institute (INPE) show a 40% increase in deforestation rates between 2014 and 2017, or 2 million km², equivalent to almost two times the area of the city of Rio de Janeiro[13]. Potential causes include the lack of priority granted to this issue by government, as well as the resource limitation for monitoring and combating deforestation[14].

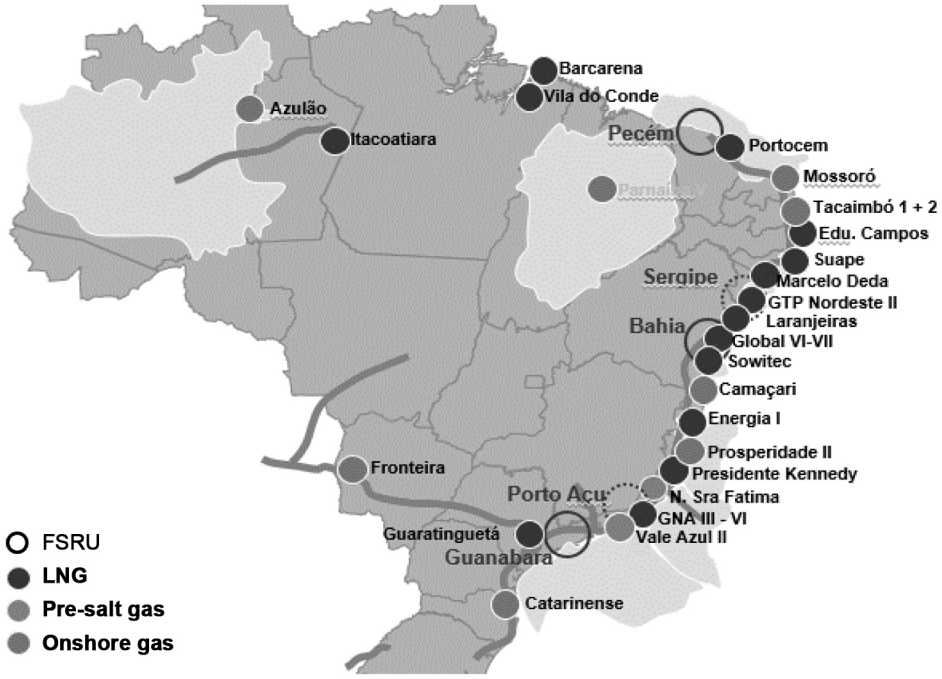
A recent study by COPPE-UFRJ researchers published in the scientific journal Nature shows that, since the Brazilian climate target is not specific to certain sectors, a failure to control deforestation will probably lead to an increase in the cost of meeting commitments to be borne by other economic sectors. An inefficient environmental governance scenario leads to a cost increase of US$ 2 trillion, particularly concentrated in the sectors of electric power and fuels[15]. Thus, it is important to reinforce that the agenda for combating deforestation must be closely linked to the Brazilian energy sector agenda.

11. ITAMARATY. Brazilian iNDC. COP 21. 2015
12. CEBRI, CATAVENTO. Energy Program Position Paper. The energy sector in 2022 (2018)
13. INPE/PRODES: Monitoramento da Floresta Amazônica Brasileira por Satélite. 2017.
14. COALIZÃO BRASIL: CLIMA, FLORESTAS E AGRICULTURA. Prorrogação do Cadastro Ambiental Rural ameaça implementação do Código Florestal. 2017
15. COPPE/UFRJ – Nature. The threat of political bargaining to climate mitigation in Brazil. 2018.

Furthermore, energy security in Brazil must be guaranteed through the diversification and competitive use of the country's vast natural resources and regional potentials. In 1995, the Brazilian electricity matrix was 92% hydroelectric, a percentage that was reduced to 62% in 2017. This scenario was due to, among other factors, greater social and environmental restrictions on large hydroelectric plants, as well as changes in the hydrological regimes that led to more reliance on thermal oil and gas plants.

In this context, Brazil has the opportunity to consolidate the clean vocation of its energy matrix, opening space for new renewable sources, as well as biofuels. Natural gas, produced in pre-salt fields, could provide energy and flexibility to a power system increasingly dependent on intermittent sources, while also allowing for the monetization of this vast wealth. The map below highlights Brazilian potential for expanding the natural gas market, based on the diversification of suppliers, customers and project profiles.

Figure 5. Brazilian natural gas potential



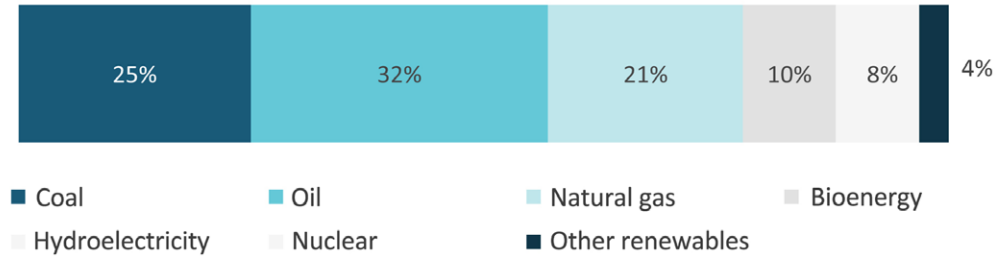
Source: SIEMENS – "SHAPE THE ENERGY TRANSITION", 2018

Finally, the energy transition offers Brazil the opportunity to lead among emerging countries in pursuit of a low-carbon economy because of its clean and diversified energy matrix, supported by vastly available natural resources. In addition to its agricultural power, Brazil can become an energy powerhouse, with gains in terms of soft power, investments attraction, technological cooperation, and commercial differentiation.

Energiewende: the German energy transition

Unlike Brazil, 81% of German GHG emissions come from the energy sector[16]. This can be explained by the profile of its energy matrix, which is highly dependent on fossil fuels. Currently, renewable sources comprise only 15% of the German energy matrix, while coal still accounts for one-quarter of its energy mix and oil, nearly, one-third[17].

Figure 6. The German energy matrix



Source: IEA – "IEA World Energy Balances", 2017

The country has historically been adopting measures to lead the energy transition, promoting greater penetration of renewable sources through governmental incentives. The first German Renewable Energy Sources Act was announced in 2000 and has been revised numerous times over the past few decades. Under the leadership of Angela Merkel, the country has committed to (i) reduce its GHG emissions by 40%, compared to 1990, (ii) reduce its primary energy consumption by 20%, compared to 2008, and (iii) to increase the share of renewable energy sources to 20%[18].

To achieve its goals, the German government has implemented the feed-in tariff model, subsidizing the increase in the Erneuerbare-Energien-Gesetz (EEG) tax on consumer energy rates. This increase would enable the insertion of new renewables, such as solar and wind, hitherto uncompetitive. As a result of increased penetration of renewables, the EEG rate increased by almost 31 times from € 0.19 / kWh in 2000 to € 6.79 / kWh in 2018[19]. In this sense, the cost of electricity to the German consumer has more than doubled from € 0.14 / kWh in 2000 to € 0.29 / kWh in 2018. The cost of such a subsidy was estimated by the German Ministry of Economic and Energy to be about € 680 billion by 2022[20].

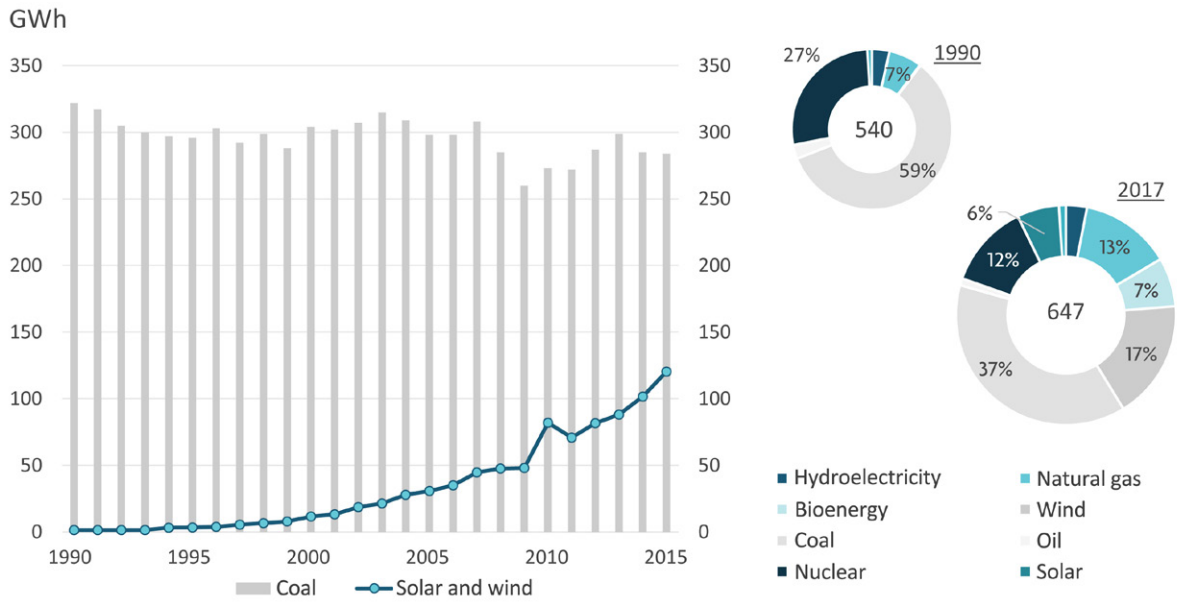
16. CLIMATE TRANSPARENCY. The G20 Transition to a low carbon economy – Germany profile. 2017
17. INTERNATIONAL ENERGY AGENCY – IEA. World Energy Balances. 2017.
18. FEDERAL MINISTRY FROM THE ENVIRONMENT, NATURE CONSERVANCY AND NUCLEAR SAFETY. German Climate Policy. 2018
19. CLEAN ENERGY WIRE. What German households pay for power. 2018.
20. CLEAN ENERGY WIRE. How much does Germany's energy transition cost? 2018.

In 2017, in view not only of the high cost imposed on society, but also of the growing competitiveness of renewable sources, the government promoted adjustments in the legislation, creating an auction model for new renewables, similar to Brazil's. In this sense, the government defines the volume of capacity to be auctioned each year, leaving solar and wind energy projects to compete for generation at the lowest cost to the system. Among the benefits are a reduction in costs for government and consumers, as well as greater predictability for energy planning. In the last auction in 2017, for example, the lowest cost of solar projects reached a new record (€ 0.491 / kWh) and the average cost was 40% lower than in the first auction[21].

Although criticized by German industry for undermining the competitiveness of the country due to its rising costs, the Energiewende still enjoys great support from society. Research conducted in 2017 by the Institute for Advanced Sustainability Studies of Potsdam noted that 88% of voters support the German energy transition strategy[22]. Such popular support was crucial for the government to maintain the subsidy program, even though costs were continually growing.

As a result of the Energiewende, Germany managed to increase the share of renewables in electricity generation, including hydroelectricity, from 4% in 1990 to 33% in 2017. Solar and wind power have grown 19% a year since 1990, as can be seen in the chart below. On the other hand, the challenge of reducing emissions still runs up against the dependence on coal-based electricity generation, which remained stable in absolute terms, despite having lost 22pp in the German energy matrix.

Figure 7. Germany: electricity generation by source



Source: Analysis Catavento, based on IEA STATISTICS

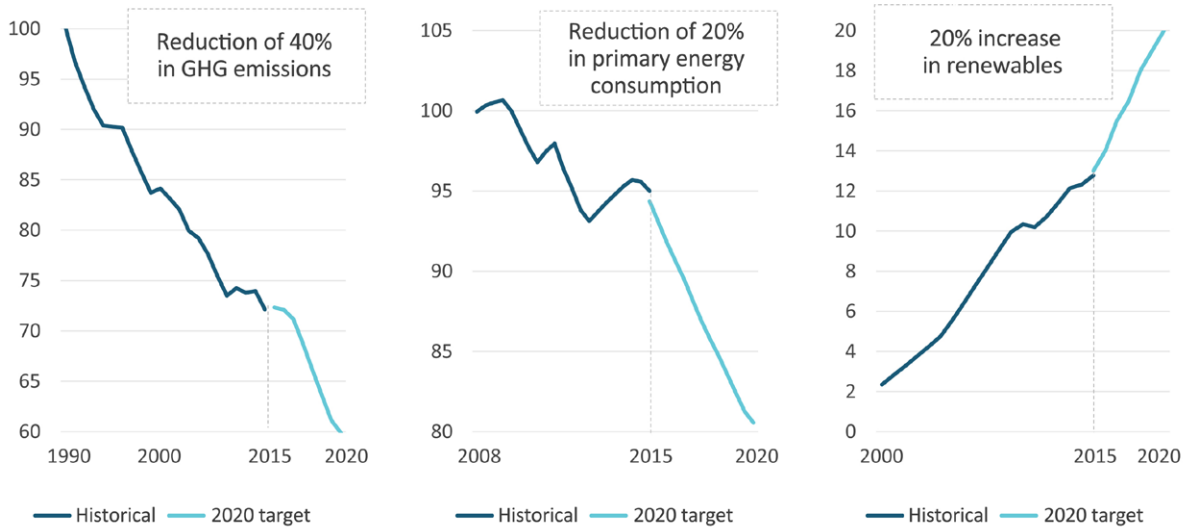
21. BUNDESMINISTERIUM FÜR WIRTSCHAFT UND ENERGIE. Costs of solar parks continue to fall. 2018
22. INSTITUTE FOR ADVANCED SUSTAINABILITY STUDIES. Social Sustainability Barometer for the Energiewende. 2017

The challenge of phasing out coal, the source which provides flexibility to the system in the face of increased penetration of renewables, is aggravated by (i) the commitment to deactivate nuclear power plants, an aftermath of the Fukushima disaster; (ii) the political weight and strength of the coal industry union and (iii) the dependence on imports of Russian gas, bringing geopolitical aspects to the coal phase out equation. In the second quarter of 2018, the German government established the Commission on Growth, Structural Change and Employment taskforce, to evaluate the best strategy for the coal phase-out, bringing together members from different segments of society and led by the Ministry of Economy[23].

With respect to labor, the renewable industry already employs 15 times more people than coal, with about 330,000 employees, compared to 20,000 in the coal industry[24]. Therefore, the great challenge lies in union strength, in their political influence, and in the historical debt that the German society has to the coal industry, given its extreme importance in the postwar recovery of the country.

Faced with such challenges, Germany faces the reality of not meeting the targets announced for 2020, as can be seen in the graphs below. This situation undermines the leadership of Chancellor Angela Merkel, compromising the position traditionally exercised by the European bloc in climate negotiations.

Figure 8. Challenges in achieving German energy and climate commitments by 2020



Source: BLOOMBERG NEW ENERGY FINANCE – Germany's Failed Climate Goals. 2018

23. FINANCIAL TIMES. Germany's coal task force can change things for Europe. 2018
24. EINFACHER DIENST - ENERGY POST. Why are German coal workers so powerful, when there are so few? 2018

An agenda for bilateral cooperation in energy

Bilateral cooperation between Brazil and Germany in energy is not new, since numerous investments and partnerships exist in different sectors. The approximately 1600 German companies in Brazil today account for 8-10% of Brazil's industrial GDP. Germany is Brazil's main trading partner in Europe and its fourth largest trading partner overall. Brazilian exports to Germany in 2014 were US $ 6.6 billion, concentrated in minerals, coffee, soy, iron, steel, machinery and mechanical devices. Brazilian imports from Germany reached US $ 13.8 billion in 2014, concentrated in manufactured goods, such as nuclear reactors, boilers, machinery, automobiles, tractors, organic chemicals, pharmaceuticals and electrical goods[25].

It is important to highlight that, in order to attract investments and partnerships to the energy sector, market size and political-regulatory stability are two very important criteria. Regarding the former, Brazil is well positioned, since it is among the 10 largest energy producers in the world[26], and energy demand is expected to grow 40% by 2040, according to the IEA reference scenario[27]. With respect to the latter criterion, it is important to address issues related to Brazil's business environment to make the country a more attractive partner for Germany to leverage its position as an energy powerhouse.

Among the most recent expressions of interest of German companies in Brazil we can highlight forays into the O&G sector[28], stakes in the agrochemical sector, and relevant synergy regarding energy transition through investments in infrastructure, services, renewables and natural gas.

However, there is still room to expand this cooperation to make Brazil the German hub for multilateral partnerships in Latin America in a context of energy transition. Among the opportunities, we can highlight: (i) strategic partnerships and intergovernmental cooperation for energy transition, (ii) renewable energy, (iii) electric mobility, (iv) R&D for energy transition and (v) training of the workforce. Such opportunities are discussed in more detail in Annex 1 of this document.

Finally, partnership opportunities are based on exchanges of lessons learned, investment and comercial relations to increase the penetration of renewable energies, technological innovation geared towards the energy transition and a robust governance framework. This framework should, by itself, encompass greater definition of government objectives and guidelines for climate and energy, stakeholder engagement, notably with the private sector, and transparency as to the costs of energy transition for society as a whole.

25. ITAMARATY. Foreign policy and bilateral relations: Federal Republic of Germany. 2018
26. IEA. IEA Atlas of Energy – Total Energy Production. 2018.
27. IEA. World Energy Outlook. 2017.
28. The German O&G company Wintershall was one of the highlights of the 15th Concession Round, having obtained around seven blocks in Santos, Campos, Potiguar and Ceará basins. The firm intends to invest approximately US$ 10 million in the first exploratory phase of petroleum blocks.

Final thoughts

The geopolitics of energy and climate is now undergoing a paradigm shift. Brazil and Germany in this context have the unique opportunity to exchange experiences about their challenges and form a partnership that will once again propel German leadership in the global energy transition agenda, while Brazil can serve as a model for emerging countries.

Opportunities exist in several fields, as illustrated throughout this paper. There is no doubt that both countries can benefit from closer cooperation while simultaneously being open to contributions from other parts of the world.

At a time when challenges, notably in the areas of energy and climate, call for global approaches, it is up to each country to determine the best solution it can offer, whether in terms of technology, regulation, or business environment. This is the context in which to lay the foundations for a new model of cooperation between Brazil and Germany.

Annex: Opportunities for Brazilian-German Cooperation

1. Strategic vision

One of the greatest learning opportunities from the German experience is the importance of the government setting clear objectives and guidelines, transparency regarding the costs of the objectives to society, and challenges to the grid from increased penetration of renewable sources (eg, costs, intermittency).

In Brazil, the experience of years of auctions, including for renewable sources, can serve as a lesson for the model recently implemented in Germany, as well as the role of the planning agency EPE in the formulation of auction conditions and rules.

A structured partnership that would allow greater exchange between the governments and state agencies of the two countries could bring gains in productivity and efficiency for both.

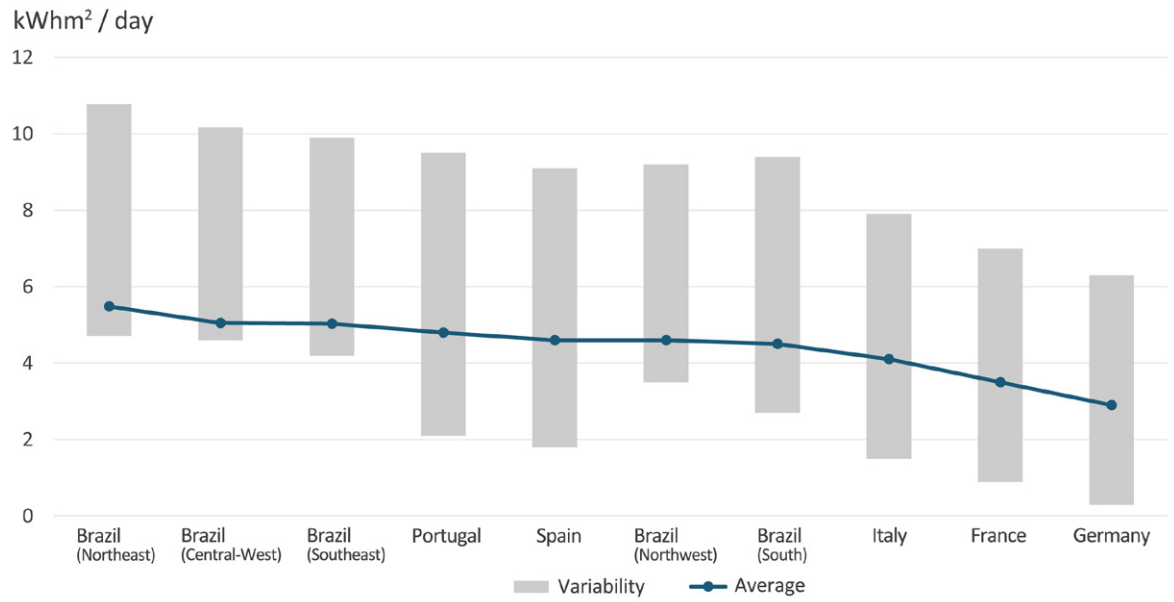
2. Renewable Energy

Brazil has great untapped potential in solar energy. The Northeast region, the leader in sunshine, has an average horizontal global irradiance of 5.49 kWh/ m², compared to an average irradiance of 4.53 kWh/ m² in the southern region[29]. These averages are higher than the rate found in Germany, 3 kWh/ m².

In addition to the high irradiance, solar insolation in Brazil presents lower levels of variability, even in comparison with other large solar energy producers, as can be seen in the chart below. Despite such great potential, Brazil generated only 832 GWh of solar photovoltaic energy in 2017, a volume well below Germany's 38,726 GWh[30].

29. INPE. Atlas Brasileiro de Energia Solar. 2017
30. EPE. Balanço Energético Nacional. 2018; IEA. Solar PV generation – Germany. 2018

Figure 9. Comparison of solar insolation in Brazil and countries with significant solar energy capacity



Source: INPE – Brazilian Solar Energy Atlas. 2017.

In addition to the vast potential of solar energy, Brazil has a wind power capacity factor higher than the global average (42% in Brazil and 24% in the world)[31]. Nonetheless, despite the significant growth in recent years, Brazil has only 12,763 MW of installed wind capacity, while Germany has a capacity that is almost 4x greater (56,132 MW), the third in the world.

Germany has boosted its renewable energy sources in the last decades and today has acquired great regulatory, technological, and operational expertise. This knowledge can be of great value to the development of this industry in Brazil and it may also encourage investments by German companies.

3. Electric Mobility

In a world that advances toward a fleet comprised of 33% of electric vehicles in 2040[32], there are great opportunities for cooperation to address challenges such as charging infrastructure, battery development, and electric vehicle production. Such opportunities become even more concrete given the uncertainty regarding the players who will lead this revolution: infrastructure operators, vehicle manufacturers, energy distributors, or a combination of the above. There is, therefore, an opportunity to identify partnerships between Brazil and Germany, either in terms of charging infrastrucure , electric buses or light vehicles, or some other area where one of the two countries can demonstrate comparative advantages.

31. ABEEÓLICA. Boletim anual de geração eólico. 2017
32. BNEF. Electric Vehicle Outlook 2018. 2018

4. RD&I linked to the energy transition

The O&G concession and production sharing agreements in Brazil establish that companies must carry out research, development and innovation (PD & I) investments corresponding to 1% of gross production revenue[33]. These resources were historically used to promote academic research centers, focused on topics related to the sector. Currently, there are ongoing discussions led by the National Agency of Petroleum, Gas and Biofuels (ANP) on ways to improve the allocation of these resources, to stimulate the competitiveness of the Brazilian energy sector.

Within the framework of a bilateral agenda between Brazil and Germany, there are opportunities for greater integration of research centers in the technological sphere, focusing mainly on bioenergy (with emphasis on biogas), smart grids and energy efficiency, areas where Germany already has demonstrated progress.

Ongoing initiatives which merit attention include the joint project between Brazil and Germany to produce alternative aviation biokerosene andsynthetic paraffinic kerosene (SPK), obtained from the capture of CO2 from the atmosphere, a process based on German and Swiss technology. Coordinated by the Brazil-Germany Cooperation Agency (GIZ), the project includes the participation of the German Aerospace Agency (DLR) and technology and equipment companies[34].

5. Training the workforce

Which professionals are needed for Brazil to effectively be part of the future of energy? In addition to shortfalls of skills aligned with digitalization and industry 4.0, such as information technology, programming, and robotics, Brazil has other basic deficiencies. The country still needs to guarantee quality medium and high school education, to prepare the population for the industry of the future and to ensure productivity gains.

There is great potential for cooperation with Germany, mainly through partnerships between academic centers, companies, and technical courses. Leveraging on German expertise, the Brazilian workforce can be prepared in all academic levels to a new reality of work in the energy sector, which requires stronger cognitive and analytical skills than in the past.

33. The contract on transfer of rights provides 0,5% of gross revenue. ANP. Pesquisa, Desenvolvimento e Inovação, 2018.
34.ANP. CTP/ANP receives German delegation to discuss joint biofuel project. 2018.

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